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We believe the Hippocratic principles that medicine is governed by logic, that disease is governed by rules and that he or she who gives treatment should know the whole person

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Abstracts

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Editor's letter

Tim Germon

Consultant Spinal Neurosurgeon, Derriford Hospital Plymouth
Past President, British Association of Spine Surgeons

We believe the Hippocratic principles that medicine is governed by logic, that disease is governed by rules and that he or she who gives treatment should know the whole person.

Welcome to the first issue of *Column & Cord*, *The Journal of the British Association of Spine Surgeons*, a joint venture between BASS and BIBA Publishing.

Our goal is to produce our own publication with editorial and commercial independence and a reasonable citation rating. However, any relationship we have explored with an established journal, which has an established citation rating, means that we give up editorial freedom. We have negotiated an arrangement with BIBA Publishing, the publisher of *Spinal News International*, to produce a joint venture where we retain absolute editorial independence but collaborate to optimise industry engagement with the objective of covering publishing costs. We can work towards citation but have agreed amongst ourselves that appearing in a Google Scholar search is the more important objective in the short term.

We have to consider our journal's content. In our supplements we originally published abstracts to coincide with the meeting at which the work was being presented. This was problematic because some abstracts were not presented, and some contained data which were different to that presented at the meeting. Therefore, we decided that to publish an abstract which had been presented the previous year would be more appropriate. We also considered that the point of presenting research findings was to submit them to the scrutiny of the audience. We thought it would be of value to include any relevant discussion about presented work, along with the abstract, in the publication. This has been surprisingly difficult to achieve.

Our current concept is that the content of the published journal will reflect the content of our meeting and will first appear online. We hope to make the most of any debates, invited talks, podium presentations or anything else that might be of value in pursuing the objectives of the society. We hope that people will be able to post comments regarding any item published on the web page. Each year the web content deemed worthy of publication will be produced in a printed version which will be circulated at the annual meeting. Our goal is that we will one day be able to accept original papers for consideration of publication.

Publishing a journal requires money. We are also working with BIBA Publishing and the relevant industries to explore novel ways of making members aware of advances in technology as well as securing commercial financial support.

This first issue is a small step at the beginning of a new journey. The journal belongs to members of our society(s) and in small steps we can develop it however we see fit. We need some direction and some way of differentiating ourselves from an already over-provided marketplace. We have attempted to define what we might consider as our principles in the strapline referring to Hippocratic principles. That is to say, articles appearing in our journal should recognise these principles. We need to ensure that it is a meaningful and relevant publication. If anyone has any ideas that they would like to contribute, please let us know.

Tim Germon - *Editor-in-Chief*

Original articles

Spine surgery in patients with cerebral palsy

Ian Nelson MBBS, MChOrth, FRCS
North Bristol NHS Trust

There has been an increase in spine surgery interventions in patients with cerebral palsy in the UK since the millennium following a trend in North America, and subsequent publications suggesting favourable quality of life outcomes for correction of deformity[1].

The Gross Motor Function Classification System (GMFCS)[2], as well as documenting motor function, provides significant information on prognosis, risk of developing scoliosis, and need for interventions for spasticity. Spine deformity is common in the most severely affected GMFCS groups IV and V[3]. The linking of progression to indicators of Peak Height Velocity (age, menarche, Risser sign) may be not as defined and may continue after skeletal maturity as in other neuromuscular disorders.

The same groups have a shorter life expectancy[4] with over half severely affected group not expected to live beyond 20 years of age. This is of significance if considering surgical intervention and may render 'growth friendly' systems of less relevance.

Spasticity interventions such as Intrathecal Baclofen (ITB) may complicate scoliosis surgery, but do not seem to accelerate progression[5]. Selective Dorsal Rhizotomy (SDR) has been most frequently indicated in ambulant patients GMFCS II and III and may be complicated by hyperlordosis, spondylolisthesis and laminoplasty non-union[6]. It has been suggested that SDR may be an appropriate alternative to ITB in Groups IV and V[7] reducing cost, being less intrusive and more effective.

Loss of seating balance, and its restoration, is the primary indication for scoliosis correction. Other important goals perceived by surgeons and caregivers include prevention of respiratory compromise, pain improvement, improvement of head control/position[8].

There is a 'window of opportunity for treatment'. As the curve size increases beyond 90 degrees surgery complexity and complications increase and the improvement in quality of life lessens[9]. Timing in relation to other interventions such as gastro-intestinal, neurosurgical, orthopaedic may need to be co-ordinated.

Peri-operative challenges start with low body weight and nutrition, pulmonary care and need for intensive care support, which may be prolonged. The mortality rate after surgery is 1–2%[1]. Operative neuromonitoring may or may not be possible and its relevance in wheelchair bound is often debated but preservation of any bladder function is highly desirable.

It is often debated as to whether fusion should routinely extend to the pelvis. Most published series document 'routine' fixation to the pelvis. The evolution of effective pelvic fixation by, for example, the S2AI technique[11], the ability of pelvic fixation to enable correction of pelvic obliquity and maintain the correction over longer follow–up[12] are probable explanations for this.

Postoperative complications are common[1], especially wound related complications and early and late deep wound infections which may be mitigated in part by a standardised care pathway[13].

Improvement in quality of life after surgery is reported but relies on subjective carer assessment such as with the Caregivers Questionnaire (non-validated)[1] and CP Child (validated)[14], in spite of complication rates of 46% at one year.

These children frequently have complex social needs with a single-parent carer and this may be on a long standing medico-legal background. These many issues present an ethical dilemma which has been modelled to assist clinicians and carers in decision making about surgery[10]. These decisions are best undertaken in a multi-disciplinary setting.

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Original articles

Surgical implant surveillance in spinal surgery

Sashin Ahuja
Consultant Spinal Surgeon
Welsh Centre for Spinal Surgery & Trauma, University Hospital of Wales, Cardiff

Implants are commonly used in spinal surgery with a variety of implants utilised for surgical management of various spinal pathologies. In the recent past some of the spinal implants have had some bad press for the concerns raised with their use. One significant coverage recently was in the BBC Panorama programme telecast in November 2018 which raised concerns about a type of cervical disc replacement and magnetically controlled growth rods for early onset scoliosis.

