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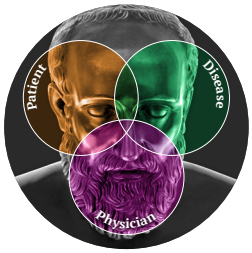

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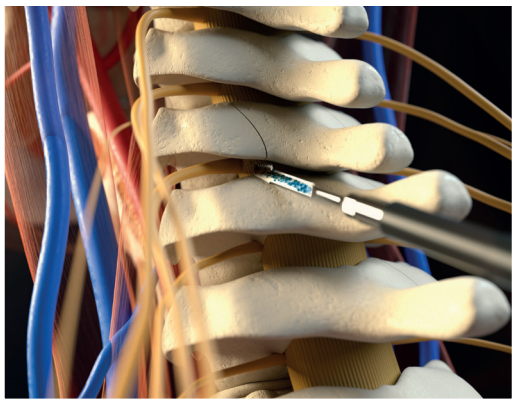

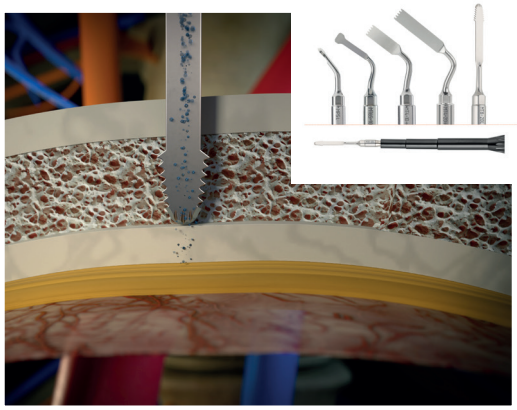

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Edited by Tim Germon & Sashin Ahuja. Special thanks to Henry Dodds for his invaluable assistance.

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Editors letter

Science, Citation and Truth

Tim Germon

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"Follow the science", or similar phraseology has been used again and again throughout the COVID era to justify various public health measures. The implication is that "the science" is a discrete entity or truth which leads to an unquestionable and righteous course of action. In fact, science is much more a verb than a noun. It is a process which involves constant questioning and testing and re-testing of hypotheses which might lead us to an incontrovertible truth. Even then, in the light of overwhelming evidence it can be hard to change peoples' minds.

In the 3rd century BCE, Aristarchus provided incontrovertible evidence that the sun, rather than the earth was at the centre of the solar system, but it took another 2000 years for this to be accepted by western Europeans because it did not suit Christian teaching.[1]

At the same time, well established principles can be readily ignored when they are inconvenient. For example, the NHS website states that, "screening is a way of finding out if people are at higher risk of a health problem, so that early treatment can be offered all information given to help them make informed decisions".[2] The Public Health England website states that, "there should be an effective intervention for patients identified through screening" and that, "where there is no prospect of benefit for the individual screened then the screening programme should not be further considered".[3] In 2015 a government response to a House of Commons science and technology committee report on National Health screening stated, "that all screening programmes should be grounded in robust evidence".[4] Testing asymptomatic people for COVID is a screening test which does not fulfil these principles. They have been displaced by, "the science".

Because the truth can be elusive the scientific process requires transparent debate. The traditional forum has been the scientific journals. However, it is questionable whether the journals provide a forum which is fit for purpose, depending on how you define their purpose. If you define their purpose as making profits for their owners, then they are very successful. For example, Elsevier (owned by Robert Maxwell's legacy, the RELX group) in 2018 had an operating profit margin of 37% with profits of £950 million. These profits are based on work which has been paid for, often by charities and often contributed to by the people, including many in our surgical community, undertaking work in their own time for the common good. We must then pay the journal for access to our own work. I uploaded a letter which colleagues and I had written to The Lancet on ResearchGate and was threatened with breach

of copyright. The Lancet wanted to keep even this contribution (which happened to be critical of a series of editorials which they had commissioned) behind a paywall, even though it is now accessible without charge.

So what do the medical journals add to the scientific process? Perhaps they are more parasitic than they are catalytic. Not only do they make money from our work by charging us to view it, and collecting advertising revenue, but they also act as censors. Much is made of peer review. However, most papers are rejected without peer review and without any explanation as to why they have not been sent for peer review. This is a completely opaque process. If they are sent for review, what makes an appropriate reviewer and how well informed is the editor who has the final say? The journals will all be critical of vested interests, but they fail to acknowledge that this opacity means their own vested interests are hidden.

Citation impact is another aspect of the scientific publishing business which requires scrutiny. Citation impact factors are provided by a multinational company called Clarivate which in 2019 had a gross profit margin of 64%. We are encouraged to believe that publishing in a journal with a high citation impact factor is what we should aim for. This is because we are led to believe that a paper published in such a journal is likely to be better. Given that the editorial process of the journals is opaque, it is hard to know how true this is. In any case, each individual paper should be assessed on its own merits and not determined by the citation impact factor of the journal it is published in. The citation impact factor is used as a surrogate for high quality publications and is promoted by the major journals to maintain their profit margins. Unfortunately, grant awarding bodies and employers collude and consider the citation impact factor as more important than the actual content of any paper.

The internet with more sophisticated search engines has provided us with the means to contribute to the scientific process. Currently, other agencies pass judgement on, have control over and make money out of our academic efforts. This journal, Column & Cord, is owned by our society, we have complete editorial control, and it is free to be accessed by anyone. The intention is that we will have a web-based platform where anyone can comment on the content and contribute to debate. In this edition we have two articles presenting the opposing views on sacro-iliac joint dysfunction and an objective assessment of research priorities in scoliosis. We think they are balanced and thought provoking. The question is, how to attract high quality articles, avoid bias, stimulate debate and make sure articles are identified in literature searches? ■

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Original articles

Sacro-iliac joint dysfunction: disordered dynamics or disordered diagnosis?

Sacro-iliac joint dysfunction is a non-diagnosis

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It is my contention that the only indication for fusing the sacroiliac joint is disruption because of tumour, trauma, infection, or inflammation. These indications are rare and yet fusion of this joint has become increasingly common. This is because the term 'sacroiliac joint dysfunction,' (SIJD) has evolved as a potential explanation for pain in the region of the SIJ, along with it a range of potential interventions. Most notable and relevant to surgeons is SIJ fusion. In my view, the rationale for this is based on a fundamental misunderstanding of the SIJ.

The sacro-iliac joint is one of the most robust and stable joints in the body it acts as the gothic key stone of the pelvic arch connecting the axial skeleton to the lower limbs. It is designed to be strong and only move with minimal glide supported by strong ligaments. The joint space is fibrous apart from the caudal third which is synovial in the early years, progressing to fibrous with age. The proposition that fusion will help pain emanating from the SIJ assumes that the pain is in some way related to abnormal movement and/or inflammation of the joint. Inflammation of the joint does occur in ankylosing Spondylitis and post-partum SIJ inflammation, where there are clear clinical and radiological signs of inflammation and potential instability. The natural history of these conditions is fusion and therefore, there may be a rational argument for surgical fusion in people disabled by these conditions.

In contrast, the diagnosis SIJD is not based on clearly defined clinical and radiological findings. No inflammation or abnormal movement of the joint need be demonstrated. Diagnosis is based on a history of pain that is localised to the SIJ area, radiates to the groin, down the back of the thigh, provoked by sacral joint stress tests and with an SLR above 60 degrees considered positive. The question is how well do these symptoms and signs predict the presence of abnormal movement and or inflammation of the SIJ when imaging is completely normal?

De Phillipo et al concluded that the SIJ is a rare pain generator (3%-6%) but that SIJ region is a common site of referral for pain generated by the lumbar spine (88%-90%).[1] Therefore, potential sources of pain in the lumbo-sacral spine must be excluded.

Radiographic evidence of sacroiliac joint degeneration is common in the asymptomatic population and as expected, is associated with age. The prevalence of sacroiliac joint degeneration is 65.1%, 91% of people in the ninth decade have radiological changes and substantial degeneration occurs in 30.5% of asymptomatic subjects.[2] As with the rest of the spine, caution must be exercised when attributing pain to the SIJ based on radiological evidence of degeneration, which could well be coincidental and of no relevance.

One method proposed to try and establish the diagnosis of SIJD is to inject local anaesthetic and steroid into or around the joint. There is no convincing evidence to support this as an accurate method of diagnosis.[3] Understanding the anatomy of the joint helps to understand why this might not be as straightforward as it might at first seem. The only area of joint space that can accommodate fluid is the lower third in the younger patient.

In the adult it is difficult to know where the precise target for an injection should be and to confirm whether the target has been hit. Injections using anatomical landmarks are only accurate 22% of the time and fluoroscopy with an arthrogram is required for more reliable access.[4] Even then, only 50% of injections are within the joint space.[5]

Given the uncertainty surrounding the diagnosis it is not surprising there is little evidence to support interventions based on the diagnosis. A review of 3 randomized clinical trials of participants with pain, thought to be originating in the facet joints, sacroiliac joints, or intervertebral discs, concluded that radiofrequency denervation combined with an exercise program was no more effective than an exercise program alone.[6] The findings do not support the use of radiofrequency denervation to treat chronic low back pain thought to be emanating from the SIJ, facet joints or discs.

Various fusion techniques have been proposed to treat SIJD. Dengler et al conducted a prospective, open-label, multicentre randomized controlled trial of SIJ fusion versus "conservative" treatment.[7] In this study people having fusion reported greater improvement at 2 years than the conservative group in VAS, ODI, EQ-5D, the Zung depression score. However, there was a 43% cross over from the conservative to surgical group. Perhaps this was because the conservative group had no structured treatment plan. This would be reminiscent of other studies which have been criticised because the conservative arm of the study is doomed to fail.[8] At the same time, there were 39 adverse events in the surgical group. This is not the only study to raise concerns about the safety of SIJF. A systematic literature review has revealed a re-operation rate of 0-65% with a mean of 15%, adverse event rates as high as 56% and major complication rates of 5-20%.[9]

In conclusion SIJD is difficult to define as a pathological entity let alone to diagnose. Surgical fusion is not proven to be effective and is associated with high rates of complications and re-operations. ■

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Original articles

Sacro-iliac joint dysfunction: disordered dynamics or disordered diagnosis?

Sacro-Iliac Joint Fusion – The enigma or lynch-pin in post-lumbar fusion back pain?

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Sacroiliac Joint (SIJ) pain has been reported as one of the commonest co-existing causes for low back pain in patients with lumbar disc herniation, with a prevalence ranging from 33% to 72%[1,2]. There are ongoing controversies with regards to both diagnosing and treating SIJ pain, especially the role of fusion surgery. In order to understand the rationales for SIJ fusion, it is important to review the anatomy of the SIJ and conditions that disrupt its functions.

Historically, the SIJ was viewed as a simple immobile joint with the sacrum functioning as a wedge between the iliac bones[3,4]. A recent systematic review has concluded that nutation (anteroinferior) and counter-nutation (posterosuperior) of adult SIJs ranges from 0.01° to a maximum of 2.27°[5]. Bowens and Cassidy used autopsy specimens, from foetus to the 8th decade of life, to demonstrate that the SIJ is far from an immobile, fibrous joint; the SIJ has hyaline cartilage covering the sacral articular surface while fibrocartilage is only on the iliac surface[6]. They also reported that the SIJ is very mobile in all directions in the first decade of life, whereas specimens from the 3rd decade showed the development of a convex ridge running along the central aspect of the iliac joint surface, limiting movements of nutation and counter-nutation. Further gradual age-related histological changes in other specimens were found with increasing stiffness and irregularity of the joint surfaces.

Biomechanically, SIJs serve as the link between body and the lower limbs, transmitting the weight of the trunk and ground reaction force. Finite element analysis demonstrates that stress concentrates at the SIJs during bipedal walking[7], requiring numerous static and dynamic supports to maintain stability.

Multiple ligaments provide static support to the SIJ. The interosseous ligament and the long posterior sacroiliac ligament function as primary restraint in sacral flexion and rotation, and sacral extension respectively[8]. Histological studies show that these ligaments contain both mechanoreceptors and nociceptors providing proprioceptive and pain sensation[9,10]. This has also led to speculation that the long posterior sacroiliac ligament could be a cause for SIJ pain during pregnancy secondary to hormonal effect on the ligament[11].

Regarding dynamic restraints, activation of muscles counteract the shearing forces by increasing the friction and stiffness of the SIJs and contribute to the stability of the pelvis through a force closure model[12]. The SIJs are subjected to an increase in motion of up to 168% to compensate for an immobile L4-S1 segments, consequently a corresponding increase in force across the SIJs is required to achieve the same stability[13]. This theory may explain the finding of persistent or recurrent low back pain following lumbar spine fusion surgery, occurring in

32-45% of patients[14,15]. This is further supported by radiographic degenerative changes being reported in 75% of patients at 5 years after lumbar fusion[16]. Just as lumbosacral fusion causes adjacent segment degeneration through increased facet joint loading[17]; it is logical that biomechanical factors such as leg length discrepancy, lower limb arthroplasty (in particularly hip replacements), hypermobility, degenerative arthropathy and previous trauma may lead to SIJ dysfunction and pain. Several studies have looked at the relationship between SIJ and hip pathology. Increased incidence of SIJ degeneration was found in patients with end-stage hip osteoarthritis, while 25% of patients with femoroacetabular impingement also had radiographic changes of the SIJs[18,19]. Interestingly, a study by Kozaki et al identified that instrumented spinal fusion including the SIJs was a predictor for hip osteoarthritis progression and proposed that this was due to adjacent segment disease[20].

Another challenge in the management of SIJ dysfunction (SIJD) is to recognise the condition and confirm the diagnosis. Both clinical history and examination may demonstrate overlapping features with both lumbar spine and hip pathologies[21-23]. This, in part, can be explained by variations in the innervation pattern from the lumbosacral rami supplying the SIJs[24-26]. A systematic review suggests SIJ provocative tests have a sensitivity and specificity of 85% and 76% respectively; when 3 out of 5 tests are positive, including either the thigh thrust or compression test[27], but this conclusion does need to be interpreted with caution due to the possibility of missed studies and uncertainties surrounding the analysis.

A diagnostic injection should be performed to confirm the clinical suspicion. Several review articles have tried to ascertain the definition of a positive response to a diagnostic SIJ injection[28-30]. While no consensus has been reached, Simopoulos et al assessed the evidence on single and dual blocks with varying level of pain relief, concluding that a reduction in the pain of more than 70% as a standard is supported by several high quality studies. Jung et al published a review article describing their technique for SIJ injections and suggested that following the diagnostic block, symptomatic relief when repeating previously painful provocative tests is a helpful aid for confirming SIJ pain, although no patient data was provided and should be interpreted with care[31].

Treatment options for confirmed SIJ pain should follow the same principles for adjacent segment degeneration or instability, ranging from simple analgesia, physiotherapy and bracing to injections and denervation type procedures. If the pain is refractory to these modalities then fusion surgery is an option supported by a large range of published literature[32-37]. Despite this, SIJ fusions still harbours controversies with a lack of consensus regarding surgical approach, unilateral versus bilateral fusion, implant choice and associated complications[38-41].

The National Institute for Health and Care Excellence (NICE) published their official guidelines in 2017: recommending SIJ fusion by minimally invasive surgery (MIS) in patients with chronic SIJ pain who have failed to respond to non-operative measures[42]. Lingutla et al performed a systematic review and meta-analysis on SIJ fusion following confirmation as the pain generator with significant improvement in all Patient Reported Outcome Measure (PROM) scores[32]. A recent narrative review by Yson et al found similar improvement in PROMs following MIS fusion, although these publications were sponsored by the manufacturer of the implants[34,43-47]. Yson also found MIS surgery resulted in reduced blood loss, shorter surgical time and a reduction in hospital length of stay when compared to an open approach[33].

The International Society for the Advancement of Spine Surgery (ISASS) published an update in 2020 on their policy statement for SIJ fusion[48]. Following on from their previous publications in 2014 and 2016, they have included more recent evidence and made recommendations regarding surgical indications, patient selection and surgeon qualifications prior to undertaking SIJ fusion surgery. They included forty-eight publications in their literature review and found consistent improvement in PROMs including VAS and Oswestry Disability Index (ODI). The reported revision rate ranged between 1% to 5%, with a survivorship of 96.5% at 4 years in one study[49]. They concluded that patients who have had more than 6 months of SIJ pain, positive findings in at least three SIJ stress tests, confirmation of pain generation via diagnostic injection and failure of non-operative treatments would benefit from SIJ fusion via a MIS lateral transiliac approach, with the implant choice according to surgeons' preference.

Based on the available evidence, MIS fusion can be very effective in the treatment of SIJ pain and improving outcomes in appropriately selected patients. Patients with persistent low back pain symptoms originating from their SIJ after previous lumbar spine fusion surgery would benefit most from this procedure. However, most of the studies were industry-sponsored and reported their outcomes from patients with de novo SIJ pathology as well as those with previous lumbar spine fusion with adjacent segment disease. Future high-quality independent studies looking solely at those with previous lumbar spine surgery could provide further insight on this condition.

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I would like to acknowledge Mr Khai Sing Lam. He was a very experienced and skilled surgeon who embraced innovation and technology, applying both to the challenges of treating complex spinal pathology. He inspired many spinal surgeons who worked with him during their fellowships and well liked by his patients. At a personal level, he was a mentor I feel privileged to have worked with during my orthopaedic spine training. I believe I am not alone to say that his untimely demise in December 2022 is a great loss to the spine surgery community. ■

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Original articles

Dealing with Third Parties in Providing Private Healthcare

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Providing spinal surgery in the private sector brings its own challenges. Professional Practice subcommittee and BASS exec have continued with the efforts to engage with various Private Medical Insurers (PMIs) to improve members' working, keeping the interest of patients and members alike.

The mandatory MDT proposed by Vitality was challenged at the outset, highlighting well-functioning local and regional MDTs in many units have helped provide high quality patient care over the years. It was indeed a shame that a reasonable agreement with Vitality could not be arrived at, to draw a line under this matter. Although Vitality still plan to continue with an amended service, it is implied that they would be more accepting of the decisions at established robust local and regional MDT's.

Frequent change of procedure codes has often affected members practice and billing. BASS is unaware of any formal representation from the exec team or members when such changes are undertaken by Clinical Coding & Schedule Development (CCSD) Group. Engagement with other professional societies who may be similarly affected has recently been explored. Further such attempts must continue while working within the limitations imposed by the Competition and Markets Authority (CMA). BASS would aim to offer its help in any further change to codes so that they remain comprehensive and well reflective of the nature of complexity of the procedures. The change of procedure code should not be a way to undermine the procedure fees especially when a substantial proportion of the members practice on a fee assured basis. There is a strong view amongst members that the fee assurance potentially affects treatment standards and more so patients' choice. Indeed, the principle of fee assurance, if must be applied by the PMIs, should work both ways! With the rising inflation many hospitals have increased the cost of self-funded packages, PMIs have increased the subscription to the end user and our indemnifiers are not far behind. One truly wonders, whether fee assurance by the PMIs should be index linked?

BASS has renewed its working with Federation of Independent practitioner organisations (FIPO). Whereas the efforts by FIPO in identifying and addressing issues affecting across specialities are acknowledged, BASS would be looking for more effective outcomes to achieve the best value through the mutual engagement.

Private Healthcare Information Network (PHIN) has been pushing to include fee and reimbursement information about consultants on their website. PHIN has a CMA mandate[2] and there is no denial that it is a good practice to be transparent and upfront regarding fees with the patients. It must, however, be accepted that the complexity, duration and risks of seemingly same surgery in different patients could be as different as chalk and cheese. It would also be vital to ensure that any data published by PHIN2 about outcomes is robust and validated.

It has been encouraging to see discussion on BASS forum and the momentum must continue. Whereas the exec team may not be able to address all issues, they welcome involvement of the membership to endeavour to address the recurring themes. ■

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Original articles

Identifying the Top 12 research priorities for diagnosis and management of scoliosis – The Scoliosis PSP

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Full paper: https://spinesurgeons.ac.uk/resources/Documents/Journal/Docs/Identifying%20the%20Top%2012%20research%20priorities%20for%20diagnosis%20and%20management%20of%20scoliosis.docx

Abstract

Study Design
National Institute for Health Research (NIHR) James Lind Alliance (JLA) Priority Setting Partnership (PSP) protocol.

Objectives
To identify the research priorities for diagnosis and management of patients with scoliosis, their parents and carers, and professionals involved in their treatment.

Summary of background data
Research funders are faced by difficult choices when developing policy for allocating scarce research funds in an optimum way. In many cases this has not been done systematically, and depends largely on the priorities of investigators and grant committees. The JLA movement was set up to develop methodology for patients, their families, and front-line clinicians to develop patient centered research priorities. To our knowledge this methodology has not been applied to scoliosis.

Methods
We used the James Lind Alliance Prioritisation methodology and investigator conversion to research questions where feasible. Results 697 participants submitted 1961 questions or statements. These were reduced to 1231 'in-scope' raw questions, that were grouped by topics into 54 indicative questions. An online poll was used to select a shortlist of 27 questions. These were prioritised to 12 ranked by a panel of patients, carers and clinicians. Finally, we have used this list to generate research questions where possible.

Conclusions
The Scoliosis PSP used a systematic and transparent process to identify and prioritise research priorities of relevance to patients, their families and clinicians.

Level of Evidence Level V

Key Words
Scoliosis Research Priorities; Priority Setting Partnership; Patient and Public Involvement in Research

Introduction
The Scoliosis Priority Setting Partnership (S-PSP) used the James Lind Alliance methodology[1] to investigate priorities of for future scoliosis research of those with lived personal or professional experience of scoliosis.

Despite its prevalence, scoliosis has not attracted major research investment. It impacts public and individual health depending on underlying diagnosis, age and comorbidity. There are a number of aetiologies for scoliosis (congenital, syndromal, neuromuscular or idiopathic aetiology) and the manifestation and impact of scoliosis on these groups is variable. As yet there is no clear aetiology for most of the clinical scoliosis subgroups including adult scoliosis. All of these are associated with

different clinical problems, long term consequences[2,3,4,5] and research priorities.

Similarly, the management of scoliosis is variable both between the clinical subgroups and even within the same subgroup. Although there is robust evidence to support bracing in idiopathic scoliosis[6], other treatment strategies are not as founded in clinical evidence.

There is evidence of a mismatch between priorities of researchers and those with lived experience of a healthcare condition and healthcare professionals who care for these individuals[7,8]. Scoliosis is no different from any other disease in this respect[9]. The James Lind Alliance (JLA) was set up to address this mismatch[9] by bringing together patients, carers and clinicians in Priority Setting Partnerships (PSPs). The aim is to ensure that those who fund healthcare research are aware of what matters most to patients, carers and the clinicians that care for them[10,11,12]. It is not the objective to find new research questions that no expert has not previously considered. It is more to identify the priority of those 'treatment uncertainties' that are important to patients. The JLA has facilitated over 50 PSPs in diverse conditions and subject areas to develop priority lists for future research. These influence grant giving bodies internationally, and PSP's have been established in other countries. In this paper we bring together these processes to generate a list of research questions based on the PSP top 12 priority list. We hope that this list will not only influence research funding decisions in the UK, but internationally as well. It is likely that some questions will require large scale international collaborations to answer them. The questions may seem broad because the original suggestions are aggregated in the review process. We recognize that some of these treatment uncertainties are very difficult to answer.

Materials and Methods

Stage I – Initiation

The S-PSP was established in 2015, with the first Steering Group meeting held in December 2015. The Steering Group comprised representatives from Stakeholder organisations [Table 1], together with patient representatives, carers and clinicians. Regular meetings were facilitated by a JLA adviser, and took place either face to face or via teleconference, between December 2015 and November 2017.

A protocol was developed based on methods outlined in the JLA Guidebook[1]. The objectives of the S-PSP were to:

- work with patients, carers and clinicians to identify uncertainties
- to agree by consensus a prioritised list of those uncertainties, for research
- to publicise the results of the PSP and process
- to consider developing the resulting priorities into research proposals where possible

Stage II – Promotion

Designated pages were created for the S-PSP on social media platforms Facebook and Twitter together with short, informative videos to inform patient, carers and clinician groups about the S-PSP aims and objectives as well as how to get involved.

A website was created to complement social media pages and provide more in-depth information.

Stage III – Uncertainty gathering

A survey was developed as a means of gathering questions from patients, carers and healthcare professionals. The survey consisted of three parts, with the first presenting an overview of the S-PSP aims and objectives and clarifying the scope for the project. Part 2 gave participants the opportunity to enter their questions in free text about the diagnosis and management of scoliosis and Part 3 was an optional section for collection of demographic description of participants.

The survey was produced in an online format, with links on the S-PSP website, Facebook and Twitter that were shared widely following our social media strategy. A paper version was also available.

Stage IV – Processing

Raw questions from the initial survey were processed by the information specialist

(KS) and the lead author (JF), and included the following steps:

1. Identifying questions that were out of the scope

These included:

a) Questions about the cause of scoliosis as agreed in the protocol.
b) Questions asking for information or advice about current treatments and services, such as: "Where can I find clothes that fit?" and "What can we expect if surgery is the most optimum route?"
c) Questions about the quality and availability of health and social care services, such as "What percentage of children with scoliosis have an advanced care plan i.e. what to do if there were sudden life threatening problems?" and "Why aren't osteopaths, chiropractors and more physiotherapists available on the NHS for back pain?
d) Questions that were either too broad (e.g. "What is the best treatment?"), or unclear, or about an unrelated topic.

2. Identifying questions that had already been answered through research
We used systematic reviews relating to scoliosis treatment found by searching The Cochrane Library, DARE and PubMed.

Stage V – Prioritisation
An interim online survey was developed to narrow down the long list of questions/ statements to a manageable quantity to put forward for final prioritization. The survey was promoted through the S-PSP website, social media and networks of Steering Group members. Subsequently 20 participants then took part in the final one-day face to face prioritization meeting in London.

Stage VI – Conversion of Treatment Uncertainties to Research Questions for BSS
The British Scoliosis Society (BSS) had been approached independently by NIHR to generate a top research question. The PSP top 12 questions were converted to research questions by VJ and JF, who attended the final Prioritization Meeting. These were circulated to members of BSS and voted on at the Annual Meeting of BSS in Birmingham on 29th November 2017. Members of BSS endorsed the PSP by choosing research questions derived from the top three items on the PSP list.

Stage VII – Dissemination
The top 12 list of research priorities for diagnosis and management of scoliosis are published on the JLA website. They have been circulated to the participating organisations and to international spinal societies and national and international funding organisations. The research questions will be posted on BSS and other websites.

Results
There were 697 patients and carers (78%) and healthcare professionals (22%) submitted 1,231 research questions regarding the management of scoliosis; 730 'out of scope' questions were excluded as follows:

1. Although the survey stated that questions about cause would not be included, 195 questions were still submitted. These were passed to the funding organisation (BSRF) for further consideration.
2. Questions seeking information and advice (265) were answered by staff at the Scoliosis Association UK (SAUK). These responses were used to develop a list of 'Frequently Asked Questions' now available on the SAUK website.
3. Questions about the quality and availability of health and social care services were also passed to SAUK (114).
4. Questions where either too broad (e.g. "What is the best treatment?"), or unclear, or about an unrelated topic. There were 156 questions in this category.

Based on the survey responses, it seems most responders were interested in:

- Preventing a curve happening in the first place
- Decreasing a curve/ avoiding the need for surgery
- Preventing a curve from getting worse over time
- Reducing chronic pain
- Managing other symptoms e.g. breathing problems

Following this screening 1231 questions were agreed to be in-scope: 26 had been asked only once; the other 1205 had been asked by one or more contributor. These were grouped under 30 indicative questions, to give a long-list of 56 questions. Two questions were then removed because they had already been answered, and two questions were amended because they had been partially answered.

The remaining 54 questions went through to the next stage. The second survey prioritized these to a shortlist of 27 questions. Of 24 invited participants, 20 took part in the final one-day Prioritization meeting in London, narrowing down 27 to 12 uncertainties and ranking them in order of priority. Demographics of participants are detailed in Table 2. The list of top 12 uncertainties for the diagnosis and management of scoliosis are presented in Table 3.

Conversion to suggested Research Questions
Q2 and Q10 have been subject to a further workshop involving patients, carers and health/ social care professionals. The remaining uncertainties were reformatted by VJ and JF for the British Scoliosis Society to choose its Research priorities in response to a request from National Institute for Health Research (Table 4).

Discussion

Key achievements
To the authors' knowledge, this is the first paper to report the results of a systematically conducted, multi-stakeholder priority setting exercise for treatment uncertainties about scoliosis in the UK. Comprehensive inclusion of people/patients with scoliosis, their families, carers and health professionals in the priority setting process has ensured that the top list of uncertainties reflect those that matter most to the people who are most affected. We considered splitting the S-PSP into separate parts, because scoliosis and other spinal deformities can be secondary to a wide range of conditions and present in various age groups, and considered multiple PSP's to be impractical and costly. We recognise that some questions appear indistinct, but this reflects the wide frustrations of patients and their carers that we professionals are not able to provide answers.

Final prioritization process: workshop

The final part of the prioritization stage comprised a workshop whereby short-listed uncertainties were narrowed down to the final top 12. This was achieved through JLA facilitator-led discussion in small groups, with representation in each small group from stakeholders, patients, caregivers and healthcare professionals, followed by whole group discussion. Each participant arrived at the workshop with their individual views on which questions were a priority. During the workshop, there were multiple opportunities to hear other people's views on priorities and to understand the reasons why some questions were thought important (or less important) by others. Through dialogue and debate, the group realised that some questions would be more relevant to patients with different types of scoliosis and/ or to health professionals offering different types of care. They reached consensus to ensure that there was at least one question in the final list that would reflect a high priority issue for all the different groups, includi ng those who were unable to attend on the day. This resulted in a final top 12 (rather than a final top 10 which is standard JLA practice).

Strengths

A key strength of this process is involvement of patients, carers, their representatives, health and social care professionals and other stakeholders throughout. Social media were employed as a means of reaching groups. This was the first PSP to produce a 'meet the team' video series, which introduced the concept of the S-PSP, its aims and objectives, as well as highlighting how to get involved.

Limitations

We used well tried methods to identify and recruit patients and their families to the study.We developed a strong social media based publicity programme, which was novel (compared with previous PSP's). This was probably effective in attracting young people but less effective in gathering responses from adults. In spite of our best efforts to recruit patients and carers to the final workshop to represent all patient groups, some were under-represented, in particular adults with scoliosis. Our scope included both children and adults affected by scoliosis, and multiple causes including idiopathic to neurological impairment. We may not have captured more granular issues specific to particular categories that may have been lost in the aggregation process. We appreciate that the treatment uncertainties we identified reflected conditions in the UK, and it may be that these issues would vary between countries. We did not have resources to explore this question. Due to the distinct patient related, clinical and treatment issues of adult onset scoliosis, we would recommend a PSP dedicated to this group of patients to clarify their research priorities. ■

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BritSpine 2021 Podium Abstracts

Paper Session 1: Fundamental Science

Regenerative characteristics of NC cells for the treatment of lower back pain

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Introduction
Intervertebral disc (IVD) degeneration accompanying with lower back pain is a serious worldwide problem. In spite of the fact that surgical treatments are available for pain relief, there is an urgent need to establish enduring cell-based remedies. Notochordal (NC) cells, the progenitor of nucleus pulposus (NP) cells in human IVD, are a promising therapeutic candidate with regenerative effect. In this study, we aimed to optimise the culture of NC cells in vitro avoiding the use of bovine serum and using available culture systems as the first step in establishing this procedure.

Methods
Porcine NC cells were extracted using pronase and collagenase II treatments (Sakai et al. 2018). Extracted cells were cultured either in alginate beads or laminin-coated plates (Humphreys et al. 2018) representing 3-dimensional (3D) and 2-dimensional (2D) in vitro culture systems, respectively. In both systems, cells were harvested for gene expression analysis and Immuno-staining of NC markers (CD24, KRT8, KRT18, KRT19 and T) and NP markers (ACAN, COLII, PAX1 and FOX-F1) and histology analysis.

Results
A mixed phenotype of NC and NP cells was observed in alginate bead cultures. NC phenotype was observed within all culture conditions with production of GAGs and maintenance of vacuolated phenotype.

Conclusions
Optimising the culture of NC cells in vitro could not only help us to establish their culture for further experiment, but also to efficiently expand them in larger scale for therapeutic purposes.

A caprine model of intervertebral disc degeneration: a testing platform for an injectable hydrogel

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Introduction
Whilst there are animal models to investigate IVD degeneration, many of these are not representative of the human condition. Here we develop an ex vivo caprine IVD degeneration model for use in testing our synthetic, injectable hydrogel (NPgel). NPgel has been shown to induce differentiation of human mesenchymal stem cells (hMSCs) towards a nucleus pulposus (NP) cell phenotype in vitro. Through utilising our caprine model we aim to validate the effects of NPgel injection on the catabolic processes that occur during IVD degeneration in vivo.

Methods
Caprine IVDs were degenerated enzymatically and subjected to simulated physiological loading. Changes in disc height were determined and histological staining was performed to assess extracellular matrix (ECM) production and expression of catabolic proteins. Following establishment of the IVD model, NPgel (+/- hMSCs) was injected into degenerated caprine IVDs and cultured for 21 days before similar experiments were carried out.

Results
Enzymatic degradation decreased disc mechanics. Histological staining identified catabolic protein expression in enzyme degraded caprine IVDs, similar to changes observed during human IVD degeneration. The injection of NPgel (+/- hMSCs) increased the expression of healthy NP matrix proteins and decreased the expression of catabolic proteins.

Conclusion
The development of treatments for IVD degeneration is hindered using models which do not closely represent human IVD degeneration. Here we have established a reproducible, large animal model of IVD degeneration. Within this model NPgel initiated regeneration of the IVD, indicating that in the future this may become a viable treatment strategy for IVD degeneration.

The Human Enthesis Harbours Resident Adaptive Cd4+ And Cd8+ T-Cells With Inducible Il-17a And Tnf Protein In A Novel In Vitro Enthesitis Model

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Background

Animal models have demonstrated that enthesitis is the primary lesion in experimental spondyloarthritis (SpA). We set to investigate whether the enthesis harbours tissue resident T-cells. We also assessed their ability to express SpA-related cytokines including TNF and IL-17A.

Methods

Entheseal spinous process was obtained from patients undergoing elective orthopedic procedures (n=20) and mechanically digested for confocal staining and flow cytometry. T-cells were sorted and analysed by qPCR. Magnetically isolated cells were stimulated using an anti-CD3/CD2/CD28 bead with and without the presence (methotrexate (MTX), and phosphodiesterase type 4 inhibitor (PDE4i)) and RORγt inhibitors (RORγti). Following stimulation IL-17A and TNF were measured by ELISA and intracellular flow cytometry.

Results

CD4+ and CD8+ T-cells represent 35.7% and 23.7% of T-cells in the enthesis, respectively, with topographic confirmation by anti-CD3 immunofluorescence staining. Sorted T-cells from entheseal tissue had a gene expression profile consistent with a tissue resident phenotype Following stimulation CD4+ T-cells produced more TNF than CD8+ T-cells ($p<0.05$), IL-17A was robustly detected in CD4+ but not CD8+ T-cells. TNF and IL-17A production from CD4+ T-cells was effectively inhibited by PDE4i ($p<0.05$), while RORγti only reduced IL-17 secretion ($p<0.001$). MTX had no significant impact on both TNF and IL-17A production in either cell population. This pattern of inhibition was mirrored in TNF secretion from CD8+ T-cells.

Conclusion

This is the first description of conventional CD4+ and CD8+ enthesis resident T-cells. PDE4i was effective in abrogating induced TNF production and IL-17, whereas RORγti is highly effective for IL-17A production but not TNF.

M2 Macrophage Upregulation By Calcium Phosphate With Submicron Topography Promotes Angiogenesis And Osteogenic Differentiation In Vitro

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Introduction

In pre-clinical models, it has been shown that calcium phosphate grafts with a submicron surface topography demonstrate enhanced bone healing compared to conventional calcium phosphate. It is hypothesized that calcium phosphates with submicron topography upregulate pro-regenerative M2 macrophages, explaining their enhanced bone healing characteristics.

Methods

Primary CD14+ monocytes were isolated from buffy coats and seeded on granules of a biphasic calcium phosphate with submicron topography (BCP<µm) and one with a conventional surface (TCP). To determine macrophage phenotype, protein markers for M1 (CCL5, IL-6) and M2 (CCL18, CD163) macrophages were measured in cell-culture supernatants by ELISA. Moreover, macrophage-conditioned media were used in HUVEC angiogenic tube formation assay and MSC osteogenic differentiation assay.