The vast majority of implants used in Spinal surgery are for stabilisation to fuse the spinal motion segments and these usually do not cause any significant biological reaction once fusion is achieved. Biological reactions are more prevalent in implants used for motion preservation, for example arthroplasty or used for non fusion surgery.

Hip and Knee joint arthroplasty are one of the commonest motion preserving implants used in orthopaedics. During their course of development there have been major lessons learnt from failures requiring early revisions which has implications on the function and outcome. In the UK the Orthopaedic Device Evaluation Panel (ODEP)[1] was set up in 2003 after the failure of the 3M Capital hip replacement requiring early revision. The ODEP process evaluates data from various national registries, randomised controlled trials, publications and in-house study data from industry. The data is evaluated against agreed benchmarks of certain accepted complications most of which require surgical intervention to rectify. These procedures are logged and hence can be evaluated accurately as an adverse event. The above information helps to assess the longevity of the arthroplasty implants in years with the end point being revision surgery. The strength of the data is categorised as A*, A and B from highest strength classed as A*. Thus the process helps improve potential outcomes and reduce adverse events which is a major benefit for patients.

The above process has helped streamline the engagement of the relevant stakeholders i.e. the patients, manufacturers of the implants and the surgeons with one objective to provide the best outcome for patients.

One may look at this as a barrier to innovation and newer implants and their introduction, but the above process encourages introduction of innovative implants using the Beyond Compliance vehicle whereby data and evidence is gathered prospectively using the pilot centres with close working between the surgeons, patients and the manufacturers which helps early identification of complications and concerns or adverse events. This would allow all concerned to act responsibly so as to provide the highest quality of care to our patients.

There have been examples of concerns raised with regards spinal implants over the year. The most recent coverage was presented in BBC Panorama programme[2] about Cadisc disc replacements and Magec (Magnetically controlled growth rods) for early onset scoliosis.

The 2019 Spine GIRFT report[3] recommended to "Implement a range of specific measures to ensure spinal surgery implants are introduced and adopted in line with emerging evidence and best practice, and that comprehensive data is collected to support appropriate dissemination."

Taking into account the above recommendations the Spine Surgical Societies i.e. British Association of Spine Surgeons (BASS), British Scoliosis Society (BSS) and the Society of British Neurological Surgeons (SBNS) under the United Kingdom Spine Societies Board (UKSSB) have unanimously agreed to engage with the ODEP and Beyond Compliance process to improve surveillance of spine surgery implants in the UK, starting from 2020.

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BASS 2019 Podium Abstracts

Paper Session 1

Incidence and risk factors for sacroiliac joint pain following lumbar fusion

Yu Chao Lee[1], Robert Lee[1], Clare Harman[1]
[1]*Royal National Orthopaedic Hospital, Stanmore, UK*

The sacroiliac joint (SIJ) can be a new source of pain following lumbar fusion. This is thought to be due to transfer of mechanical stress to the SIJ following fusion. We performed a retrospective analysis on prospectively collected data of a single surgeon case series over five years, consisting of 319 patients who underwent lumbar spinal fusion, to determine the incidence of and predisposing surgical factors for new onset sacroiliac joint pain following surgery. All patients did not have symptomatic sacroiliac joint pain pre-surgery.

Diagnostic criteria for sacroiliac joint pain used in this study was in accordance with previous published studies: New onset of pain localised to the lower lumbar region and buttocks not originating from spine or hip, at least two positive provocative tests of SIJ and pain relief of >70% achieved from SIJ block.

There were 38 patients who developed new SIJ pain following fusion with an overall incidence of 11.9%. The average time to new onset SIJ pain following fusion was 22 months. Of the patients with newly developed SIJ pain, 57.9% had fusion to sacrum. The overall incidence of SIJ pain in patients who had fusion extending into sacrum was 12.6% vs. 11% in those who had not. The incidence of SIJ pain was 11.1% with 1-level fusion, 11.9% with 2-level fusion and 13.3% with ≥3 levels fused.

In conclusion, new onset SIJ pain can arise following spinal fusion and is associated with fusion to the sacrum and length of spinal construct.

The sound of subsidence and endplate fracture—a comparative biomechanical study of intervertebral fusion devices using acoustic emission technology

John Afolayan[1,2], John McCrory[1], Davide Crivelli[1], Rhys Pullin[1], Sam Evans[1], Sashin Ahuja[3]
[1]*Cardiff University School of Engineering, Cardiff, UK* [2]*Trauma & Orthopaedic, Kent, Surrey and Sussex Deanery, UK* [3]*University Hospital of Wales, Cardiff, UK*

Aim
To investigate the compressive behaviour of different intervertebral fusion cages (IFCs) using acoustic emission, a non-destructive failure analysis technique, to provide real-time failure analysis at the IFC/endplate interface.

Methods
Three IFCs were tested: (1) a rectangular highly porous metallic (tantalum) cage; (2) a bullet-shaped PEEK cage; (3) a banana/curved PEEK cage. Two sections of Sawbones blocks were fixed either side of the IFCs in a loading cell, simulating surgical placement. AE sensors were secured to each block. Loading rate was 1mm/minute. Data were captured from the cephalad and caudad blocks and analysed at 6mm displacement (represented 50% intervertebral height loss). Each IFC was tested four times with two block densities (15PCF [0.24 cm^3] and 20PCF [0.32 cm^3]).

Results
At 6mm displacement, mean loads were 1652N (IFC 1), 1216N (IFC 2) and 1569N (IFC 3) for 15PCF blocks compared to 3207N (IFC 1), 2115N (IFC 2) and 2801N (IFC 3) for 20 PCF blocks. Higher AE cumulative energies were observed in the 15 PCF blocks. Less AE cumulative energy was generated for PEEK cages IFC 2 and 3, compared to the metallic IFC 1 with the 20 PCF blocks. PEEK IFCs had a central hollow for bone graft. Observed data paradox may be a function of the reduced block contact area in the PEEK cages.

Conclusion
Subsidence in standalone IFCs is strongly dependent on the vertebrae density. Combined data highlight the importance of IFC/endplate contact area. In vertebrae of normal density, the clinician should strive to maximise the IFC/endplate contact area.