Results

After 24h and 72h of culture, M2 marker concentrations were significantly higher when macrophages were cultured on BCP<µm than on TCP ($p<0.001$). While M1 marker expression was initially higher on the submicron topography (24h), this later decreased to the level of the material with conventional surface (72h). SEM revealed that the shape of macrophages was elongated on the surface of BCP<µm, while spherical on TCP. Results of angiogenic tube formation showed enhanced tube formation with macrophage-conditioned medium from the BCP<µm condition. Osteogenic differentiation assay demonstrated higher ALP secretion normalized to macrophage DNA for BCP<µm than TCP.

Conclusions

These results indicate upregulation of M2 macrophages at the surface of calcium phosphate with submicron topography, which may play a role in its enhanced performance in bone healing compared to conventional calcium phosphates.

Amyloid deposits in the ligamentum flavum related to lumbar spinal canal stenosis and lumbar disc degeneration

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Introduction
Amyloidosis is a protein conformational disorder with some distinctive features of accumulation of protein fibrils in different body tissues causing wide range of signs and symptoms. These amyloid fibrils usually derived from different precursors that till now about thirty different precursor proteins are identified. Although the most common tissue for their accumulation is the cardiac, amyloidosis may accumulate in extra cardiac tissues; one of these extracardiac tissues is the ligamentum flavum.

Patient and methods
Patients with lumbar spinal canal stenosis or lumbar disc degeneration, who were scheduled for surgery, were included in the study. 17 LF specimens obtained from 16 patients with lumbar spinal stenosis (2 specimens were taken from 2 consecutive stenotic levels belong to one patient) and 11 LF specimens obtained from 11 patients with lumbar disc degeneration. Tissue biopsy was taken from the ligamentum flavum at the affected level and was stained with special immunohistochemical stain to detect amyloidosis. The diameter of the lumbar canal and the ligamentum flavum thickness were measured by radiologist at the affected level.

Results
Eight out of sixteen patients with lumbar spinal canal stenosis tested positive with the immunohistochemical stain for amyloid deposits with a P value less than 0.05; while, all the specimens taken from lumbar disc degeneration patients stained negative.

Conclusion
There is relation between accumulation of amyloid precursors and ligamentum flavum hypertrophy in lumbar spine canal stenosis in middle age patients.

Paper Session 2: Lumbar Degenerative

Validity of "Appropriate Use Criteria" for surgery in degenerative spondylolisthesis: a prospective, controlled, multicentre study

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Introduction
Failures in spine surgery are sometimes attributable to inappropriate treatment. Appropriate Use Criteria (AUC) serve to help clarify the indications for a procedure. We evaluated the validity of recently developed AUC for degenerative spondylolisthesis.

Methods
This prospective, controlled, multicentre study included 736 patients (493 surgical and 244 nonsurgical controls; 70±10y; 67% female). Patients completed the Core Outcome Measures Index (COMI) at baseline and 3 months' FU. The care plan (surgery or nonsurgical care) was at the discretion of the treating physician, as per their normal practice and irrespective of the AUC.

Results
According to the AUC, surgery had been appropriate (A) in 143/493 (29%), uncertain (U) in 230/493 (47%) and inappropriate (I) in 120/493 (24%) of the surgical patients; it would have been A in 43/244 (18%), U in 94/244 (38%) and I in 107/244 (44%) of the nonsurgical patients. As per convention, A and U were combined for comparison with I. The benefit of surgery compared with nonsurgical care was greater in patients for whom surgery was A/U (2.9-point greater reduction in COMI for surgery vs nonsurgical) than in those for whom it was I (1.8-point greater reduction). In A/U patients, the MCIC for COMI was reached by 76% who got surgery and 27% who got non-surgical care; for I patients, the corresponding figures were 61% and 26%.

Conclusion
The AUC successfully identified patients who derived greater benefit from surgery. If the findings are confirmed at later follow-up, widespread adoption of the AUC should be encouraged.

Impact of adjuvant spinal anaesthesia on early outcomes of multi-level lumbar decompression surgery

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Introduction
Multi-level lumbar decompression is painful procedure requiring strong opioid use. This has significant side effects for the patient and a domino-effect on the theatre flow-through and hospital discharge. We hypothesise that adjuvant spinal anaesthetic could reduce morphine requirement, length of recovery and inpatient stay as well as operative-day mobility. Reduction in opioid use by implementing regional anaesthesia techniques is a core principle of enhanced recovery in surgery.

Method
A 7-year, prospective case-control study of age, ASA and number of decompression level matched patients were undertaken. Eighty-two patients had adjuvant spinal anaesthetic (treatment-group) and 226 patients received standard anaesthetic care (control-group) between 2013 and 2019. For treatment group, a lumbar spinal anaesthetic with 1 to 4 ml 0.25% Bupivacaine was used prior to induction depending on expected duration of surgery. The control group received a standard opioid based GA. Both groups received multimodal analgesia and surgical local infiltration with 60ml 0.25% Bupivacaine. Statistical analysis was performed using "Matching" package of R. Outcome measures were total perioperative morphine consumption, 48-hr morphine consumption, recovery time, time to mobilisation and length of stay.

Results
In the treatment group, the mean perioperative morphine requirement was 6.7-6.9 grams less and the mean 48hr post-operative Oxycodone use was 22 grams less. This equated to a 11-minute early discharge from recovery, one-day less of inpatient stay with 80% patients mobilising within 12-hrs, all of which were statistically significant.

Conclusion
Our study clearly demonstrates a significant advantage of adjuvant spinal anaesthetic in early outcomes of lumbar decompression surgery.

Early-to-moderate disc degeneration does not affect inter-vertebral motion in asymptomatic controls

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Early disc degeneration (DD) has been thought to be associated with a loss of spine stability and has been implicated in approximately 40% of cases of low back pain. However, before the relationship between low back pain, intervertebral motion and DD can be understood, it is necessary to know the relationship between DD and intervertebral motion in people without pain. This study aimed to discover if, in the absence of back pain, early to moderate DD is associated with intervertebral motion. Ten pain free adults, received recumbent and weight bearing MRI scans and video fluoroscopy screenings during passive recumbent and active weight-bearing lumbar flexion bending. Forty individual level and 10 composite (L2-S1) radiographic and MRI DD gradings were recorded and correlated with IV-RoM, translation, laxity, and dynamic motion sharing inequality and variability for both bending protocols. Kinematic values were similar to previous control studies. DD was evidenced up to moderate levels by both radiographic and MRI grading. Disc height loss correlated slightly, but negatively with IV-RoM during weight bearing flexion (R=-0.356, p=0.0.025). Composite MRI DD and T2 signal loss evidenced similar relationships (R= -0.305, R= -0.267) but did not reach statistical significance (p=0.056, p=0.096). No significant relationships between any other kinematic variables and DD were found. There was little, if any, correlation between early DD and intervertebral motion in healthy controls. Motion sharing in the absence of pain was also not related to early DD, consistent with previous control studies. Further research is needed to investigate these relationships in patients.

Over Reporting Disc Herniation by Radiologists in Lumbar Spine MRI's Performed for Patients with Spondylolisthesis

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Introduction
MRI findings often guide treatment in spine surgery. Spondylolisthesis is often misdiagnosed in MRI as a disc herniation since the slip may reduce to a normal alignment as the patient lies supine while getting the MRI. A "pseudo-disc" herniation at the level of spondylolisthesis is not truly

herniated as it remains anterior to the posterior longitudinal ligament and in line with the posterior vertebral line of the caudal vertebral segment. The purpose of the current study was to review lumbar spine MRI reports of patients with established spondylolisthesis to determine the over diagnoses rates of disc herniation at the level of spondylolisthesis.

Methods
258 consecutive patients met the inclusion criteria (age >18 year, and study performed for the evaluation of spondylolisthesis) were included. All images were reviewed by a senior radiologist and a senior spine surgeon.

Results
There were 173 (67%) female and 85 (33%) male patients with a mean age of 57 years (range 18-95). Disc herniation over reporting ratio was 4.48/1 (P<0.02). More specifically, they over reported the findings of disc bulges. For that, the over reporting ratio was 7.2/1 (statistically highly significant (P<0.01). In contrast, they under reported the findings of pseudo-disc herniation at the level of spondylolisthesis. The under reporting ratio of pseudo-disc herniation was 0.64/1 (P <0.05).

Conclusion
In lumbar spine MRI's for patients with spondylolisthesis, the findings of a true disc herniation at the same level is over reported by radiologists. This may affect accurate diagnosis and treatment decision plan.

Prognostic factors associated with walking ability after surgery for lumbar spinal stenosis: A systematic review

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Background
Approximately 40% of patients report post-operative walking disability following surgery for lumbar spinal stenosis (LSS). Identifying the factors which influence post-operative walking could inform pre-operative decision-making and rehabilitation. This systematic review identifies the pre-operative factors associated with post-operative walking ability in adults (≥40 years old) with LSS.

Methods
Data sources consisted of 5 electronic databases (MEDLINE, CINAHL, EMBASE, PsychINFO, Web of Science to 31/07/19), with cross referencing and expert review. Inclusion criteria were observational studies that reported relationships between pre-operative factors and post-operative walking in adults undergoing surgery for LSS. Independent data extraction and quality assessment (Quality In Prognosis Studies tool) was conducted by 2 reviewers and data synthesised narratively.

Results
A total of 5027 studies were retrieved. Of these, 32 studies (25 high, 1 moderate and 6 low risk of bias) representing 9863 participants met the eligibility criteria. There is strong level evidence that greater pre-operative walking ability predicts better post-operative walking; and that spondylolisthesis is not associated with post-operative walking. There is moderate level evidence that social support is not associated with post-operative walking; weak level evidence that increased BMI, comorbidities, poorer self-rated health and lower income are associated with poorer walking. There is weak level evidence that gender, disability, pin-prick sensation and education is not associated with post-operative walking ability.

Conclusion
Most of the identified prognostic factors are non-modifiable. High quality observational studies are required to identify modifiable physical and psychosocial factors that could be targeted with rehabilitation, to improve post-operative walking in people with LSS.

Prognostic indicators of surgical outcome in painful foot drop: a systematic review and meta-analysis of observational studies

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Background
Foot drop is a relatively uncommon presentation of lumbar degenerative disease (LDD). There is limited evidence available on the management and outcome of foot drop which reflects the lack of standardised treatment provided to patients. The purpose of this systematic review and meta-analysis was to determine the effectiveness of surgical management and identify factors that predict surgical outcome.

Methods
A systematic database search of Cochrane Library, Ovid Medline, Pubmed, Embase and Google Scholar was undertaken from inception through August 2018. Only studies reporting on surgical outcome in adult patients who had a painful foot drop and underwent decompression were included. Study quality was assessed using the Newcastle-Ottawa Scale (NOS). Data were pooled using a random-effects model.

Results
797 studies were screened and 9 observational studies met the inclusion criteria. This resulted in a total of 431 patients who underwent decompression for foot drop. Pooled rates of outcome for improvement in foot drop MRC grade were 84.5% (range 67.9%-96%). Sub-group meta-analyses of studies revealed a statistically significant association between duration of foot drop (pooled 4.95 [95% CI 1.13-21.74]), severity of pre-operative weakness (pooled 0.38 [95% CI 0.15-0.93]) and age (pooled 6.28 [1.33-29.72]) on post-operative outcome.

Conclusion
This is the first systematic review and meta-analysis to explore the outcome and prognostic indicators of lumbar decompression for foot drop. Findings indicate that age, duration of foot drop weakness and pre-operative MRC grade are strong predictors of surgical outcome. The authors propose a national observational study to establish current management in the UK.

A stitch in time saves nine - comparative analysis of spinal dural tear repair surgery

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Introduction
Dural tears are a common spinal surgery complication associated with several potentially significant side-effects. Despite their relatively common occurrence, there are limited clinical guidelines on how best to repair the defect. This study aims to determine which intraoperative repair method is associated with the best postoperative outcomes.

Methods
Data was collected from the research hospital's patient databases between 01/01/2016 and 04/11/2019. 106 intraoperative dural tears were identified and grouped per repair method. A MANOVA was used to compare 5 variables between groups: length of stay, length of additional stays, further admissions, infection rate and neurological symptoms. Sub-analysis was conducted on the type of patches, primary closure vs non-primary closure, patient demographics and surgeries causing the tears.

Results
Operations at the L4/L5 level were most commonly associated with dural tears. The incidence rate was reported at 5.81% and most prevalent in emergency operations (56%). Statistical significance was achieved when comparing artificial versus autologous patches in favour of artificial patches. Age also had a significant impact on post-operative outcomes. Although significance was not achieved, primary closure was the most advantageous method with respect to 4 out of 5 observed outcomes.

Conclusions
This study suggests that primary repair ± an artificial dural patch is the most advantageous form of repair for intra-operative dural tears and that artificial patches are superior to autologous patches but that further research is required to confirm these results.

Rate and Risk Factors for 5-year Postoperative Disc Herniation after Lumbar Decompressive Surgery: Analysis of 1656 cases

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Introduction
Lumbar decompressive surgery, with or without fusion, is an effective treatment for disc prolapse and spinal stenosis. However, postoperative disc herniation (PDH) causes significant healthcare, personal and economic burden. The rate and risk factors for PDH is unclear.

Method
We retrospectively analysed prospectively collected data on 1656 consecutive lumbar decompressive patients. Postoperative data was collected from clinical notes and the centre's MRI database, with all imaging providers in the region checked for missing data. Statistical analysis used Kaplan Meier to calculate hazard function. Cox proportional hazard model was used to identify independent variables predictive of PDH. Hazard ratios (HR) were calculated with 95% CI.

Results
PDH and non-PDH group mean age was 50.1 (SD 14.3) and 56.8 (SD 15.9) years, respectively. Median non-PDH patient follow-up time was 2.7 years (IQR range 1.0–5.0 years). PDH occurred in 150 patients at a 5-year incidence rate of 14%. Preoperative Oswestry Disability Index score ⩾60% (HR 2.10; 95%CI 1.29–3.43, p=0.000), current smoker (HR 1.79; 95%CI 1.25–2.57, p=0.002), rheumatic disorder (HR 1.82; 95%CI 1.04–3.18, p=0.036), operation category (p=0.000) and employment status (p=0.010) were independent risk factors associated with PDH. Most of the increased risk associated with ODI and smoking status appeared to occur in the first 2 years. Secondary analysis identified fusion as a risk factor for PDH at a level different to the index operation (p=0.010).

Conclusion
We identified modifiable PDH risk factors to inform spinal surgeons and rehabilitation specialists on risk assessment and targeted postoperative recovery.

Paper Session 3: Conservative Therapies (1)

Predictors of analgesic dependence among patients with spinal pain

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Introduction
Spinal pain patients commonly use analgesics for pain relief, however increased use has the potential to cause dependence. Psychological factors such as stress, anxiety, depression, pain acceptance, pain catastrophising and alexithymia influence both the pain response and analgesic use, yet to our knowledge no studies have explored all these variables combined in spinal pain patients. Therefore, this cross-sectional study aimed to assess the nature, prevalence and correlates of analgesic dependence among this cohort.

Method
106 chronic spinal pain patients attending outpatient services at two Derby hospitals and currently using analgesics for pain relief completed a questionnaire survey including the; Current Opioid Misuse Measure (COMM) assessing aberrant medication-related behaviour (AMRB), Depression, Anxiety and Stress Scale-21 (DASS-21), Chronic Pain Acceptance Questionnaire-8 (CPAQ-8), Pain Catastrophising Scale (PCS), Toronto Alexithymia Scale-20 (TAS-20) and Leeds Dependence Questionnaire (LDQ), a measure of analgesic dependence.

Results
Multiple regression analyses indicated that pain severity (β 0.23), AMRB (β 0.20), rumination (subscale of the PCS) (β 0.26) and difficulty identifying feelings (DIF) (subscale of the TAS-20) (β 0.20) independently predicted greater analgesic dependence. Furthermore, pain acceptance and pain catastrophising influenced dependence but only when pain was more severe.

Conclusion
Results suggest initiatives to increase pain acceptance and reduce pain catastrophising and alexithymia among chronic spinal pain patients using analgesics are worthwhile. The study contributes to the potential of future research on tapering spinal pain patients off analgesic medication and highlights the need to understand additional factors that influence analgesic dependence among patients with chronic spinal pain.

How effective is physiotherapy for people with sciatica? A systematic review and meta-analysis

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Background
Sciatica is a broad term describing spinally referred pain of neural origin that radiates into the leg. Sciatica is a significant burden to healthcare and health economies globally. Physiotherapy is often prescribed for the treatment of sciatica, however its effectiveness remains controversial.

Purpose
This systematic review will establish whether physiotherapy is effective for people with sciatica.

Methods
Cochrane Central Register of Controlled Trials (CENTRAL), CINAHL (EBSCO), Embase, PEDro, PubMed and Scopus were searched from inception to July 2018 without language restrictions. Inclusion criteria were randomised controlled trials evaluating physiotherapy intervention compared to a control intervention with a long-term follow-up of at least six months. The systematic review was registered on PROSPERO CRD42018103900.

Results
3479 records were identified, of which 22 studies, (from 19 randomized controlled trials) were included. Eighteen studies had a high or unclear risk of bias. Meta-analysis suggested that at one year there is minimal evidence to support the use of physiotherapy for pain and disability compared with minimal intervention (e.g GP care, or advice). Surgery is slightly more effective than physiotherapy at one year for pain and disability. Clinical and statistical heterogeneity of included studies was however, high, especially in regards to diagnosis and duration of symptoms.

Conclusions
Based on currently available, mostly high risk of bias data, there is inadequate evidence to make clinical recommendations on the effectiveness of physiotherapy for people with sciatica.

Implications
High quality trials are required to establish the effectiveness of physiotherapy in patients with sciatica.

The clinical and cost effectiveness of radiofrequency denervation for chronic, moderate to severe low back pain: RADICAL randomised controlled trial protocol

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Background
Radiofrequency denervation (RFD) is a minimally invasive procedure which aims to reduce pain by interrupting the pain signal between the medial branch nerves and brain by destroying the nerves. The intervention is endorsed by NICE and included in the NHS England National Low Back and Radicular Pain Pathway and British Pain Society Low Back and Radicular Pain Pathway. However, there is uncertainty regarding the effectiveness of RFD. The aim of RADICAL is to investigate the clinical and cost-effectiveness of RFD for chronic, moderate-severe LBP.

Methods
RADICAL will be a 20-centre, double-blind, parallel group, superiority randomised controlled trial with internal pilot, qualitative research and health economic analysis. 250 patients with chronic, moderate to severe LBP, referred to secondary care, with a positive response to a single diagnostic medial branch block will be recruited. Patients will be randomised to receive RFD or placebo RFD. Participants who do not experience improvement in pain 3 months after randomisation will be offered blinded "repeat RFD" with the alternative intervention to the one provided at the outset. The primary outcome will be pain severity, measured using a Numeric Rating Scale, at 3 months after randomisation. Secondary outcomes will be assessed over 2 years and include disability, health-related quality of life, psychological well-being, satisfaction, adverse events, work outcomes and healthcare utilisation. The RADICAL trial will provide definitive evidence on the clinical and cost-effectiveness of RFD to inform clinical guidelines and commissioning of care to ensure patients are offered effective and appropriate treatments for LBP.

Physiotherapists' awareness, knowledge and confidence in screening and referral of suspected axial spondyloarthritis: A survey of UK clinical practice

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Background
Axial Spondyloarthritis (axSpA) is an inflammatory disease associated with significant diagnostic delays and is commonly missed in assessments of persistent back pain.

Objective
To explore musculoskeletal physiotherapists´ awareness, knowledge, and confidence in screening for signs, symptoms, and risk factors of suspected axSpA and criteria for rheumatology referral.

Design
An online UK survey was undertaken combining back pain vignettes (reflecting axSpA, non-specific back pain and radicular syndrome) and questioning on features of suspected axSpA. Recruitment utilised online professional forums and social media. Data analysis included descriptive statistics and conceptual content analysis for free text responses.

Results
132 survey responses were analysed. Only 67% (88/132) of respondents identified inflammatory pathologies as a possible cause of persistent back pain. Only 60% (79/132) recognised the axSpA vignette compared to non-specific low back pain (94%) and radicular syndrome (80%). Most suspecting axSpA would refer for specialist assessment (77/79; 92%). Awareness of national referral guidance was evident in only 50% of 'clinical reasoning' and 20% of 'further subjective screening' responses. There was misplaced confidence in recognising clinical features of axSpA (⩾7/10) compared to knowledge levels shown, including high importance given to inflammatory markers and HLA B27 (median = 8/10).

Conclusions
Musculoskeletal physiotherapists may not be giving adequate consideration to axSpA in back pain assessments. Awareness of national referral guidance was also limited. Professional education on screening and referral for suspected axSpA is needed to make axSpA screening and referral criteria core knowledge in musculoskeletal clinical practice, supporting earlier diagnosis and better outcomes.

Paper Session 4: Impact of COVID

Patient and Neurosurgeon perceptions of virtual neurosurgery consultations in the COVID-19 era: A prospective mirror-survey evaluation study

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Background
The COVID-19 pandemic has compelled a global shift in health-care service delivery from face-to-face to virtual (video) consultations, including Neurosurgery outpatient appointments. Our study aims to address the patient and neurosurgeon perceptions of virtual neurosurgery consultations (VNC) and formulate the guidance algorithm based on our experience.

Methods
Between June 2020 and December 2020, we prospectively surveyed patients and Neurosurgeons following their VNC using a 10-item survey (four qualitative and six five-point Likert scale questions). We analysed satisfaction, preferences, challenges and perceived relative indications/contra-indications pertaining to VNC. Non-parametric hypothesis testing and grounded coding with inter-coder agreement was used to analyse quantitative and qualitative data, respectively.

Results
106 patients and 7 Neurosurgeons completed the survey. Wilcoxon rank-sum test revealed a statistically significant difference between the Neurosurgeon and patient responses (p-value=0.0003). On qualitative categorisation, patient-perceived VNC benefits: enhanced efficiency (n=142) and communication (28); VNC drawbacks: safety (46), technological (32), and administration (15) issues. Neurosurgeons perceived VNC benefits: enhanced efficiency (6); VNC drawbacks: examination practicality (3), technological (4), and concerns for patients (3). Our guidance algorithm suggests use of VNC for post-operative follow up clinics, cancer surveillance, consent clinic, and scan result discussions; and VNC is at risk of missing findings in new patient or those with worsening neurological status.

Conclusions
Our study provides preliminary evidence that virtual consultations come with increased efficiency, communication, and safety in the current COVID-19 era. Further improvement in technology and administration is necessary, and Neurosurgeons are to exercise clinical discernment when and when not to use VNC.

Restoration of elective Spine surgery in the UK during COVID-19 Recovery Phase: A Multi-centre BASS Collaborative Prospective Longitudinal Study

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Background
With resumption of elective spine surgery services in the UK during the COVID-19 pandemic, we conducted a multi-centre BASS collaborative study to examine the clinical outcomes at the re-introduction phase of the pandemic.

Methods
Prospective data was collected from six spinal centres for the first month of operating following restoration of elective spine surgery in each unit. Primary outcomes measures were the 30-day mortality rate and postoperative Covid-19 infection rate. Secondary outcomes analysed were the surgical adverse events, medical complications and length of inpatient stay.

Results
138 patients (81 Male) with an age range of 2-88 years formed the study cohort. The average workload from each unit was 23 (range 16-34) with 82 procedures (59%) done as category 2 prioritisation level (Procedures performed in < 1 month). 89% of patients were low-medium "risk stratification" category. 118 patients (85%) isolated for two weeks preoperatively and all but one patient had COVID-19 negative test prior to surgery. None of the patients were diagnosed with COVID-19 infection nor was any mortality related to COVID-19 during the 30 day follow up period, with 13 patients having been tested for symptoms. Twenty patients (14%) developed a total of 23 complications with the majority (75%) being grade 1-2 Clavien-Dindo classification of surgical complications.

Conclusions
As per our study safe and effective planned spinal surgical services can be restored avoiding viral transmission, with diligent adherence to national guidelines and COVID-secure pathways tailored according to the resources of the individual spinal Units.

Spinal Rehabilitation During Coronavirus Restrictions: Challenges and Experiences of Piloting a Virtual Back Group

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Introduction
There is clear evidence to support group exercise in the treatment of back pain. The unprecedented SARS-CoV-2 pandemic has required changes to traditional ways of working and the rapid adoption of alternative solutions. Content, delivery and platforms were explored in order to deliver remote group spinal rehabilitation.

Methods
A mixed group of 4 current and previous back rehabilitation patients, a specialist fitness instructor and 3 physiotherapy students piloted three different modes of spinal rehabilitation. The patients were sent a personalised exercise programme and goal-setting questionnaire. We sought patient feedback on both technical issues and content. All were Physiotherapist led. Pilot 1 - Hybrid group of patients attending in person and virtually using Attend Anywhere (AA) Pilot 2 - Virtual session on AA with fitness instructor and large screen. Pilot 3 - Virtual session on Microsoft Teams (MS) with large screen and soundbar.

Results
AA had poor sound quality, increased interference and a limit of six participants. MS Teams worked well without limiting numbers. Two participants reported technical difficulties when downloading the application and logging on. Participants preferred 30 minutes exercise and 15 minutes of spinal/pain information. Patients felt it was important to be physiotherapist-led for confidence with exercise rather than a general virtual exercise class.

Conclusion
Virtual spinal rehabilitation group programmes are challenging but could play an important role in improving general and spinal health. Pilot 3 methodology will be implemented with outcomes compared to the group running prior to COVID-19.

The impact of the COVID-19 pandemic first national lockdown on emergency referrals to a tertiary referral spine centre

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Introduction
The novel virus SARS-Cov-2 has had a profound worldwide impact with 1.86 million deaths worldwide, and unprecedented pressures on healthcare. This study aimed to establish the effect of a national lockdown on referrals to an emergency spinal surgery service.

Method
All emergency referrals by Sheffield's adult spine centre (direct emergency referrals and tertiary emergency referrals from 5 surrounding hospitals) over a six-month period were analysed (January 6th 2020 to July 26th 2020). Data collected included demographics, pathology being referred, mechanism of injury (where relevant), and treatment.

Results
A total of 1156 patients were referred during the period studied. (680 direct and 411 indirect referrals, and 65 indirectly assessed and transferred to the spinal centre). Referrals were 21% lower across the lockdown. Mean referrals 43.3 patients per week (p/w) pre-lockdown, 34.2 p/w during lockdown, 45 p/w post lockdown. Referral patterns changed during the lockdown period with mean 17.75 referrals p/w during the first 4 weeks and returning to 38.3 p/w referrals during the second month.

Conclusion
Referral patterns changed dramatically during the initial stages of the national lockdown, before recovering to normal levels. This emphasises the need for clear communication with both patients and colleagues that emergency spinal services are available during lockdown. Without this, there is a risk that patients with treatable pathology may come to unnecessary harm.

Safety of corticosteroid injections during the COVID-19 pandemic – a retrospective observational study

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Introduction
Corticosteroid injections are an important treatment for a wide range of musculoskeletal and spinal conditions. At the onset of the COVID-19 pandemic, national guidelines were published cautioning against use of CSI – largely due to the proposed risk of immunosuppression exacerbating COVID-19 infection. Our study investigates whether use of CSI in our trust led to increased or more severe COVID-19 infection.

Methods
A retrospective observational study was undertaken of consecutive patients who had CSI in our local hospitals. Records of CSI on Electronic patient records (EPR) and radiology information system (RIS) databases were crossreferenced with SARS-CoV-2 RT-PCR testing, SARS-COV2 IgG antibody testing, and radiological investigations on RIS. Reference was made to the incidence of lab-confirmed COVID-19 cases in our region.

Results
During the study period, 1,656 lab-confirmed COVID-19 cases were found - a rate of 306.6 per 100,000. A total of 504 CSI injections were performed. 16 CSI patients had laboratory investigations for COVID-19 (11 RT-PCR and 5 IgG antibody), of which 2 were found to be positive on IgG antibody, having had asymptomatic infections in both cases. 7 CSI patients had radiological investigations for respiratory symptoms, identifying indeterminate ground glass change in one.

Conclusion
We identified a very low incidence of COVID-19 infection following CSI in our cohort and found no serious adverse clinical outcomes following COVID-19 infection. The results of our small observational study are consistent with CSI being low risk during the COVID-19 pandemic and support current multi-society guidelines regarding the judicious use of CSI.

Paper Session 5: Innovation & Technology

Feasibility & Costing study of bone harvest during lumbar spine surgery for subsequent use as fresh frozen allograft

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Introduction
Allograft bone is commonly used in spinal fusion procedures to augment autologous bone graft. Factors influencing the choice of graft include surgeon past experience/preference, availability & cost. The availability of fresh frozen femoral heads can be limited and post-thawing milling is required. NHS Blood & Transplant (NHSBT) freeze dried and irradiated bone is an expensive alternative. We conducted a prospective study to look at the feasibility of harvesting bone during lumbar spine decompression surgery and the processing costs involved for clinical use as fresh frozen allograft.

Materials & Methods
In 30 consecutive patients, the amount of 'rongeur bite' bone granules harvested per spinal level was measured (potentially fresh frozen allograft). Processing costs were calculated based on existing practice for harvesting/storing femoral head allograft in our local bone bank.

Results
An average of 4.1grams (g) was harvested per spinal level (range 2.2 -8.3g); 2 level decompressions therefore yielding approximately 8 grams of allograft. In the presence of an existing local bone bank facility, total processing costs (irrespective of number of levels harvested) per patient was £94.03, comparing favourably with equivalent amounts of allograft material sourced from NHSBT.

Conclusion
We consider the harvest of lumbar spine decompression bone granules, for use as fresh frozen allograft to augment autologous bone in lumbar spinal fusions, to be a safe and economical alternative to femoral head frozen allograft and NHSBT freeze dried and irradiated bone.

Ultrasonic bone cutting device use in spinal surgery: a systematic review

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Introduction
High-speed rotary drills have long been the mainstay for bone dissection within spinal surgery. The associated risks of iatrogenic injury to surrounding structures such as nerves, vessels and the dura mater are well documented. Ultrasonic bone cutting devices (UBD) have recently gained favour for use in spinal surgery. They offer theoretical advantages including less soft tissue trauma, bleeding, neurological injury and shorter operative time. In this study we provide a comprehensive summary of all the evidence to date pertaining to the use of UBD in spinal surgery.

Method
A systematic review adhering to the PRISMA guidelines was performed. Qualitative analysis was conducted to compare the reported outcomes and complications associated with the use of UBD in spinal surgery.

Results
A total of twenty-nine studies were included, evaluating 1,996 cases of UBD use within various procedures; the most common being laminectomies, followed by facetectomies and corpectomies. Consistent reductions in blood loss and requirements for transfusion were reported. Studies reported

lower rates of dural injury and cerebrospinal fluid (CSF) leak, reduced heat generation and thermal induction of bone necrosis. No differences between UBD and traditional bone cutting devices were found for length of operative time or post-operative infections. Savings made in complication reduction and blood transfusion may offset the high costs associated with UBD use.

Conclusion
UBD use within spinal surgery offers compelling advantages in operative outcomes, complication rates and technical approaches. Further high quality research, including randomised studies are required to evaluate their use further in a variety of approaches.

Application of Full Spinal Endoscopy for the treatment of Thoracic Disc Prolapse and other pathologies

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Introduction
Technical developments enable spinal surgeons to adequately visualize thoracic anatomy using endoscopic equipment. Our aim was to review the literature relating to thoracic Full Endoscopy (FE) comparing routes of access and outcomes.

Methods
PubMed, the Cochrane database and Google Scholar were searched for full text articles in any language. Additional material was sought from personal bibliographies and by reference tracking. Excluded were technical reports, meeting abstracts and animal studies.

Results
95 unique articles yielded 17 patient series, 1 cohort study and 13 case reports (460 patients) meeting the inclusion criteria. A transforaminal approach was favoured for resection of disc prolapse (20 articles) and an interlaminar (6 of 11 articles) for cord compression due to ligament stenosis from ossification of the flaval or posterior longitudinal ligaments. The remainder included extra-foraminal, transpedicular or transcorporeal access. Three studies described use of a Hol-YAG laser and one of an ultrasonic bone knife. Excellent or good outcomes were achieved in 81% patients (range 46-100%). Complications at 8% compared to rates of 11-39% in meta-analyses of open procedures. 11 patients (2%) suffered dural tear primarily during interlaminar surgery. FE improved VAS for back and leg pain by 78±14% and 75±19%. ODI decreased from 60±7% to 19±11% ($p<0.001$, paired t-test). Twenty-one of the 31 author groups used local anaesthesia plus sedation rather than general anaesthesia.

Conclusions
The data shows excellent results from FE approaches to the thoracic spine with route of access determined by pathology. Reported complications rates are lower than those from comparative open studies.

Robotic Assisted Versus Fluoroscopic Guided Approach In Pedicle Screw Insertion: A Systematic Review And Meta-Analysis

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Objectives
The robotic assisted surgery has become prevalent in most of the surgical subspecialty. The adaption of such technique in spine surgery has resulted in minimising several issues encountered with fluoroscopic guided approach. The aim of this study is to compare the outcomes of robotic assisted approach and fluoroscopic guided approach in pedicle screw insertion.

Methods
PUBMED, EMBASE, MEDLINE and CENTRAL database were systematically searched from its inception until November 2020. All the studies comparing robotic assisted surgery and fluoroscopic guided approach in pedicle screw insertion were included for quantitative and qualitative analysis.

Results
Twenty-eight studies enrolling 2105 patients (robotic group: 1027, fluoroscopic: 1078) and total screws of 8668 screws (robotic group: 4217, fluoroscopic group: 4451) were eligible for inclusion, these studies consisted of 19 observational studies, 7 randomised controlled trials (RCTs) and 2 cadaveric study. Robotic assisted approach was associated with significantly higher accuracy (Grade A+B) (OR=2.34; $P<0.0001$) and distance between pedicle and screw (MD: 1.69; $P=0.001$), lower incident of facet joint violation (OR=0.22; $P<0.00001$), screw revision (OR=0.38; $P=0.009$), intraoperative blood loss (MD:-116.95; $P=0.0006$), shorter pedicle screw placement time (MD: -4.66; $P<0.00001$), radiation exposure time (MD:-5.27; $P=0.0001$), radiation dose (MD:-22.30; $P=0.0002$) and postoperative hospital stay (MD: -0.79; $P=0.02$) compared to fluoroscopic guided approach. There was no significant difference in operative time and wound infection.

Conclusion
In this meta-analysis, robotic assisted approach is more effective in achieving better clinical outcomes compared to fluoroscopic guided technique in pedicle screw insertion. However, future adequately powered RCTs are warranted to generate standardised outcomes.

Paper Session 6: Care Pathways

Patients' experiences of a new UK sciatica pathway. A qualitative, interpretative study.

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Purpose
Amid a political agenda for integrated, high-value care, the UK is implementing its Low Back and Radicular Pain Pathway. To align care with need, it is imperative to understand the patients' perspective. The purpose of this study was therefore, to explore how people experience being managed for sciatica within an NHS care-pathway.

Method
This qualitative interpretative study was located in a UK NHS, Musculoskeletal Service. Fourteen participants with a clinical presentation of sciatica were recruited, sampled purposively for variation in age and gender. Data were collected using individual semi-structured interviews (duration: 38-117 minutes; median: 82.6 minutes), which were audio-recorded and transcribed verbatim. Data were analysed thematically.

Results
A series of problems with the pathway (insufficient transparency and information; clinician-led decisions; standardised management; restricted access to specialist care; and a lack of collaboration between services) made it difficult for patients to access the management they perceived necessary. Patients were therefore required to be independent and proactive, or to have agency. Agency was, however, difficult to enact (due to the impact of sciatica and because patients lacked the necessary skills, funds and support) and together with the pathway issues, this negated patients' capability to manage sciatica.

Conclusions
This paper, the first to our knowledge, to explore patients' experiences of a sciatica pathway, suggests the need for sciatica care-pathways to align with recommended best practice, and also to be more person-centred and to empower patient agency.

Keywords
Agency; Care-Pathway; Patient experience; Qualitative Research; Sciatica; Treatment Burden.

The Watching Pregnancy Project: LBP occurrence, symptoms and healthcare use from 20-weeks' gestation until 6-months after birth

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Introduction
Many pregnant women experience LBP during pregnancy, which often persists after birth. Those effected have reported frustration that their symptoms are not taken seriously, along with limited availability of treatments to meet their needs.

Method
A prospective observational cohort study followed a sample of pregnant women living in the UK, from their routine anomaly scan until six months after birth. An online questionnaire was employed to remotely collect data about LBP history, presentation, treatment and patient reported outcomes at four pre-defined study time-points, two during pregnancy and two after delivery. The study objectives were to test the feasibility of the proposed methods of recruitment and data collection, to describe changes in outcomes and healthcare use at each study time-point.