Outcome of non-instrumented lumbar spinal surgery in fibromyalgia—a retrospective matched cohort study

Shivan Marya[1], Roberto Carrasco[2], Naveed Yasin[3], Irfan Siddique[3], Rajat Verma[3], Saeed Mohammad[3]
[1]*Salford Royal NHS Foundation Trust, Salford, UK*

[2]Division of Academic Neurosurgery, Manchester Academic Health Sciences Centre, The University of Manchester, Manchester, UK
[3]Salford Royal Foundation Trust, Salford, UK

Introduction
Patients with fibromyalgia suffering from spinal disorders are often perceived to be challenging to manage. Surgical outcomes in these patients are believed to be less favourable, however there is a paucity of literature to support this.

Aim
To determine the outcome of lumbar decompression and discectomy surgery in patients with fibromyalgia and compare the results with a matched cohort.

Study design
Retrospective analysis of prospectively collected data on 24 patients with fibromyalgia having undergone single level lumbar decompression or discectomy compared with 24 controls matched with the same age, sex, ASA grade and pre-op COMI score.

Outcome measures
Comparison of COMI, leg pain VAS and back pain VAS scores pre- and postoperatively between fibromyalgia and non-fibromyalgia cohorts.

Results
The mean age of the 48 patients (24 patients in each group) was 50.5 years of which 44 were female (22 in each group). Fisher's exact test comparison of the pre-op leg and back pain VAS scores revealed the patients with fibromyalgia had significantly more back pain when compared to their controls. Postoperative improvement in leg pain VAS was significantly higher in the non-fibromyalgia group (p-value 0.01). COMI score improvement was greater in the non-fibromyalgia group too (p-value 0.06). Low back pain VAS improvement was greater in the fibromyalgia group (p-value 0.08).

Conclusion
Patients with fibromyalgia show significantly less improvement in leg pain postoperatively when compared to patients without fibromyalgia, which would help in pre-operative decision-making and counselling of these patients.

Anterior lumbar interbody fusion with expandable hyperlordotic cages for adult spinal deformity—early clinical and radiological results

Yu Chao Lee[1], Galateia Katzouraki[1], Robert Lee[1]
[1]Royal National Orthopaedic Hospital, Stanmore, UK

Restoring sagittal alignment has been shown to improve clinical outcomes in adult spinal deformity. As two thirds of lumbar lordosis is anatomically distributed between L4-S1, anterior lumbar interbody fusion (ALIF) using hyperlordortic cages allows restoration of significant lordosis in the lower lumbar segments which recreate normal spinal harmony and also improve overall sagittal correction. In addition, expandable design also allows easier implantation in the collapsed disc space with subsequent expansion allowing controlled restoration of intended lordosis.

The aim of this study is to evaluate the early clinical and radiological outcomes in patients who underwent ALIF using expandable hyperlordotic cages (EHC) and posterior instrumented fusion. There were two groups of patient: (1) patients without significant pelvic incidence–lumbar lordosis (PI-LL) mismatch but have a non-harmonious lordosis, (2) patients with PI-LL mismatch with positive sagittal balance. A total of 34 EHC were inserted in 24 patients.

One-year clinical results showed an average reduction in VAS Leg from 8.4–1.0, VAS Back from 8.1–1.4, ODI from 64–22 and an increase of EQ-5D from 0.357–0.856. Spinal harmony was restored in group one and correction of sagittal alignment in group two. PI-LL mismatched improved from 20 degrees to 5 degrees and SVA reduced from 85mm to 35mm. Radiological union was observed at latest follow up for all patients and there were no loss of segmental lordosis.

In conclusion, ALIF using EHC can produce reliable segmental lordosis correction with low complications and good clinical outcome.

Smoking and lumbar micro-decompression surgery outcomes—1,287 patients, single-centre prospective study

Abdul Nazeer Moideen[1], Roberto Carrasco[2], Mahmoud Elmalky[1], Irfan Siddique[1]
[1]Salford Royal NHS Foundation Trust, Salford, UK [2]Manchester University, Manchester, UK

Introduction
Few studies reported positive correlation between smoking and low back pain (LBP). Others claimed that smoking increases the risk of chronification of LBP.

Aim
To study the effect of smoking on the functional outcomes after single-level primary lumbar micro-decompression surgeries.

Methods
We analysed our prospectively collected spine registry data for patients who had micro-decompression surgery in single tertiary referral spine centre (2011–2017). Pre-operative characteristics were compared between smoking status groups using Wilcoxon rank test and Fisher exact test. Postoperative outcomes and changes in COMI scores and back/leg pain scales from pre-

operative were analysed using Wilcoxon rank test for the non-normally distributed variables and t-test for the rest. Based on the response to the global outcome question, we had two outcome groups (good & poor). Outcomes were tabulated for smoking status and analysed using Chi square test.

Results
We included 1,287 patients with mean follow up (1.4 years). Smokers (230, 16%) were younger (p<0.0001) and presented higher values for the pre-operative COMI score (p=0.0005) and both back (p=0.008) and leg (p=0.009) pain visual analogue scales (VAS) when compared with non-smokers. Postoperative COMI-score, back and leg VAS scores were significantly higher in the smoking group; improvement in COMI score, back and leg pain were higher for the non-smoking group. Forty per cent of smokers got a poor outcome versus 25% of non-smokers (p<0.0001).

Conclusion
Postoperative back and leg pain improved significantly in the non-smokers. The effect of smoking as a lifestyle habit should be carefully considered while consenting patients pre-operatively. Also, the likelihood of poor surgical outcome is to be clearly discussed with smokers.

The morbidity of out-of-hours surgery in cauda equina syndrome

Aditaya Kumar[1], Christopher Barrett[1]
[1]Neurosurgery Department, Institute of Neurological Sciences, Glasgow, UK

Aim
There is no literature specifically addressing the morbidity of out-of-hours surgery for cauda equina syndrome (CES). This is conceded as a known unknown in the British Association of Spinal Surgeons most recent standards of care. Our paper rectifies this in the first national study on this cohort of patients.

Methods
A retrospective case series analysis. Individual cases were identified using local electronic theatre management systems in the four neurosurgical centres for Scotland in 2017. "Out-of-hours" surgery was defined as starting outside the times 0900–1700, Monday to Friday.

Results
Eighty-six patients underwent out-of-hours surgery for CES over one year. Age range was 16–72 years with mean age 48.5 years. Seventy-five per cent of operations (n=64) started between 1800–0600 hours. Operations were performed by neurosurgical trainees/clinical fellows alone in 60% of cases (n=52). Four patients had an operative complication of CSF leak giving a risk of 4.7%. Seven patients underwent early re-operation for either: postoperative haematoma; repair of CSF leak; or residual symptomatic disc giving a re-operation risk of 8.1%.