Results
307 women consented to participate and completed the first questionnaire, with 50% attrition over the course of the study. 121 women completed all four questionnaires. Clinically important changes were observed in quality of life and functional disability with high fear-avoidance beliefs between 31 to 33 weeks' gestation. Women with a history of LBP were more likely to have symptoms persisting 6-weeks after birth. Over 50% did not receive any treatment for their LBP. A significant proportion opted to self-medicate with painkillers, and many of those receiving physiotherapy for their LBP chose to self-refer.

Conclusion
The sole use of remote data collection was a feasible methodology. The deterioration in function and health-related quality of life, along with high fear-avoidance beliefs about physical activity, observed in this study warrant further investigation.

The acceptance of clinical decision support systems among clinicians in the treatment of neck and/or back pain in primary and secondary care.

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Introduction
Clinical Decision Support Systems (CDSSs) are computerized systems using case-based reasoning to assist clinicians in making clinical decisions. Despite the proven added value to healthcare, the implementation of CDSS in daily clinical practice is scarce. Particularly, little is known about the acceptance of CDSS among primary and secondary care clinicians in the treatment of Neck and/or Low Back Pain (NLBP).

Method
To assess the acceptance of CDSSs among clinicians we conducted a mixed method analysis of questionnaires and focus groups. An online questionnaire sent to Dutch GPs aimed to identify the factors influencing the acceptance of CDSSs in primary care (intention to use, perceived threat to professional autonomy, trusting believes and perceived usefulness). Next to this, two focus groups were conducted with clinicians in secondary care addressing the general attituded towards CDSSs, the factors determining the level of acceptance, and the conditions to facilitate use of CDSSs.

Results
A pilot-study of the questionnaire is completed and the final results are expected in April 2020. Eight clinicians participated in two focus groups. After being introduced to various CDSSs, participants were positive about the value of CDSS in the care of NLBP. The clinicians agreed that the human touch in NLBP care must be preserved and that CDSSs must remain a supporting tool, and not a replacement of their role as professionals.

Conclusion
By identifying the factors hindering the acceptance of CDSSs in the primary and secondary care settings, we can draw implications for implementation in the treatment of NLBP.

Developing a pathway for the management of patients presenting with suspected myelopathy in secondary care

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Introduction
Degenerative cervical stenosis (DCS) is the most common cause of spinal cord compression. Progression of spinal cord compression to myelopathy is less common, but may occur in approximately 8% of those with DCS. It is difficult to predict progression, making it challenging to decide when to intervene with surgical management. A secondary spinal unit, with seven spinal extended scope practitioners (ESP), identified inconsistent management of suspected myelopathy and a reliance on consultant input.

Method
A rapid review of current evidence and management of degenerative spinal cord compression was completed in 2017, updated in 2020. This informed the development of a myelopathy pathway. The pathway was presented to peers and consultants within the Trust for input, before modification and approval.

Results
A myelopathy pathway was designed for use by ESPs. This pathway uses the Modified Japanese Orthopaedic Assessment (MJOA) tool, which classifies patients into mild, moderate, and severe cases, including asymptomatic patients with MRI signal change. For all cases, in the event of acute deterioration referral to the emergency department or on-call fellow is advised. Surgery is advised in severe cases (MJOA 1-11), and a sub-category for non-myelopathic patients with spinal cord compression with or without radiculopathy is also included. All patients are counselled on the risks and symptoms of myelopathy and a cervical stenosis booklet for patients, was developed alongside.

Conclusion
The pathway has been used in clinic for 3 years. Future plans to evaluate the effectiveness of the pathway through retrospective patient review, alongside patient feedback and experience.

Paper Session 7: Adult Deformity & Fusion

Opioid free analgesia in posterior lumbar fusion surgery to enhance recovery

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Introduction
Enhanced recovery after surgery (ERAS) promotes early recovery from major surgery by minimizing opioid consumption with use of regional anaesthesia and multimodal analgesia to promote positive outcomes after surgery. Reports of an ERAS based approach are rare in spinal surgery because regional anesthesia is used rarely. The purpose of this study was to measure perioperative opioid requirements with a technique using low dose spinal with morphine and local anaesthetic and to compare with a matched cohort of patients managed with traditional opioid analgesia.

Material And Methods
The treatment group (26 patients) patients had GA with low dose spinal prior to induction using 1-4mls of 0.25%Bupivacaine and 0.2mg morphine. Dose of spinal local anaesthetic was reduced to aid motor recovery and facilitate neurological assessment in recovery. The standard group (40 patients) had general anaesthesia without spinal but with traditional intra-operative opioid analgesia. Both groups had multimodal analgesia and surgical local anaesthetic infiltration with 60ml 0.25% Bupivacaine.

Results
In spinal group, the mean total amount of perioperative morphine equivalent was 15 grams less, and postop 48hr oxycodone 70 grams less, mean LOS was over one day less, and the mean VAS for pain in recovery 3 points lower. The Spinal group mobilised at a mean of 18 hrs vs 32 hrs for the GA group. All these results were statistically significant.($p< 0.001$)

Conclusion
Adding a spinal anesthetic to a GA reduces the perioperative opioid consumption and enables patients to achieve enhanced recovery goals like early mobilization and shorter length of stay.

Minimally Invasive Lateral Lumbar Interbody Fusion for Adult Spinal Deformity: Efficacy and Complications According to MiSLAT classification

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Introduction
Indications of minimally invasive lateral lumbar interbody fusion (LLIF) have increased in recent years. Adult deformity patients were classified according to MiSLAT classification and efficacy and complications of LLIF were evaluated.

Material and methods
This is a Prospective study of 115 patients (186 levels) operated between 2014-2019. All the patients were classified as per MiSLAT algorithm and surgically intervened with LLIF along with percutaneous pedicle screws posteriorly. Radiological and clinical outcome, PROM's (VAS, ODI, EQ-5D) and complications including revision rate were evaluated.

Results
Mean follow up was 21.70 months. Average segmental lordosis improved from 8.2° to 12.2° in MiSLAT 3 patients. In MISLAT 4 patients, average pre-operative lumbar lordosis and scoliosis improved from 23.6° and 11° respectively to 28. 6° and 3°. In MiSLAT 5 and 6 groups, the average pre-operative lumbar lordosis of 14.7° and pelvic tilt of 37° improved to 34° and 16°. Overall complication rate was 19.13 %, however, it was 38.8% in MiSLAT 5 and 6 group. Five patients had revision surgery within one year of the index procedure. Clinical outcomes and PROM's remained significantly improved at ⩾1-year. Mean pre-op ODI and VAS were 54.36 and 66.04 which improved to 39.25 and 39.37 post-operative period.

Conclusion
MiSLAT algorithm acts as a useful tool for classifying and planning surgical intervention. It also apprises surgeon of increased risk of complications in higher grade. Its implications while consenting cannot be disregarded.

Risk Factors for Distal Junctional Failure in Long Construct Instrumentation for Adult Spinal Deformity

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Background
The surgical management of adult spinal deformity (ASD) presents a difficult challenge for spine surgeons and is associated with a high complication profile in the postoperative period. Particularly, junctional failure is a major postoperative complication that necessitates revision. Little is known about risk factors for distal junctional failure (DJF) compared to proximal junctional failure (PJF). The aim of this study is to identify risk factors associated with postoperative DJF in long constructs for ASD.

Methods
A retrospective review was performed at a tertiary referral spine centre from 1st Jan 2007 to 31st December 2016. Demographic, clinical and radiographic parameters were collated for patients with DJF in the postoperative period and compared to those without DJF.

Results
102 patients were identified. 41 (40.2%) suffered DJF in the postoperative period, with rod fracture being the most common sign of DJF (13/65; 20.0%). Mean time to failure was 32.4 months. On multivariate analysis, pedicle subtraction osteotomy (OR: 27.3; p=0.03), postop SVA (OR: 1.66; p<0.01) and LL correction (OR: 1.12; p=0.02) remained statistically significant as independent risk factors for DJF.

Conclusion
Recently, DJF has received recognition as its own entity due to a notable postoperative incidence. Few studies to date have evaluated risk factors for DJF. The results of our study highlight that pedicle subtraction osteotomy and poor correction of lumbar lordosis and sagittal vertical axis are significantly associated with postoperative occurrence of DJF.

Retrospective Evaluation of Spinal Fusion Using a Biphasic Calcium Phosphate Bone Graft with a Novel Submicron Surface Topography

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Study Design
Retrospective Cohort Study Level of Evidence: IV Background: Limited availability of autologous bone graft has led to a vast array of allograft options available to surgeons correcting progressively more complicated spinal deformities in an ever-aging and challenging patient population. Utilizing modern bone biology knowledge, a novel submicron surface topography biphasic calcium phosphate (BCP) bone graft was utilized for spinal arthrodesis to assess the fusion rate and clinical outcomes in patients surgically treated.

Methods
Two cohorts of 25 cervical and 52 lumbar reconstruction patients underwent circumferential, or anterior column interbody reconstruction surgery with contemporary 3D-printed titanium interbody cages filled with combined allograft cortical shavings and a novel BCP with a unique submicron surface topography to achieve solid spinal arthrodesis. Fusion was assessed via CT-scans at various postoperative time points when flexion-extension radiographs failed to confirm a solid arthrodesis.

Results
Lumbar fusion rates were 94/97 levels (96.9%), or 94.2% in all lumbar reconstruction patients. Cervical fusion was observed in 75/80 (93.8%) levels or 21/25 patients in the cervical cohort. All pseudo-arthroses were observed in three, or more level reconstructions, with 100% fusion rates in all one and two-level cases. Modified Prolo scores showed Meaningful Clinically Important Differences (MCID) in 74/77 patients with 46.3% and 48.1% improvements in the lumbar and cervical cohorts, respectively.

Conclusions
For patients in need of complex cervical, or lumbar reconstruction surgery, this novel submicron surface topography BCP can offer a viable bone graft substitute for reliable augmentation of interbody arthrodesis formation with excellent clinical outcomes.

Paper Session 8: Conservative Therapies (2)

The usage of patient-reported data in machine learning to predict pain rehabilitation: possible or not?

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Aims
In the Netherlands, pain rehabilitation centres offer multidisciplinary biopsychosocial rehabilitation. Multidisciplinary treatments are defined as treatments that target physical as well as psychological or social aspects of musculoskeletal pain and involve a team of healthcare providers with different professional backgrounds and training. A patient should first fill in an intake questionnaire and must be seen by the multidisciplinary team before the final decision is made whether the patient actually can start. The objective of this study was to examine if patient-reported intake data only can be used to predict for pain rehabilitation admission with the help of machine learning (ML).

Methods
The clinical database of the Roessingh Center for Rehabilitation contains patient-reported intake data collected from 2013 to 2019. From 1652 patients was known whether they were admitted or not. With this dataset, two ML models – neural network and boosted trees - were trained and validated (80%), and tested (20%). AUROC (Area Under the Receiver Operating Characteristics) was used as performance measure.

Results
The AUROC values indicated small learning effects. The neural network predicted pain rehabilitation with AUROC 0.73 (validation) and 0.54 (test). The boosted trees predicted pain rehabilitation with AUROC 0.54 (validation) and 0.56 (test).

Conclusion
Patient-reported intake data does not contain enough information to predict if a patient will be admitted to a pain rehabilitation trajectory. More information is needed to develop more accurate ML prediction models i.e. information retrieved during the intake moment with the multidisciplinary team and other data sources e.g. patient health records.

State anxiety improves prediction of pain and pain-related disability after 12 weeks in patients with acute low back pain: a cohort study

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Introduction
Do measures of state anxiety and trait anxiety in people with acute low back pain (ALBP) improve prediction of chronic low back pain (CLBP).

Method
Observational multi-centre prospective cohort study in primary physiotherapy care with measurements at baseline and at 12 weeks of state and trait anxiety, as well as other established prognostic factors for CLBP. CLBP was defined as having pain 3/10 on the Numerical Pain Rating Scale and as a pain-related disability score 19/70 on the Pain Disability Inventory. Univariate and multivariate logistic regression analyses estimated how the risk of CLBP differed with state and trait anxiety.

Results
204 participants completed both assessments. State anxiety was an independent predictor of CLBP, whether defined as pain or pain-related disability at 12 weeks, in contrast to trait anxiety. State anxiety improved the predictive performance of the model, with area under the curve (AUC) increasing from 0.64 (95% CI 0.56 to 0.71) to 0.75 (95% CI 0.68 to 0.82) and Nagelkerke's R2 increasing from 0.08 to 0.24 for the primary outcome measure, pain. For pain-related disability: AUC 0.63 (95% CI 0.54 to 0.72) improved to 0.73 (95% CI 0.65 to 0.82) and Nagelkerke's R2 increased from 0.05 to 0.16. Adding trait anxiety to the prognostic model for pain improved the AUC from 0.64 (95% CI 0.56 to 0.71) to 0.70 (95% CI 0.62 to 0.77) and Nagelkerke's R2 from 0.08 to 0.15.

Conclusion
State anxiety in patients with ALBP improved prediction of CLBP.

Patient journey following lumbar discectomy surgery: A qualitative analysis of the patient rehabilitation experience using patient diaries

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Introduction
Success rates for discectomy are 78-95%. This study aim is to understand recovery from a patient's perspective and gives insights to factors that influence their outcomes.

Methods
A purpose sample of 14 patients was used who had discectomy surgery. Patients recorded a weekly diary that captured post-operative experiences. A topic guide was developed to help patients. Interpretive Phenomenology Analysis (IPA) was utilised to analyse the diaries. Strategies such a reflexology were employed to ensure trustworthiness. Ethical approval was by London-Bloomsbury Research Ethics Committee (18/LO/0459; IRAS 241345)

Results
4 themes; i) Waiting. The initial weeks post-surgery were characterised by, isolation and poor understanding. Lack of contact with health professionals was a major influence; ii) Patient/Health care interaction. Contact with health professional resulted in reassurance and self-evaluation meant they could make sense of their recovery. However, some interaction let to avoidance of activities and increased vigilance of symptoms which hindered progress; iii) Progress and Recovery. A return to work and valued activities was the barometer for successful recovery; iv) Emotional response. Positive emotions were linked to being able to perform a valued activity and increased motivation to do more. When negative (stress, fear) this slowed recovery and reduced patient motivation and self-management.

Conclusion
Times frames between discharge and initial contact with a health professional should be considered. Health professionals influence a patient's journey positively and negatively and must do their utmost to limit the later. Attainment of valued activities encouraged progress and positive emotions, thus, should be considered during individualised rehabilitation.

Paper Session 9: Cauda Equina Syndrome

Urodynamic post-residual urine volume value in Cauda equina syndrome assessment (A Meta-analysis study)

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Background
Cauda equina syndrome (CES) is a rare but serious condition that, if missed at initial presentation, can lead to serious morbidity and disability. Early diagnosis is crucial for a favourable outcome. Few studies included urodynamic test and measurement of post-void residual urine (PVR) as an adjunct screening tool for acute CES before proceeding to MRI scan, yet there are differences in the cut-off point as a threshold volume for doing MRI amongst these studies.

Aim
Meta-analysis and systematic review of literature that included PVR as a predictive tool in CES to identify the reliability of PVR and the optimal numerical value to predict CES.

Material & Methods
A comprehensive literature search was undertaken in PubMed, Medline, and Embase databases using our search strategy. Meta-analysis of collated data was done.

Results
A total of seven studies were included with a total of 938 patients. The number of cases suitable for meta-analysis was 714. CES was confirmed in 73. urodynamic testing and PVR diagnosed 86 and excluded 426. The sensitivity of PVR> 100ml was 64% (CI 97.5%: 0.44-0.80), specificity 59.2% (CI 97.5%: 0.46 - 0.711), while PVR >200 showed more predictive figures, with sensitivity improved to 83.1% (CI 97.5%: 0.62-0.94) and specificity to 93.5% (CI 97.5%: 0.50-0.99).

Conclusions
Urodynamics test is an essential tool in CES assessment. Authors recommend PVR > 200 ml as the numerical cut-off point might be the used along with other clinical red flags to recommend urgent MRI in suspected acute CES.

Understanding Cauda Equina Syndrome: A UK multicentre prospective observational cohort study

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Introduction
We aim to describe the clinical presentations, investigation, management, and outcomes of Cauda Equina Syndrome (CES). This will improve understanding of current practice, likely outcomes, and features associated with better outcomes.

Methods
This is a prospective multi-centre observational cohort study of adults with clinical and radiologically confirmed CES admitted to UK spinal units between June 2018 and May 2019. Patient reported outcome measures (PROMs) at 6 and 12 months include pain scores, Oswestry Disability Index, and validated bladder, bowel, sexual, and quality of life questionnaires. All results are provisional as data cleaning is in progress.

Results
661 patients from 35 centres were identified (53% female, median 43yrs). 426 (63%) agreed to complete PROMs. Surgical decompression was performed as an emergency in 549/661 (83%), with 291/549 (53%) performed out of hours. 547/661 (83%) of patients underwent decompression within 48 hours of admission. Symptoms on admission were: bilateral sciatica (40%); bladder dysfunction (74%); bowel dysfunction (21%); sexual dysfunction (8%); loss of saddle sensation (59%). Complete resolution of symptoms at discharge occurred in 256/661 (39%). Ongoing symptoms included sciatica (7%); bladder dysfunction (16%); bowel dysfunction (4%); and saddle sensory changes (10%).

Conclusion
This is the largest prospective cohort of patients with CES. Over 80% of patients undergo decompression within 48 hours of admission, but fewer than 40% have resolution of symptoms at discharge. Six month follow up data will be available by April 2020. Analysis of six and twelve month PROMs will allow stratification of outcomes by presentation and management.

Invisible Disabilities – Do I need rehabilitation when I am walking? Specialist Inpatient Rehabilition for Ambulant Patients with Cauda Equina Syndrome (CES)

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Cauda equina syndrome (CES) presents from multiple pathologies. While the incidence of the disease is low, with estimates between 1 in 33,000 to 100,000, the long term sequelae of the disease can be devastating. Bladder, bowel, sexual dysfunction and neuropathic pain are common issues following CES but are often invisible and ignored. Early rehabilitation is crucial and provides the best opportunity for optimal management of persisting deficits even when the neurological recovery is incomplete. In 2016, a review of 37 CES patients showed that only 50% received inpatient rehabilitation. In cases where patients were ambulant they were treated in outpatients, with multiple reviews, in different departments, spanning many years. Since 2017 we have been providing inpatient rehabilitation for ambulant patients with CES. Ambulant-CES Pathway We have developed a focused, goal-orientated 3 week multidisciplinary integrated care pathway (ICP) which has significantly improved care provision, outcomes and patient satisfaction. We will present the results of our audit which show that 100% of patients are received neuro-urology care; 90% received specialist bladder investigations; 95% received CES education; 93% were reviewed by Orthotics; 79% had discussion about long term prognosis with a specialist spinal rehabilitation consultant. Spinal Cord Injury Outcomes (SCIM) show an average improvement of 15 points following an inpatient stay. The ICP provides comprehensive multidisciplinary assessment and action within three weeks. This unique approach is now being considered by other Spinal Rehabilitation Units. It provides a holistic pathway for all patients with CES even when they have hidden neurological impairments.

What impact has the 2019 GIRFT report had on Out of Hours MRI access for Cauda Equina Syndrome in England?

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Introduction
The British Association of Spine Surgeons and the Society of British Neurological Surgeons both recommend that emergency MRI scanning for patients with expected Cauda Equina Syndome (CES) must be available 24/7. The 2019 Getting It Right First Time (GIRFT) report on Spinal Services in England highlighted that "whilst MRI scanners are physically present in many hospitals they are not functional out of normal working hours" and recommends that all trusts review their on-call arrangements for radiography. The purpose of this audit was to determine current National practice against these guidelines.

Methods
Using the NHS Service Directory, 166 Hospitals with A&E departments were identified. The On-call Orthopaedic Doctor at each hospital was contacted and an over the phone questionnaire completed. Details regarding the access to Out of Hours (OOH) scanning were recorded as well as the location of the referring hospital if no such on-call service existed.

Results
Currently 49 hospitals have been contacted and 29 responses gained. 3 hospitals offered an acute spinal service and 23 offered assessment only. Of these 23 hospitals, only 30% had OOH access on site with the other 70% requiring transfer to the local referral centre. Only 2 hospitals had on-site 24/7 access. None of the hospitals contacted had changed their management pathway since the recommendations of the GIRFT report.

Discussion
The preliminary results reveal that the 2019 GIRFT report appears to have had little impact on the timely OOH access to MRI scanning for patients with suspected Cauda Equina Syndrome.

Diagnostic accuracy of digital rectal examination in detecting cauda equina compression in people presenting with acute cauda equina syndrome. A systematic review with meta-analysis

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Background
Digital rectal examination (DRE) is commonly used to triage people with suspected cauda equina syndrome despite research suggesting its low reliability. This review aimed to determine the diagnostic accuracy of DRE in assessing anal tone, squeeze, sensation and reflexes as predictors of cauda equina compression (CEC).

Methods
A systematic review of studies investigating the reliability of DRE for diagnosing CEC compared with lumbar MRI was undertaken. Six electronic databases were searched from inception to 6th July 2020 for articles published in English. Two assessors independently performed screening, data extraction and risk of bias assessment (QUADAS-2).

Results
Six studies were included in the final analysis (n=741), of which five had a high risk of bias. Five studies provided anal tone data. Meta-analysis of these found pooled sensitivity: 0.37 (95% CI; 0.28, 0.50) and pooled specificity: 0.81 (95% CI; 0.78, 0.85). One study on anal sensation found no correlation with CEC (Kendalls tau test: 0.102) and another found sensation had test accuracy: 0.49. One study identified sensitivity: 0.29 and specificity: 0.96 for anal squeeze, while another identified sensitivity: 0.38 and specificity: 0.6 for anal reflexes.

Conclusion
DRE for anal tone testing cannot reliably identify CEC. It carries a high risk of false reassurance and is therefore not recommended. Clinicians should adopt a low threshold for emergency MRI, when onset or progression of CES symptoms is within recent days or weeks. Insufficient evidence was found to determine the reliability of anal squeeze, sensation and reflexes.
Keywords; cauda equina syndrome, DRE, anal tone.

Paper Session 10: Infection

Spontaneous pyogenic spondylodiscitis: Is Spinal Biopsy must in all cases?

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Background
Spondylodiscitis is increasing in prevalence due to the combined effect of an increase in susceptible population and improvement of ascertainment and there appears to be little consensus on the optimum management of this condition.

Methods
This study analyses treatment of 61 consecutive patients who were treated conservatively for spontaneous pyogenic spondylodiscitis with antimicrobial therapy with or without spinal biopsy and their associated clinical, serological, radiological outcomes over a three year period at a tertiary spinal referral centre in United Kingdom trust hospital.

Results
A retrospective search strategy identified 61 patients, 45 patients treated with antimicrobial therapy without spinal biopsy and 16 patients treated with spinal biopsy followed by antimicrobial therapy. The treatment outcome of 11/16 (68.75%) patients in the biopsy group was successfully based on their clinical, serological, radiological outcome measures and the duration of antimicrobial treatment. Two out of the five patients were considered to be unsuccessfully treated had prolonged duration of antimicrobial treatment and three other patients considered to be unsuccessfully treated had worsening radiological parameters. In the non-Biopsy group, 41/45 (91%) patients were treated successfully based on these outcome measures. Of those four patients that failed to be successfully treated in non-biopsy group, one was treated for prolonged duration and three had worse outcomes.

Conclusion
The study found significant difference in the treatment outcome of spondylodiscitis patients in nonbiopsy group as compare to the biopsy group ($p<0.05$). The study recommended further prospective, randomised controlled trials to evaluate thoroughly the efficacy and requirement to perform spinal biopsy.

A proposed classification based on surgical treatment strategies for reconstruction of the lumbosacral spine in advanced lumbosacral tuberculous spondylodiscitis

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Introduction
Surgical reconstruction of the lumbosacral junction in advanced lumbosacral tuberculosis is technically demanding due to the complex local anatomy, unique biomechanics and difficult fixation in the diseased bone. We have analysed the difficulties encountered in surgical reconstruction of the lumbosacral junction, in order to describe an effective strategy for tuberculosis with extensive destruction of lumbosacral spine.

Methods
We reviewed a prospective cohort of 46 patients with advanced lumbosacral tuberculosis (L3 to sacrum) who underwent surgical reconstruction according to the following protocol. Patients with L5 tuberculous spondylitis (Type-1) were treated with posterior stabilization involving L3, L4, S1(with supplemental iliac screws, if anchorage in S1 was inadequate). In L5-S1 spondylodiscitis with extensive destruction of sacral promontory with disease free sacral ala (Type-2), lumbosacral spine was reconstructed by spinopelvic stabilization using alar screws with supplemental iliac screws. In

extensive L5-S1 spondylodiscitis with destruction of both sacral promontory and sacral ala (Type-3), stability was achieved with spinopelvic stabilization using iliac screws alone as distal anchors. Additional anterior reconstruction was performed when there was a significant anterior column deficiency and an additional restoration of lordosis within physiological limits was needed.

Results
Average follow-up was 43.5+/-6.2 (38-120) months.All patients showed good bone healing at a mean of 9.6+/-1.4 months, significant improvement in neurology, VAS and ODI scores,ESR and CRP, p<0.05.

Conclusion
The proposed classification and the corresponding treatment strategies are effective in addressing various scenarios of lumbosacral tuberculosis with extensive destruction of lumbosacral spine, in a systematic way. It helps reconstruct the lumbosacral spine, restore stability and physiological lumbar lordosis as evidenced by good radiological and functional outcomes at a mean follow-up of 43.5+/-6.2 months.

Management of Deep Spinal Infections – a Regional Tertiary Centre Experience

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Introduction
De novo spinal infections classically presents with pain, neurological deficits and systemic infection but may present vaguely thus delaying management. Guidelines An algorithm for the management of spinal infections (Vaccaro et al (1)) was used as our standard. In 2019, the British Association of Spinal Surgeons (BASS) issued a management update for pyogenic spinal infections. (2) Both share similarities and we have taken this into account.

Methods
A single-centre retrospective review of patients referred to our unit with a clinical and radiological diagnosis of spinal infection over two separate 12-month periods. Data from electronic records were collated and compared to best practice management as described above.

Results
Just over 40% of referred patients were managed within the tertiary spinal unit in both series. Most were conservatively managed: in the initial series 26% underwent surgery, compared to 38% subsequently. Image-guided biopsy was performed in 18% cases from our original series with a positive yield of 11%. Subsequently, image-guided biopsies were performed in 38% cases with a positive yield of 42%.

Conclusions
Most patients were managed non-operatively following contact with the regional spinal unit with evidence of favourable outcomes. A modified algorithm appears to have contributed to this. It would be beneficial to have a standardised pathway for patients with deep spinal infections facilitating initial management in non-specialist hospitals.

References
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Paper Session 11: Paediatric Deformity (1)

Reducing surgical site infection in complex paediatric spinal surgery through the use of an infection bundle

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Background
Minimising Surgical Site Infection (SSI) is essential in reducing patient morbidity and mortality. A multimodal prevention strategy is recognised as a preventative measure but is yet to be formally adopted as routine practice within the spinal community.

Purpose
To evaluate the efficacy of a preventative infection bundle for patients undergoing complex paediatric spinal surgery.

Study Design/Setting
Retrospective review of SSI data prior to and after introduction of a preventative care bundle

Patient Sample
All paediatric patients who underwent complex deformity surgery in a tertiary referral centre.

Outcome Measures
Surgical Site Infection rates within one year of index procedure.

Methods
A 6 month retrospective audit evaluating SSI rates (defined as an infection within 1 year of index procedure) followed by impact assessment of a novel infection bundle on SSI rates 18 months after it's introduction.

Results
Pre-bundle, 10/47 patients developed a SSI, with an infection rate 21.3%, mean average age 10.6 years (4 – 15 years). At latest follow up post bundle introduction, 3/135 (mean average age 16 years, 5-17) developed a SSI (2.2%) with 0/66 developing SSI within 1 year of their index procedure ($p<0.05$).

Conclusions
This study demonstrates a significant improvement in rates of SSI in paediatric patients undergoing complex deformity surgery following introduction of a preventative care bundle. We recommend the routine use of such measures to reduce what is a potentially devastating complication.

What is the need of the High Dependency Unit in adolescent idiopathic scoliosis surgery?

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Introduction
There are guidelines from the British Spinal Society and NHS England's contract for complex spinal services pertaining to the management of adolescent idiopathic scoliosis (AIS). All AIS patients at our unit are managed on a paediatric ward post-operatively, without HDU support. We evaluated patient related outcome measures to ensure management without HDU support in the post-operative phase continues to be safe practice.

Methods
AIS patients undergoing correction between 2016 – 2018 had their data prospectively recorded. Patients were managed according to a locally developed scoliosis pathway. Patients were older than 12 years and surgery was undertaken through posterior approach only.

Results
Of the 33 patients(mean age 15.2 years +/-0.9) none had a significant medical event that warranted intervention or transfer to a HDU type facility. The mean length of stay was 5.5(SD+/-1.6) days. Mean Oxycodone IR requirement was 53mg. There was no relation between body weight and the dosage of analgesia required. The comparison of pain scores (new anaesthetic regime/historical control) showed a statistically significant improvement ($p=0.035$). The highest cumulative incidence of nausea (45%) and vomiting (45%) was seen on day 2. 85% of the patients achieved their physiotherapy goals on day 1 and 96% by day 2.

Conclusion
This quality improvement study demonstrates that AIS surgery can be performed safely without the need for a HDU in healthy adolescents. The new regime compares favourably to the historical control and indicates these patients can be managed with oral analgesia and a strong multi-disciplinary support on a paediatric ward.

Vertebral body tethering in Adolescent Idiopathic Scoliosis. A prospective look at early intra-operative, radiological and patient reported outcomes of a single surgeon series

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Introduction
Anterior vertebral body tethering (AVBT) may have a role in selected patients, allowing modulation of spinal growth whilst preserving spinal mobility. We present the initial experiences of a single surgeon, with radiological and clinical outcomes.

Methods
The initial 14 consecutive patients with adolescent idiopathic scoliosis undergoing AVBT were recruited. Radiological parameters were collected pre-operatively, and at mean of 11.1 days, range 6-43 (m.11.1, r6-43) post-operatively. SRS22r scores were obtained in all patients pre-operatively and post-operatively in 10 at m157.4 days (r35-343).

Results
We had 13 females and 1 male aged m12.9 yrs (r10-15), Risser m0.86 (r0-4), Sanders m3.7 (r2-7). 6 patients comprised a selective thoracic tethering group (STG) (m7.7 levels tethered, r7-8), and 8 patients comprised a double-tether group (DTG) (m11.5 levels, r11-12) with staged procedures. We utilised a thoracoscopic assisted technique for thoracic and mini-open thoracoabdominal approach for lumbar curves, without annulotomy. Mean STG pre-operative thoracic Cobb reduced from 46.7°(r30-62) to 29.8°(r7-42), lumbar from 27.8°(r20-38) to 15.3°(r2-26). DTG thoracic Cobb reduced from 45.1°(r36-62) to 16°(r11-21), lumbar from 44.9°(r32-58) to 12°(r4-40). Mean pre vs post op SRS domains were: Function 4.2(r3.2-4.8) vs 4.2 (r2.6-5.0); Pain 3.9(r2-4.8) vs 3.9(r2.6-4.6); Self-image 3.5(r2.2-5), vs 4.2(3.4-5.0); Mental health 4.1(2.8-5) vs 3.5(r3.0-4.6); Satisfaction 3.7(r1-5) vs 4.7(3.2-5); Overall 3.9(r2.5-4.8) vs 4.1(r3.2-4.8). No complications were recorded at m470.5 days post-operatively (r300-678).

Conclusion
We demonstrate reduction in thoracic and lumbar Cobb measurements for both groups. Our small data set doesn't demonstrate any trend in domain/overall SRS22r score. Optimum patient selection and ideal timing of intervention require clarification.

Enhanced Recovery After Surgery (ERAS) in Adolescent Idiopathic Scoliosis (AIS) - A Systematic Review

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Introduction
Spinal fusion for AIS may be associated with significant postoperative pain,prolonged hospital stay and lengthy rehabilitation. ERAS is a multidisciplinary approach aimed at improving outcomes of surgery by a specific evidence-based protocol.The rationale of this rapid recovery regimen is to maintain the homeostasis so as to reduce the postoperative stress response and pain.

Methods
A systematic review of the English language literature was undertaken using search criteria (postoperative recovery AND adolescent idiopathic scoliosis) using the PRISMA guidelines (Jan 1999-Sept 2019). Isolated case reports and case series with <5 patients in the study population were excluded.

Results
Out of 21 articles,8 studies that met inclusion criteria(7 of Level III and 1 of level IV evidence)were analysed.Overall,865 patients were identified who underwent ERAS-type protocol following posterior correction of scoliosis and were compared to 627 patients following conventional protocol(table 1).There was significant difference in length of stay and rate of complications when compared to conventional protocols.Each protocol employed a multidisciplinary approach focusing on optimal pain management, nursing care and physiotherapy.

Conclusion
Preliminary studies have highlighted advantages in reduction in length of stay and as well as lower complication rates but with more readmission rates for ERAS as compared to conventional protocols.However,current literature is restricted largely to retrospective studies with non-randomized data. Table1 Parameter ERAS Traditional approach Number(n) 865 627 Age(years) 14.41(range 11-20) 14.64(range 11-21) LOS(days) 3.48(range 2.2 – 4.1) 4.59(range 3.9 to 5.7) Complications(%) 6.15 %(range 1 - 15.6) 11.06 %(range 0.02-20) Readmission Rate(%) 3.25 %(range 0 - 5.0) 1.73 %(range 0-3.0)

Reducing dependency on critical care support in adolescent idiopathic scoliosis (ais) surgery: a critera-based pathway

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Background
The paucity of paediatric critical care provision relative to the demand results in many elective AIS surgery cancellations. There are examples or ward-based post-operative care pathways, but no robust data to provide assurance on safety and efficacy. This paper describes our retrospective and prospective experience of an Adolescent Scoliosis Pathway (ASP).

Methods
It was our standard practice to send all post-operative AIS patients either to PICU/PHDU. Using a previously published pre-operative predictive scoring we specified the predicted level of care for the AIS patients(1). In the retrospective study, that predicted level of care was compared to the actual post-operative care delivered (based specified critical care[CC] escalation triggers). Prospectively, 12 patients were thereafter operated as per the pathway criteria.

Results
The retrospective cohort consisted of 54 consecutive patients. The predicted vs.actual care numbers were 20 vs.6 patients for CC and 34 vs.32 patients for ward-based care. 70% of those treated on PHDU received only ward-based input. Only 6% of those predicted as ward-based care required CC escalation. The sensitivity & specificity of the predictive scoring were 75% & 70% respectively. The negative predictive value for CC escalation was 94%. The unnecessary CC-booking would have reduced from 85% to 26%. In the prospective ASP cohort of 12 patients, all ended with ward-based care postoperatively; none had any PEWS alerts or required CC escalation.

Conclusions
A clinical criteria based ASP is effective in predicting ward level care as sufficient for their needs and provides an effective planning tool, especially during winter pressures.

A 3D cluster analysis classification of adolescent idiopathic scoliosis using spine and torso parameters

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Purpose
This study examined and classified the variability and subtypes of the combined shape of the spine and the torso in 3D in Lenke 1, convex to the right, AIS.

Methods
Measures of coronal deformity, kyphosis and skin angulation (measuring torso asymmetry) were collected from ISIS2 surface topography images taken as part of routine care. A k-means clustering technique was used to identify the number and dimensions of the different subtypes of shape within the group based on these parameters. Using a k-nearest neighbour algorithm, the accuracy of automatic machine identification of the subtypes was established.

Results
There were 1399 pre-operative images from 691 different individuals. Using the elbow method, 5 clusters were identified. These clusters represented the spectrum of mild, moderate and marked scoliosis, normal and hypokyphosis along with mild, moderate and marked torso asymmetry. The k-nearest neighbour algorithm was accurate in 93% of cases.

Discussion
This study demonstrates that a 3D classification of AIS could include parameters describing both the shape of the spine and the torso. In those described as right sided Lenke 1 curves, there are 5 different patterns of deformity. The fully automated nature of the measurements along with the subsequent identification of the position in the cluster removes the element of human error. Further work will examine how surgery affects the 3D shape relative to the position in the cluster.

What does a diagnosis of AIS and Scheuermann's kyphosis do to the coronal and sagittal balance of the individual?