Conclusion
The morbidity of out-of-hours surgery for CES is comparative to that of elective microdiscectomy. In our units the majority of these operations are being performed by trainees or clinical fellows alone and in the night. Operating out-of-hours for CES does not present an increased risk of morbidity to patients and should not be factored into decision making with regards to timing of surgery.

Paper Session 2

Does silicate-substituted calcium phosphate bone graft (Inductigraft) packed into 3D printed lamellar titanium cages increase lumbar interbody fusion rates?

Michael Mokawem[1], Galateia Katzouraki[2], Clare Harman[2], Robert Lee[2]
[1]Leeds General Infirmary, Leeds, UK [2]Royal National Orthopaedic Hospital, Stanmore, UK

Aim
The synthetic bone graft material, silicate-substituted calcium phosphate (SiCaP), has been successfully used in spinal fusion surgery. However, the efficacy of SiCaP-packed 3D printed lamellar titanium cages used in transforaminal lumbar interbody fusion (TLIF) and lateral lumbar interbody fusion (LLIF) has not been investigated. This study aimed to evaluate the efficacy of this combination in TLIF and LLIF surgeries treating adult spinal deformities and degenerative disorders.

Methods
We retrospectively analysed a consecutive case series of 93 adult patients with lumbar degenerative disease or deformity who underwent TLIF or LLIF surgery with SiCaP-packed 3D printed lamellar titanium cages. Surgeries were performed at two centres by a single lead surgeon. The primary endpoint was solid fusion at 12 months postoperatively, assessed using computed tomography (CT) scans. Secondary endpoints included patient-reported clinical outcomes (EQ-5D, EQ-5D-VAS, ODI, VAS leg and back). Safety data and complications were recorded.

Results
CT scans revealed solid fusion in 92 out of 93 (98.9%) patients and 149 out of 150 interbody levels with good integration of the cage at the vertebral body interface and no evidence of screw loosening. Pain and disability scores reduced greatly and quality of life improved in both TLIF and LLIF surgery patients at six months and one year.

Conclusion
SiCaP-packed 3D printed lamellar titanium cages provided high rates of solid fusion in TLIF and LLIF surgeries with a corresponding notable improvement in patient-reported outcomes. We believe

that this combination of bone graft and implant provides reliably good outcomes.

Ionising radiation exposure during TLIF surgery—a comparison of open versus MIS techniques from a tertiary spinal unit

K H Sunil Kumar[1], David Cumming[1], Robert Lovell[1], Alister Hudd[1], Shaishav Bhagat[1], Saajid Kaleel[1]
[1]Ipswich Hospital, Ipswich, UK

Introduction
Excessive use of image intensifier causes unnecessary exposure of ionising radiation both to the patient and the clinician involved in their care. The aim of the study was to evaluate the use of image intensifier during transforaminal lumbar interbody fusion (TLIF) procedure and evaluate the difference in the radiation exposure between open and minimally invasive surgical (MIS) techniques.

Methods
One-hundred-and-thirty-one TLIF procedures were undertaken at Ipswich Hospital from January 2012–October 2017. Medical records and data from PACS were reviewed.

Results
Eighty-seven via a standard open technique and 44 via MIS technique. One surgeon performed 73 TLIF procedures and a majority of MIS procedures (n=38/44). The mean ionising radiation dose for open TLIF was 192.59 (SD=116.49) cGy·cm^2 compared to 687.95 (SD=589.26) cGy·cm^2 for MIS TLIF. This was statistically significant with a p-value <0.0001. The image intensifier screening time was 0.3033 (SD=0.2813) min for open TLIF compared to 1.5453 (SD=0.7076) min for MIS TLIF, which was also statistically significant (p<0.0001).

Conclusion
MIS TLIF procedure carries a 3.5 times increased risk of radiation to the patient compared to open procedure. In addition there is potentially an increased risk of radiation exposure to the practicing clinicians with the use of MIS technique. Proper education of the practicing surgeons, to take necessary steps to minimise the exposure to radiation both the patient and themselves, is essential.

Triaging back pain: STarT Back or start again?

Tim Germon[1], Alex Jack[1], Jeremy Hobart[1]
[1]University Hospitals Plymouth, Plymouth, UK

Introduction
The STarT Back Screening Tool (SBST) is a questionnaire purporting to identify people with back pain likely to benefit from "sophisticated" treatments such as manual treatments, exercise and cognitive behavioural therapy. SBST classifies people with lumbar pain as low, medium or high "risk" of prolonged symptoms. Using SBST is claimed to bring generic health benefits and cost savings. This concept differs from traditional principles where diagnosis guides rational treatment. To be an effective triage tool, SBST should distinguish structural from non-structural pain. We tested this requirement in consecutive people referred to a single triage practitioner.

Methods
We studied consecutive referrals with lumbar pain triaged by a single ESP over 22 months (November 2015–September 2017). SBST and pain VAS scores were collected at the initial consultation. We compared data for people with and without surgically remedial lesions.

Results
1,042 people were seen (61% female, mean age 53), n=294 (28%) had surgically amenable explanations for pain. Mean (SD) [%] values were: people with no surgical lesions; age 51, female 484 [65], SBST high 227 [30], SBST medium 241 [32], SBST low 126 [17], missing 154 [21], VAS back 6 (2.6), VAS right leg 5 (3.2), VAS left leg 5 (3.5). People with surgical lesions; Age 58, female 154 [52], SBST high 107 [37], SBST medium 132 [45], SBST low 23 [8], missing [5], VAS back 7 (2.3), VAS right leg 7 (2.6), VAS left leg 7 (2.8).

Conclusion
People with surgical lesions had higher pain and SBST scores. Results show SBST triages people to the wrong intervention. This is consistent with expectation as diagnosis should guide treatment.

Predictors of poor outcome after single-level lumbar micro-decompressive surgery—a single centre study of 3,308 patients

Abdul Nazeer Moideen[1], Roberto Carrasco[2], Mahmoud Elmalky[1], Irfan Siddique[1]
[1]Salford Royal Foundation Trust, Salford, UK [2]Manchester University, Manchester, UK

Introduction
Lumbar micro-decompression is the commonest spinal intervention. One in four patients have suboptimal outcome postoperatively, however no large studies identified clear poor outcome predictors.

Aim
To determine predictors of poor outcome post-lumbar micro-decompression.

Methods
Prospectively collected spinal registry data were analysed for patients who underwent primary, single-level, micro-decompression at single spinal centre (2011–2017). Based on the response to the Likert global outcome question, we had two outcome groups (good & poor). Minimum clinically relevant change (MCRC%) for COMI score, LBP and leg pain (LP) were examined. A two-step approach was adopted. First, COMI score, LBP and LP VAS trajectories were modelled using a discrete mixture model. Second, multinomial logistic regression was used to determine the association between variables and trajectories.

Results
We included 3,308 patients with mean follow-up 1.4 years. MCRC was achieved in 63%, 42% and 62% of COMI score, LBP and LP respectively. A three-group trajectory model was identified: large improvement (LI) (n=980), moderate improvement (MI) (n=1,364) and no-improvement (NI) (n=966) with 99.5%, 84.5% and 31.5% of patients presenting good outcome, respectively. Higher pre-op LBP and COMI score and reporting LBP or sensory disturbance as the major problem for the patients were associated with MI and NI. In addition, smoking and LP and lumbar canal stenosis were associated with NI.

Conclusion
This is the first large-scale study reporting pre-operative LBP severity, spinal stenosis and smoking as predictors for poor functional outcomes post lumbar micro-decompression. This is very useful while counselling patients for surgery to meet realistic expectations.

Expandable vs. non-expandable cages: radiographic evaluation of disc height, vertebral body height, subsidence and clinical outcome in patients with degenerative lumbar disease

Chadi Ali[1], Simran Parmar[2], Georgios Solomou[2], Ziead AlShameeri[1], El Nasri Ahmed[1]
[1]*University Hospital North Midlands, Stoke-on-Trent, UK*
[2]*Keele University, Medical School, Stoke-on-Trent, UK*

Aim
To compare the outcome of expandable vs. static lumbar interbody cages based on radiological cage subsidence and functional scores.

Methods
A retrospective study of adult patients who underwent posterior or transforaminal lumbar interbody fusion up to three vertebral levels (L2-S1). The anterior and posterior disc heights were measured pre-operatively, immediately and one year postoperatively. The grading of cage subsidence was measured as previously described by Matchi ***et al*** (2013). Data on patients' demographics, diagnosis, the spinal procedure, Oswestry Disability Index (ODI) and VAS scores were also gathered. Adjusted p-values were calculated based on all baseline characteristics.

Results
A total of 68 patients were eligible to be included. The expandable cage group (n=30) showed 148% immediate post-op disc height expansion vs. the static (n=38) showing 72%, p=0.001 and adjusted p=0.007. A 12.9% decrease in disc height was shown at one year postoperatively by the expandable cages vs. 19.0% by the static group, p=0.022 and adjusted p=0.1408. Static cages showed a greater degree of cage subsidence. For those with recorded functional scores, pre-op ODI was 29.3±6.0 and 22.6±11.7 in expandable and static cages, respectively. During the first six months postoperatively ODI improved in both groups to 27.7±9.3 and 14.6±1.0 in expandable and static cages, respectively. The improvement in ODI was only significant in the static cage group (p=0.009).

Conclusion
Patients undergoing TLIF or PLIF with implanted expandable cages showed a significantly greater disc expansion postoperatively. However, this did not translate to a significant reduction in ODI compared to static cages.

Effect of spinal decompression on back pain in lumbar spinal stenosis: a Canadian Spine Outcomes Research Network (CSORN) study

Shreya Srinivas[1], Greg Mcintosh[2], Charles Fisher[3], Nicolas Dea[3]
[1]*Alder Hey Children's Hospital NHS Trust, Liverpool, UK*
[2]*Canadian Spine Society, Canada*
[3]*Vancouver General Hospital, Vancouver, Canada*

Introduction
In lumbar spine stenosis, surgical decompression is offered for improvement of neurogenic claudication but little is known about its effect on the commonly associated low back pain (LBP) symptoms in these patients. This study aims to quantify the improvement in LBP following surgical decompression for lumbar canal stenosis.

Methods
This is a multicentre, ambispective review of patients enrolled by the Canadian Spine Outcomes and Research Network (CSORN) who underwent surgical treatment for symptomatic lumbar spine stenosis without instability between 2014 and 2017. Primary outcome was change in LBP on the Numeric Rating Scale (NRS) including multivariable logistic regression to model relationship between outcome and potential factors associated with achieving minimal clinical important difference (MCID) in back pain.

Results
1,221 patients (mean age 64 years, 58% males) were included in the analysis with follow-up evaluations available in 968/1,133 (85%) patients at three months, 649/903 (72%) patients at 12 months and 331/454 (73%) at 24 months. LBP significantly

improved three months after surgery and sustained at 24 months ($p<0.001$). We found 74% of patients reached the MCID in back pain. Predictive factors for sustained improvement (12 and 24 months) in LBP after surgical intervention were absence of narcotic usage or compensation claims and increased severity of LBP prior to surgery (high NRS).

Conclusion
Alleviation of clinically significant LBP was observed at three months after lumbar decompression surgery for neurogenic claudication that was maintained at 12 and 24 months after surgery in the majority of patients.

Evaluating the role of dynamic MRI in cervical myelopathy

Amit Thakrar[1], Mark Nowell[1], Georgios Prezerakos[2], Kia Rezajooi[1]
[1]Royal National Orthopaedic Hospital, Stanmore, UK [2]The National Hospital for Neurology and Neurosurgery, London, UK

Introduction
There is interest in the role of dynamic MRI (dMRI) in the clinical management of cervical myelopathy.

Aim
To describe our experience using dMRI in the clinical evaluation of patients with cervical myelopathy.

Methods
This is a multicentre retrospective descriptive study. We identified patients undergoing work up for clinical cervical myelopathy who underwent dMRI. We examined the reasons for this additional imaging and, whether this informed or changed clinical management and decision making.