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Purpose
This study was performed to analyse the variability of coronal and sagittal balance in cohorts of individuals without spinal deformity, with AIS and with Scheuermann's kyphosis (SK).

Methods
From ISIS2 imaging, measures of coronal and sagittal imbalance were collected from those with outside spinal deformity (normals), with AIS (pre and post-operatively) and with SK. Both coronal and sagittal imbalance is a horizontal linear measure in millimetres reflecting the position of the Vertebra Prominens (VP) relating to that of the sacrum. The data was plotted using means and 95% confidence ellipse, demonstrated as a birds eye plot. Statistical significance was examined. The scoliosis and kyphosis (for AIS and SK only) was measured on radiographs.

Results
There were 829 normals, 289 with AIS and 59 with SK. The mean scoliosis was 58° pre and 21° post with a mean kyphosis of 68°. The mean coronal offset for all groups was between 2 and 6 mm and the sagittal offset was 12 and 26 mm. Statistically significance was seen for both measures between the non-scoliotic and both AIS groups, along with the pre-operative AIS coronal offset and post-operative AIS sagittal offset and the SK measures. However, all mean values were within the 95% confidence ellipse for all of the groups.

Discussion
Regardless of type or size of spinal deformity, the position of the VP and sacrum remain within the 95% confidence ellipse of the normals. This work defines the MCID for all diagnoses.

Specific Sagittal Alignment Patterns Are Already Present in Mild Adolescent Idiopathic Scoliosis

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Purpose
The complex three-dimensional spinal deformity in AIS consists of rotated, lordotic apical areas and neutral junctional zones that modify the spine's sagittal profile. Recently, three specific patterns of thoracic sagittal 'malalignment' were described for severe AIS. The aim of this study is to define whether specific patterns of pathological sagittal alignment are already present in mild AIS.

Methods
Lateral spinal radiographs of 192 mild (10-20 degrees) and 253 severe (>45 degrees) AIS patients and 156 controls were derived from an international consortium. Kyphosis characteristics (T4-T12 thoracic kyphosis, T10-L2 angle, C7 slope, location of the apex of kyphosis and of the inflection point) and sagittal curve types according to Abelin-Genevois were systematically compared between the three cohorts.

Results
Even in mild thoracic AIS, already 49% of the curves presented sagittal malalignment, mostly thoracic hypokyphosis, whereas only 13% of the (thoraco)lumbar curves and 6% of the nonscoliosis adolescents were hypokyphotic. In severe AIS, 63% had a sagittal malalignment. Hypokyphosis+thoracolumbar kyphosis occurred more frequently in high-PI and primary lumbar curves, whereas cervicothoracic kyphosis occurred more in double thoracic curves.

Conclusions
Pathological sagittal patterns are often already present in curves 10-20 degrees, whereas those are rare in non-scoliotic adolescents. This suggests that sagittal 'malalignment' patterns are an integral part of the early pathogenesis of AIS.

Paper Session 12: Cervical Degenerative (1)

Recurrent Laryngeal Nerve Palsy Following Anterior Cervical Discectomy and Fusion – the current UK practice.

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Introduction
Anterior Cervical Disectomy and Fusion (ACDF) is a commonly performed procedure to treat cervical disc disease. Recurrent Laryngeal Nerve Palsy (RLNP) following ACDF is a recognised complication with a quoted incidence of 7-24.2%. Despite the significant morbidity caused by RLNP there is no standard of care to reduce/manage the risks or consequences of RLNP.

Aim
In this study we aimed to establish the current UK surgical practice to reduce/manage RLNP after ACDF.

Method
An electronic questionnaire sent to UK Neurosurgeons and Spinal Orthopaedic surgeons via SBNS and BASS.

Results
185 surgeons completed the questionnaire. 52.9% had seen a RLNP after ACDF. There was a variation in the consent process but the majority (88%) consented for either RLNP or symptoms of RLNP. 86.4% of the surgeons operate from the right side. 1% of responders routinely undertake pre-operative assessment of the vocal cords. The vast majority do not undertake any formal intraoperative monitoring. Management of RLNP is variable with 58.5% referred to ENT, 34.6% observed and 30% referred to SALT.

Conclusions
We have demonstrated variations in the UK with respect to prevention and management RLNP and ACDF amongst spinal surgeons. The majority consent for complications but very few perform any pre or postoperative monitoring of recurrent laryngeal nerve function. Studies suggest that deflating ETT cuff pressure during ACDF reduces RLNP and based on our findings of significant variations in practice, we suggest a BASS/SBNS working party to set clinical standards of care for RLNP in ACDF.

Integrity test for the assessment of whiplash-associated disorders

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Introduction
Whiplash-related injuries are controversial, partly due to suspicion of symptom faking, associated to the existence of potential secondary gain or compensation, which is reported to have negative effects on recovery of claimants. Therefore, it is useful to provide clinicians with tools to assess the risk of feigned symptomatology, in contexts where the effect on compensation is concerning. We present a study to determine if such a tool can be developed, combining measurements derived from biomechanical evaluation, behavioural tests and evidence from self-reports, as indicators of malingered pain related disability.

Method
The study sample consisted of 68 participants, including patients who reported neck pain, classified by two independent examiners as "true" or "biased" responders, and recovered patients who were asked to "fake" the symptoms of former painful episodes. Patients passed the autobiographical Implicit Association Test (aIAT), an self-report questionnaire based on rare and impossible symptoms, and a physical assessment of neck motion patterns.

Results
The answers to questions related to "possible" and "rare" symptoms, and a combination of maximum angular velocity, harmonicity and variability of neck motion were chosen to fit a linear discriminant model. The model had limited sensitivity (58%), but a high specificity (90%).

Conclusion
The fitted model is conservative, i.e. there is low risk of "blaming" patients for exaggerating, which is the weak point of previous approaches. Sensitivity may be improved by increasing the sample of participants.

The effects of Ligamentum Flavum Unbuckling (LFU) on indirect posterior cervical decompression in a multicentre retrospective cohort study

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Introduction
Atraumatic degenerative cervical myelopathy (DCM) remains the commonest cause of spinal cord impairment in adults and carries considerable morbidity with surgery as the gold standard. We investigate whether anterior cervical decompression is associated with indirect posterior decompression.

Methods
The multicentre retrospective study identified 87 consecutive patients with cervical myelopathy from circumferential spinal cord compression who underwent anterior cervical decompressions across two centres. All patients underwent post-operative MRI as part of clinical follow-up. Circumferential cord compression was defined radiologically as cerebrospinal fluid (CSF) effacement anteriorly and posteriorly on mid-sagittal T2-weighted cervical spine MRI at the pertinent spinal level. Primary outcome was the presence of continued CSF effacement posterior to the spinal cord at the operated level; used as a proxy marker for ligaments flavour unbuckling (LFU).

Results
The primary endpoint of indirect posterior decompression based on the absence of posterior CSF effacement on the post-operative MRI was achieved in 94/120 levels (78.3%). In the remaining levels there was either improvement or no change in 24/120 levels (20%) and a worsening in 2/120 levels (1.7%). 2/87 patients (2.2%) required further surgery at that index level.

Conclusion
This study demonstrates the effectiveness of indirect posterior decompression with anterior surgery. The postulated mechanism for this is interdisc height restoration and ligamentum flavum unbuckling.

Does Surgery for Cervical Spondylotic Myelopathy produce Improvements in Function? Findings of the British Spine Registry

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Aims
To review the 1 year outcomes of patients undergoing surgery for CSM. To identify independent predictors of outcome.

Methods
Patients undergoing surgery for degenerative CSM with complete PROMS at 1 year recorded on the BSR were included. Primary outcome measure was myelopathic disability index (MDI). ANOVA was performed on 1 year outcomes.

Results
525 patients were identified: 81% underwent anterior surgery. The median MDI score prior to surgery was 22 (16.1-23.2), and 17 (24.1-32.6) one year post-operatively. 58% (303) of patients had improved MDI scores one year post-operatively. No significant differences detected between gender or age groups. SOM clustering identified five major clusters with significant differences in age, gender and the success of the operation (ANOVA $p < 0.01$)

Conclusion
Over half of patients improve following surgery for CSM at least 1 year post-operatively. There are a proportion of patients who deteriorate which may represent patient-specific factors, surgical selection, natural history or a combination. Further work is required to elucidate the underlying factors responsible for outcomes in CSM surgery.

Can Co-Authorship Networks Be Used to Predict Author Research Impact? A Machine Learning-Based Analysis of Degenerative Cervical Myelopathy Research

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Introduction
Degenerative Cervical Myelopathy (DCM) is a common but under-researched condition. The AO Spine RECODE-DCM project has recently established the top priorities for DCM research. Uptake of these priorities ('knowledge translation') depends on identifying key agents of change within the field. In this paper, we aim to identify agents of change by generating a co-authorship network and using this to predict author impact.

Methods
Using a database of 1674 scientific papers in the DCM field, a co-authorship network graph was created. For each author, statistics about their connections to the co-authorship network were generated. Using these statistics, a multilayer perceptron neural network was used to predict author impact (through the surrogate metric of h-index) using only connectedness statistics. The neural network was retrospectively validated on an unseen author set.

Results
DCM research is regionally clustered, with collaboration between centres, but seldom across borders. In retrospective validation, the neural network achieves a correlation coefficient of 0.86 ($p<0.0001$) between the true and predicted h-index of

each author. Thus, author impact can be predicted with high accuracy using only the nature of an author's collaborations.

Discussion
Analysis of the neural network shows that collaboration strongly impacts authors research visibility. In particular, collaboration with highly-visible (high-impact) authors is associated with high research impact. Greater collaboration within the DCM field, such as through mentorship, could therefore help to improve research impact and avoid duplication of effort. Use of this approach to identify key agents of change may depend on prospective validation of network predictions.

Paper Session 13: Surgery & co-morbidities

Discontinuing anticoagulants for spinal injections; is it necessary?

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Aims
To evaluate if the routine discontinuation of anticoagulants in those undergoing spinal injections is necessary.

Patients
All patients who underwent a therapeutic spinal injection from 2014-19 in a single spinal unit whose anticoagulants were not stopped.

Methods
Retrospective review of patient data undergoing spinal injections in the time frame 2014-19 within a single spinal unit, when the protocol to not stop anticoagulants was started, and analysis of any complications that could be attributed to bleeding.

Results
In the five year time frame, 3016 patients underwent a therapeutic spinal injection. Analysis of all patients undergoing injections revealed 0 complications related to bleeding in the period.

Conclusions
In our experiences, the routine practice of stopping anticoagulation prior to spinal injections is not necessary owing to the fact that our centre is yet to see a complication related to bleeding despite anticoagulants being continued when injections have been performed.

Comparison of clinical outcomes and complications after minimally invasive extreme lateral interbody fusion based on body mass index

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The purpose of this study was to determine the effect of BMI on the clinical outcomes and complications in patients treated with ELIF. We identified 135 consecutive patients undergoing ELIF for lumbar pathology. PROMS and complications were collected in 98 patients preoperatively, and up to 12 months postoperatively. PROMS included ODI, VAS BP and LP and SF-36. We categorised patients as Normal, Pre-obese and Obese according to their BMI. There were 55% female and 45% male patients with a mean age of 55 (26-84) years. 33 patients were identified as normal, 39 as pre-obese and 25 as obese. For ODI, mean improvements from pre-operative to last follow-up were 23.7 ± 21.3 ($P<0.0001$) for normal, 17.7 ± 23.7 ($P<0.0001$) for pre-obesity and 16.04 ± 4.25 ($P<0.0001$) for obesity. For VAS BP, mean improvements from pre-operative to last follow-up were 3.4 ± 3.08 ($P<0.0001$) for normal, 3.6 ± 3.04 ($P<0.0001$) for pre-obesity and 3.5 ± 3.3 ($P<0.0001$) for obesity. For VAS LP the mean improvements were 3.4 ± 3.08 ($P<0.0001$) for normal, 3.6 ± 3.04 ($P<0.0001$) for pre-obesity and 3.5 ± 3.3 ($P<0.0001$) for obesity. PCS and MCID results to be presented during talk. There were few minor and no serious complications between the groups and no statistical difference between the groups. Our analysis revealed that BMI did not affect the mean PROMS or complications between the groups of patients who underwent ELIF surgery to the lumbar spine. Comparison between baseline and follow-up results demonstrated a similar improvement in all BMI groups.

Best Practice Tariffs: the key to improving data entry in the British Spine Registry

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Background
Use of the British Spine Registry (BSR) database has been encouraged but not compulsory which has led to a variable level of engagement in the UK. In 2019 NHS England and NHS Improvement introduced a new Best Practice Tariff (BPT) to encourage input of spinal surgical data on the BSR. The aim of our study was to assess the impact of the spinal BPT on compliance with the recording of surgical data on the BSR.

Method
A retrospective review of data was performed at a tertiary spinal centre, between 2018-2020. Data was collated from electronic patient records, theatre operating lists and trust specific BSR data. Information from the BSR included operative procedures (mandatory), patient consent, email and demographic details.

Results
3587 patients were included in our study. 1684 patients were eligible for BPT. In 2018-19 269/974 (28%) records were complete on the BSR for those that would be eligible for BPT. Following introduction of BPT in 2019, 671/710 (95%) records were complete having filled in the mandatory data (P<0.01). Patient consent to data collection also improved from 62% to 93%. Email details were present in 43% of patients compared with 68% following BPT introduction.

Conclusion
Our study found that following the introduction of a BPT, there was a statistically significant improvement in BSR record completion compliance in our unit. The BPT offers a financial incentive which can help generate further income for trusts. National data input into the BSR is important to assess patient outcome following spinal surgery.

Impact of Parkinsonism in Spinal Surgery

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Introduction/Aim
Parkinson's Disease is a progressive neurological disorder associated with rigidity, reduced mobility, poor posture and frequents falls. Surgery for degenerative spine disease in patients with Parkinson's Disease (PD) remains a controversial topic, especially if the intervention requires instrumentation.

Methods
We conducted an age and sex-matched retrospective analysis on clinical outcomes (COMI scores) following lumbar spine surgery in patients with Parkinson's Disease. Among other factors, we also analysed morbidity, intraoperative complications, postoperative adverse events, and length of stay. We compared this PD group of patients with a similar group who did not have this condition with a ratio of PD patients to non-PD control patients of one to three. Spinal surgical procedures included in the study group comprised of posterior lumbar decompression with and without instrumented fusion.

Results
The PD group had a higher incidence of degenerative spondylolisthesis and needed more extended in-hospital stay compared to the non-PD group. Besides, we noticed a statistically significant difference in reoperation rates between the groups; Parkinson's disease patients had higher rates of repeated interventions. However, the clinical and functional outcomes and observed improvement were similar between the groups. We did not notice any statistically significant difference in complication rates between these two groups.

Discussion
Parkinson's Disease was not a barrier to a satisfactory clinical outcome of spinal surgery of the type described above, provided longer hospital stays and rehabilitation are accounted for.

Keywords
Parkinson's Disease, Outcomes, Risks, Complication rates, Hospital stay, COMI score, Lumbar decompression, Lumbar fusion.

Paper Session 14: Cervical Degenerative (2)

Does Preoperative Inferior Endplate Morphology Influence Outcomes of Cervical Disc Arthroplasty at C5/6 Level: A Retrospective Study

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Objectives
To investigate the effects of preoperative inferior endplate morphology on clinical and radiological outcomes after cervical disc arthroplasty (CDA) at C5/6 level with Prestige-LP Disc.

Methods
132 patients who underwent C5/6-level CDA with Prestige-LP Disc were retrospectively reviewed. Their inferior endplates on the mid-sagittal plane were visually classified into 3 types: type I with the endplate concavity apex located posteriorly, type II with the apex located in the middle and type III with the apex located anteriorly. Japanese Orthopedic Association (JOA), VAS and Neck Disability Index (NDI) were used to evaluate clinical outcomes. Range of motion (ROM) and sagittal alignment including C2-7 and C5-6 angle were assessed.

Results
The type I, type II and type III endplates accounted for 25.00%, 51.52% and 23.48% of 132 individuals. Most patients achieved significant reduction in VAS scores and NDI but the significant increase in JOA scores without substantial intergroup differences. Compared with preoperative values, the C5-6 ROM, C2-7 ROM and C2-7 angle were preserved, while the C5-6 angle increased significantly from kyphosis to lordosis. At the last follow-up, type

I endplate had the least C5-6 angle (2.03°, 3.94° and 4.46° for type I, II and III endplates) and the highest incidence of segmental kyphosis at C5-C6 level (33.30%, 14.70% and 9.70% in the same order, P=0.028). Conclusions: Patients achieved satisfactory clinical outcomes after C5/C6-level CDA without significant differences among three endplate types. Type I endplate had a high incidence of segmental kyphosis at C5-C6 level.

A randomized controlled trial comparing efficacy and safety of ProDisc®C implant to anterior cervical discectomy and fusion (ACDF) in treating symptomatic cervical disc disease (SCDD)

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Introduction
ACDF is the standard-of-care for treating symptomatic cervical disc disease (SCDD) and PRODISC®C is a cervical disc replacement preserving motion, which is an alternative. We compared safety and efficacy of PRODISC®C to ACDF surgery in treatment of single-level SCDD and investigated whether PRODISC®C reduced or eliminated the occurrence of adjacent disc disease (ASD) in these patients at 24-month post-surgery.

Methods
Patients with single-level SCDD involving C3-C7 vertebral segments were treated surgically during Jan2008-Jul2015 in a multi-center, prospective, randomized controlled clinical trial and followed up at 6-week, 3, 6, 12, 18 and 24-months annually to 7years post-surgery. Of the 120 enrolled patients (80PRODISC®C: 40ACDF), 76PRODISC®C: 37ACDF were treated as per protocol. Follow-up was carried out as per trial protocol. Physical & neurological examinations were done and adverse events recorded as per FDA Investigational Device Exemption (IDE) studies. Outcome Measures included patient self-assessments: NDI, SF-36, VAS neck & arm pain intensity/ frequency and satisfaction. Post-operative radiological imaging was used to assess ASD by comparing disc heights of adjacent levels to pre-operative radiographs.

Results
PRODISC®C showed non-inferiority at 3-months (p=0.0547). At 24-month post-surgery: overall success rate was 76.5%PRODISC®C: 81.8%ACDF; PRODISC®C group demonstrated clinically significant improvement in NDI/VAS pain scores and SF-36. PRODISC®C replacement showed sustained ROM throughout study. There was no difference in the adverse events in the two groups during the 2-year time period.

Conclusion
PRODISC®C is as safe and effective as ACDF. PRODISC®C replacement had range of motion (ROM) matching baseline values throughout 24-months theoretically with decreased risk of ASD.

Clinical and Radiological Outcomes of Single-level Cervical Disc Arthroplasty in the Patients with Preoperative Reversible Kyphosis: A Matched Cohort Study

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Objectives
To investigate the efficacy of cervical disc arthroplasty (CDA) in the single-level disc degenerative disease with reversible kyphosis (RK), and to compare these results with a matched cohort of lordosis.

Methods
Twenty-eight patients with single-level CDA and preoperative RK were matched for age, surgical level and follow-up time with 209 with single-level CDA and preoperative lordosis. JOA scores, NDI and VAS were used to evaluate clinical outcomes. Range of motion (ROM), functional spinal unit (FSU), heterotopic ossification (HO) and sagittal alignment including C2-7 angle and segmental angle (SA).

Results
The mean follow-up time was 40.1 months (18-80 months). Both groups achieved significant improvements in clinical outcomes without substantial intergroup differences. ROMs were preserved in both groups and remained comparable between groups throughout the study. In RK group, C2-7 angle and SA increased significantly. In lordosis group, C2-7 angle, SA and FSU were maintained. Before surgery, lordosis group had significantly greater C2-7 angle (10.5° vs -5.4°), SA (0.2° vs -3.7°) and FSU (2.9° vs -3.0°). After surgery, SA and FSU became comparable between groups, but the intergroup difference of C2-7 angle remained significant (11.3° vs 1.7°, P<0.001). By McAfee classification, there was a significantly greater incidence of high-grade HO (grade 3-4) in RK group (P=0.027).

Conclusions
For single-level disc degenerative disease with preoperative RK, CDA provided favorable clinical outcomes. Despite the significant improvements after surgery, the cervical alignment in RK group was inferior to that of lordosis group. Patients with preoperative RK seemed to have more HO formation.

Is there an argument for implant related cost reduction in ACDF? A-retrospective comparative review of complication profile between PEEK-cages and Zero- P cage screw constructs

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There is no consensus on the choice of implants for ACDF, and it varies between surgeons. This study aims to analyze the early-complications following ACDF performed using a standalone-cage versus a pricier Zero-P- construct for patients with cervical-degenerative-disc-disease. A total of 162 patients underwent an ACDF in between August 2016-to-July 2018. There were 83 patients-(111 levels) with standalone cage (SA) and 79 patients-(111 levels) with cage-screw (CS) fixation. There was no difference between the groups in terms of age, gender, and levels of surgery. The follow-up ranged from 2 months to 24 months. Complications, both clinical and radiological were assessed between the groups.: Both the SA and Zero P (CS) groups were subdivided into single and multilevel surgery. Complications encountered in the SA group were temporary swallowing problems 10, hoarseness of voice 3, cage migration 1, delayed union 1, Horner's syndrome 1. In the CS group swallowing problems 4, hoarseness of voice 4, CSF leak 1, recurrent symptoms 1. The observed difference in the incidence of complications between the groups did not reach statistical significance. Univariate-analysis between the groups did not show any difference in the improvement of cervical-sagittal-balance, fusion-rate, subsidence, and complications-encountered. Multivariate-logistic-regression-analysis for complications showed no difference between the groups when assessed for smoking, gender, age, Charlson-comorbidity-index, levels-of-surgery, fusion-status, Odom-score, or the type-of-implant. The standalone cages showed no difference in their complication profile in comparison to a cage-crew construct for both single and multilevel ACDF. Standalone cages might be a more economical option without increased complication risks.

Paper Session 15: Spinal Cord Injury & Trauma (1)

ASIA A traumatic cervical spinal cord injury conversion rates in Scotland

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Introduction
All spinal cord injuries can be graded from A to D based on the American Spinal Injury Association (ASIA) grading system. ASIA A cord injuries have the worst outcomes. The aim of this study was to investigate the ASIA A conversion rates for patients who were admitted to the National Spinal Injuries Unit (NSIU) for Scotland with a cervical spinal cord injury..

Method
All ASIA A cervical cord injuries (C1-T1) were retrieved from the NSIU database and analysed. Patient's electronic records were reviewed.

Results
We found 165 patients with ASIA A cervical cord injury over an 11 year period. The average age was 54.8 years with 77.2% of patients were male. The median time from injury to admission to NSIU is 2 days. 76 (61.8%) patients were managed conservatively. The average length of stay for these patients was 200.4 days. 9 patients died within 30 days of admission, 8 were inpatients at his time. Our ASIA A conversion rate was 17.1%. 5 patients had 3 grade improvement, 11 patients had a 2 grade improvement and 5 patients had a 1 grade improvement.

Conclusion
Our ASIA conversion rates are lower than the international average of around 30%. One of the explanations for this difference might be time to decompressive surgery (>48hrs in our unit) for their cervical cord injury patients. It will be interesting to review the changes to our ASIA conversion rates after we introduce early surgery in patients with cervical spinal cord injuries.

Polytrauma with spinal cord injury: challenges and scope for doing things differently?

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Background
The introduction of Trauma Networks in the UK has improved outcomes for polytrauma. However, rehabilitation programmes developed for monotraumatic spinal cord injury (SCI) may not meet the additional needs of polytrauma patients.

Aim
To characterise the additional complexity and rehabilitation needs of polytraumataic SCI patients, and develop Integrated Care Pathway.

Method
Retrospective analysis of traumatic SCI inpatient rehabilitation admissions over two years during 2016-2017. Polytrauma was defined as at least one additional non-spinal injury scoring at least 2 on the Abbreviated Injury Score.

Results
The majority of admissions (61% of 85) were for polytrauma. Polytrauma patients spent slightly longer in the acute hospital setting before admission to specialist services. Polytrauma patients were more likely to have additional speech/swallowing and wound healing (17 vs 3%) needs. Regarding specialist psychology input, the polytrauma group were more likely to have significant mood issues (62 vs 42%) or neuropsychiatric needs (25 vs 18%). Additional to SCI, 58% of polytrauma patients sustained chest injuries, 17% visceral injuries, 15% pelvis fractures, 31% upper limb fractures, and 19% lower limb fractures. 50% of polytrauma patients had evidence of brain injury on imaging, and 35% had cognitive impairment. This likely represents the tip-of-the-iceberg. The two groups had similar Spinal Cord Independence Measure (SCIM) scores on discharge (56 vs 59).

Discussion and Conclusion
Polytraumatic SCI , brings additional rehabilitation needs. Programmes incorporating formal musculoskeletal and cognitive rehabilitation are vital to optimise outcomes. We call for collaborators to establish standards to manage this complexity for high quality patient care.

The outcomes of both conservative and surgically managed spinal ankylosing spondylitis fractures

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Introduction
The management of Ankylosing spondylitis (AS) fractures are complex and requires a multidisciplinary approach. We aim to describe our experience and outcomes in managing these injuries.

Methods
All AS patients with a fracture between 01/01/2010 to 31/12/2018 were collated from the PACS database. Data were collected from electronic and paper notes.

Results
Over a nine year period, there were 71 patients with AS fractures of which 52 patients were managed in the Scottish National Spinal Injuries Unit. The average age was 68 years with 87.3% being male patients. 63 (77.8%) were managed conservatively and 18 patients had surgery. 22/38 conservatively managed cervical fracture patients were managed in a Halo. 13/25 of the thoracolumbar fracture patients were managed with bed rest. 4 (5.3%) patients had one grade of AIS improvement. One (1.3%) patient had a deterioration of their AIS grade. The average change in motor and SCIM scores were 8.1% and 50.0%, respectively. The average length of stay was 82.9 days. 59.9% of patients had evidence of fusion within 6 months and 89.4% had evidence of fusion within 1 year of injury. The 30-day mortality was 11.6% (8/71) and most patients died of pneumonia. There was no statistical difference between the above outcomes between surgical or conservatively treated patients.

Conclusion
Neurology recovery is limited but through rehabilitation patients can gain substantial improvements in their functional outcomes. Cervical AS fractures can be safely and successfully managed conservatively.

Paper Session 16: Paediatric Deformity (2)

The Scoliosis Service in Northern Ireland: A Blueprint for Service Improvement

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Introduction
Scoliosis is a three dimensional deformity of the spine which has significant impact on a patients quality of life. Within Northern Ireland the scoliosis service has long waiting lists for first review, time to operation and follow up appointments. A quality improvement (QI) project was performed aiming to improve the efficiency of the scoliosis service whilst ensuring no compromise of surgical outcomes.

Methods
Multiple PDSA (Plan, Do, Study, Act) cycles were performed over a two year period. These included the introduction of a new pre-assessment, virtual scoliosis and a new patient mega-clinics. Additional interventions included a review of the management of waiting lists and introduction of regular multidisciplinary governance meetings.

Results
Through the utilisation of these methods average time to first clinical review has been reduced by 84% (36 vs 6 weeks), time to surgery has been reduced by 80% and 75% for the paediatric and adult patient populations respectively and the total number of patients awaiting an outpatient review is less than 500 with pre intervention levels greater than 1500. There was no statistically significant increase in morbidity or mortality.

Conclusion

Through the utilisation of QI methodology the Northern Ireland scoliosis service has been able to reduce waiting list times for first clinical and follow up review appointments and reduced time to surgery. These advancements have not come at the cost of patient care. These methods have implications for other services and for other trusts.

Effectiveness of the Ultrasonic Bone scalpel Ponte Osteotomy (UBSPO) in posterior correction of Lenke Type1 Adolescent Idiopathic Scoliosis (AIS)

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Background

Partial facetectomies with pedicle screw instrumentation is widespread and a well described technique for achieving posterior correction of scoliosis.Newton et.al first described the use of the UBS in the posterior correction of AIS in 2014. The study compares the effectiveness of the UBSPO and partial facetectomies in achieving posterior correction in Type1 AIS.

Methods

A retrospective review of 40 patients with type 1 AIS who had undergone a posterior correction of scoliosis between 2010 and 2016 was performed.Group A(n=20) consisted of consecutive patients that had partial facetectomies while Group B(n=20) consisted of consecutive patients having UBSPO.Both groups were matched for demographic parameters. Pre and post-operative radiographic parameters and operative data in both groups were compared. The Mann-Whitney U test was used for statistical analysis.

Results

There was no significant difference between the two groups in terms of age, sex, magnitude of curves, apical rotation and flexibility on the preop imaging. There was a significant difference between the mean postop Cobb angle(21.9° vs 9.8°, $p<0.0005$), correction(63.04% vs 84.3%, $p<0.0005$) and postop apical rotation($p=0.008$) in favour of the UBSPO group. At 2-year follow-up there was a statistically significant increase in the cobb angle in the facetectomy group (21.89° (immediate post op) Vs 24.64° $P=0.033$) and no such difference in the UBSPO group. There was no significant difference between surgical time($p=0.536$) and blood loss($p=0.380$).

Conclusion

The use of the UBSPO for posterior release provides more effective correction in the coronal and axial planes than traditional partial facetectomies in type 1 AIS.

Index radiographic measurements in the prediction of progression in infantile idiopathic scoliosis; a comparative analysis and description of a novel predictive model

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Introduction

Prognosis in IIS is an imperfect science despite the aid of classically described radiographic indices. This work assess the comparative accuracy of commonly utilised index radiological measurements in the prognosis of infantile idiopathic scoliosis (IIS) and build a parsimonious prognostic model utilising these measurements.

Methods

This was a retrospective analysis of a UK population of patients with IIS. Index radiological parameters were analysed and outcome of their condition determined over long term follow up. Comparative accuracy of each radiological measurement category was determined by logistic regression analyses and the corresponding receiver operating characteristic (ROC) curve. A predictive model of IIS progression using these measurements was then created.

Results

All radiological measurement categories were predictive of IIS progression. However, on pairwise comparison of ROC curves and multivariate analysis, the index Cobb angle proved the most significant predictor of curve progression. Using the index Cobb angle only, a predictive model of curve progression achieved an accuracy of 81.18% with a cut-off Cobb angle of 34.5° found to be the optimal threshold to discriminate a progressive from resolving curve.

Conclusion

Of the analysed index radiological parameters commonly used by surgeons in the prognosis of IIS, we found the Cobb angle is the most accurate predictor. Further, neither addition of the RVAD nor convex RVA provided significant further prognostic value in a multivariate model of progression. However, not even the Cobb angle model was accurate in all cases; emphasising caution should be applied when relying on index radiological measurements to predict IIS outcomes.

The long term results of surgery for AIS. A longitudinal study using SRS-22 outcome scores from the British Spine Registry

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Purpose
The purpose of this study was to examine the outcomes of surgery for AIS based on the SRS-22 outcomes scores using data from the British Spinal Registry (BSR).

Methods
All of the SRS-22 outcome scores for primary AIS surgery recorded on the BSR were analysed. Data is captured pre-operatively and at 6 weeks, 6 months, 1, 2, 5, 7.5 and 10 years post-operatively.

Results
The BSR recorded 3481 individuals with a diagnosis of AIS and a primary procedure. Of that 1912 (55%) have a pre-operative score, 1367 (39%) a 6 week score, 1290 (37%) a 6 month score, 1215 (35%) a 12 month score and 865 (25%) a 2 year score. Across all domains and as a total score, surgery for AIS improved the score. There was a statistically significant difference seen between the score at one year and greater than one year in function and total score only. A number of individuals had multiple diagnoses recorded.

Discussion
Using the SRS-22 questionnaire, surgery for AIS improves quality of life. This is maintained in the longer term, apart for function. This may reflect the decrease of function seen between adolescence and adulthood as well as the diagnosis of AIS. However, there is missing data at all time points, which increases with length of follow up. Consideration needs to be given to making follow up data collection mandatory in a similar fashion to the NJR.

The Alder Hey experience of 44 patients treated with magnetically-controlled growing rods in the treatment of early onset scoliosis with mean follow-up of 4.1 years

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Aims
We present Alder Hey experience with the first 44 magnetically-controlled growing rods consecutive cases. Patients and

Methods
This is a retrospective review of consecutive cases of MCGR in our institution between 2012 and 2018, of 44 children (25 females and 19 males), with a mean age of 7.9 years (3.7 to 13.6). There were 41 primary cases and 3 revisions from other rod systems. The majority (38) had dual rods. The group represents a mixed aetiology including: idiopathic (20), neuromuscular (13), syndromic (9) and congenital (2). The mean follow-up was 4.1 years, with a minimum of 2 years. Nine children graduated to definitive fusion. We evaluated radiological parameters of deformity correction (Cobb angle), and spinal growth (T1-T12 and T1-S1 heights) as well as complications during the course of treatment.

Results
The mean Cobb angles pre-operatively, post-operatively and at last follow-up were 70° (53 to 103), 35° (15 to 71) and 39° (15 to 65) respectively ($p < 0.001$). There was a mean of 14° (-6 to 27) of additional Cobb angle correction upon graduation from MCGR to definitive fusion. Both T1-T12 and T1-S1 showed significant increase in heights of 27mm and 45mm respectively at last follow-up ($p < 0.001$). Ten children (23%) developed 18 complications requiring 21 unplanned operations. Independent risk factors for developing a complication were single rod constructs and previous revision surgery.

Conclusions
MCGR is an effective tool in treatment of early-onset scoliosis. It maintains the flexibility of the spine, allowing further correction at the time of definitive fusion.

A comparison in patient reported outcomes in patients undergoing anterior or posterior correction of scoliosis

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Introduction
Scoliosis is a deformity that predominantly affects school age children, between the years 10-15. In the UK 3 or 4 in every 1,000 children need treatment for scoliosis. There is a paucity of literature comparing the return to school/activity following anterior or posterior scoliosis correction.

Aim
To determine the recovery time for patients with scoliosis who underwent anterior spinal fusion (ASF) and posterior spinal fusion (PSF).

Methods
Patients undergoing corrective scoliosis surgery from 2017-20 were identified from our scoliosis database. Patients over 18 were excluded. A validated post-operative questionnaire was administered to patients to complete regarding return to school, sports and other physical activities. The results were then collated using Microsoft Excel.

Results
92 patients were contacted with a response rate of 62% (57 patients).30 had PSF and 27 ASF. 82% of responders were female (n=47) and 18% were male (n=10). Mean age for both groups was 16. Within 1-3 months, 80% of the PSF group and 70% of the ASF group had returned to school. By 12 months, 60% of PSF group and 37% of ASF group had returned to PE. Comparing ASF and PSF at 6 months post-operatively, outcomes were as follows: return to running (67% vs 63%) ability to bend (89% vs 80%) ability to carry a backpack (78% vs 73%).

Conclusions
The results have shown that PSF patients returned to school and PE quicker than ASF patients. However, anterior patients did show faster recovery in other areas such as running, bending and carrying a backpack.

Paper Session 17: Fragility Fractures & Miscellany

Pedicle screw insertion - an educational assessment of accelerated learning

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Introduction
In the era of European Working Time Directive (EWTD), surgical trainees have less opportunity to acquire skills. Josh Kauffman (Author of The First 20 Hours) suggested that you can be good at anything in 20 hours following 5 methods. This study was done to show the use of accelerated learning in trainees to achieve competency and confidence on the insertion of pedicle screws.

Methods
Data was collected using 3 experienced spine surgeons, 8 trainees and 1 novice (control) on the cadaveric insertion of pedicle screws over a 4 day didactic lecture. Each candidate had 2 cadavers and 156 screw placements over 4 hour shifts.

Results
There were 8 candidates (surgeons) involved. 1 spinal SpR, 6 spine fellows and 1 junior consultant. A physiotherapist was the control novice. The surgeons and the control got significantly faster over time. The control made significantly more errors than the surgeons. Surgeons were significantly faster by the end (p value < 0.05). The control got faster over time and by the end, was no longer significantly slower than the surgeon when they first started.

Conclusion
This focused pedicle screw course shows that a junior spinal surgeon can achieve improved competency and confidence in 20 hours but furthermore a complete novice can learn to insert pedicle screws and reach a level of competence almost at the level of the trainee in 20 hours as well. With EWTD in mind procedural based specialties may be able to incorporate this philosophy for improved training.

Vertebral augmentation for painful type 4 osteoporotic compression fractures: a comparative study

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Introduction and purpose of the study
Type 4 osteoporotic fracture (OF4), according to the classification system of the Spine Section of the German Society for Orthopaedics and Trauma (DGOU), is unstable and requires fixation as per the guidelines of the same group. We evaluated the response of this fracture type to stand-alone vertebral body augmentation (VBA).