Results
Fifty patients were identified across two sites. The indications for dMRI were: 1) clinical myelopathy but no radiological spinal cord compression on neutral MRI, or, 2) multi-level spinal cord compression. In this cohort dMRI was thought to have changed clinical decision making in approximately one-fifth of cases. In these cases dMRI demonstrates ligamentum flavum buckling, previously not seen. The clinical significance of this is twofold: 1) promote surgery when no previous clear neurosurgical target, and, 2) promote multi-level decompression.

Conclusion
In a subset of patients with cervical myelopathy dMRI has a role to play in clinical evaluation, demonstrating ligamentum flavum buckling and worsened posterior compression.

The use of platelet-rich fibrin in lumbar interbody-fusion in lytic spondylolisthesis

Joseph Boktor[1,2], Ahmed Sultan[2], Awf Al-shahwan[1], Mahmoud Abousayed[2], Wael Koptan[2], Yasser Elmiligui[2]
[1]Kettering General Hospital, Kettering, UK [2]Kasr Al Aini Medical School, Cairo, Egypt

Study Design
Prospective comparative study on 40 patients with spondylolisthesis divided into two equal groups. Measuring the outcome of posterior lumbar interbody fusion (PLIF) technique combined with platelet rich fibrin (PRF) vs. PLIF alone in the management of low grade lytic spondylolisthesis.

Objectives
Evaluate the effectiveness of applying PRF in accelerating the rate of lumbar inter-body fusion.

Methods
We prospectively reviewed 40 adults treated with instrumented PLIF for low grade lytic spondylolisthesis who were followed up for a minimum of 12 months, divided into two groups, 20 with addition of PRF while another group of twenty without PRF. Radiological outcome was measured by standing X-ray at three, six, 12 months as well as CT at 12 months postoperatively. Clinical outcome was measured by Oswestry Disability Index (ODI) and Visual Analogue Score (VAS) for leg pain and back pain at three, six, 12 months postoperatively.

Results
ODI for the PRF group improved by 60% & 79% at six, 12 months respectively, while for the non PRF group, it improved by 55% & 70%. Radiological outcome showed fusion in 15 of 20 cases in PRF group (75%) by sixth month and in 19 of 20 cases (95%) by one year, reaching 100% at two years follow up. In the non-PRF group, fusion was present in 12 of 20 cases (60%) by sixth month and in 13 of 20 cases (65%) by one year, reaching 18 of 20 at two years follow up 90% (p value: 0.031, 0.038 at six, 12 month).

Paper Session 3

Do intraoperative radiographs in adult deformity surgery reflect the final radiographic result?

Aaron Hilis[1], Khalid Salem[1], Nasir Quraishi[1]
[1]Queen's Medical Centre, Nottingham University Hospitals, Nottingham, UK

Introduction
One of the main goals of adult spine deformity (ASD) surgery is to obtain a balanced fused spine. Radiographs are the only available tools to verify accurate correction intraoperatively. The aim of this study was to show whether intraoperative radiographs of the sagittal correction accurately reflected the final radiographic result during correction of ASD with pedicle subtraction osteotomies (PSOs).

Methods
A retrospective review of all ASD patients who underwent PSOs performed by a single surgeon. We analysed the pre-operative, intraoperative (after instrumentation and correction), early and last follow-up postoperative upright sagittal radiographic for the segmental lumbar lordosis (SLL) at the PSO level.

Results
A retrospective study was performed on 47 (31 female, 16 male), mean age 62.7 years (31.4–77.3) consecutive ASD patients treated with PSOs (29 at L3, 17 at L4). The mean follow up was 3.9 years (16.7 years). There were 30 patients who had a T9/10 pelvis fusion and 17 patients with T2/4 to pelvis. Of these, 16 patients had a combined anterior/posterior procedure and 31 patients had only a posterior approach. The mean gain of the SLL intraoperatively after a single PSO was 28.9 degrees (21–34.6 degrees; p=0.045). This correction decreased slightly at the immediate standing sagittal X-ray to 26.7 degrees (20.923.6; p=0.63). At the last follow up, the mean SLL value of 23.4 degrees (18.3–28.6 degrees; p=0.03), decreasing by an average of 5 degrees.

Conclusion
PSO is highly efficient to restore segmental lordosis but our results show that there is approximately 5 degree loss of this correction with time.

Reducing surgical site infection in paediatric scoliosis surgery: a multidisciplinary improvement programme and prospective four year audit

Geoffrey Tipper[1], Jonathan Lucas[1]
[1]Guy's and St Thomas' Hospital Trust, London, UK

Introduction
Surgical site infection (SSI) following paediatric spinal corrective surgery is associated with significant morbidity, lengthened hospital stays, and expense. Reported incidences of infection range from 0.5–41.7%. In 2013 a cluster of SSIs in our institution resulted in an incidence of 8.6%, a significant increase on our baseline. This prompted a multidisciplinary led revision of current practice and implementation of a formal protocol with set criteria. A four-year prospective audit to monitor the results was initiated and overseen by a specialist nurse for infection control.

Methods
(1) Pre-operative skin decontamination with Octinesan (2) Operative site preparation with 2% Chlorhexidine (3) Betadine soaked swabs applied to wound edges (4) Blood loss minimisation through meticulous haemostasis, maintaining mean arterial pressure of 65 to 70 mmHg, the use of a cellsaver device, tranexamic acid and Surgiflo (5) 3 litres 0.9% Saline pulsed-lavage (6) Defined protocol of glove changes (7) Antibiotic regime of pre-operative gentamicin, intra-operative subfascial vancomycin powder, 48-hour cefuroxime cover (8) Normothermia.

Results
Four-hundred-and-twenty-two paediatric scoliosis correction surgeries were performed between 1 January 2014 and 1 January 2018: 133 male, 289 female, average age 13.7 years, 280 idiopathic, 142 neuromuscular (34% of total). The average number of operated levels both overall and for infected cases was 13. There were nine surgical site infections in eight patients (50% neuromuscular), resulting in an overall SSI per operation of 2.1%.

Conclusion
A multidisciplinary approach with standardised measures significantly reduces surgical site infection in paediatric scoliosis surgery.

Predicting the need for surgical intervention in patients with spondylodiscitis—the Brighton Spondylodiscitis Score (BSDS)

Nageswary Appalanaidu[1], Roozbeh Shafafy[2], Christopher Gee[2], Kit Brogan[2], Shuaib Karmani[2], Giuseppe Lambros Morassi[2], Sherief Elsayed[2]
[1]Brighton and Sussex Medical School, Brighton, UK [2]Brighton & Sussex University Hospitals NHS Trust, Brighton, UK

Purpose
Spondylodiscitis represents a condition with significant heterogeneity. Most patients are managed without surgical intervention, but there remains a group where surgery is mandated. The aim of our study was to create a scoring system to guide clinicians as to which patients may require surgery.

Methods
A retrospective analysis of patients presenting to our institution with a diagnosis of spondylodiscitis between 2005 and 2014 was performed. Data for 35 variables, characterised as potential risk factors for requiring surgical treatment, were collected. Logistic regression analysis was performed to evaluate the predictability of each. A prediction model was constructed and externally validated using a second series of patients from 2014–2015 meeting the same standards as the first population. The predicted odds were calculated for every patient in the dataset. Receiver operating characteristics (ROC) curves were created and the area under curve (AUC) was determined.

Results
Sixty-five patients were identified. Surgery was deemed necessary in 21 patients. Six predictors: distant site infection, medical co-morbidities, the immunocompromised patient, MRI findings, anatomical location and neurology were found to be the most consistent risk factors for surgical intervention. An internally validated scoring system with an AUC of 0.83 with an AIC of 115.2 was developed. External validation using a further 20 patients showed an AUC of 0.71 at 95% confidence interval of 0.50–0.88.

Conclusion
A new validated scoring system has been developed which can help guide clinicians as to when surgical intervention may be required. Further prospective analyses are required to further validate the model.

Features of dural ectasia in neurofibromatosis type I

Joshi George[1], Savan Shah[2]
[1]Salford Royal Foundation Trust, Salford, UK [2]University of Manchester, Manchester, UK

Introduction
This study aims to establish the prevalence of dural ectasia in patients with complex NF-1 and the possible aetiological link with key spinal deformities that manifest alongside. It also aims to establish which deformities progress over time and compare the burden of these deformities on the different sections of the spine. The lack of available research surrounding this key complication of NF-1 has prompted this specific study.

Methods
The neuroradiological notes of 378 complex NF-1 patients were reviewed from 24 months of multidisciplinary team meetings (from Manchester which is one of the two specialist centres for complex NF-1 in the UK). Data relating to patients with dural ectasia and spinal deformity were obtained and statistically interpreted. The MRI films of all patients dural ectasia were reviewed and graded according to the severity. An attempt to establish a link between severity and concurrent deformity was made.

Results
Of these 378 patients, 38 (10.05%) were identified as having spinal dural ectasia and 103 (27.25%) of these patients were identified as having a spinal deformity of some degree. 90.91% of the patients with a major form of dural ectasia had a concurrent deformity whereas only 18.18% of patients with a minor form of dural ectasia had a concurrent deformity.

Conclusion
In conclusion, the more severe the dural ectasia, the greater the likelihood a concurrent spinal deformity will be present in patients with NF-1. The vertebral bodies and pedicles are more commonly involved than the posterior elements.

Reduced radiation protocol for O-arm navigation in paediatric deformity patients: a feasibility study

Saurabh Kapoor[1], Kenneth O'Dowd[1], Aaron Hilis[1], Nasir Quraishi[1]
[1]Queen's Medical Centre, Nottingham, UK

Introduction
O-arm assisted pedicle screw placement has been proven to be more accurate than freehand technique. Radiation exposure remains the primary drawback. We determined the feasibility and safety of a reduced radiation protocol in paediatric patients undergoing scoliosis correction.

Methods
A reduced radiation protocol for a Medtronic O-arm navigational system was devised. 3D CT reconstructions of an anthropomorphic pelvic phantom indicated adequate image quality after reduction to 20% of current manufacturer recommended factors devised by the Mayo Clinic. A feasibility study to test the image quality was undertaken on three patients, one with syndromic and two with idiopathic scoliosis each receiving reductions in radiation exposure to 60%, 50% and 40% of what would have been delivered using the Mayo Clinic protocol by reducing the X-ray tube current to 10mA while keeping the tube potential consistent with the Mayo clinic recommendations.

Results
A low dose O-arm protocol was able to generate adequate image quality while delivering as little as 40% of the recommended protocol radiation dose. The total radiation dose delivered with this protocol was approximately 0.77 milliSieverts (mSv), which includes a pre- and post-instrumentation spin. This effective dose represents <1/3 of average UK and <1/6 average US annual radiation exposure. There were no neurological or implant related complications.

Conclusion
Our low dose O-arm radiation protocol significantly reduces the radiation exposure compared to the Mayo Clinic protocol providing operational image quality to allow more accurate screw placement in deformed spines.

Transoral surgery for craniovertebral junction pathology in children: an institutional experience

Fahid Rasul[1], Zubair Tahir[1], Dominic Thompson[1]
[1]Great Ormond Street Hospital, London, UK

Aim
Indications for transoral surgery in the paediatric population are limited, however, patients with mass lesions or fixed deformity with ventral neural compression at the craniovertebral junction (CVJ)

may benefit from a transoral approach. Here the authors report their experience of transoral surgery in children.

Methods
Retrospective review of a prospectively collected electronic database included all patients who underwent transoral surgery at our unit. Indications for using the transoral approach were documented. Neurological function was measured using the Frankel grading system and pre- and postoperative measurements were analysed using the paired t-test.

Results
Thirty patients underwent 31 open transoral operations. Age range 1–15 years (median: 6 years), M:F=18:12. Twenty-six patients were under the age of 10 at time of surgery. The commonest indication for transoral surgery was a tumour (11 operations). Twenty-four patients also underwent posterior occipitocervical surgery. Complications included intraoperative CSF leak (three patients with chordoma) managed with temporary lumbar CSF diversion. Three patients died in the follow-up period, all these patients had malignant tumours. Post-operative neurological function showed significant improvement compared to pre-operative measures (two-tailed p-value=0.0003, 95% CI = -0.92 to -0.29) at a mean follow-up period of 11 years. 12 patients improved after surgery and no patient experienced neurological deterioration.

Conclusion
Open transoral surgery continues to have a role in selected cases of ventral compression at the CVJ. Operative and post-operative morbidity is comparable with adult series. Mortality reflects the underlying pathology. Occipitocervical fixation was required in 75% of operations, somewhat less than is reported in adult series.