Methods
This is a single centre, in two hospitals, comparative study to evaluate the effectiveness of percutaneous vertebroplasty (PVP) and kyphoplasty (KP) in pain control of OF4. OF4 patients treated with VBA were compared to a conservatively treated control group. The two groups of OF4 were then compared to similar cohort of OF2 and OF3 patients who were treated by either VBA or expectantly.

Results
A total of 78 cases studied. VBA of OF4 showed a statistically significant better pain control than conservative treatment. The response of this group of fractures to VBA was similar to that of OF2 and 3.

Conclusion
VBA can provide satisfactory pain control in OF4 patients.
Keywords: Vertebroplasty, kyphoplasty, osteoporotic compression fractures, DGOU

Implementation & Adoption of Streamlined Acute Vertebral Fracture Compression (VCF) Pathway

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Introduction
Osteoporotic Vertebral fractures are a substantial burden on public health with an annual incidence of 700000 per annum, twice that of hip fractures. The treatment include physiotherapy, pain management, and optimisation of calcium, vit d, and bisphosphonates rarely requiring surgical intervention. The aim of this study was to evaluate the existing treatment pathway and to introduce a streamlined management strategy incorporating the gold standard management (physiotherapy, pain management, and bone protection) delivered in a defined one stop shop.

Methods
Patients with acute vertebral compression fractures were identified from primary and secondary care PACS database over a 6-month period from March 2020 – September 2020 with the extraction of demographics, levels of fractures, investigative imaging, and existing treatment modalities.

Results
In total, 67 fracture s(VCF) were identified with T12 fracture being the most common. As expected aVCF occurred in 25% of males and 75 % in females with a steeper increase after 70years. Furthermore, X-rays were the primary investigative modality (88%) with cross-sectional imaging used in 43%. The majority of the patients (63%) received pain management with 13% requiring specialist physiotherapy and 3% vertebroplasty and none requiring surgical intervention. Hence, after interdepartmental discussions (Orthogeriatrics) with an innovative focus on improving and adopting the preventative approach, a streamlined pathway was introduced to effect a radical shift in the deliverance of gold standard management strategies.

Conclusions
A unique and clear pathway for the management of acute vertebral compression fracture has been introduced delivering gold standard management of this rapidly increasing and substantial condition.

Paper Session 18: Spinal Cord Injury & Trauma (2)

Management and outcomes of DISH fractures in the West of Scotland. A 17 years experience

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Introduction
DISH, is a rare and insidious disease that when associated with a fracture can be difficult to manage. We aim to characterise the demographics of DISH associated fractures in the West of Scotland, and describe the outcomes of DISH related fractures.

Methods
All intrasegmental DISH fractures over a period of 17 years were compiled from the PACS database. Data was collected from electronic and paper notes.

Results
There were 32 patients (35 fractures) over the 17 year period. The average age was 74.6 years, with 81.3% male. Eighteen patients sustained low velocity injuries. Seven (20%) patients had a delayed diagnosis (>24 hrs). Most were discs fracture and almost all concentrated in the cervical and thoracic region. 28/32 patients were managed conservatively. Eleven were treated in an orthosis, seven in a halo. The average time of conservative treatment was 74 days. Only one out of the four surgically managed were operated from an anterior approach. The average time to surgery from admission was seven days. 81.0% achieved radiological or clinical fusion within 180 days. Two patients improved by one ASIA grade and one patient improved by two ASIA grades. Two died within 30 days of injury.

Conclusion
The majority of DISH fractures were treated successfully conservatively. To achieve this, the presence of DISH, the patient's premorbid condition and goals of management should be taken into account when making decisions about the best management option.

Feasibility, safety and outcomes of treatment of neglected post-traumatic AO type F4 injuries of the subaxial cervical spine using the Anterior-Posterior-Anterior approach

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Introduction
The management of neglected (presenting beyond 3-weeks since injury) post-traumatic facet dislocations of the sub-axial cervical spine(AO type F4 injury) is challenging, due to the difficulty in achieving reduction of the subluxated or dislocated facets. We describe an effective surgical strategy for the management of neglected AO-F4 injuries and have analysed its efficacy, safety and outcomes.

Method
This is a retrospective review of twenty-four patients with a mean age of 42. 6+/-14. 5(range,36-53) years, with neglected facet dislocations of the sub-axial cervical spine. Following a trial of closed reduction, open reduction was carried out as a three-stage procedure(anterior-posterior-anterior approach) under a single anaesthesia. Outcomes were assessed with respect to VAS(Visual Analogue Scale) and NDI(Neck Disability Index) scores, satisfactory reduction and maintenance of alignment on radiographs,with evidence of fusion on radiographs at follow-up.

Results
Patients presented at a mean of 7. 1+/- 6. 7(range, 3-24) weeks since injury. The mean follow-up was 27. 5+/-2. 4(range, 25-42) months. There was no neurodeterioration in any patient. Radiographs showed satisfactory reduction in 22/24(91. 7%) patients. Radiological evidence of fusion was seen at a mean of 9. 2 +/- 1. 4 months. Spinal alignment was well maintained in all cases at final follow-up. No revision surgeries were needed. VAS and NDI scores showed significant improvement at final follow-up, p<0. 05.

Conclusion
The single stage, anterior-posterior-anterior approach is an effective and safe surgical strategy in the management of neglected AO-F4 injuries of the sub-axial cervical spine, as evidenced by a 91. 7% success rate in achieving reduction, and satisfactory spinal alignment and fusion with good clinical and functional outcomes, at a mean follow up of 27. 5+/-2. 4 months.

Thoracolumbar Injury Classification Systems in Pediatric Patients

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Pediatric thoracolumbar fractures currently lack a particular Thoracolumbar Injury Classification system. This study aims to provide an up-to-date review, that will evaluate the validity, reliability and safety of current classification systems for paediatric patients (age ⩽ 18). This will be the first systematic review that focuses on paediatric thoracolumbar classification systems. This review focuses on the validity and reliability of the overall and sub-group classification of Thoracolumbar Injury Classification and Severity Score (TLICS) and AOSpine Thoracolumbar Classification System. It also includes the shortfalls of the two classification systems and mentions important diagnostic points specific to paediatrics using additional literature. This review contains thirteen articles, filtered from hundred and thirty-one articles using PRISMA and CASP guidelines. This review suggests that in comparison with AOSpine, TLICS has almost perfect agreement and a higher number of literature done over two years, in different hospitals with a range of observers (spine, orthopaedic and neurosurgeons) at different levels of surgical training. However, TLICS is most effective only for scores ⩽ 3 and ⩾ 5. TLICS also has a lower validity for PLC as compared to AOSpine. In conclusion, TLICS is a highly valid and reliable classification system which can be used in children along with evidence from paediatric specific literature identified in this study (Transient Breath Holding Sign, misdiagnosis and treatment specific to paediatric anatomy).

Paper Session 19: Spinal Oncology

Surgical Aggressiveness Index (SAI) in surgery for spinal metastases

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Introduction
Metastatic Spinal Tumour Surgery (MSTS) covers a broad spectrum of surgical operations and complexity depending on the extent and severity of the disease. A standardized scoring system can help analyze the variables affecting surgical outcomes, compare data between institutions and weigh treatment options. This will help plan treatment and research.

Aim
Retrospective review of our tumour database to formulate "Surgical Aggressiveness Index" (SAI)

Methods
SAI score was based on the extent of surgical intrusion of the vertebral column, number of vertebrae instrumented, the number of levels decompressed by posterior approach, extent of anterior decompression (total/partial corpectomy), posterior fusion and vertebroplasty. SAI was validated by retrospective analysis of patients undergoing MSTS from 2005-2014. Data included demographics, primary tumour type; extent, type and duration of surgery and blood loss/transfusion. Relationship of SAI to outcome measures of blood loss/transfusion, operative time and post-operative complications were analyzed.

Results
241 patients (age 25-87; mean: 60years) were analyzed. Median score of SAI was 7 (range 1-20). After adjusting for a number of potential confounders, multivariate analyses revealed that SAI score was independently associated with increased blood loss blood transfusion and prolonged operative time. A unit increase in SAI reflected an increase of 42ml in mean blood loss (95% CI 29-51, P=0.01), 10minutes in mean operative time (95%CI 5-18, P=0.01) and 1.1times odds of blood transfusion (95% CI: 1.05-1.19, P=0.03).

Conclusion
SAI correlates well with surgical outcomes, blood loss, transfusion and operating time. It will aid in clinical decision making, and to compare outcomes between institutions.

Preliminary results of vertebral body cemented stent for anterior column support in surgical treatment of metastatic spinal cord compression (MSCC) of thoraco-lumbar spine

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Introduction
Extensile interventions to provide anterior spinal column support in MSCC surgery incur added morbidity in this surgically frail group of patients. We present our preliminary results of posterior spinal decompression and stabilisation coupled with vertebral body cemented stents for anterior column support in MSCC.

Methods
Fourteen patients underwent posterior spinal decompression and pedicle screw construct along with vertebral body stenting (VBS) technique for reconstruction and augmentation of the vertebral body. The primary in all except one was solid organ malignancy and ten patients (71%) were treatment naïve. The mean modified Tokuhashi score was 10.7 ± 2.7 and the mean SINS score was 9.6 ± 1.9. All vertebral body lesions were purely lytic and were associated with a defect in the posterior wall. All procedure related complications were studied till final follow-up.

Results
A mean 5.4 ±2.7 ml low viscosity PMMA bone cement was injected within the stent at each compression level. No cement extrusion posteriorly was noted in any case from intra-operative fluoroscopy or post-operative radiographs. Eight patients also had cement insertion into adjacent level vertebral bodies via fenestrated pedicle screws for added construct stability. Four patients died at a mean 6.8 months (range 1-15 months), while the remaining patients have a mean survival of 17 months. Neither further revision surgical intervention nor any neurological deterioration was noted in any patient.

Conclusion
In lytic vertebral body lesions with posterior wall erosions, cemented VBS technique adds to the surgical armamentarium in MSCC surgery showing promising early results without added complications.

Malignant spinal cord compression in the paediatric population-a systematic review, metaanalysis and formulation of national guidelines

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Introduction
Malignant Spinal Cord Compression (MSCC) has been noted in 3-5% of children with primary tumours. MSCC can be associated with permanent neurological deficits and prompt treatment is necessary.

Methods
A systematic review of the English language was undertaken using (PRISMA) guidelines. Search criteria included 'MSCC in paediatric and metastases' for papers published between January1999-September 2019. Isolated case reports/case series with <10 patients were excluded.

Results
From a total of 17 articles identified, a final 7 were analysed (Level III/IV). Neuroblastoma constituted the most common cause for MSCC in children(62.7%) followed by sarcoma(14.2%). Soft tissue sarcomas constituted the most frequent cause of MSCC in children >5years old. The median age at time of diagnosis was 50.9 months (0.5-204). The median follow up duration was 50.3 months(14.8-139). A multimodality approach

to treatment was utilised depending on the primary tumour. The prognosis for neurological recovery was found to be inversely proportional to the degree of neurological deficits and duration of symptoms in four studies.

Conclusion
Neuroblastoma is the most common cause for MSCC in children(62.7%) followed by sarcoma(14.2%).Whilst, soft tissue sarcomas constituted the most frequent cause of MSCC in children >5years old. In children with neuroblastoma /lymphoma, chemotherapy was the primary treatment. Early surgery should be a consideration with rapid deterioration of neurology despite chemotherapy. A multimodality approach including chemo-radiotherapy and surgery should be the treatment of choice in metastatic sarcomas.It is worth noting that multi-level laminectomy/decompression and asymmetrical radiation to the spine can lead to spinal column deformity in the future.

Evaluation of metastatic spinal cord compression (MSCC) referral pathway at a regional referral centre

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Background
MSCC is a major cause of morbidity in cancer patients, being the presenting finding in up to 20% of patients. Clinical outcomes appear to be improved with early intervention, especially in patients with neurological deficits. National and regional guidelines recommend completion of decision making processes within 24 hours for patients with neurological compromise and within 7 days in patients with spinal pain alone.

Purpose
Assessment of referral pathway and reasons for delays in decision making process. Study design: Retrospective review of MSCC referrals to a UK regional centre. Patient sample: MSCC Referrals (N=174) between 1 Jan 2018 and 31 March 2019.

Methods
Quantitative and qualitative assessment of data on web based referral system. Decision making within recommended time frames assessed. Factors possibly impacting on ability to deliver service at recommended standard categorised and assessed.

Results
75% had Modified Rankin Score (MRS) >1 at the time of referral, but only 35% had a decision made within 24 hours. A surgical decision could not be made in the suggested timeframe in 93% due to inadequate supporting information. Reasons for could be categorised into four groups – inadequate or inaccurate clinical information (13%), imaging (33%), oncological assessment and prognostication (47%).

Conclusion
The MSCC referral pathway depends on multiple input streams, and could be facilitated by improved co-ordination. Our recommendations were for improving awareness of existing referral pathways, and improvement of referral pathways using web-based referral platforms.

The Outcome of Expandable Titanium Cages in Vertebral Compression Fractures Caused by Myeloma

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Background
Painful vertebral compression fractures (VCF) in myeloma patients severely reduce quality of life. Currently, the International Myeloma Working Group and National Institute of Clinical Excellence NICE 1 advocates the use of either balloon kyphoplasty or vertebroplasty in the management of these fractures. We present the outcome of the largest series of multiple level myeloma VCF treated using expandable titanium cages (Osseofix®).

Methods
All patients with VCF and myeloma who adhered to the IMWG indications for vertebral augmentation were treated with the Osseofix® implant. Visual Analogue Scores (VAS) and Oswestry Disability Index (ODI) were taken pre-operatively and at one year follow up. Cobb angle and implant migration were measured on lateral standing radiographs.

Results
16 patients consisting of 82 levels were stabilised. The average length of stay was 2.2 days (SD=1.7) with no perioperative complications. The median preoperative VAS was 8.6 (IQR 7.3-10.0) dropping to 3 (IQR 1.0-4.0) after 1 year (P<0.001) whilst an average improvement of 31.4 (SD=19.6) points in the ODI scores was reported (P<0.001). There was no significant collapse or implant failure at one year with a greater improvement in the VAS / ODI the more cages used (P=0.049 and 0.008, respectively).

Conclusion
Patients treated with this implant, have shown a statistically significant improvement in both pain and outcome scores. There were no complications or radiological deterioration of spinal alignment over the course of a year. We believe that this implant is an alternative to more commonly used vertebral augmentation techniques with a better risk profile.

Can MRI be used as a safe and expedient option for calculating Spinal Instability Neoplastic Score (SINS) for patients with metastatic spinal cord compression?

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Aim
The aim of this study was to assess the reliability of Magnetic Resonance Imaging (MRI) scans to calculate the SINS score in patients with MSCC. Current guidance states that only CT scans should be used for calculating SINS scores.

Patients and methods
100 individuals were retrospectively identified as suitable for review. Each patient's MRI and CT scans were reviewed by two Consultant Musculoskeletal Radiologists and one Consultant Spinal Surgeon and then used to calculate the SINS score. To avoid potential bias in assessment, MRI scans were reviewed in the first instance. Bland-Altman analysis was performed to identify the limits of agreement between the SINS scores from the MRI and CT scans for the three independent observers.

Results
The limits of agreement between the SINS score from the MRI and CT scans between the observers was -0.11 for observer 1 (95% CI 0.82 to −1.04), -0.12 for observer 2 (95% CI 1.24 to −1.48) and -0.37 for observer 3 (95% CI 2.35 to -3.09). The use of MRI tended to increase the SINS score when compared to that derived from the CT scan. At the cross over point of classifying a spinal lesion as indeterminate or stable, the use of MRI led to a SINS that would not have led to a different clinical decision being made.

Conclusion
The results from this study show that both Consultant Spinal Surgeons and Musculoskeletal Radiologists can use MRI scans to calculate the SINS score reliably.

Spinal cord Compression Outcomes Of Treatment (SCOOT) Delphi Study

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Background
A rise in metastatic disease and MSCC comes with advances in medical and clinical oncology. NICE guidelines were last updated over a decade ago, while high quality evidence remain limited, making the management of these complex patients, nearing the end of their lives, very challenging. Aims: Identify thresholds for surgical intervention in MSCC patients and factors influencing those thresholds.

Methods
A modified Delphi study with results quantitatively and qualitatively analysed. Thresholds reached based on RAND criteria and percentage agreement. Expert panel predefined; survey of decision making questions on six clinical vignettes of most commonly occurring primary tumours with spinal metastasis.

Results
Thirty-five initially agreed to take part, 24 completed the first round and 22 completed remaining rounds. Experts had a total of 312 years' experience in managing MSCC patients. SINS was the most commonly used scoring system. The most important factors in decision making were primary tumour, neurological function at presentation, functional status and type of spinal lesion; age and visceral metastases were least important. Overall, 74% of experts would not operate on paralysed patients; 33% would operate within 24 hours.. Pain level of 6/10 was the threshold for surgical intervention with 82% expecting to achieve pain relief from intervention.

Conclusion
Individual treatment algorithms were concluded from the experts' responses for each primary tumour type. The threshold for surgery was pain level of 6/10 and unstable stable. Factors influencing decision making are pain and prognosis. Careful consideration in cases of Lung, Multiple Myeloma and cancer of unknown origin.

Comparison of stereotactic radiosurgery, surgery and conventional external beam radiotherapy for the treatment of spinal oligometastatic disease: A Systematic Review

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Background
The objective was to determine whether there is a benefit to using stereotactic radiosurgery (SRS) versus surgery or conventional external beam radiotherapy for spinal oligometastatic disease.

Methods
A systematic review was conducted by searching electronic databases and using the PRISMA checklist. Retrospective and prospective studies were identified that investigated methods of treatment such as SRS, surgery and radiotherapy of spinal oligometastatic disease. Local Control rates (LC), overall survival (OS) rates, pain response (PR) and toxicities were extracted to be investigated and compared. A study eligibility criterion was made to ensure results were valid, statistically significant and relevant to the investigation.

Results
105 articles were found that were relevant to oligometastatic disease with the mention of spinal metastases however 89 of these articles were excluded based on irrelevance to investigation, title, abstract and duplication. 16 full text articles were thoroughly screened including 9 of them in the review. For 601 patients the average 1-year local control rate was 89%, average 1-year overall survival rate was 88%, evidence of pain relief was present, and some patients suffered low grade 1,2,3 and 4 toxicities.

Conclusion
Stereotactic radiosurgery is an excellent modality of treatment of spinal oligometastatic disease as local control rates, overall survival rates, pain response and toxicities indicate improved outcomes in comparison to studies that investigated the same factors with the treatment of surgery or cEBRT. However, there is a lack of data here to make statistically valid claims and require more studies/data to be analyzed and compared.

Paper Session 20: Best of the Best

Spinal Fusion post NICE guidance – shall we pick up the baton?

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The most recent NICE guidance for non-specific low back pain in 2016 recommended that spinal fusion surgery should only be offered as part of a randomised controlled trial (RCT). At the Leeds BritSpine 2018 meeting, a multidisciplinary group (n=126) of orthopaedic surgeons, neurosurgeons, physiotherapists, osteopaths, chiropractors, researchers and patient representatives worked together in a dedicated workshop to consider whether a future RCT is needed, agree the research question, trial design and explore the degree of interest of participants in being involved. We used the PICO Model to formulate the research question, and phrased it in such a way as to promote the development of an RCT. We facilitated separate discussion groups to each reach a recommendation on the patient population (P), the fusion surgery intervention (I), the control/comparison intervention(s) (C) and the most important outcomes (O). Participants supported the need for a definitive RCT that addresses the NICE guidelines recommendation and proposed that it should i) compare the clinical and cost-effectiveness of spinal fusion versus sham fusion versus usual care for adults with persistent, severe, non-specific low back pain, ii) also seek to determine the reasons why fusion surgery is performed, and iii) identify specific subgroups of patients who benefit most from fusion surgery. This presentation will share the details of the PICO generated through the BritSpine 2018 workshop process, consider the options for the design of a future RCT, and discuss the next steps.

The clinical and cost-effectiveness of a stratified care model for patients with sciatica: the SCOPiC randomised controlled trial RCT (ISRCTN75449581)

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Introduction
Healthcare for sciatica is usually 'stepped' with initial advice and analgesia, then physiotherapy, then more invasive interventions if symptoms continue. The SCOPiC trial tested a stratified care algorithm combining prognostic and clinical characteristics to allocate patients into one of three groups, with matched care pathways, and compared the clinical effectiveness and cost-effectiveness of stratified care (SC) with non-stratified, usual care (UC).

Methods
Pragmatic two-parallel arm RCT with 476 adults recruited from 42 GP practices and randomised (1:1) to either SC or UC (238 per arm). In SC, participants in group 1 were offered up to 2 sessions with a physiotherapist, group 2 were offered up

to 6 physiotherapy sessions, group 3 was 'fast-tracked' to MRI and spinal specialist opinion. Primary outcome was time to first resolution of sciatica symptoms (6-point ordinal scale) collected via text messages. Primary analysis was by ITT. Incremental cost-utility analysis was undertaken to calculate the cost per QALY gained.

Results
Primary outcome data were obtained from 89.3% (88.3% SC, 90.3% UC). Survival analysis showed a small but not statistically significant difference in time to resolution of symptoms (SC reached resolution 2 weeks earlier than UC. There were no significant between-arm differences in secondary outcomes. Cost and outcome differences were not significant between arms (mean difference (95% CI) £-26: (£-183, £135); QALYs -0.011 (-0.035, 0.013)).

Conclusion
The SC model, tested in this trial was not more clinically or cost-effective than UC. On average, patients in both arms made similar good improvements over time, on most outcomes.

Fibular Allograft as a Salvage Option in Revision Pedicle Screw Fixation

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Introduction
In the setting of revision surgery, a variable amount of pedicle bone loss may be present. This is a result of screw loosening and subsequent screw track widening. Current options for revision pedicle screw fixation include cement augmented screw fixation, cannulated-fenestrated or expandable pedicle screws, and custom-made large diameter screws. Based upon the authors' review of the literature, using fibular allograft in the setting of revision pedicle screw fixation is a novel technique, without any prior published results.

Methods
Fibular allograft was cut into small, longitudinal strips. The length of each fibular allograft strut was trimmed to coincide with the length of the former screw, allowing for overhang. Allograft strut was inserted into the screw track along all four walls. The screw was advanced, and after full insertion of the screw, the fibular allografts were then trimmed.

Results
This technique was successfully used in 25 consecutive patients during revision lumbar spine surgeries for pseudoarthrosis. Excellent purchase was achieved in all patients. CT scan at the last follow up showed incorporation of the fibular allograft and sound fusion in all patients except one.

Conclusions
Fibular allograft is a viable option in the setting of revision pedicle screw fixation and has several advantages. It avoids complications associated with cement augmented screws, can be used impromptu, when other options are not immediately available, this technique can be employed without specialized instrumentation at significant cost savings when compared to custom screws. Finally, this technique allows for biologic fixation at the screw-bone interface.

Assessment of clinically relevant measures for injection of intervertebral disc therapies

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Introduction
Many early stage interventions for intervertebral disc degeneration are under development, often involving injection of a novel biomaterial into the nucleus aiming to restore disc height and general functionality. Currently the optimum volume to inject has not yet been investigated. Under- or over-injecting could result in unsuccessful treatment or potential increased risk of herniation. The aim of this work is to identify clinically relevant quantitative measures that indicate the mechanical performance of an injectable biomaterial.

Method
Bovine tail bone-disc-bone units (n=22) were mechanically tested under cyclic loading sequentially in native, artificially degenerated and treated states. Treatment involved injection of a peptide:glysosaminoglycan mixture into the degenerated disc to a predetermined load using a syringe driver with an integrated force sensor. The restorative effect of the treatment was determined by comparing the normalised biomechanical behaviour of the native state to the treated state of each disc.

Results
The normalised injected volume was found to have a strong relationship with the stiffness restoration (r2=0.71). As nucleus begins to fill, the stiffness increases until it reaches the native state and will eventually over-restore the disc. There was a weaker relationship between normalised injection force and stiffness restoration (r2=0.28). This is attributed to permeation through or breaking of annular layers, resulting in inconsistent rises in nucleus pressure.

Conclusion
This work showed that measuring the injection force for injectable therapies of the disc can provide lower and upper limits for delivery, but the injected volume is a better indicator of disc biomechanical restoration.

Reducing Uncertainty in Anterior Vertebral Body Tethering: Predicting Postoperative Curvature with Fulcrum Bending Radiographs

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Introduction
In Anterior Vertebral Body Tethering (AVBT), mid-term results demonstrate an acceptable degree of clinical success, yet the revision rate remains notably higher than traditional fusion. Surprisingly little attention has been paid as to how curve magnitude and flexibility may impact outcomes following AVBT, potentially overlooking a valuable aspect of surgical planning. Fulcrum-bending radiographs have previously been shown to more reliably predict radiological outcomes in AIS as compared to supine-lateral bending radiographs. This study aims to discern how Fulcrum Flexibility Rate (FFR) correlates with Correction Rate (CR) and establish whether this can reliably predict residual deformity following AVBT surgery.

Methods
An IRB-approved retrospective chart review of 38 consecutive AIS patients undergoing thoracic AVBT between 2015 – 2020 was performed. Preoperative (standing and fulcrum-bending) and postoperative (first-erect) radiographs were evaluated for curve magnitude using the Cobb-method. The FFR, CR and Fulcrum Bending Correction Index (FBCI) were calculated. Student t-test, Pearson correlation and linear stepwise regression was applied.

Results
AVBT resulted in a significant improvement in the major Cobb angle (Preoperative: 50.9±7.5° vs Postoperative: 19.9±9.4°; $p<0.0001$) with a mean FBCI of 98.0%. Bivariate correlation revealed a strong relationship between fulcrum-bending and first-erect Cobb angle ($r=0.5306$, $p=0.0006$). Linear regression demonstrated a predictive relationship between fulcrum-bending and first-erect Cobb using the equation 'Postoperative Cobb = 7.5 + 0.65(Fulcrum-bending Cobb).'

Conclusion
This is the first study to demonstrate the predictive ability of fulcrum-bending radiographs to determine early radiographic outcomes following AVBT ('timepoint-zero' for the growth modulation process) and may help to better inform patient selection.

Spinal Chest Intrusion and Bronchial Narrowing In Relation To Pulmonary Function in Adolescent Idiopathic Scoliosis

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Purpose
To describe the relation of spinal chest intrusion and bronchial narrowing with pulmonary function in preoperative AIS patients.

Methods
Spinal radiographs, low-dose CT scans of the spine including the chest and pulmonary function tests were retrospectively collected for eighty-five preoperative thoracic AIS patients in two centers and compared to fifteen matched controls. Three-dimensional lung and airway reconstructions were acquired. Correlation analysis was performed between radiographic spinal parameters, CT-based chest deformity parameters (rib-hump index (RHi), spinal penetration index, endothoracic hump ratio, hemithoracic-width ratio), lung volume asymmetry and bronchial diameters versus percent-predicted spirometry results.

Results
41 (48%) patients had a FEV1% or FVC% below 65%. All chest deformity parameters correlated significantly with FEV1% and FVC%, RHi was the strongest predictor ($r_s = -0.52$ and -0.54 respectively). AIS patients with impaired pulmonary function had a smaller thoracic kyphosis, larger rib hump, increased spinal and thoracic rotation, a narrower right hemithorax and increased intrusion of the spine into the chest. Increased spinal intrusion correlated with right-sided bronchial narrowing, relative right lung volume loss and decreased FEV1% and FVC%. Multivariate regression including spinal and thoracic deformity parameters, lung volume asymmetry and airway parameters could explain 57% of the variance in FEV1% and 54% of FVC%.

Conclusions
Chest intrusion by the endothoracic hump is related to right-sided bronchial narrowing and lung function loss in preoperative AIS. The findings support that ventilatory dysfunction in AIS is not only restrictive but frequently has an obstructive component, especially in patients with hypokyphosis.

BritSpine 2021 Poster Abstracts

Surgical Treatment / Intervention

Nonagenarians and Spinal Surgery – Our Experience

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Introduction
With a growing elderly population, there is an increasing number of patients presenting to our spinal practice. We present our experience in operating on those over 90 years.

Methods
We included patients in this age group undergoing surgery over a 5 year period (Aug 2014 - Aug 2019). We assessed pre and postoperative mobility and function using the validated Clinical Frailty Score (CFS) with an improvement in CFS of 1 being significant. We excluded patients undergoing local anaesthetic procedures, biopsy or vertebroplasty.

Results
A total of 21 nonagenarians (mean age 91.7) underwent 23 operations. There were 18 elective and 4 emergency procedures. This compared to 175 operations on patients aged 85-90 years amongst a total of 8807 operations on adults. There were 3 complications (1 reoperation due to a malpositioned pedicle screw, 1 dysphagia following cervical laminectomy and 1 mortality 23 days post surgery from chest infection). Overall complication rate of 14% was comparable to our other subgroup of patients aged 80-90 years. Average length of stay was 14 days (Emergency 20 and elective 13 days) Those undergoing lumbar surgery (n=10) had a significant improvement from CFS of 4.7 (vulnerable) to 2.6 (well). Those undergoing cervical surgery also improved CFS from 6.5 (mod/severely frail) to 5.5. 20/21 patients felt that surgery was worthwhile with a significant improvement in symptoms.

Conclusion
Although the numbers are small, we found that it was safe and effective to offer nonagenarians spinal surgery with overall complications being low. However there was a selection bias.

Cervical Disc Arthroplasty versus Anterior Cervical Discectomy and Fusion for the Treatment of Single-level Disc Degenerative Disease with Reversible Kyphosis

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Purpose
To compare the clinical and radiological outcomes of single-level cervical disc arthroplasty (CDA) and single-level anterior cervical discectomy and fusion (ACDF) in patient with preoperative reversible kyphosis (RK).

Methods
From 2013 to 2018, patients who had preoperative RK and underwent single-level CDA/ACDF were consecutively reviewed. The Japanese Orthopedic Association score, Neck Disability Index, Visual Analog Scale were used to evaluate clinical outcomes. Range of motion (ROM), segmental angle (SA) at index level, C2-7 angle, functional spinal unit (FSU) angle and heterotopic ossification (HO) were assessed.

Results
There were 24 patients in CDA group (mean follow-up of 39.8 months) and 27 patients in ACDF group (37.6 months). Both groups had significant improvements in clinical outcomes without substantial intergroup differences. Before surgery, the C2-7 angle was significantly more kyphotic in CDA group (-7.1° vs -3.4°, P=0.035). The C2-7 angle and FSU increased significantly in 2 groups while C2-7 ROM was preserved after surgery. Segmental ROM at index level was preserved in CDA group but nearly vanished in ACDF group. At the last follow-up, the C2-7 angle, FSU and C2-7 ROM were comparable between groups. According to McAfee classification, 70.8% (17/24) patients in CDA group developed HO (6 cases of grade 3; 3 cases of grade 4).

Conclusion
Both CDA and ACDF achieved satisfactory clinical results for the treatment of single-level disc degenerative disease with preoperative RK. CDA was non-inferior to ACDF with respect to the postoperative cervical alignment. CDA group had a relatively high incidence of HO formation.

Pre-operative factors predicting walking ability following posterior decompression for lumbar spinal stenosis. A study from the British Spinal Registry

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Background
The hallmark impairment of lumbar spinal stenosis (LSS) is walking difficulty yet ⩽40% patients report post-operative walking disability. If predictors of poor walking are identified and targeted, post-operative walking and quality of life may be improved. The objective was to identify the pre-operative factors that predict walking ability 12 months following surgery for LSS.

Method
A prospective cohort study using data from the British Spine Registry (2012-2019) of adults (⩾50 years) with LSS, who underwent ⩽2 level posterior lumbar decompression. Exclusion criteria included surgical fixation and previous lumbar surgery. Walking ability was assessed by a single item on the Oswestry Disability Index (ODI) questionnaire and dichotomised into poor/good outcome. Linear and logistic multivariable regression models were performed. Categorisation was used to deal with missing data.

Results
40,011 patients were identified (mean age 67.4±10.5 years, 52% female). Median pre-operative ODI score for walking was 3.0[1.0, 3.0], and at 12 months was 1.0[0.0, 2.0]. Predictors associated with poor walking ability was surgery type (+/-discectomy) (OR 4.87; 95% CI 2.14, 11.0, P<0.001); ODI (OR: 1.09; 95% CI 1.05, 1.12, p<0.001); and pre-operative distance walked (OR: 0.99; 95% CI 0.98, 1.00, P=0.034). There was no statistically significant association between risk of poor walking ability and pre-operative BMI, age, gender, neurological deficit, pain and quality of life.

Conclusion
Pre-operative walking distance, disability levels and surgery type are predictive of walking ability after surgery for LSS. Issues with data quality limited number of potential predictors that could be included in the analyses, therefore limiting conclusions.

Validation of four pre-operative risk prediction scoring systems in spinal surgery.

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Pre-operative risk prediction scoring systems use patient-specific information to predict the risk of adverse outcomes to guide both surgical decision-making and informed consent. Four such scoring systems are the Surgical Outcome Risk Tool (SORT), the American College of Surgeons (ACS NSQIP) risk calculator, the Revised Cardiac Risk index (rCRI) and the Spine Sage tool. The aim of this study was to validate each scoring system in spine surgery patients at a tertiary spinal centre. 398 patients underwent spinal surgery between 01/06/17 and 25/04/18. Patient data for all scoring variables were collected retrospectively and scoring systems outcome values calculated together with the observed morbidity and mortality. The Discriminatory accuracy was determined by the Area Under the Receiver Operator Characteristic Curve (AUROC, SPSS), which measures the ability of the tool to "discriminate" between patients that do or do not have the outcome of interest (0.5 = no better than chance, >0.9 = good accuracy). A comparison of predicted and observed 30-day mortality for the SORT and ACS NSQIP scores gave an AUROC score of 0.931 and 0.984 respectively, classifying it as an excellent test. The rCRI score produced an AUROC score of 0.536, implying a poor test. A comparison of predicted and observed morbidity for ACS NSQIP and Spine Sage scores gave an AUROC score of 0.590 and 0.517 respectively, indicating a poor test. This study therefore suggests that both the SORT and ACS NSQIP scoring systems are good predictors of perioperative mortality, but no system is able to predict morbidity.

Does Instrumentation Of The Fractured Level In Thoracolumbar Fixation Affect The Radiological And Functional Outcome? A comparative prospective study

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Introduction
Though posterior pedicle screw fixation is the gold standard for unstable thoracolumbar fractures, instrumenting the fractured level in the construct is a relatively new technique. Our study

assesses both radiological and functional outcomes of this construct in single level fractures of the thoracolumbar junction (T11-L1).

Methods
Radiological parameters and functional outcomes (hospital registry database) were prospectively collected for 53 consecutive thoracolumbar junction fractures operated between the years 2010-2018. Patients where the fracture level was instrumented (FL group: 34 patients) were compared with the group where fracture level was not instrumented (NFL group: 19 patients).

Results
Post-operative back pain score was significantly lower in the FL group ($p < 0.025$) compared to NFL group. Core Outcome Measures Index (COMI) scores and leg pain scores, though low in the FL group, were not statistically significant. Though the bi-segmental Cobb's angle correction did not differ in either group, the degree of vertebral height restoration was significantly better in the FL group at the final follow up ($p < 0.032$). Moreover, the sagittal index was significantly better restored by the FL fixation technique in the immediate post-operative period ($p < 0.037$). There was no significant difference between the groups for revision surgery, deep infection, implant failure or post-operative length of hospital stay.

Conclusion
The inclusion of the fracture-level pedicle screw in the fixation construct seems to significantly improve the immediate and final measured radiological parameters along with better functional scores in patients with single level unstable vertebral fractures of the thoracolumbar junction.

Operative Management Of Giant Calcified Thoracic Disc Herniations And Use Of Intraoperative Neuromonitoring (IONM)

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Introduction
Surgery in patients with giant calcified thoracic disc herniation (GCTDH) is challenging with no firm recommendations on the use of IONM. Our aim was to report our experience with use of IONM in the surgical treatment of these patients.

Methods
A retrospective study of patients operated for GCTDH from (2004-2019) was conducted. Radiological assessment was done by noting the percentage of spinal canal occupation (SCO) and spinal cord compression (SCC). Neurological assessment (Frankel grading), type of surgery, IONM use and intra-operative complications were also noted.

Results
In total, 30 patients underwent surgery for GCTDH [mean age 56.7 years (range 31-83 years); average follow-up 12.6 months]. The mean SCO and SCC were 62.2% (range 38%-90%) and 51.5% (range 24.5%-77%) respectively. Thoracotomy was employed in 25 patients and other 5 underwent a posterior transpedicular approach. IONM was used in 18 patients (60%), 6 of whom had a significant drop (MEPs), with 1 patient developing immediate post-operative neurological deterioration but recovered over the follow-up. In 12 patients without IONM, no patient developed post-operative neurological deficit. Overall, during follow-up, the Frankel grade either remained same (13, 43%) or improved (17, 57%). Complications occurred in 5 patients (17%; 3 durotomies, 1 abducens palsy and 1 recurrence).

Conclusion
IONM was preferentially utilised in 60% (18/30) of patients undergoing surgery for GCTDH. Only 1 in 6 of the significant drops in IONM, corresponded to a transient post-operative neurological deficit. However, absence of IONM did not make surgical patients with GCTDH more susceptible to neurological deficit post-operatively.

Intraoperative Neuromonitoring in Treatment of Patients with Giant Calcified Thoracic Disc Herniations (GCTDH): A Systematic Review

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Introduction
There are presently no recommendations on the use of intraoperative neuromonitoring (IONM) in surgery for patients with GCTDH. Our aim was to conduct a systematic review of literature pertinent to this group of patients and evaluate the use of IONM.

Methods
A systematic review was conducted in PubMed database and Google scholar with relevant keywords: ''Giant OR huge'' AND Thoracic Disc. Using a standard PRISMA template, 54 articles were identified after removing duplicates; 36 full-text articles were assessed for eligibility, of which, 17 were finalized as they fully met the search criteria.

Results
From the 17 papers analysed, a total of 263 patients were operated for GCTDH. IONM was used in 59 (22.4%) patients of whom 8

(13.5%) had immediate post-operative neurodeterioration. In the remaining 204 (77.6%) patients, 19 (9.3%) developed post-operative neurological deterioration.

Conclusion

Our systematic review showed that IONM was only utilised in approximately 1/4 of cases with 13% showing a post-operative neurological deterioration, compared to 9% in the cases without IONM (78%). Beyond reassurance when all the IONM is unchanged intra-operatively in the surgical treatment for GCTDH, its' use remains uncertain and ultimately down to the surgeon's preference.

Back pain outcomes in single level lumbar spine surgery – a registry study

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Introduction

Lumbar spine decompression surgery aims to improve radicular / stenotic leg pain. This study aims to quantify the improvement in back pain following single level lumbar decompression or discectomies.

Methods

All patients undergoing single level lumbar discectomy (D) and single level decompression (SLD) in our unit between June 2012 and July 2018 were identified using the British Spine Registry. Patients with pre and post op VAS scores were included. There were 1,353 patients in the lumbar discectomy group and 914 patients in the single level decompression group. Primary outcome was change in VAS back pain score (VAS back) at six months.

Results

There were 1159 discectomy patients (mean age 44 years, 51.5% male) and 778 decompression patients (mean age 61 years, 49.5% male). Mean pre-operative VAS back was 6.2 in both groups. 86.6% of discectomy patients had an improvement in back pain at 6 weeks and 79.3% at 6 months. 55.6% of patients achieved MCID (minimum clinically important difference) in VAS back at 6 weeks, and 43.7% at 6 months. 83.5% of decompression patients had an improvement in VAS back at 6 weeks and 75.8% at 6 months. 55.5% of patients had a MCID in VAS back pain score at 6 weeks and 42.3% at 6 months.

Conclusion

Less than 50% of patients undergoing lumbar discectomy or decompression achieve the VAS back MCID at six months after surgery. This data is potentially useful when counselling patients about treatment options.

Novel combined double-incision technique for extreme lateral interbody fusion (elif) and antero-lateral anterior lumbar interbody fusion (al-alif) in the lateral decubitus position for degenerative scoliosis

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We present a novel combined procedure to treat degenerative scoliosis using both approaches via a double skin incision whilst the patient is in a lateral decubitus position. Between January 2017 and June 2019, we identified 9 patients who underwent this approach. PROMS were collected preoperatively, and up to 12 months postoperatively. PROMS included ODI, VAS BP and LP and SF-36. Placing the patient in a lateral decubitus position, while using spinal neuromonitoring, an ELIF approach is perfomed. We carry out the discectomy and endplate preparation for placement of the interbody cage. This can be performed up to three levels with this skin incision. Whilst in the same position, an oblique skin incision is performed in the lower abdomen for the AL-ALIF. After visualisation of the targeted lumbar disc level, routine discectomy is performed followed by endplate preparation before insertion of an ALIF cage. In a prone position, a second stage posterior pedicle screw fixation and fusion is carried out. For ODI, the mean improvement from pre-operative to last follow-up was 15.8 ± 12.6 from a baseline of 47.3 points. For VAS BP, the mean improvement was 2.7 ± 1.9 from a baseline of 6.7 points. For VAS LP the mean improvement was 3.3 ± 5.1 from a baseline of 6.1 points. No minor or serious complications. Demographics, PCS and MCID results to be presented during talk. AL-ALIF in combination with the ELIF approach allows for a truly safe minimal invasive surgery and is a promising option for adult deformity.

C5 Nerve Palsy after Cervical Spine Surgery: Towards a Predictive Scoring Tool

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Introduction

C5 nerve palsy is a known complication following cervical spine surgery. Theories on C5 palsy causality focus on pre-existing cord compression, intra-operative approach and the amount of shift of the spinal cord. Cardiovascular risk factors may further predispose patients to developing ischemia re-perfusion injury and C5 palsy. In this study we analyse risk factors, with the aim to develop a predictive risk score.

Method
Retrospective cohort of 102 patients who underwent cervical spine surgery. Analysed variables included (1) Patient based factors (demographics, co-morbidities), (2) Pathological factors (pathology type, clinical presentation, imaging and electro-physiology) and (3) Surgical factors (approach, complexity and levels involved). Baseline differences were analysed using Chi-squared and t-tests. Odds ratio was calculated for the potential contributing variables.

Results
Of the 102 patients, 6 (5.9%) developed C5 palsy (mean age 61.3 years, 3 years older on average than those without C5 palsy). Significant patient risk factors included male gender (OR 2.1) and having 3 more cardiovascular risk factors (OR 8.3 CI 0.9-74). Pathology based risk factors included myelopathic features (OR 1.6) and having OPLL (OR 1.3). Neurophysiology was not a predictive factor. Regarding surgical factors multi-level decompressions with prosthesis or fixation (OR 3.0) presented the greatest risk. We found no significantly increased risk between posterior or anterior approach per se.

Conclusion
We demonstrate the importance of cardiovascular risk factors in the development of post-operative C5 palsy. The next phase of this study is to prospectively test a developed risk score, with the ultimate goal of improving pre-operative counselling.

Long-term outcome after surgery for Chiari malformation in pediatric scoliosis

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Background
Paediatric scoliosis (PS) and Chiari malformation type 1 (CM1) with or without syringomyelia (syrinx) have been reported to be linked. Scoliosis curve progression has been associated with the presence of CM1 with or without syrinx. Indications for posterior fossa upper cervical decompression (PFUCD) in the presence of scoliosis are symptomatic CM1 and/or a planned scoliosis surgery to reduce the risk of cord injury and neurological complications.

Methods
Retrospective analysis of Cohort of patients with CM1 and PS.

Results
From 11.2011 to 12.2018 we identified 15 patients with CM1 & PS. Eleven underwent PFUCD, 10 were symptomatic CM1, 1 was asymptomatic but with curve progression. The remaining 4 were asymptomatic and treated conservatively. Average follow up post PFUCD was 26.2 month. Scoliosis surgery was performed in 7 cases. PFUCD was done prior to the scoliosis correction in 6 cases. One case of scoliosis was operated in the presence of mild CM1 that was treated conservatively. The remaining 4 cases are scheduled for scoliosis correction surgery while 3 cases are managed conservatively with one case lost to follow up. The average time between PFUCD and scoliosis surgery was 11 months. None of the cases had an intraoperative neuromonitoring alerts or perioperative neurological complications.

Conclusion
In our series, the long term surgical outcome of PFUCD is good with documented significant improvement in clinical and radiological findings. PFUCD was found to be a safe procedure which allowed the subsequent scoliosis correction to be performed with no neuromonitoring alerts or perioperative neurological complications.

Surgery for Degenerative Lumbar Spondylolisthesis: Does the British Spine Registry inform Decision Making

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Abstract Surgery for Degenerative Lumbar Spondylolisthesis: Does the British Spine Registry inform Decision Making?

Background
A variety of operations are used to treat degenerative lumbar spondylolisthesis the UK. Identifying the Patient Reported Outcome Measures (PROMS) associated with different procedures should inform decision making.

Methods
All patients registered on the British Spinal Registry who underwent surgery for degenerative lumbar spondylolisthesis and had 1 year follow up data were included. Charlson comorbidity index was calculated. Outcome measures were ODI, EQ5D, VAS (back/leg). Multivariate analysis was conducted.

Results
1 year outcomes were available in 491 patients. 246 patients underwent decompression alone, 168 posterolateral fusion, 61 TLIF, 45 PLIF, 4 direct lateral, 1 arthroplasty, 6 ALIF. Significant improvements in all PROMS was seen across all procedures. No significant difference between procedure was identified. Higher Charlson score was associated with smaller improvements in function.

Conclusions
These findings support simple decompression as the procedure of choice for degenerative lumbar spondylolisthesis.

Outcomes after cervical spinal fixation in patients with Ehlers Danlos Syndrome and Hypermobile Spectrum Disorder treated abroad

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Introduction
There have been anecdotal reports in the media of patients from the UK with Ehlers Danlos Syndromes (EDS) and Hypermobility Spectrum Disorder travelling abroad for spinal fixation for cervical instability with varying outcomes. The treatment is controversial due to, in part, difficulties in diagnostic assessment of instability compared to hypermobility, limited understanding of the underlying pathogenic mechanism, and minimal published outcome data. There has been no previous report of this group of patients.

Methods
An anonymised questionnaire was developed and disseminated by UK-based EDS charities using their websites and social media between the 23rd of April 2020 and the 23rd of July 2020.

Results
Thirty-eight respondents (35 / 92% female) completed the questionnaire, of which, twenty-six (68%) underwent cervical spine fixation. Fixation was most commonly C0 to T1 or longer, and the majority of this group had one or more additional procedures. The most commonly reported symptoms prior to surgery were pain, weakness, spasticity or mobility problems, and headaches or pressure. Twenty-two respondents (84%) reported improvements following surgery. The median cost was £50,000-£100,000 and the NHS financially contributed in only three cases (12%).

Conclusions
Patients travelling abroad to receive treatment report significant improvement of symptoms and quality of life, but at significant cost. Further investigation into this patient group, the possible underlying mechanisms involved, and a more detailed review of the surgical outcomes are required.

Charlson Comorbidity Index Score Is Associated with 90-Day Return to Surgery Following Endoscopic Discectomy for Far Lateral Disc Herniation

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Introduction
The Charlson Comorbidity Index (CCI) score combines age and numerous comorbidities to predict 10-year all-cause mortality. This study examines the relationship between CCI score and adverse outcomes following endoscopic discectomy for far lateral disc herniation (FLDH).

Methods
All patients (n = 52) undergoing endoscopic discectomy for FLDH at a single, multihospital academic medical system from June 2017 to April 2020 were included. Data were acquired via the EpiLog tool, a non-proprietary data acquisition tool created by the senior author on the present study. Adverse outcomes included 30-day and 30-90-day rates of readmission, reoperation, and emergency department (ED) evaluation, as well as 30-day neurosurgical outpatient visit and 30- and 90-day return to surgery for either any surgical service or neurosurgery specifically. Univariate logistic regression was used to analyze the relationship between CCI score and patient outcomes.

Results
Age of the population was 64.35 ± 11.42 years, 28 (53.9%) were female, and 45 (86.5%) were non-Hispanic white. Average CCI score among the patient population was 3.48 ± 2.81. CCI score was significantly correlated with 90-day frequency of return to surgery. However, CCI score was not found to be correlated with rates of 30- and 30-90-day readmission, 30-90-day reoperation, 30- and 30-90-day ED visit, or 30-day return to surgery. No reoperations within 30 days of the index operation or returns to neurosurgery within 90 days were reported.

Conclusion
CCI score predicts 90-day return to surgery in patients undergoing endoscopic discectomy for FLDH.

360 Fusion of Monosegmental Traumatic Thoracolumbar fracture with associated Spinal Cord Injury: Does an Mini-Open Anterior Corpectomy add to the operative morbidity? Surgical Case Series

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Background
Traumatic thoracolumbar fractures can be managed surgically using the anterior, posterior approaches or via a combined approach. The ideal approach remains controversial. Previously approaching anterior has been considered to have a higher morbidity and therefore underutilized.

Aim
This study investigates the clinical outcomes of patients, who sustained a monosegmental traumatic thoracolumbar fracture with associated spinal cord injury. They underwent immediate posterior decompression and instrumented fusion followed by a planned delayed mini-open anterior corpectomy for 360 degree fusion.

Materials and Methods
A retrospective review of consecutive patients admitted who sustained unstable traumatic thoracolumbar fractures with associated spinal cord injuries. Patients who underwent anterior approach mini-open corpectomy and instrumented fusion for traumatic thoracolumbar fractures were included. Patients received posterior fixation prior to anterior surgery. Demographic and clinical information, fracture classification perioperative parameters and complications were analyzed.

Results
Twelve patients were included. Fracture patterned ranged from AO type A3 to C. Mean anterior operative duration was (195.3 ± 32.6) min. The postoperative haemoglobin decrease was greater during posterior approach compared to the anterior approach (-27.4±11.7 g/L v -17.4±7.9 g/L, p=0.034). No patient had neurological deterioration postoperatively. At final follow-up, 6 patients (50.0%) had preserved neurological function, and 6 patients (50.0%) improved by one ASIA grade. The addition of the anterior approach and fusion added no further operative morbidity to the patients' outcome.

Conclusion
Adding a delayed modern, mini-open, anterior corpectomy and fusion of a thoracolumbar fracture is a safe and effective method of managing monosegmental traumatic thoracolumbar fractures.

Assessing the validity of a temperature sensor to monitor patient adherence to cervical spine orthosis wear time

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Introduction
Currently no objective measure of compliance with cervical orthosis wear exists.

Aim
To evaluate the validity of a generic orthosis temperature sensor to monitor compliance with a cervical orthosis.

Methods
This observational study involved healthy participants, wearing a cervical orthosis according to a 150 minute protocol (n=8), tested at threshold temperatures of 22-31 degrees, sampling every 15 minutes. University of Sheffield ethical approval reference: 031694. Primary outcome: agreement of temperature sensor with digital camera to determine collar on versus collar off. Secondary outcome: validity of mean wear time.

Results
The mean temperature whilst collar off was 22 degrees (SD=5.0) and whilst collar on was 28 degrees (SD=4.2). The highest agreement of the 160 data-points was demonstrated at a threshold of 25-27 degrees, which showed moderate agreement between sensor and camera for collar on time and collar off time. (Kappa = 0.60, p value <0.001). These analyses are adversely affected by warm-up and cool-down lag. The mean warm-up of 16.8 minutes and cool-down time of 13.2 minutes were similar (p value>0.05), thus negating one another in wear time analysis. Mean detected wear time ranged from 189-90 minutes for thresholds 22-31degrees. A threshold of 25.5 degrees gives optimum correlation between sensor detected wear time and true wear time.

Conclusion
This novel study demonstrates a widely available temperature sensor can be used to accurately and objectively measure patients' compliance with cervical orthoses wear time. This has important implications for both clinical practice and research studies such as the forthcoming NIHR DENS study.

Routine in-hospital radiographs following anterior cervical discectomy and fusion surgery: neither necessary nor cost-effective?

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Purpose
To evaluate whether a post-operative radiograph of the cervical spine before discharge is either clinically justified or cost-effective in patients who have undergone an ACDF, despite having satisfactory intra-operative imaging.

Design
A retrospective review of 101 consecutive ACDF patients: whether radiographs were performed before discharge, associated length of inpatient stay and any complications involved.

Methods
A retrospective review of 101 ACDF patients from a single neurosurgical centre. 78 had an in-hospital post-operative radiograph, 23 did not. In 95 of these, it was documented that there was 'satisfactory intra-operative imaging'. All patients had intra-operative imaging of completed instrumentation. Any post-operative complications were noted, and the length of hospital stay (LOS) recorded. Study parameters also included: levels operated on, whether or not a plate was used with a cage, additional costings to the hospital.

Results
There was one post-operative complication relating to the metalwork in the 101 patients. However, the decision to perform this x-ray was based purely on the deteriorating post-operative clinical picture. In the cohort that had POXR's, the average length of stay was 66.7 hours. Without POXR, it was 21 hours. The additional cost to the trust of performing the in-hospital radiographs was calculated to be £71,523 per year.

Conclusion
In patients who undergo ACDF surgery with an uneventful post-operative course and satisfactory intra-operative imaging, in-hospital post-operative radiographs serve no clinical purpose and delay discharge. This gives additional cost to the trust, unnecessary radiation exposure and occupies potential bedspace.

What is the optimal surgical method for achieving correction and avoiding neurological complications in paediatric high-grade spondylolisthesis?

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Introduction
Controversy persists in the treatment of high-grade spondylolisthesis (HGS). This study compares the outcomes and complications at a minimum of two years follow up for patients with HGS treated with instrumented fusion with partial reduction (IFIS) with those treated with reduction, decompression and instrumented fusion (RIF).

Methods
A retrospective comparative analysis of paediatric patients treated for ⩾ grade 3 spondylolisthesis between 2006 and 2017 with a minimum of 2 years follow up was carried out. Patients were excluded if surgery did not aim to achieve arthrodesis or was a revision procedure.

Results
30 patients with a mean follow-up was 4 years were included. Ten patients underwent IFIS and 20 underwent RIF. The two groups showed no difference in demographics, grade of slip, deformity or presenting symptoms. Of 10 treated with IFIS, the slip angle (SA) reduced by a mean of 10° and C7 sagittal vertical line (SVL) changed by 31mm. In the RIF cohort, SA reduced by 16°and C7 SVL reduced by 26mm. Pelvic tilt was unchanged in both groups. In IFIS cohort 2 patients showed post-operative weakness, resolved by 2 years. None required revision surgery. In the RIF group 4 sustained dural tears and 1 a laminar fracture, 7 showed post-operative weakness or dysaesthesia, 3 of which had not resolved by 2 years. 8 patients underwent unplanned further surgery, 3 for pseudarthrosis.

Conclusions
RIF and IFIS show similar radiological outcomes. RIF shows a higher rate of unplanned return to surgery, pseudarthrosis and persisting neurological changes.

CT guided spine biopsy for the diagnosis of malignancy and infection

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Background
Computed tomography (CT) guided percutaneous biopsies are used to guide treatment in vertebral osteomyelitis and spinal malignancy, but the efficacy of this study remains unclear.

Objective
This study investigates the performance of CT-guided spinal biopsy, and factors that may influence its success.

Methods
Retrospective study of all consecutive patients who underwent a CT-guided spine biopsy at a UK teaching hospital between April 2012-February 2019. Biopsies were performed by three consultant neuroradiologists for a lesion suggestive of either malignancy or infection. Data collection included patient factors, biopsy factors, further investigations required, and diagnosis. Data were analyzed using contingency tables, ANOVA, unpaired t-test, chi-squared test, and Fisher's exact test.

Results
124 percutaneous biopsies were performed on 109 patients with a mean follow up of 34.5 months (range 4-86 months) and a mean age of 66 (range 27-93). 32.3% (n = 40) of the biopsies investigated possible infection, and 67.7% investigated malignancy. The sensitivity for infected cases was 37.0% and for malignancy 72.7%. The diagnostic accuracy was 57.5% and 78.6% respectively. The complication rate was 1.6%. In our study, neither needle gauge, anatomical level of the biopsy, nor bone quality significantly affected the rate of a positive biopsy.

Conclusion
Both in our study and in the wider literature, CT-guided biopsy has a vastly superior sensitivity for malignancy compared with suspected infection. These procedures may be painful, poorly tolerated, and are not entirely risk-free. As such we advocate judicious use of this modality particularly in cases of suspected infection.

Safety and reliability of NanOss in paediatric scoliotic deformity corrections

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Introduction
The current gold standard for bony regeneration and fusion is an autograft harvest from iliac crest or local bone. But the inherent disadvantages of its limited supply, increased operating time and donor site morbidity still constant drives our quest for alternative solutions. NanOss® Bioactive (Regeneration Technologies Corporation: RTI, Alachua, FL, USA) is an advanced Bone Graft Substitute composed of nano-structured hydroxyapatite (NHA) granules in an open structured engineered collagen carrier. It provides more surface area which allows increased potential for cell attachment. Nano-structured HA is similar to bone, which increases its propensity to remodel into new bone. We present a case series to demonstrate its clinical safety and reliability in the paediatric scoliotic deformity corrections.

Method
This is a single surgeon retrospective review of prospectively collected data of 24 consecutive cases from February 2017 to August 2018. Clinic letters were reviewed for levels of grafting and analysis of complications.

Results
All patients were females between age 13-17 years (mean: 14 years 3 months), with pre-operative deformity ranging 41'-70' (mean: 51.6'). Post-operative deformity measured 5'-29' (mean: 12'). Average correction was 40.2' (range: 26'-46') on 12 grafted segmental levels. There were 3 reported wound infections, one needed a wound wash-out and the rest settled with oral antibiotics.

Conclusion
Our results show that NanOss Bioactive 3D is a safe, reliable and efficient advanced bone graft substitute for use in the paediatric scoliotic deformity corrections. To our knowledge, there is no report documenting the use of this bone graft for these corrections.

A novel quantitative study of Hounsfield Units of CT artefact and proposition of a grading system comparing carbon vs titanium pedicle screws in MSCC

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Background
Carbon fibre (CF) instrumentation is known to be radiolucent and has a tensile strength similar to metal.* A specific use could be primary or oligometastatic cancer where regular surveillance imaging and Stereotactic Radiotherapy are required. CT images are inherently more prone to artefacts which affect Hounsfield unit (HU) measurements. Titanium (Ti) screws scatter more artefacts. Until now it has been difficult to quantify how advantageous the radiolucency of carbon fibre pedicle screws compared to titanium or metallic screws actually is.

Methodology
In this retrospective study, conducted on patients from 2018 to 2020 in SGH, we measured the HU to compare the artifact produced by CF versus Ti pedicle screws and rods implanted in age and sex matched group of patients with oligometastatic spinal disease.

Results
Eleven patients were included in each group. We compared the change of HU between preoperative and postoperative cases of both CF & Ti screws, which clearly shows Ti screws scatter lot more artefacts than CF screws.We are proposing a CT artefact grading system from grade 0 to grade 4 based on the percentage change of HU for unequivocal understanding of the CT artefacts.

Conclusion
This study clearly shows the artefacts produced by the metallic implants are significantly higher than the carbon fibre implants. Considering the efficacy of the RT and the increased life expectancy as a consequence, carbon instrumentation MAY BE superior to titanium or metallic instrumentation. The artefact grading system will help the clinicians in describing and planning where the artefacts need to be factorized.

A systematic review of outcome measures used in randomised trials investigating spinal fusion or total disc replacement in the treatment of chronic low back pain

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Introduction
Decades of research into the efficacy of spinal fusion or total disc replacement has failed to definitively demonstrate superiority over non-surgical treatments for the treatment of chronic low back pain (CLBP). Calls for further trials have been made, but given conflicting existing results, we sought to review the outcome measures used in published trials investigating spinal fusion or total disc replacement in the treatment of CLBP.

Methods
A systematic review of all major databases identified prospective randomised trials investigating either spinal fusion and/or disc replacement, extracting outcome measures used.

Results
127 publications representing 101 cohorts were included. 184 outcome measures (excluding composites) covered 8 categories relating to the following domains: operation-related (n=20), satisfaction (n=10), pain (n=22), quality of life (n=29), radiological (n=72), economical (n=14), functional (n=12), and psychological (n=5) status. The most common patient-reported outcome measures were the Oswestry Disability Index (ODI) (n=100), Visual Analogue Scale (VAS) back (n=96) or leg pain (n=52), Short Form 36 (n=43), and overall satisfaction (n=30). Significant heterogeneity exists in the minimal clinically important difference assumed for ODI, of which the proportion of patients achieving a 15 point or 15% improvement (n=13), 25% improvement (n=5), and 10 point improvement (n=4) were most common.

Conclusion
Heterogeneity exists in outcome measure choice and interpretation when assessing surgical interventions in CLBP, making study comparisons challenging. Consensus must be reached about how outcome measures are used, particularly with regard to the threshold for meaningful change. This will rely on ongoing collaborative consultation with both patients and clinicians.

What are the radiological outcome measures used in randomised trials assessing surgical interventions for chronic low back pain? A systematic review

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Introduction
Extensive research has been performed assessing the effects of spinal fusion and total disc replacement in patients with chronic low back pain (CLBP), with many studies reporting radiological outcome measures. We aimed to quantify the use of radiological outcome measures and describe differences in determining radiological fusion status.

Methods
A systematic review of all major databases identified prospective randomised trials investigating either spinal fusion and/or disc replacement, extracting radiological outcome measures used.

Results
Out of 127 studies included, 97 assessed radiological outcome measures, broadly categorised into biomechanical (n=23), disc, allograft or prosthesis-related (n=17), soft tissue (n=6), spinal fusion assessment (n=6) or analysis of adjacent-segment disease (n=5). 58/71 (81.7%) studies since 2010 assessed radiological outcome measures, compared to 39/56 (69.6%) in the two decades prior. 66 studies assessed fusion, and 45 different criteria were identified which were used in the assessment of fusion status. Areas of greatest variation in the cut-off used to determine fusion status were translational shift (<2mm [n=1], <3mm [n=17], <4mm [n=1], and unspecified distance [n=6]) and angular motion (<1.5° [n=1], <2° [n=5], <3° [n=3), <4° [n=3], <5° [n=18], and <10° [n=1]). Additionally, 15 studies assessed adjacent segment disease, of which 13 were published since 2010.

Conclusions
Radiological outcome measures continue to be assessed in randomised prospective trials assessing fusion and disc replacement, despite controversy existing between the relationship between radiological and clinical outcomes. Significant ongoing variation exists in the criteria used to determine radiological fusion. Finally, there has been an increase in interest in adjacent-segment disease.

A modified MIS approach to spinal fixation in the multiply injured patient to reduce both blood loss and radiation exposure

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Background
MIS surgery improves the management of spinal fractures, particularly for multiply injured patients, as the theatre time, incisions, paraspinal trauma and blood loss are greatly reduced. This enables surgeons to operate earlier with less physiological impact and avoiding the sequelae of prolonged bed rest, at the expense of an increased radiation exposure. We propose a modified MIS approach utilising the advantages of MIS but allows the insertion of multiple pedicle screws via standard freehand methods without the need for guidewires, reducing radiation exposure. This is of particular importance where the radiation exposure and operative time needs to be as low as possible.

Methods
We included all patients at Hull Royal Infirmary who had suffered at least 2 unstable spinal fractures with significant extra-spinal trauma injuries (AIS>3), and who underwent modified MIS to stabilise and correct their spinal fractures. The radiation exposure was compared to standard 4-hole plate DHS hip fixations.

Results
22 patients underwent our modified MIS techniques to stabilise their spinal fractures, with no complications or screw misplacement/revision. Patients had average of 10 screws, ISS score of 22.8, intraoperative blood loss of 116mls and an operating time of 4 hours and 7 minutes. The radiation exposure of 4.04mGy across 27.5 intraoperative intensifier images was very similar to a 4-hole plate DHS fixation.

Conclusion
We believe that our modified MIS technique reliably provides the benefits of traditional MIS surgery with minimal blood loss, small incisions and the least possible surgical trauma but with lower radiation exposure.

The effects of long-term blood-thinner usage on the operative complications and patient-reported outcome measures of elective lumbar microdecompression surgery

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Introduction
An increasing number of patients who undergo lumbar microdecompression surgery also have a history of blood-thinner usage secondary to cardiovascular and other co-morbidities. This study aimed to investigate how long-term blood-thinner usage in patients before operation affects surgical and patient-reported outcome measures (PROMs) of elective lumbar microdecompression surgery.

Methodology
Surgical outcomes were retrospectively compared in 26 patients who were on blood-thinners (BT) and 30 patients not on blood-thinners (NBT) who underwent elective lumbar microdecompression surgery. Surgical outcomes were then further analysed in the BT group (n=22) according to data on whether the patient stopped their blood-thinner use immediately before the operation (BTstop) or continued blood thinners intraoperatively (BTnstop).

Results
There were no statistically significant differences in the rates of venous thromboembolisms (0% incidence), wound complications ($p = 0.640$), dural tears ($p = 0.373$), neurological complications ($p = 0.353$), blood transfusions ($p = 0.763$) or bleeding complications ($p = 0.122$) between BT and NBT groups. The NBT and BT group had similar improvements in postoperative pain and functional scores. Even when patients continued blood-thinners intraoperatively, long-term pre-operative blood-thinner usage did not correlate with increased incidence of operative complications or lower levels of patient improvement postoperatively following elective lumbar microdecompression.

Conclusions
This study's results show that patients with long-term blood-thinner use are not at higher risk of important postoperative complications than patients not on blood thinners, even if blood-thinner use is continued intraoperatively. Patients taking blood thinners have similar improvements in pain and functional abilities post-operatively to not on blood thinners.

Outcome of Coccygectomy using a paramedian curvilinear skin incision in adults and children with analysis of the literature focusing on post-operative wound infection

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Aims
To evaluate the clinical outcome and patient satisfaction following coccygectomy for coccygodynia in adults and children using a curvilinear paramedian skin incision and to conduct a meta-analysis of the literature to determine the associated infection rate with different surgical factors.

Study Design
A case series and meta-analysis.

Methods
45 consecutive patients (40 adults and 5 children) underwent surgical coccygectomy for persistent coccygodynia symptoms using a paramedian curvilinear incision. Postoperative clinical outcome scores, patients' satisfaction and wound complications were assessed. A literature search and meta-analysis was also conducted covering the period from 1980 to 2020.

Results
The average age of patients was 39 years with a mean duration of symptoms prior to surgery of 7.4 Years. The mean Oswestry Disability Index improved from 29 to 7.7 ($P < 0.001$). The mean pain Visual analogue scale improved from 8 to 2 ($P < 0.001$) and the median patient satisfaction score was 8 (out of 10) suggesting good to excellent outcome. The clinical improvement was the same in children and adults. There was a total of 5 (11%) wound infections, two of which needed surgical debridement. The use of prophylactic antibiotics for 24 hours, non-absorbable skin sutures and glue were associated with low infection rate according to the literature analysis.

Conclusions
Coccygectomy using curvilinear paramedian skin incision for chronic coccygodynia is an effective procedure with similar or lower complication rates as reported in the literature.

Comparison of different anterior approaches to the dens

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Introduction
Odontoidectomy represents the treatment of choice in case of irreducible atlanto-axial dislocation with compression of the ventral spinal cord. The microscopic transoral-transpharyngeal approach represents the gold standard technique. However, the use of an endoscope via the same route or the endonasal approach provide direct, minimal access to the odontoid process.

Methods
We reviewed our 15 year experience with all three techniques, comparing technical factors, complications, and functional outcome. 47 microscopic transoral cases, 18 endoscopic endonasal cases and 6 endoscopic transoral cases were compared.

Results
Endoscopic endonasal odontoidectomy proved to be a safe and effective procedure. Anatomically, there is overlap at the pharyngeal level in the structures that can be viewed by the transoral and transnasal routes. The transoral approach provides a wider corridor with less restricted manipulation of instruments, but the transnasal approach provides a better view of the clivus, upper part of the craniovertebral junction, and the structures posterior to the removed odontoid and anterior arch of C1. The endoscopic transoral approach provides a panoramic view of the retropharyngeal region, including the ability to see around corners.

Conclusions
The different approaches for odontoidectomy should be considered complementary rather than strict alternatives. The endonasal route can be advantageous in selected cases, especially with conditions related to restricted access through the oral cavity and to high position of the odontoid. Careful patient selection and preoperative surgical planning is critical to obtaining satisfactory results. The approach selection should be tailored to each patient. Combined approaches may be necessary in particular cases.

Spinal Pathways / Triage / Assessment

Postoperative Medical Optimization after Spine and Total Joint Arthroplasty Surgery Decreases Readmission Rate

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Introduction
New health care reforms, due to the Patient Protection and Affordable Care Act, have introduced all-cause hospital readmission as a determinate metric for quality of care. Concurrently, payers have started to implement bundled payment systems, in which hospitals will be accountable for the costs of readmissions for any reason, up to 90 days from discharge. The aim of the current study was to assess factors associated with 30-90 day readmission after spine and total joint replacement surgeries.

Methods
999 consecutive patients who underwent surgery were included. We compiled a database with information regarding the length of stay, number of consults, 30- and 90-day readmission, medical comorbidities, and patient demographics. Pearson correlation coefficients were calculated between the variables of interest.

Results
A 90-day re-admission correlation coefficient of -0.13 was observed when compared to the number of consults obtained after surgery (P<0.05). A -0.11 correlation coefficient was observed when correlated with length of stay (P<0.05). A 30-day re-admission correlation coefficient of -0.09 was observed when correlated with number of consults (P<0.05). A -0.07 correlation coefficient was observed when correlating 30-day re-admission and length of stay (P<0.05).

Conclusion
Patients who are optimized medically for discharge have a significantly lower likelihood of readmission at 30 and 90 days. Furthermore, patients with longer lengths of stay necessary, for medical optimization, will lead to a lower likelihood of readmission. The authors recommend, medically optimizing patients prior to discharge to decrease readmission and the associated penalties. This may require more consults and longer hospital stay.

Assessment of the reliability of spinal muscle volume determinations and the dependence on participant position

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Introduction
Changes in spinal muscle size have been implicated in alterations in spine function and back pain. It is therefore important to assess reliability of spinal muscle volume measurements. The current study aims to examine this by undertaking repeat measurements with participants in different positions, leading to varying degrees of spine curvature.

Methods and Materials
16 healthy participants were recruited. T1 weighted MRI images were acquired with participants examined in four different positions. Initially images were acquired in a conventional flat, supine position (P1). Foam wedges were then placed under the pelvis and knees (decreasing lordosis) and measurements repeated (P2). Wedges were then placed under the lower back to increase lordosis (P3). Finally, the initial neutral position with no wedges was repeated (P4) Images were analysed in Simpleware ScanIP and lumbar muscle volume and Cobb's angle, as an indicator of spine curvature, determined. Paired t-tests were applied to assess for differences in total muscle volume and spinal curvature with position.

Results
Muscle volumes and spinal curvatures (mean±sd) were determined as follows: P1: 1228±326cm3, 51.78±8.53°, P2: 1239±328cm3, 42.59±8.99°, P3: 1213±296cm3, 59.98±7.51°, P4: 1221±315cm3, 49.96±8.73°. Significant differences in spinal curvature were found between positions P1 and P2 ($p<0.001$), P1 and P3 ($p<0.001$), but not between P1 and P4 ($p>0.05$). No significant differences were found in muscle volumes between any of the positions ($p>0.05$).

Conclusion
The findings suggest that spinal muscle volume determinations are robust in terms of participant positioning, providing confidence in studies that undertake longitudinal measurements to assess potential volume changes.

Hard collar compliance - is it an issue?

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Cervical fracture management often involves hard collar immobilisation. A previous study by this team has indicated a significant rate of non-compliance. This study sets out to explore compliance in more detail. An anonymised questionnaire was sent to 100 patients who had been prescribed a hard collar for a confirmed cervical spine fracture. 52 forms were returned. Compliance with hard collar usage was assessed. Common reasons for non-compliance were also explored along with an opportunity for free text responses. Failure to attend follow up was also assessed given the long distances involved in attending a regional unit for review. 67% of patients reported wearing their collar as prescribed. The main reason for non-compliance was dysphagia (19%) followed by pain (9%) and skin irritation (6%). 70% of free text comments about hard collars were negative, including difficulties in sleeping and showering. These difficulties, however, did not lead to non-compliance. Whilst only 1 patient reported missing a follow-up appointment, 21% of respondents expressed a desire for follow up to be at their local hospital. This study suggests that collar compliance is an issue and is mainly related to dysphagia. To improve compliance, specific advice should be given relating to eating (softer diet or removal of collar at meal times), adequate pain management and skin care. Regional pathways should also be reviewed to consider follow up at local hospitals with remote viewing of imaging by the specialist team.

Application of a universal spine nomenclature for full endoscopic spinal surgical procedures

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Introduction
Considerable confusion is present in the world literature with respect to the terminology used to describe minimally invasive spinal surgical techniques. It is particularly important that data from clinical studies reporting outcomes from full endoscopic techniques should not be confused with those from endoscope-assisted approaches.

Methods
The scientific literature was screened via PubMed search terms for all key words used to describe minimally invasive procedures on the spine. A taskforce then collated all terms used to describe any form of full endoscopic surgery with the aim of rationalizing these terms into a workable and internationally recognized format that would delineate the terms by approach, instrument, spinal segment, and procedure.

Results
Terms 'minimally invasive', 'percutaneous', 'endoscopic' and 'tubular' in the literature were identified with an exponential increase in annual publications noted: Total 2005 to 2019: Minimally Invasive Spine Surgery 4630, Percutaneous Spinal 3919, Tubular Spinal 393, Full Endoscopic Spinal 148. Considerable overlap in terminology was found. From those performed only by fully endoscopic techniques characterization by spinal segment - Cervical, Thoracic and Lumbar – allowed sub-division into discectomy, foraminotomy, lateral recess decompression and unilateral laminotomy for bilateral decompression. Endoscopy-assisted surgery was viewed as a separate category including Decompression and Fusion.

Conclusions
Common nomenclature should foster formation of a uniform body of literature, formalised teaching of standard techniques and appropriate procedure reimbursement.

Bladder scanning in Cauda Equina Syndrome: Interpretation of results

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Background
Initial assessment of cauda equina syndrome (CES) is complex as determining who requires urgent definitive investigation is a challenging initial step. Recent studies have identified bladder scanning as an objective method of identifying patients requiring urgent MRI scans.

Aim
In this study we investigate the value of bladder scan results in the context of patients presenting with symptoms of CES.

Methods
All referrals to the Royal Derby Spinal Centre with suspected CES were reviewed from January to August 2019. Demographic and clinical information (including bladder scan results, MRI findings and management) was obtained. Sensitivity, specificity, positive and negative predictive values were calculated for a threshold post void residual (PVR) of 200ml (or catheterised with a pre void volume >200ml) with a positive outcome being defined as radiological cauda equina compression with decompressive surgery occurring within 48 hours.

Results
Twenty seven patients were identified with sufficient data. The negative predictive value (NPR) was 71%. The sensitivity, specificity and positive predictive values were 43%, 50% and 23% respectively. The NPR reduced to 64% with inclusion of cases with potential cauda equina compression on MR imaging where it was necessary to delay surgery beyond 48 hours for confounding clinical reasons.

Conclusion
Our study suggests that bladder scanning may be helpful in excluding the presence of CES, but it is not sufficiently powerful to exclude CES in all patients. Establishing threshold values and outcome definitions are crucial if bladder scanning is to be used effectively in the management of patients with suspected CES.

Cauda Equina Screening in Physiotherapy: are we asking the right questions and are we asking the questions right?

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Cauda Equina Syndrome (CES) is a surgical emergency. With Physiotherapists increasingly taking on first-contact and spinal triage roles, screening for CES must be as thorough and effective as possible. This study explores whether Physiotherapists are asking the correct questions, in the correct way and investigates their experiences when screening for this serious condition.

Thirty physiotherapists working in a community musculoskeletal service were purposively invited to participate in semi-structured interviews. Data was transcribed and thematically analysed. All participants routinely asked bladder, bowel function and saddle anaesthesia screening questions although only 9 routinely asked about sexual function. Whether questions are asked in the correct way has never been studied. Sufficient depth of questioning was achieved by 63% of participants, 76% used lay terminology and 73% used explicit language. Only 43% framed the questions before asking them and only 16% combined all four dimensions. Whilst most participants (n = 25) felt comfortable asking general CES questions, 50% reported feeling uncomfortable when asking about sexual function. Issues around; gender, culture and language were also highlighted. Four main themes emerged from this study; i) Physiotherapists ask the right questions but frequently omit sexual function questions, ii) mostly, Physiotherapists ask CES questions in a way that patients understand however, there needs to be improvement in framing the context of the questions, iii) Physiotherapists generally feel comfortable with CES screening but there is some awkwardness surrounding discussion of sexual function and iv) Physiotherapists perceive there to be barriers to effective CES screening caused by culture and language.

Assessing the impact of a novel day surgery pathway on our national outlier status in the provision of day case lumbar decompression/ discectomy

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Introduction
Performing outpatient lumbar discectomy or decompression facilitates continued operative patient care even during a time of national bed shortages. An in-house audit identified multiple shortcomings in the provision of lumbar discectomies as day case operations. The unit was highlighted by GIRFT as a national outlier. We analysed our patient journey and developed a quality improvement project to change current practice. We piloted the introduction of a novel day surgery microdiscectomy pathway and assessed patient satisfaction.

Methods
A nationally agreed day-case suitability checklist was implemented along with the education of staff involved in the patient journey. An anaesthetic and surgical protocol was devised to enable same day discharge. An entire single surgeon cohort of simple lumbar decompressions/discectomies were converted to day case between January 2020 and October 2020. A post service satisfaction questionnaire was conducted at a median follow up of 18 weeks (2-28).

Results
Twenty-three patients were identified and 5 were excluded. Eighteen patients were eligible for telephone satisfaction survey and 17/18 (94%) patients were contactable. The majority of cases were single level decompression/ discectomy (76%). All patients were satisfied with their experience and 94% were happy with information they were given. However, we observed 23% of patients who were dissatisfied with their analgesia.

Conclusion
We present an easily reproducible protocol which has enabled our unit to perform significantly more lumbar day-case surgery with high patient satisfaction. We plan to implement changes in line with patient feedback and commence an automated prospective satisfaction score collection.

The patient journey following lumbar discectomy surgery: A qualitative study

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Introduction
Recovery after lumbar discectomy (LD) is reported by 79-95% of patients. Improved understanding why some patients' recovery and outcomes are better than others will enable Health Care Professionals (HCPs) to fully address patients' needs.

Aim
To gain insight into patients' perceptions and lived experiences relating to their LD journey.

Methods
A phenomenology framework using interpretative phenomenological analysis (IPA) was utilised. A purposive sample of 14 patients undergoing primary LD was recruited. Semi-structured interviews were completed following discharge with topic guide developed from literature and input from patient co-investigators. Strategies to ensure trustworthiness were included (e.g. blind-reviewer independently grouped themes, peer/ patient critique). Ethical approval was granted by London-Bloomsbury Research Ethics Committee (18/LO/0459; IRAS 241345).

Results
Four themes emerged. i) High satisfaction was reported. Symptomatic and functional improvement, meeting expectations, trust in the surgeon, perceptions of care and experiencing

unexpected events influenced satisfaction. ii) Strong and variable emotions were experienced throughout the patient journey. Predominantly negative pre-op emotions were reported (e.g. uncertainties for the future, frustration). iii) Communication and language powerfully influenced participant's beliefs and behaviours. Peri-operative information provided by HCPs was highly regarded with strong compliance. However, examples of HCPs providing non evidence-based advice inadvertently incited maladaptive behaviours. iv) Self-efficacy influenced expected and perceived post-operative support.

Conclusion(s)
HCPs must recognise their strong influence to ensure input positively modifies recovery. Supportive and accurate communication is important to address concerns and optimise satisfaction which is linked with better outcomes. However, further development of the evidence-base to guide peri-operative care is required.

A Spinal Triage Unit evaluation through COVID-19 Pandemic – outcomes and impacts

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Chronic spinal pain is increasingly managed in secondary care by advanced musculoskeletal physiotherapists. Spinal services have benefited from this triage model as advocated by the National Low Back Pain Pathway, but the impacts of COVID-19 on patient care is unknown.

Methods
A retrospective service evaluation of a spinal practitioner service (SPS) was performed between March and September 2020, evaluating routinely collected data of referrals, attendance rate, numbers discussed with Consultants for management and surgical decision-making, and numbers listed for injections and surgery. Patient satisfaction data was collected telephonically by a health care assistant with randomly selected patients.

Results
A total of which 768/1077 (71%) new patient referrals were allocated to the SPS. All SPS appointments were converted to telephone from mid-March. Face-to-face consultations were reinstated for urgent cases after 4 months, and after 6 months all new patient appointments were face-to-face. Of a total of 1305 new appointments, 81 (6%) did not attend. 128/1956 (6%) patients were discussed with Consultants for management advice, 125/1956 (6%) patients were discussed for surgical consideration, and 57/125 (46%) were listed for surgery. 110/1956 (6%) patients were listed for injections. 77/768 (10%) SPS patients were contacted as part of the patient satisfaction assessment. 39/77 (51%) found telephone consultations more convenient, although 42/77 (55%) would prefer in-person, and 84% would recommend this service.

Conclusion
This service evaluation demonstrates the ability of a secondary care SPS to adapt to the restrictions imposed by COVID-19. Although referral rates initially dropped, overall patient satisfaction with the service remained high.

A Same Day Emergency Care (SDEC) Unit for Atraumatic Spinal Pain – Preliminary Results

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NHS improvement advocates same day emergency care (SDEC) for patients requiring additional specialism than can be provided in an Emergency Department (ED). Atraumatic spinal presentations often exceed ED wait time, require admission and remain as inpatients for several days. Costs associated have been estimated in excess of £500,000 p/a. A non-medically led SDEC unit for spines was initially piloted and became established in January 2020, integrated within the regional on-call spinal service.

Methods
A 12- month retrospective service audit (January to December 2020) was performed. Ward admission, ED re-attendance and imaging requests were evaluated. Serious pathology findings were recorded. Patient satisfaction data was collated.

Results
A total of 972 spinal presentations attended the SDEC over the 12-month period, with 828 follow-up appointments made on the unit (total seen 1800). 107/972 (11%) of all cases seen were admitted. Only 11/1800 (1%) re-attended the emergency department after SDEC attendance. 451/972 (46%) of those seen on the unit had MRI scans arranged, of which only 113/972 (25%) were same day scans. 129/972 (13%) of all patients seen had serious pathology. 185/972 (19%) patients completed satisfaction questionnaires, 96% were satisfied or very satisfied and 92% would recommend the SDEC unit.

Conclusion
A SDEC unit led by a Consultant Physiotherapist and integrated within the regional on call service, offers a cost and clinically effective way of managing atraumatic spinal pain. Low numbers of admission and re-attendance rates have been observed, with high levels of patient satisfaction since the unit's inception.

A survey of smart phone and wearable technology attitudes usage in a spinal patient population

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Introduction
There is increasing interest in potential applications of wearable technology and smart phone apps to monitor patient outcomes from spinal interventions. In this study we investigated the smart phone habits and potential acceptability of this technology in a spinal outpatient population.

Methods
With input from patients and experts in the field we designed and administered a questionnaire to assess the smart phone use of patients. The survey was administered to cohort of 100 consecutive patients attending spinal outpatient services. Eighty-three participants completed the survey.

Results
The response rate was 83% and 84% of respondents carried a mobile telephone or smart device, 15% did not and 1% failed to complete that question. 20 percent of respondents used an alternative wearable monitoring device. In our cohort 82% wear their smart device regardless of the activity undertaken. The average number of hours in which a smart phone was carried upon their person was 10.5 hours. 32% of respondents were already using health apps to measure their daily activities. 53% of participants were comfortable sharing activity data from their smart device with their clinician. 22% requested further information while 25% were resistant to the idea.

Conclusion
The majority of our patients were comfortable with the idea of using their devices to measure their activity. Use of smart phones is widespread and therefore phone app based technology may be suitable for many patients. Wearable monitoring devices are usually worn for more the day and may give a more accurate indicator of total daily activity.

Spinal Oncology

Clinical response to denosumab in treatment of giant cell tumours of the spine

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Background
Giant Cell Tumours (GCT) of the spine may be large at presentation and cause severe pain. The current recommended treatment modality is en bloc resection but is associated with significant morbidity and mortality. Denosumab is a monoclonal RANKL inhibitor that may be used neoadjuvantly to reduce tumour size and improve pain pre - operatively. Purpose To evaluate the efficacy of neoadjuvant Denosumab in reducing tumour size and treating pain associated with GCT of the spine.

Study Design
Retrospective review of reduction in tumour size and pain symptoms prior to surgery in patients treated with neoadjuvant Denosumab for GCT of the spine.

Patient Sample
All patients treated with neoadjuvant Denosumab for GCT of the spine in a tertiary referral centre.

Outcome Measures
Reduction in tumour size. Time taken to effect a clinically significant improvement in pain.

Methods
Retrospective review of 8 patients treated with neoadjuvant Denosumab for GCT of the spine. Evaluation of reduction in tumour size and time taken to effect significant improvement in pain.

Results
There was a mean pre–operative reduction in tumour volume of 36% (7%-73%). All tumours ossified following treatment. Four patients (50%) reported significant reduction in pain within 48 hours, 1 patient within 6 weeks and 1 patient within 3 months. 2 patients (25%) reported little improvement in pain.

Conclusions
This study demonstrates a significant reduction in tumour volume and rapid improvement in pain following treatment. We recommend routine use pre – operatively to improve symptoms and facilitate oncologically appropriate resection.

Multilevel Total En-bloc Excision of Primary Chondrosarcoma of the Thoracic spine through an all Posterior Approach – Case Presentation and Systematic Review of Literature

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Purpose
Chondrosarcomas are resistant to chemo-radiotherapy, en-bloc excision of the tumour with wide margins is the only option that provides maximum disease free survival. We present two cases of multi-level primary chondrosarcoma of the thoracic spine treated by en-bloc excision through an all posterior approach and review the literature pertaining to multilevel en-bloc excision of malignant spinal tumours.

Methods
Two cases of multilevel chrondrosarcoma are presented who both underwent posterior only approaches. Further, a systematic review of the English language literature was carried out using search criteria multilevel en-bloc spinal tumour resections.

Results
Both our patients tolerated the procedure well without any major perioperative complications. No local tumour recurrence or distant metastasis was observed till last follow up at48 months. From our systematic review 7 papers were analysed. These studies reported the outcome of 169 cases of multilevel en-bloc resections with a mean follow up duration of 36.6 months. The overall complication rate following multilevel en-bloc resections was 57.7%. The complication rate was higher when combined anterior+posterior approach (48.3%) was performed as against posterior only approach(10.6%;p<0.0001)). The local recurrence rate following en-bloc resections was found to be 13%, and was higher in patients undergoing en-bloc resection for a recurrent tumour than previously untreated tumour (38.9% versus 7.1%p<0.0001). 79.8%(135/169) patients were alive at the time of final follow up, out of which 53.8%(91/169) showed no evidence of disease.

Conclusions
Multilevel en-bloc tumour resection of the spine is a technically demanding procedure. Although the overall complication percentage following multilevel en-bloc resections was high(57.7%), the local recurrence rate was low(13%).

Aneurysmal Bone Cysts of the spine: a proposed surgical strategy and its midterm outcomes

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Introduction
Management of ABC(Aneurysmal Bone Cysts) of the spine is challenging, as it requires adequate resection to ensure complete disease clearance and subsequent reconstruction of the involved functional spinal unit to address the resultant instability. Various treatment modalities described in literature have been used singly or in combination. Yet the recurrence rate ranges from 4% to 44%. We describe a strategy for the management of aneurysmal bone cysts of the spine.

Method
Our experience in the management of six patients with spinal ABCs [thoracic(n=4) and lumbar(n=2) spine] is presented. After a detailed radiological evaluation, the appropriate treatment plan was devised based on Enneking staging. Posterior stabilization, followed by en bloc resection with anterior column reconstruction was done through a transthoracic approach for dorsal spine lesions. Lumbar lesions were managed with posterior stabilization and intralesional curettage through a transforaminal approach. Outcomes were analyzed using VAS (Visual Analogue Scale) and SF-12 scores, neurological improvement and radiological evaluation of recurrence.

Result
The mean age at presentation was 21.5+/-5.3 years. There was significant improvement in VAS and SF-12 scores at a mean follow-up of 39.2+/-6.7 months. Both patients who presented with neurological deficit showed complete recovery at final follow-up. One patient with lumbar spine lesion who had recurrence, was treated with reexploration, complete excision of the lesion and adjuvant therapy with denosumab. There were no intra-operative or post-operative complications.

Conclusion
Pre-operative embolization facilitates complete removal of tumor by reducing tumor vascularity. Complete removal of lesion based on Enneking staging, along with reconstruction of the spine, through an all-posterior or separate anterior and posterior approaches, where appropriate is essential to prevent recurrence.

Spinal Deformity

How does reduction of isthmic spondylolisthesis restore lumbar lordosis?

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Introduction
Isthmic spondylolisthesis is commonly associated with back pain and neurological symptoms. The primary localised kyphotic deformity at the level of the spondylolisthesis is counterbalanced by increased lordosis across the lumbar spine. Spondylolisthesis reduction and fusion corrects the initial deformity and may also restore lumbar lordosis and sacral slope.

Aims
We investigated how lumbar lordosis normalises following short segment TLIF for isthmic spondylolisthesis.

Methods
37 consecutive patients from a single surgeon series of isthmic spondylolisthesis undergoing reduction and TLIF performed between 2013 and 2019 underwent retrospective radiological analysis by two independent observers. Measurements of the lumbar lordosis across the lumbar spine as a whole and individual motion segments were taken using pre and post-operative standing radiographs.

Results
27 fusions were performed at L5/S1, 9 at L4/5 and one at L3/4. Normalisation of lordosis was noted at all spinal levels, including those distant from the surgical site. Overall mean lordosis reduced from 63.43 to 48.89 degrees ($p < 0.0001$) and sacral slope from 45.78 to 39.12 degrees ($p=0.0001$). When mapped level-by-level the greatest proportional change was at L1/2, with a 27% reduction in lordotic angle. The greatest angular correction was consistently observed at L5/S1 with a mean reduction of 3.55 degrees ($p=0.009$). This is likely to be a result of the decrease in sacral slope following reduction.

Conclusion
Limited level reduction and fusion for isthmic spondylolisthesis can normalise lumbar lordosis at all levels of the lumbar spine. This study determines that this occurs level-by-level.

Cervical sagittal balance : a predictor of neck pain after anterior cervical spine surgery?

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Introduction
Anterior cervical spine surgery is used to treat degenerative cervical spine pathologies. These surgeries alter the cervical sagittal balance (CSB). In the lumbar spine, changes in spino-pelvic balance are associated with chronic low back pain. No such correlation has been described in the cervical spine regarding neck pain.

Methods
Retrospective single centre review (Brussels, Belgium) of patients undergoing anterior cervical surgery between 2014 and 2016. All patients had pre- and postoperative clinical (NDI - Neck Disability Index) and radiological assessments to measure parameters of CSB (Cobb angle and modified Toyama method). All patients had pre-operative MRI or CT-scan and postoperative X-rays. The aim of the study is to determine the relation between CSB and neck pain in patients undergoing anterior cervical spine surgery.

Results
85 patients (35M/50F) were included. Mean follow-up was 20.5 months. Preoperative Cobb angle was 6.68°(+/- 12.16) with 27% of patients in lordosis. The average preoperative NDI score was of 42.31%. Postoperatively, the average Cobb angle was 10.34°(+/- 11.29) ($p < 0.05$), 49.4% of patients were lordotic and the average NDI was 22.69% ($p < 0.01$). There is a correlation between Cobb angle and NDI ($r = - 0.31$) ($p < 0.05$).

Conclusion
Alterations in the CSB are correlated to neck pain. Preoperative radiological parameters should be taken into account when planning a surgical intervention in order to maintain cervical alignment and limit occurrence of neck pain.

A Comparison of Hybrid and All Poly-axial Pedicle Screw Construct in Correction of Idiopathic Scoliosis

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Study design
Single centre retrospective radiological analysis of idiopathic scoliosis correction comparing hybrid screw construct (poly-axial & mono-axial) to all poly-axial screw construct.

Objective
Compare loss of correction between hybrid screw construct group (HSG) and all poly-axial screw construct group (PSG).

Method
Retrospective review of preoperative, post-operative and latest follow-up radiographs for cohort of 42 patients over period of 28 months operated by single surgeon.

Results
19 patients (16 females, 3 male) in HSG and 23 (18 females, 5 male) in PSG. 3 patients excluded due to complications. Average age at surgery: 14 years for HSG and 15.8 years for PSG. The average baseline Cobbs angle for HSG was 64.57 degrees and 60.79 degrees for PSG. In the HSG, on average 11.6 levels were fused and, in the PSG, it was 11.3. Mean screw density for HSG was 1.54 and PSG was 1.6. Mean correction from pre-op to immediate post-op was 46.06 degrees (70.10%) in the HSG and 41.24 degrees (67.78%) in the PSG. At the last follow-up, mean correction was 45.12 degrees (68.0%) for the HSG and 42.43 degrees (70.39%) for PSG. Loss of correction from post-operative radiographs to latest follow up averaged 10.05% in HSG and 3.86% for PSG.

Conclusion
Average loss of correction showed small difference in the two groups, not clinically significant. Both techniques offer same degree of correction and there is no advantage in using hybrid construct opposed to all-poly construct. Surgical time and ease of rod handling favour of an all poly-construct.

Cardiopulmonary Exercise Testing (CPET) as a predictor of postoperative outcomes following adult scoliosis surgery

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Background
CPET provides quantitative assessment of Anaerobic Threshold (AT), which can predict postoperative outcomes following major surgery. The role of AT in spinal surgery has not been evaluated. This study aims to assess AT's ability to predict outcomes after adult scoliosis surgery.

Methods
All adult patients undergoing surgical correction of spinal deformity at our regional adult spine deformity tertiary referral centre between 1/1/2016-1/1/2019 were included. An AT value ⩽11ml/kg/min was used to identify 'high' risk patients for poor postoperative outcomes. Data was collected from the British Spine Registry; outcomes were assessed using SPSS v25. Patients were assessed for the following surgical outcomes: length of stay, length of high-dependency unit stay, post-operative reduction in haemoglobin, and SRS-22 questionnaire score. Binary logistic regression analysis was performed to assess correlation of AT with poor surgical outcomes (lowest quintile).

Results
25 patients undergoing correction of adult spinal deformity were identified over the study period. 7 patients were 'high risk' for poor postoperative outcomes, 14 were 'low risk', and 4 patients were excluded from analysis due to inability to reach AT or unrelated complications. Logistic regression demonstrated that AT did not reach significance in predicting any outcome measure (length of stay, p=0.077), length of HDU stay (p=0.440), post-operative reduction in haemoglobin (p=0.696), and SRS-22 (p=0.999).

Discussion
Although AT did not reach significance in predicting postoperative outcomes, it approached significance in predicting hospital length of stay. Further research regarding relevant stratification of AT values for adult spinal deformity patients is required to better predict postoperative outcomes.

The variability of torso shape in those without spinal deformity and those with AIS or Scheuermann's kyphosis - a seven year longitudinal study

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Purpose
This study examined the 3D shape of the posterior torso in those without spinal deformity (normals) and those with AIS or Scheuermann's kyphosis (SK), particularly examining the covariates of age, scoliosis and kyphosis on the 3D shape of the torso.

Methods
From ISIS2 imaging, and using the most prominent points on the posterior torso, the 3D x, y and z coordinates were recorded for the three cohorts of individuals. The AIS cohort was right sided Lenke 1 curves. Standardisation was performed using measures of torso size. Data was plotted using a 3D method allowing comparison between the left and right sides. A linear mixed effect modelling technique was used to quantify the the coefficients of age, scoliosis and kyphosis.

Results
There were 770 images from 194 normals, 1348 images from 765 with AIS and 59 images from 44 with SK. In the normals, the 3D position of the points was symmetrical. AIS lead to an increasing asymmetry between the left and right sides. SK lead to a symmetrical position, but different to normals reflecting the underlying shape of the thorax. The modelling demonstrates that age reflects growth of the torso. The covariates of scoliosis and kyphosis affect the points differently between the right and left sides in AIS. The SK group was too small to model.

Discussion
The most prominent points of the posterior torso are good indicators of the shape of the posterior torso. Covariates of age, scoliosis and kyphosis independently affect how the torso altered in shape.

The use of halo gravity traction in severe, stiff scoliosis

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Introduction
The correction of severe, stiff scoliosis in children is challenging. One method used to reduce the risk is pre-operative halogravity traction (HGT). In this study, we sought to define the efficiency and safety of HGT and characterize the chronology of the correction seen.

Method
A consecutive group of paediatric patients with severe spinal deformities were treated with HGT prior to definitive correction. A standard protocol with the daily addition of weight to 50% of bodyweight at 3 weeks was used. Traction remained in place until signs of impending neurological complication or 6 weeks, whichever was sooner.

Results
24 patients were included with a mean age of 11.8 years. The mean coronal deformity was 122.5°, with a T1-L5 height of 234mm. The mean duration of traction was 42 days with a mean improvement in height of 71.5mm with 82.1% occurring over the first 3 weeks. One patient showed early signs of a cranial nerve palsy prompting early surgery and 8 patients showed pin loosening, 1 of which required revision of their halo. One patient underwent a slower progression of traction due to transitory urinary disturbance.

Conclusion
HGT is a safe treatment for severe, stiff scoliosis because it can respond to early signs of impending neurological impairment. 70% of the angular correction occurs in the first 3 weeks according to Hooke's law with the remining 20% being due to a viscoelastic effect.

The use of 3 rods in correcting severe scoliosis

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Purpose
The three rod technique, utilising a short apical concavity rod is an option to achieve controlled correction in severe scoliosis. We describe this technique, the complications encountered, and the long term outcomes.

Method
All paediatric patients who had at least 2 years follow up after undergoing corrective surgery for scoliosis ⩾ 100° using 3 parallel rods were included. Radiographs were assessed to evaluate the correction and clinical records examined for any loss of correction, complications, revision procedures or neuromonitoring events.

Results
25 patients met the inclusion criteria. Four underwent prior anterior fusion to prevent crankshaft phenomenon. The mean angle of deformity was 112.0° (range 100.3- 137.1). Mean maximal kyphosis was 48.8° (range 11.4- 78.8) and mean curve flexibility 4.4% (range 0- 37.0%). Intraoperative traction achieved an average of 70.4% (95%CI 56.6- 84.1%). Nine patients (39%) showed a reduction in MEPs during definitive surgery. All returned to within 75% of baseline by the end of surgery. All patients had normal postoperative neurology. One patient underwent removal of hardware for late infection. The mean overall Cobb correction was 55.7% (95%CI 50.2-61.2%), equating to 50.2% (95% CI 44.9- 55.4%) of the mean initial deformity. Thoracic kyphosis reduced by a mean of 18.2% (95%CI 12.8-23.6%).

Conclusion
Our series suggests that three rod constructs are able to safely and effectively achieve 50% correction of severe scoliosis.

Implications of Blood Conservation Strategies in Posterior Correction of Adolescent Idiopathic Scoliosis

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Introduction
Cross matching 2 units of blood is an accepted practice for posterior correction of Adolescent Idiopathic Scoliosis (AIS). We reviewed this in light of the current anaesthetic practices and explored the economic implications of not ordering blood for uncomplicated posterior AIS corrections.

Method
In this prospective case series, 84 patients (17 males, 67 females) with a mean age of 14.6 years (range 10-18 years) and a mean BMI of 20.71, underwent a posterior correction for AIS between September 2016 and March 2018. We excluded revision and anterior procedures. The anaesthesia protocol was identical and included intra-operative cell salvage, Tranexamic acid and routine multi modal spinal cord monitoring.

Results
A mean of 11.7 levels were instrumented with Ponte osteotomies in forty-four patients (mean 3.61 levels). The mean Cobb angle was corrected from 57.2 degrees to 17.4 degrees (Correction Index 1.5). The mean blood loss was 1073.2 ml (20.09 ml / kg). The cell salvage resulted in an intra-operative replacement of 422.8 ml (mean). The mean pre-operative haemoglobin (Hb) was 138.7 and the mean lowest post-operative Hb was 97.68.

None of the patients required intra-operative homologous blood transfusion. Five patients required postoperative blood transfusion on day 2 or 3. We had ordered 195 units at a cost of £17, 665 and only 5 patients were transfused.

Conclusion
Cross matching blood is not essential on the day of the operation for a posterior correction of AIS. Modern anaesthetic practices allow for a safe operation and reduces the financial burden.

Surgeon directed spinal cord monitoring in paediatric deformity surgery: Visual observation of lower limb waveform predicts intact neurological function superior to amplitude decrease

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Introduction
Surgeon-directed monitoring (SDM) of Transcranial Motor Evoked Potentials (TcMEP) is valuable in spinal cord monitoring. This paper advocates that maintenance of visually observed lower-limb (LL) waveforms indicate intact spinal cord function, while waveform disappearance predicts potential motor deficit. Gold standard 80% Percent amplitude reduction was investigated.

Method
Surgeon-directed MEP monitoring equipment was utilised in 142 scoliosis correction surgeries (2012-2017). These included 120 cases of AIS, 9 syndromic scoliosis, 9 neuromuscular scoliosis, 2 Scheuermann's kyphosis and 2 high-grade lumbar spondylolisthesis. Mean age 13.9 years (5-17 years) and M:F = 28:114. The surgeon recognized a potential deficit warning as the persistent disappearance of LL waveforms from the monitoring screen.

Results
Mean duration of neuromonitoring was 302.5 minutes (SD 105.7 minutes) with an average of 20 stimulations per case. Three cases (2.11%) had complete visual loss of LL signals that did not resolve with re-stimulation, anesthetic stabilization, or reversed surgical manoeuvre. Correction was staged following axial scanning to check screw position and exclude hematoma. No cases with neurological dysfunction upon waking were recorded.

Discussion
MEP disappearance as an interpretation method is safe and reliable in deformity correction, with no false negative results. Conclusion: SDM of visual LL waveform maintenance is a safe method of MEP monitoring. It is a cost effective alternative to traditional neurophysiology directed neuromonitoring.

Rectification parameters for the digital design of scoliosis braces

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Introduction
The latest scanning, digital rectification, and manufacturing technologies provide the opportunity to design scoliosis braces using a completely digital design process. For this, the rectification process (shaping of patient's torso geometry) requires characterisation. This study aims to compare 3D scans of patient's torsos as well as pre- and post-rectified moulds to characterise the manual rectification process.

Methods
Five adolescent idiopathic scoliosis (AIS) patients (10-15 years, Cobb angle = 20-45°) were recruited for this study. Spherical markers were placed at anatomical landmarks and 3D scans were obtained of the patient's torso, as well as their pre- and post-rectification moulds using a handheld scanner. Anatomical landmark positions, transverse section centroids, and 3D surface deviations were analysed to determine rectification parameters.

Results
The rectification process was characterised using three parameters. Firstly, in terms of a transverse section centroid shift between the scan of the patient and the post-rectified mould (medial shift of 1-54mm in all patients). Secondly, in terms of a reduction in width at the patient's waist (by a factor of 0.21±0.01 times the waist width on the convex side and 0.13±0.06 on the concave side of the curve). Finally, the lateral profile of the brace above the patient's waist was seen to tilt to angles of 80.5°±3° and 83.2°±2.8° on the convex and concave sides, respectively.

Conclusions
This study characterised rectification parameters that can be used to define scoliosis brace shape. These results can be fed into a digital design flow that works towards automated brace design.

Spinal Cord Injury

International standards for neurological classification of spinal cord injury: factors influencing the completion and accuracy of documentation of neurology for patients with traumatic spinal injuries

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Introduction
We aim to evaluate the effects of injury-related factors and clinician training grades on the frequency, completion and accuracy of International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) charts in a neurosurgery unit.

Methods
We retrospectively analysed 96 ISNCSCI charts of 24 traumatic spinal cord-injured (SCI) patients and 26 controls (vertebral fracture but neurologically intact), written by 50 clinicians. Seven components of each ISNCSCI charts (motor scores, sensory scores, sensory levels, motor levels, neurological level of injury, SCI severity and AIS) were reviewed to evaluate the effect of injury factors and clinician grade on the completion and accuracy of the ISNCSCI components.

Results
The ISNCSCI chart was used 1.9 times on average during admission. The number of ISNCSCI assessments was significant in those with isolated spinal injuries ($p = 0.03$). The overall completion and accuracy rates of the assessed ISNCSCI chart components were 39% and 78.1%, respectively. Motor levels and AIS had the lowest completion rates. Motor levels and sensory levels had the lowest accuracy rates. The completion rate was higher in the charts of male patients, tetraplegic patients, and in patients with isolated spinal injuries. The junior clinicians had a significantly greater ISNCSCI chart completion rate than their seniors. However, the senior clinicians were more accurate in completing the ISNCSCI chart components.

Conclusion
The quality of ISNCSCI documentation remained poor regardless of the clinician training grade and injury factors. Clinicians should be educated on the ISNCSCI protocol and the importance of adequate documentation.

Clinical Assessment Tools and Their Evidence Base in Degenerative Cervical Myelopathy: A Systematic Review to Inform a Core Measurement Set (AO Spine RECODE-DCM)

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Purpose
To compile a list of relevant measurement instruments for use in degenerative cervical myelopathy (DCM) and assess their psychometric properties.

Methods
A systematic review of MEDLINE and EMBASE databases was conducted between August 2020 and January 2021. Full-text articles, whose primary purpose was to evaluate the psychometric properties or minimal clinically important differences (MCID) of DCM assessment tools, were included. Psychometric properties, MCID, and risk of bias were assessed in accordance with the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) criteria.

Results
86 studies, assessing 10,453 patients worldwide, were identified from a total of 3,239 studies. Of these, 3,623 (retrospective) and 6,830 (prospective) patients were assessed with 35 tools. The most frequently used tools were: modified Japanese Orthopedic Association score (mJOA; 55% of patient sample), Neck Disability Index (NDI; 49% of patient sample), Short Form 36 (SF-36; 43% of patient sample), and Nurick Grade (36% of patient sample). The measurement properties analysed included: construct validity (reported by 52% of studies), reliability (reported by 51% of studies), responsiveness (reported by 26% of studies), and MCID (reported by 15% of studies). All measurement properties showed variability in reporting and risk of bias.

Conclusions
A set of agreed tools to measure outcomes in DCM is needed. This review comprehensively aggregates studies evaluating assessment tools for DCM. These findings will be used as part of AO Spine RECODE-DCM to inform the most appropriate instruments for data points included in a core data elements and outcome set.

Research

Achieving consensus on the treatment targets of exercise in persistent non-specific low back pain: A modified nominal group workshop process

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Despite several hundred randomised controlled trials (RCTs) of exercise for persistent non-specific low back pain (NSLBP), the treatment targets of exercise remain unclear. A recent systematic review of RCTs identified 31 different treatment targets of the exercise interventions. Since not all treatment targets and outcomes can be assessed in all RCTs, it is important to prioritise exercise treatment targets through consensus from experts.

Objective
To generate and prioritise treatment targets of exercise interventions in persistent NSLBP.

Methods
Two modified nominal group workshops (NGWs) were held sequentially. The first, national workshop results informed the second, international, workshop. Participants included people who had experience of exercise to manage their persistent NSLBP, clinicians who prescribe exercise for persistent NSLBP, and researchers who design exercise interventions tested in RCTs. Participants were able to take part in the national workshop electronically or in person, and participants in the international workshop attended after registering via the conference webpage. All participants identified, voted and ranked the treatment targets using an online platform.

Results, Conclusions
15 participants participated in the first workshop, 24 in the second. To the original list of 31 treatment targets identified by the systematic review, a further 41 were generated across both workshops. After grouping and voting, 27 treatment targets remained. The top five ranked targets of exercise interventions were: improvement in function, improvement in quality of life, pain reduction, meeting patient specific goals and reduction of fear of movement. Future RCTs of exercise should consider more consistent assessment of these treatment targets.

Patient experiences of a functional goal orientated back group; What factors are important? A qualitative study

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Background
Chronic low back pain (LBP) continues to be a huge problem for the population and health care. Effective long term management remains a challenge. Group exercise is recommended but patient experience of this is unclear. Objectives To understand the patient experience of a functional goal orientated back group in secondary care to inform practice.

Methods
A qualitative design using phenomenological analysis. A content review of a back class feedback book from 2017-2019 was undertaken to form interview questions on recurring themes for randomly selected patients discharged from the class recently and at 1 year. 14 participants were interviewed in either 1:1 semi-structured interviews or focus groups.

Results
Reporting valued themes; Motivation from staff and other patients, support and knowledge, intensity of exercise and felt increased confidence in their ability to self-manage. Many reported improvements in pain and function despite having failed 1:1 physiotherapy in the past. Participants interviewed immediately post discharge were highly motivated, stating intentions to continue the specific exercise programme. None of the 7 participants interviewed one year post discharge were continuing the specific exercise programme but were applying the principles they had learnt to daily function, such as how to bend and lift.

Conclusion
Patients valued a functional back class and would have liked to have been referred as first line treatment. It appears to be a combination of specific exercise, motivation and intensity of the exercise that is important. Future developments would identify which patients may be seen in a group setting as first treatment.

A Qualitative Exploration of Persistent Low Back Pain Self-Management: Physiotherapy Patient Experiences

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Introduction
The persistent nature of low back pain lowers individual's quality of life with increased distress and disempowerment. Self-management has the potential to improve the lives of people with persistent low back pain. However, it remains unclear how interventions can enhance self-management and support a greater quality of life for those affected. This study will explore the experience of persistent low back pain (PLBP) self-management by patients attending physiotherapy.

Method
The constructivist grounded theory was used to explore the experience of self-management. A convenience sample of participants with PLBP was recruited from an outpatient physiotherapy department. Data from semi-structured interviews was analysed to construct a new theory for the experience of PLBP self-management.

Results
Six themes emerged from the analysis of nine interviews; self-doubt, coping day to day, independent discovery, developing resilience, healthcare: opportunity and threat and living with pain differently. These themes formed a conceptual model of self-management framed by self-efficacy, the perception of PLBP and the fluctuating nature of PLBP.

Conclusion
Self-management of PLBP for patients attending physiotherapy fluctuates on a continuum between self-doubting and living differently with pain. Episodes of increased PLBP lead to increased self-doubt which disrupts an individual from pursing their long term ambitions. Self-management strategies are influenced by the perception of pain and levels of self-efficacy. Clinicians have a role to support people with PLBP struggling to move away from self-doubt. Downgrading the threat of PLBP and the adoption of acceptance based strategies may enable individuals to live a higher quality of life.

Dynamic lumbar spinal motion differs in low back pain patients when compared to controls at specific intersegmental levels

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Continuous dynamic multi-segmental studies of lumbar motion have added depth to our understanding of the biomechanics of back pain, but few studies have continuously measured the sharing of motion between individual levels. This study compared the motion contributions of adjacent lumbar levels during an active weight bearing flexion and return protocol in chronic, non-specific low back pain (CNSLBP) patients and controls using quantitative fluoroscopy (QF). Eight CNSLBP patients received QF during guided standing lumbar flexion. Dynamic motion sharing of segments from L2 to S1 were calculated and analysed for interactions between levels. Eight asymptomatic controls were then matched to the 8 patients for age and sex and their motion sharing patterns compared. Share of intersegmental motion was found to be consistently highest at L2-L3 and L3-L4 and lowest at L5-S1 throughout the motion in both groups, with the exception of maximum flexion where L4-L5 received the greatest share. Change in motion sharing occurred throughout the flexion and return motion paths in both participant groups but tended to vary more at L4-L5 in patients ($p<0.05$). In patients, L5-S1 provided less angular range ($p<0.05$) and contributed less at maximum bend ($p<0.05$), while L3-L4, on average over the bending sequence, provided a greater share of motion ($p<0.05$). Intervertebral motion sharing inequality is therefore a normal feature during lumbar flexion. However, in patients, inequality was more pronounced, and variability of motion share at some levels increased. These effects may result from differences in muscular contraction or in the mechanical properties of the disc.

Comparative biomechanical study of 2 transdiscal fixation techniques for high-grade L5/S1 spondylolisthesis in a porcine model

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Objectives
Fusion of high-grade lytic spondylolisthesis is achieved through a variety of surgical techniques, but there are no comparative biomechanical studies on transdiscal fixation to our knowledge. Our study compares transdiscal L5/S1 screws (TDS) to the transdiscal fibula (TDF) graft technique for high-grade spondylolisthesis in a porcine lumbar spine model.

Methods
Twelve lumbar-sacral porcine spines were divided into two groups, debrided of soft tissue and potted in cement at L3 and S1. Baseline range of motion (ROM) and stiffness testing was performed on intact specimens using a pure moment protocol for 3 cycles. A high-grade isthmic spondylolisthesis was then created and surgically stabilized using either transdiscal L5/S1 screws plus L4 pedicle screws or a transdiscal fibula graft in combination with posterolateral fixation from L4 to S1. The same stiffness and ROM protocol was then performed again. Analysis used unpaired two-tail student T-test, significance was determined as $p < 0.05$.

Results
Compared to intact, both groups had significantly less ROM flexion-extension (FE) ($p<0.001$) and lateral bending (LB) ($p<0.05$) but no significant difference in axial rotation (AR). TDS group showed significantly reduced FE ROM compared to TDF group($P<0.05$), but not in LB and AR. TDS technique was significantly stiffer than TDF in AR ($P=0.004$), and approached significance in FE and LB stiffness ($P=0.05$- 0.09).

Conclusion
Both fixation techniques limit motion and increase stiffness compared to intact, however the TDS group demonstrated superior stiffness and a smaller ROM compared with the TDF group.

Development of Back-to-Fit: a digital self-management platform to help people with mechanical low back pain to be active and exercise – Physiotherapists' perspectives

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Background
Low back pain (LBP) is currently ranked as the greatest contributor to disability. Best practice guidelines including NICE guidelines, recommend self-management (SM) and endorse advice to engage in physical activity (PA) and exercise. However, people find this challenging as a result of the complex biopsychosocial nature of LBP. While digital interventions offer a promising mode of delivering SM, the evidence base for their effectiveness is poor. Available interventions providing general guidance fail to acknowledge the complexity of the problem and offering personalized exercise solutions. Aim: To explore physiotherapists perspectives to inform the development of 'Back-to-Fit' tool offering personalised SM solutions for people with mechanical low back pain (MLBP) to enhance their exercise engagement and PA.

Methods
A qualitative study (3 focus groups), was conducted with 14 clinically active physiotherapists working with LBP from England and Wales, and with more than 5 years' experience. Focus group data was analysed using thematic analysis.

Results
Four overarching priori themes were identified: assessment, exercise prescription, technology solution and delivery. Findings included the need for a comprehensive assessment, patient-education, feedback and progression-regression of exercises. Further, the necessacity of an individualised approach of delivering SM using technology, while acknowledging biopsychosocial factors was emphasized. The results suggest the potential use of a prudently designed digital intervention as a catalyst to improve SM in people with MLBP.

Conclusion
The findings will inform the content of tailored assessment and exercise features of Back-to-Fit intervention. This will be evaluated with people with MLBP for its' usability, acceptability and effectiveness.

Injectable hydrogel for disc regeneration study of injectablitiy and mechanical properties in whole human intervertebral discs

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Introduction
We have previously reported the development of an injectable hydrogel (NPgel), which has the potential to deliver patients own stem cells, via small bore needles, decreasing damage to the annulus fibrosus. NPgel drives stem cell differentiation to NP cells, and can inhibit the degenerate niche. However, clinical success of NPgel is dependent on the capacity to inject NPgel into naturally degenerate human discs, restore mechanical function to the IVD, and prevent extrusion during loading. Here, we investigated the injection of NPgel containing IOHEXOL to enable visualization during injection into human cadaveric discs and performed extrusion testing to determine whether NPgel was retained in the disc.

Methods
Cadaveric discs were prepared with intact vertebral bone, X-ray images were captured from transverse and sagittal planes together to determine disc height. Discs were pre-warmed to 37°C prior to mechanical analysis, discs were loaded under simulated walking conditions to calculate Moduli. Following initial testing discs were injected with NPgel containing IOHEXOL using fluoroscopy to visualize injection and disc height measured. Moduli measurements were determined post injection prior to ultimate strength testing to determine whether any NPgel extruded.

Results
NPgel (600-1000µl) was easily injected into cadaveric discs where it filled cracks and fissures. NPgel injection resulted in significant increase in disc height and youngs moduli, furthermore NPgel was not extruded during failure testing.

Conclusions
These results support the use of NPgel as an injectable therapy for regeneration of disc degeneration.

Does disc morphology affect the success of non-operative treatment of chronic lumbar disc herniations

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Background
An RCT to investigate surgery vs non-operative treatment for chronic lumbar disc herniations, was performed at our centre from 2010-2016. During the trial 24/64 patients crossed over to surgery following ⩾ 6 months non-operative treatment. A lack of consensus in the literature exists associating lumbar disc herniation morphology and outcomes of non-operative treatment. Our aim was to determine whether disc morphology was associated with failure of standardized non-operative treatment.

Methods
Patients in the non-operative arm of the trial had MRI scans and standing xrays reviewed by two independent observers. Characteristics of the disc herniation were recorded including type (protrusion, extrusion, sequestration), Michigan State University (MSU) grade, canal occupancy as a ratio (height, width, area of herniation vs. height, width, area of canal) on axial views, size [length (mm), and area (cm2)] on sagittal views. Pelvic parameters (pelvic incidence, pelvic tilt, sacral slope) were also measured. Imaging parameters were compared between the crossover group and the remaining non-operative patients.

Results
59/64 patients had available MRI scans for review. 24 failed non-operative treatment after ⩾ 6 months and crossed over to surgery, 35 remained in the non-operative group. There were no significant differences between the 2 groups regarding demographic characteristics or disc morphology except for significantly smaller herniation width ratios, area ratios and pelvic incidences [PI] (p=0.01, p=0.02, p=0.02) in the cross-over group.

Conclusion
Disc morphology was not associated with poorer outcomes from non-operative management in our study except for smaller width and area herniation ratios and a smaller PI.

Needle injection trace in intervertebral discs under cyclic loading

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Introduction
The spread of molecules within the intervertebral disc is relevant to therapeutic drug delivery. In this study, we assessed how molecules spread within the disc when injected by needles of differing size and type and when the disc is cyclically loaded.

Methods
Bovine tail discs with adjacent vertebral bodies were injected with trypan blue dye. In the first experiment, 20 µL was injected into each disc using one of four needles (25G and 21G hypodermic; 22G and 20G spinal). The specimens were then dissected and imaged under a microscope. In the second experiment, 20 µL was injected using one of two needles (20G and 22G spinal). Specimens were either left unloaded for 30 minutes or loaded cyclically to ±5% strain for 30 to 70 cycles. The discs were then frozen, dissected and imaged.

Results
In the first experiment, the trypan blue was mainly confined to the nucleus but spread slightly along the annulus lamellae. The needle trace width ranged from 1.4-2.0 mm in the nucleus and 0.5-0.9 mm in the annulus. There was slight increase in trace width with needle size. In the second experiment, cyclic loading increased the trace width in the nucleus but had less effect in the annulus.

Discussion
The extent of trypan blue spreading within the disc appeared to be greater with larger needles and increasing loading cycles. Our results have implications for understanding the spread of therapeutic drugs in the disc. Further work needs to done to assess spreading over longer loading periods.

Thermoresponsive injectable hydrogel for delivery of notochordal cells for intervertebral disc regeneration

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Introduction
Low back pain has been strongly associated with degeneration of the intervertebral disc (IVD).It is proposed that the early loss of notochordal (NC) cells within the centre of the disc (nucleus pulposus (NP)), contributes to altered tissue integrity through altered matrix synthesis and increased tissue degradation, which are observed in disc degeneration. Certain species that experience natural disc degeneration, including humans, lose their NC cells in mature NP tissue. Therefore, NC cells are hypothesised to have potential in mediating disc regeneration and restoring disc biomechanics. This study investigates the characteristic and behavioural changes of NC cells cultured within our injectable hydrogel system (NPgel).

Methods
NC cells were extracted from lumbar porcine IVDs. The NC cells were then immediately incorporated into NPgel at a liquid state prior to gelation. The NC cell and NPgel constructs were cultured for up to two weeks under 21% O2 and 5% O2 . Histology and immunohistochemistry were used to assess structural and morphological changes and phenotypic marker expression of NC cells.

Results
Histological analysis revealed that NC cells cultured in NPgel maintain their vacuolated structure for at least two weeks post isolation. We also observed increased deposition of proteoglycans and collagen following culture. Further to this we are currently determining the expression of NC markers using immunohistochemistry and assessing structural phenotype using the scanning electron microscope.

Conclusion
NPgel supports NCs within laboratory conditions, furture work will determine the potential of NC cell delivery via NPgel to repair and regenerate the IVD.

Development of Immersive Virtual Reality for Managing People with Chronic Low Back Pain – Study Protocol

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Background
Low back pain (LBP) is one of the leading causes of disability worldwide with almost 23% of sufferers developing chronic symptoms (CLBP). Updated national CLBP management guidelines promote self-management and staying physically active. Current self-management interventions are associated with a lack of adherence and low motivation. Virtual reality (VR) is a stimulus which provides users a computer-generated environment using sensory display systems and allowing them to interact with motivational tasks. Full immersion in VR environment was suggested to result in distraction associated with reduction in acute pain. However, understanding its mechanism to working with chronic pain conditions is unknown.

Purpose
To map the present 'state of play' and evidence base for future development of immersive VR for managing people with CLBP.

Methods
A mixed-method sequential study design will be utilised in three parts in accordance with the Medical Research Council framework. Part 1 will be an online survey with VR special interest group consisting of healthcare practitioners, researchers and immersive VR technology developers about their experiences of using immersive VR in healthcare. Part 2 will involve telephone interviews with a subset the above individuals to explore in-depth experiences, views and attitudes towards using immersive VR for chronic pain management including immersive VR components (e.g. dosage, content, frequency). Part 3 will involve focus group with physiotherapists and occupational therapists who manage patient with CLBP to establish their views on content, dosage and practicalities (including safety guidelines) of an immersive VR for the management of CLBP.

The Influence of Shape and Position of Cages on Segmental Stabilization and Bone Loading in Transforaminal Lumbar Interbody Fusion - a Finite Element Perspective

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Objective
A nonlinear finite element model of the lumbar spine with reduced bone strength was developed in order to evaluate the influence of shape and intervertebral position of TLIF cages on segmental stabilization and risk of subsidence into vertebral endplates.

Method
A lumbar spine model containing vertebrae, intervertebral discs and ligaments was validated using literature data. A banana shaped TLIF cage and the corresponding facetectomy, discectomy and posterior instrumentation were modeled in segment L4-L5. The spine was then subjected to a follower load and a force controlled flexion. This was carried out for cage positions ranging from central to anterior. Finally, these results were compared to those computed for a straight device placed in oblique orientation in the same model.

Results
The straight device generated plastic deformation of cancellous bone below the endplates and in the vicinity of the pedicle screws. This could be an indicator for risk of subsidence and screw loosening. For the banana shaped device, the volume of plastically deformed bone was smaller and it decreased with more anterior cage positions. An improved segmental stabilization was also noted.

Conclusion
Based on a finite element model, banana shaped TLIF devices, even more so when placed anteriorly, could be associated with a higher segmental stabilization and a lower bone loading compared to straight TLIF devices. This is in line with various published case series reporting better long term sagittal alignment and disc height restoration for banana shaped devices when compared to straight devices placed in oblique orientation.

Intervertebral disc cell clusters exhaust with increasing grades of disc degeneration

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Introduction
Cell clusters are considered to be a histological hallmark of intervertebral disc degeneration. Clusters arise from cell proliferation but are associated with premature replicative senescence and may a role in matrix breakdown. We hypothesize, that cell clusters are associated with increased cell proliferation in the initial stages of degeneration and increased synthesis of matrix degrading enzymes (MMP-1) during late stages.

Methods
A histological, immunohistochemical and gene expression analysis was carried out on 30 surgically removed disc tissue specimens (patients aged 31-67yrs) with disc herniation or disc degeneration. Control disc were from cadavers with no history of back disorders. Histological degenerative changes such as fissuring, proteoglycan loss, and clustering, were assessed on ordinal scales. Cell clusters immunopositive for MMP 1 and PCNA (proliferating cell nuclear antigen) were counted, along with gene expression analysis. A p value of 0.05 was considered significant.

Results
Cell clusters were abundant near fissures in herniated and degenerated discs in the inner annulus and associated with proteoglycan depletion (rs=0.53p<0.001). MMP-1immunopositivity were greatest in clusters in herniated and severely degenerated discs (p<0.05). Gene expression for MMP-1 increased with severity of degeneration, while PCNA expression declined (P<0.05). Control discs showed fewest clusters, least proteoglycan loss, least immunopositivity to MMP's while PCNA expression remain unaltered.

Conclusion
Cell clusters are common during initial stages of degeneration when PCNA expression increases, but this activity declines as severity of degeneration progresses with elevated MMP 1 expressions.

Fragmented SLRP`s and fibronectin in overloaded intervertebral disc as potential alarmins of matrix damage

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Introduction
Complexly overloaded and degenerated intervertebral disc shows increases expression of cytokines and matrix degrading enzymes. We hypothesize, persistent adverse loading stimulates proteolytic fragmentation of small leucine rich proteoglycans (SLRP`s) and fibronectin, which may serve as potential 'alarmins' in degenerated tissue.

Materials and Methods
Sparague Dawley rats were statically loaded with external fixator calibrated to 1.3 mpa. Animals were euthanized at four different time points: 7, 15 days, and 1 month with unloaded controls. After euthanasia, overloaded and control intervertebral disc from the lower lumbar level (n=24) were collected, and subjected to protein extraction, enzymatic cell isolation and histochemical staining. Protein extraction was done in 4 M guanidium hydrochloride, precipitated in ethanol, and treated with keratanase and chondroitinase ABC. These samples were analyzed with western blots using antibodies to biglycan, decorin, lumican, chondroadherin and fibronectin (1:1000). 8um thin sections were stained with safranin-O and fast green for histological & immunohistochemical studies for SLRP's, TLR-1 & 2.

Results
Fragmentation of SLRP's and fibronectin was greatest in tissues with longest loading time. Fragments of biglycan, lumican and decorin were prominent at 36 Kda, while fibronectin and chondroadherin fragments appeared between 35 to 22 Kda. Histology showed proteoglycan loss from overloaded tissue and formation of small, medium, and large size cell clusters with distinctive staining for SLRP's & TLR's.

Conclusions
Increased fragments and accumulation of SLRP's and fibronectin in the matrix may activate potent inflammatory TLR 2 receptor signaling pathway and may act as alarmins.

Developing spinal researchers of tomorrow: initial results from a collaborative systematic review using a national student network

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Introduction
Undergraduate medical curricula feature little research methodology. Systematic reviews (SRs) are the first step in clinical research but are time consuming and often left unfinished by students. We hypothesised that a collaborative, educational approach to SRs, whereby medical students with little or zero research experience work together under supervision of postgraduate researchers may improve student experience, in terms of training and efficient search.

Methods
A post-graduate team led 14 medical students working on 2 neurosurgical SRs. Students were trained on the SR background, inclusion/exclusion criteria and collaborative screening. Rayyan software enabled the search strategy to be portioned amongst reviewers. A screening pilot of 100 articles compared student performance to 'gold-standard' post-graduate results. Students completed pre-project questionnaires on their research background, perceptions, knowledge, confidence and experience. Questions were scored on numeric rating scales of 1 (lowest score) to 10 (highest score).

Results
Average pre-project questionnaire scores showed students were excited to be involved (9.1) but had poor experience (3.9) and confidence conducting SRs (5.4). Students were satisfied with the guidance provided (8.2) and enjoyed being involved (8.2). Students felt a collaborative SR would improve their understanding of research (9.5) and was a good way to build skills, experience and confidence for future SRs (9.4). Agreement between medical students and post-graduate researchers was 98% in pilot screening.

Conclusion
This approach appears an effective method of making large SSCs manageable and providing students with research training and experience. Mid-screening, post-screening and post-project questionnaires will further evaluate this approach as the SR continues.

Plasmacytoid dendritic cells in the enthesis: phenotyping and function investigation

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Background
Plasmacytoid dendritic cells (pDCs) play an important role in linking innate and adaptive immune responses and regulate the secretion of type I interferons (IFN) and other inflammatory cytokines such as TNF. pDCs have been directly implicated in psoriasis immunopathology and we posit [2-3]. We investigated whether the human enthesis contains a resident pDC population and compared TLR7/9 agonists effect on entheseal versus peripheral blood pDCs.

Methods
Interspinous process enthesis and matched peripheral blood (PB) were obtained from patients (n=11) undergoing elective orthopaedic surgeries. Cells were isolated from bone samples by mechanical digestion. Cells were stimulated with either TLR7 agonist (imiquimod) or TLR9 agonist (ODN-2216). Flow cytometry was used to phenotype pDCs, and intracellular staining used to measure IFNα and TNF. IFNα from supernatant was also measured by ELISA.

Results
pDCs were identified in the human enthesis with a typical phenotype (CD45+HLA-DR+CD123+CD303+CD11c-). By intracellular FACS, following ODN or imiquimod stimulation, IFNα and TNF was detected in entheseal pDCs and also PB. IFNα and TNF induction trended upwards in entheseal pDC when compared with unstimulated pDCs. IFNα was also detected by ELISA following ODN or imiquimod stimulation of entheseal derived pDCs.

Conclusion
The human enthesis contains a resident population of pDCs that produce IFNα and TNF following induction with relevant TLR agonists. For the first time, our findings provide a link between viral illness and vaccination and pivotal innate immune cell production of IFNα and TNF.

The role of IL-36 on resident immune and mesenchymal stem cells of the enthesis

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Background
In Spondyloarthropathies (SpA), cumulative evidence points towards the role of IL-23/IL-17 axis in disease pathogenesis. Emerging evidence suggest that IL-36 may be critical in regulating IL-23 pathway in various organs. IL-36 may function with these other key pro inflammatory mediators and could be an upstream regulator of SpA in man. Thus, we set to assess the role of IL-36 in in a novel in vitro model of human enthesitis.

Methods
Entheseal spinous process was obtained from patients undergoing elective orthopedic procedure. Immune Cells and mesenchymal stem cells (MSCs) were isolated from by mechanical digestion. Following separation, whole digest and Magnetically isolated cells were stimulated to assess IL-36 expression and to determine cellular sources. Following Stimulation with IL-36, measurement of disease relevant readouts was performed.

Results
Stimulation of isolated cells with bacterial and fungal adjuvants significantly increased the section of IL-36 ($p<0.05$). IL-36 is predominantly secreted by CD11c+ cells ($p<0.05$). Consistent with clinical practice, IL-36 production was effectively inhibited by PDE4i. When stimulated with IL-36, TNF secretion by CD14+ cells was demonstrated (28.2% versus 0.58%). Additionally, IL-36 induced both IL-23 and IL-17 production by resident immune cells. ICAM-1 expression and IL-6 and IL-8 secretion were demonstrated upon MSCs stimulation with IL-36.

Conclusion
This is the first demonstration of IL-36 expression in human enthesis. IL-36 is predominantly secreted by CD11c+ cells, and has a proinflammatory effects on resident immune and MSC cells of the enthesis. Given its pleiotropic effect and relation to IL-23/IL-17 axis, IL-36 is a potential novel therapeutic target.

Do patients with recurrent lumbar disc herniations fair worse with discectomy than primary operations?

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Introduction
Recurrent lumbar disk herniations (LDH) are common. We sought to determine whether patients undergoing a revision lumbar discectomy for radiculopathy have comparable patient reported outcome measures, as those who are undergoing the surgery for the first time.

Methods
An ambispective database was analyzed based on the Canadian Spine Outcomes and Research Network (CSORN). Only surgeries for lumbar radiculopathy, excluding fusion procedures, were included. Patients were split into two groups, Group 1 had a previous discectomy at the same level and Group 2 were undergoing surgery for the first time. Chi-square tests were used for categorical data and a 1-way ANOVA for continuous variables.

Results
A total of 935 patients were included in the analysis. Those who were first time patients represented 94.97% of the population, with the remaining 5.03% having undergone a revision. For demographic comparisons between those who had previous surgery and those who had not, no significant differences existed for sex ($p=0.131$), age ($p=0.378$), smoking ($p=0.149$) and BMI ($p=0.443$). Significant differences were observed at the one year follow-up, with an ODI of 29 for those who had a revision, and 20.65 who had surgery for the first time ($p=0.036$). The EQ5D was also significantly different at one year. Those with a revision had an index of 0.71, and 0.80 for those who had not ($p=0.02$). No significance was observed at otherwise.

Conclusion
There were no differences in demographic or anthropometric characteristics between groups. Functional outcomes at 1-year were statistically different with revision patients demonstrating worse outcomes.

Are There Differences between Men and Women regarding Pre-Operative Expectations and their Post-Surgical Outcome? A Retrospective Analysis of the Canadian Spine Outcomes Research Network

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Introduction
Men and women improve equally with surgery. We sought to determine if there are differences in their expectations prior to surgery and their satisfaction post-operatively.

Methods
The CSORN database was retrospectively analyzed for a cohort of 2642 men and 2397 women, over the age of 18, and had lumbar degenerative disease. Outcome variables included parameters related to patient expectations prior to surgery, and their satisfaction with surgery afterwards. Data was analyzed through binary logistic regression, comparing the outcome variable differences between sexes. Significance was taken at the $p\leq0.05$ level.

Results
For demographic variables, significant differences were observed between men and women in regards to BMI (p=0.008), but not age (p=0.052) or smoking status (p=0.06). Men were more likely to have had a previous surgery (p=0.032). For patient pre-operative expectations, men were more likely to expect "much better" outcomes related to sporting activities after surgery than women (p<0.001), whereas women were more likely to report "better" or "somewhat better" changes overall. No other expectations regarding outcomes and leg pain, back pain, maintaining independence, social contacts or mental health were statistically different between men and women. After surgery, women were more likely to not be able to return to recreational activities compared to men (p=0.011). No differences in satisfaction were observed.

Conclusion
Men reportedly cared more about recreational activity and sports than women prior to surgery, and are more likely to resume recreational activities than women. Otherwise, men and women do not differ in expectations or in their satisfaction with surgery.

Can a Frailty Index for Acute Traumatic Spinal Cord Injury Predict Mortality?

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Introduction
Spinal cord injuries (SCI) are devasting and carry with them significant morbidity and mortality, particularly in an elderly population. Being able to better predict likelihood of mortality can help direct shared decision making and goals of care discussions. We sought to determine whether frailty impacts survival after SCI.

Methods
A Frailty Index (FI) was developed based on routine trauma investigations for patients 50 years and older. Values were then determined to be "normal" or "abnormal" based on established cut-off points. The FI was developed on a scale of 0-1, higher scores considered "high-risk" on the index. For statistical analysis, chi-square test for proportion, and Fisher's exact test were used for categorical variables, and one-way ANOVA was used for continuous variables. Significance set at p≤0.05.

Results
There were 122 patients (91 men, 31 women, mean age 66.76) included. For all lab variables collected, 38 contributed to determining the FI. For the cohort, FI did not differ based on age (p=0.149). Analyzing men and women as two groups, there was no difference identified with regards to frailty (p=0.593) or age (p=0.531). For those who died in hospital, those patients had a significantly higher frailty index than those who survived (p<0.001). One-year mortality was also significantly different, with those who died within one year having a higher frailty index (p=0.049).

Conclusion
A frailty index, based on routinely collected lab values, can predict patients that are more likely to die in hospital, or within one year, than those with a lower frailty index.

The radiological progression of Diffuse idiopathic skeletal hyperostosis (DISH)

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Introduction
DISH is a clinically silent disease with a radiological prevalence of about 17-27%. Very little is known about the natural history of this condition. The aim of this study is to describe the natural history of DISH ankylosis.

Methods
All CT reports of DISH were queried in our regional PACS database. Measurements of the disc space fusion grade, vertebral body hounsfield units (HU), disc and vertebral osteophyte cross sectional area and HU were made.

Results
164 patients were included in this study with a mean interval between the two scans of 4.5years. 38% of measured disc space had some amount of calcification. Most of the disc space calcification occurred at T6/T7 and T7/T8 levels. Over the 4.5years, we noticed an increase in partially (4.69%) and fully calcified (5.38%) disc spaces, and a 9.5% increase in fusion score. The most common location for the starting and ending DISH segment was at T2/T3 and T11/T12, respectively. The average change in osteophyte area per year is 6.90mm2/year. There was no statistically significant difference in changes of the osteophyte HU between the newest and oldest scans.

Conclusion
Thoracolumbar ankylosis in DISH is a gradual process that starts in the mid/lower thoracic region before extending cranially and caudally. We predict that the ankylosis starts during early adulthood and does not stop even in the elderly. After the bridging osteophyte has fully formed, they undergo remodeling which results in a smaller and less dense osteophyte

Pool closures during the COVID-19 pandemic and the impact on low back pain management

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On 23 March 2020, the UK Government announced a lockdown to reduce transmission of COVID-19; measures involved closure of swimming pools until July. Swimming is often recommended as a management tool for low back pain (LBP)[1] therefore pool closures for extensive periods could negatively impact this group. Two studies exploring swimming as a rehabilitation modality for LBP were amended to consider the impact of the pool closures. The first study was an online survey of NHS patients with LBP (n=82) whilst the second study involved semi-structured interviews with swimmers who use swimming to manage LBP (n=14). In both studies, participants were asked about the impact of the pool closures on the management of their LBP; their responses were analysed using thematic analysis. The majority of participants (78%) felt that pool closures impacted on the management of their LBP. Physically, participants reported experiencing more LBP or flare-ups, gaining weight, having to restart medication, sustaining injuries due to trying another form of exercise, being less active and less mobile. Psychological impacts included low mood, loss of motivation, and loss of identity whilst socially participants missed the routine and social interaction, and not having the freedom to swim. It is recognised that managing a healthy weight and keeping active can reduce the severity and mortality of COVID-19[2], and help manage LBP. Since LBP is the number one cause of disability globally[3]; the impact of future pool closures on the ability for this group to keep active and manage their condition, should be considered.

Management of foot drop secondary to lumbar degenerative disease – a UK national survey

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Introduction

Foot drop is a debilitating condition with life-changing consequences. The lack of standardised practice reflects the paucity in evidence base for management of this condition. In this survey, we aimed to assess current practice in the UK and identify areas of variation.

Methods

A case-based survey was distributed to members of the Society of British Neurological Surgeons and British Association of Spine Surgeons through an online questionnaire. The survey consisted of 10 questions designed to determine the management of foot drop secondary to lumbar degenerative disease (LDD).

Results

A total of 163 responses were collected among UK neurosurgeons and spinal surgeons with good geographical representation. 91% were consultants. 86% respondents would offer surgery for painful foot drop and further 10% would consider this option. The grade of weakness made an impact on decision-making with most (71%) offering surgery for MRC grade 3/5. Duration and grade of weakness were predicted as prognostic indicators, 92% and 77% respectively. Interestingly, 52% of respondents think early surgery effects outcome but there was no consensus on when surgery should be offered with responses ranging from same day to 6 weeks. 42% respondents stated they were unfamiliar with evidence surrounding management of foot drop and 83% indicated interest in participating in a national study.

Conclusions

This survey highlights the significant variability in management of foot drop secondary to LDD amongst consultant surgeons within the UK. It is also suggestive of an unclear evidence base and indicates a need for a high quality national prospective study.

Testing the effects of the MkVI microgravity countermeasure skinsuit for the attenuation of lumbar disc swelling in astronauts returning to the terrestrial environment

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Astronauts returning from microgravity environments reportedly frequently suffer back pain. This is attributed to disc swelling and/or herniation resulting from reduced gravitational loading. A microgravity countermeasure skinsuit (Mk VI) has been developed to compress the spine for a short time before return to counteract this. This study aimed to determine if skinsuit use results in less disc swelling effects than a control procedure. Twenty male healthy participants received weightbearing and recumbent MRI and quantitative fluoroscopy (QF) following overnight recumbency on a special hyperbuoyancy flotation bed. A 0.5T Paramed MR Open upright scanner and a Siemens Avantic fluoroscope were used to assess disc swelling effects. Testing was carried out twice 6 weeks apart with and without 4-hour skinsuit wearing during recumbency.

For both testing sessions participants were transported on a gurney for supine lumbar spine T2-weighted sagittal MRI scans, then flexion and return fluoroscopy using a standardised motion protocol. This was followed by sitting MRI and standing QF. Lumbar motion segments from L2-3 to L5-S1 were assessed for disc height, volume and area, plus IV-RoM, translation, laxity, motion sharing inequality (MSI) and motion sharing variability (MSV) at all assessment points. Recumbent examinations following skinsuit wearing found significantly greater increased IV-RoM, MSI and disc area and decreased disc height and volume than control procedure ($p<0.05$). During weight bearing imaging, disc height was significantly more decreased and disc area more increased after skinsuit wearing. These findings are generally consistent with a reduction in in vivo disc swelling following skinsuit use.

Miscellaneous

Five-year Trends in Center of Rotation after Single-level Cervical Arthroplasty with Prestige-LP Disc

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Objectives
To assess the in vivo longitudinal kinematic performance of Prestige-LP Disc and the five-year trends in center of rotation (COR) at the instrumented level.

Methods
Forty-two patients with single-level cervical disc arthroplasty (CDA) were retrospectively reviewed. Lateral static and dynamic radiographs were obtained preoperatively and postoperatively at 1, 3, 5 years. Kinematic parameters collected included range of motion (ROM), COR, intervertebral disc height (IDH), functional spinal unit (FSU) angle. Japanese Orthopedic Association (JOA), visual analogue scale (VAS) and Neck Disability Index (NDI) scores were used to evaluate clinical outcomes.

Results
The JOA increased significantly while the VAS and NDI scores decreased significantly after CDA. The ROM were preserved, stabilizing at 7.8° at last. The IDH increased significantly from 4.4 ± 2.6 mm to 7.3 ± 1.9 mm after surgery, then it remained unchanged. The preoperative FSU increased by nearly 4° to 3.6° ± 4.4° at 1-year follow-up. But FSU failed to maintain lordosis, decreasing to 0.4° ± 4.7° at last follow-up. The mean COR-x was calculated to 38.9% preoperatively and stayed unaltered throughout follow-up period. The COR-y had a significant cranial shift after surgery, and it continued the upward trend in the following measurements (12.7%, 15.4%, 19.2% at 1, 3, 5-year follow-ups), albeit without significant differences among postoperative results.

Conclusions
The Prestige-LP Disc provided a durable solution for ROM. However, the Prestige-LP Disc failed to mimic a physiological COR with a significant increase in COR-y, followed by a mild upward trend.

The Incidence of Vertebral Artery Injury Secondary to Cervical Spine Trauma and the Management Received: Royal Victoria Hospital Belfast

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Introduction
Vertebral artery injury (VAI) is a recognised complication of cervical spine fractures, particularly those identified as involving the foramen transversarium. As such, these patients may subsequently undergo cervical angiography to identify injury of the vasculature. Anecdotally we believed these patients received little active management for VAI.

Aim
To identify the number of patients with cervical spine trauma who underwent angiography to identify possible vessel injury, the number of patients with diagnosed VAI and the management thereof.

Method
188 patients (2016-2017) were included. Initial CT scan was used to identify fracture pattern and involvement of foramen transversarium and subsequent CT-angiogram report was checked for evidence of VAI. Clinical notes were assessed to identify management and neurological deficit.

Results
40 of 188 (21.3%) patients were identified on CT scanning to have involvement of the foramen transversarium. 34 patients underwent CT-Angiography and 5 VAI (12.5%) identified with one fatality secondary to a large stroke (unilateral VAI). Mean age 50.3 (range 38-67). Unilateral VAI were identified in 4 of the 5 patients. 1 had bilateral VAI with subsequent tetraplegia and Posterior circulation stroke, managed with apixiban. Of the remaining patients only 1 received outpatient aspirin. All 5 had varying degrees of neurological deficit. From the admission records, VAI was associated with significant mechanism of injury in 4 of 5 patients.

Conclusion
VAI was identified in 5 (12.5%) of patients with documented foramen transversarium involvement. However we found that it was rarely actively managed. With only 2 of 5 patients receiving antiplatelet/DOAC medical therapy.

Cauda Equina Syndrome – A Bibliometric Analysis of the 100 Most-Cited Articles

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Introduction

Citations per article can be used as a surrogate for importance. A bibliographic analysis to identify the 100 most cited articles on the subject of cauda equina syndrome was undertaken.

Methods

The Web of Science Database (WOSD) was used to search for articles terms containing both "cauda equina" and "cauda equina syndrome". These search terms were chosen to include a broad selection of literature and to ensure no papers were inadvertently excluded; search terms were applied to all terms within the articles and were not limited to title and abstract. The top 100 articles were analyzed for year of publication, authorship, publishing journals, institution and country of origin, subject matter, article type, and level of evidence. In addition to total citation count, the number of annual citations was also calculated.

Results

Between 1948 and 2020, 4432 English articles have been published containing the key words. The number of citations ranged from 85 to 706 with an average of 158.6 per article. Spine was the journal with the most original articles (n=23) with the Journal of Neurosurgery coming second (n=12). There was only one level 1 evidence article which directly related to cauda equina syndrome with 81% of all articles listed being level 3 or above.

Conclusion

Our bibliometric analysis has produced an extensive list of the highest cited articles on cauda equina syndrome. We have reviewed the subject and highlighted clinically important papers as well as acknowledging the contributors and institutions.

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