Paper Session 4

TLICS—a useful decision making tool in non-expert hands? A pilot study

Sarah Barkley[1], Michael Athanassacopoulos[1], Neil Chiverton[1], James Tomlinson[1]
[1]*Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, UK*

Introduction
Fracture classification systems aim to standardise decision-making and optimise clinical care. Such decision-making aids are of greatest potential benefit to clinicians with the least frequent exposure to pathology. There are no published studies assessing the use of TLICS in non-expert hands.

Methods
Five consultant orthopaedic surgeons, none of whom were spine specialists, were asked to retrospectively review anonymised imaging of 25 trauma patients, and score their fractures using the TLICS scoring system. A reference group comprised three consultant spinal surgeons who also scored each case using TLICS. Inter-observer reliability was calculated using Fleiss-Kappa, and assessed against the Landis and Koch criteria. Suggested treatment by TLICS was compared to the actual treatment received in each case. Feedback on use of TLICS was obtained via a short questionnaire.

Results
TLICS score >4 (operative treatment) had inter-rater coefficient 0.75 (substantial agreement). TLICS score <4 (conservative treatment) had inter-rater coefficient 0.53 (moderate agreement), and score=4 (surgeon choice) coefficient=0.02 (slight agreement). Ten patients were managed operatively (88% accuracy) and 15 patients were managed conservatively (92% accuracy).

Conclusion
TLICS has moderate to substantial reliability when used in non-expert hands, although reliability for TLICS=4 was only slight. These results are comparable to published studies with expert spinal surgeons. This novel pilot study shows the TLICS tool can be used in non-expert hands as a decision making aid. There is a strong case for wider scale evaluation of TLICS use in non-expert hands.

Injury: a perceived cause of spinal pain

Sheweidin Aziz[1], Martyn Newey[1]
[1]*University Hospitals of Leicester NHS Trust, Leicester, UK*

Introduction
The role of injury as a cause of chronic spinal pain remains controversial, and disagreements that arise fuel the medico-legal industry. It was argued that simple backache might be due to more minor injuries to the spine or to cumulative trauma.

Aim
Investigate differences in patient-reported outcome measure scores between patients with and without a previous injury.

Methods
New patients attending a spinal clinic were asked to complete a standard spinal questionnaire as part of their assessment—including VAS for back and leg pain, the ODI, Zung Depressions and Somatisation scores.

Results
A total of 211 patients were included with 157 reporting back pain (mean age 51 years) and 54 reporting neck pain (mean age 48 years). Twenty-three per cent of patients reported symptoms starting after an injury (24.2% in the back pain group and 20.4% in the neck pain group). The VAS for back and leg pain, the ODI, Zung Depressions and Somatisation scores questionnaire scores were consistently lower in the injury reporting group of patients. When analysing the eight domains in the SF-36 Quality of Life questionnaire; patients with injury reported lower scores

throughout. General health, physical functioning and Role-Emotional all reached statistical significance (p<0.05).

Conclusion

This study has shown that being a victim of an injury certainly has a role in the perception of spinal pain. Patient education and awareness of this is vital at the first point of contact when patients first present following a spinal injury to reduce the incidence.

SpineJack system vs. conservative orthopaedic management in acute traumatic type A1 and A3.1 VCF: prospective multicentre randomised study interim results

Olivier Gille[1], Jean-Marc Vital[1], Mourad Ould Slimane[2], Emmanuel Foulongne[2], Antoine Petit[3], Alexandre Simon[4], Jean-Marc Kaya[5], Jonathan Lebhar[6], Michael Grelat[7], Cristian Vasile[8], Philippe Bacon[9], David Noriega[10]

[1]Hôpital Pellegrin, France [2]CHU de Rouen, Hôpital Charles Nicolle, France [3]Hôpital Jean Minjoz, France [4]CHU Brest Cavale Blanche, France [5]AP-HM Hôpital Nord, France [6]CHU Rennes Pontchaillou, France [7]Hôpital François Mitterrand, France [8]Centre Hospitalier de Chambéry, France [9]CH Saint Grégoire, France [10]University Hospital Valladolid, Spain

Aim

Traumatic thoracolumbar fractures are treated either with conservative orthopaedic management (bracing), open surgery, or vertebral augmentation procedures. This study aimed to compare SpineJack with bracing in acute, stable, traumatic type A1 and A3.1 vertebral fractures.

Methods

Ninety-six patients (63.5% male; 44.0±12.2 years old) with one or two acute, painful fractures were randomised to SJ (n=49) or bracing (n=47). Clinical, radiological, and medico-economic endpoints were assessed pre-operatively, at five days, one, three, 12, and 24 months post-surgery.

Results

In the first 52 consecutive patients with a 12-month follow up, improvements in mean VAS back pain score and ODI score occurred with both procedures without significant between-group differences. Kyphotic angle reduction was significantly more marked with SpineJack at day five (-9.1 degrees±5.4 degrees vs. -1.5 degrees±5.0 degrees; p<.001), one month (-7.7 degrees±5.4 degrees vs. -0.5 degrees 5.9 degrees; p<.001), and three months (-4.5 degrees 14.1 degrees; p=0.004). Over the first-year post-surgery, correction of regional traumatic angle was seen with the SpineJack only (-1.9 degrees±10.7 degrees vs. 5.6 degrees±9.2 degrees at 12 months; p=0.025). Hospital stay was significantly shorter with SpineJack (4.6±4.1 vs. 5.6±1.9 days; p<.001). At three months, complete brace removal was done in 46.7% of patients; 11 patients from the SpineJack group (22.5%) and three from Brace (6.4%) returned to work. Adverse events were more frequent after conservative treatment (36.2% vs 26.5% of patients). No adverse device effects were recorded with SpineJack.

Conclusion

This interim analysis showed that the evolution of outcomes of interest (radiological endpoints, length of hospitalisation, time to return to work) was in favour of the SpineJack procedure.

A validation of the OSRI (Oswestry Spinal Risk Index) for metastatic spinal disease

Elizabeth Hodges[1], Abdul Moideen[2], Sanjit Singh[2], Sashin Ahuja[2]

[1]Cardiff University Medical School, Cardiff, UK [2]Welsh Centre for Spinal Surgery & Trauma, University Hospital of Wales, Cardiff, UK

Introduction

Various scoring systems are available to aid the management of metastatic spinal disease by predicting the survivorship of patients who present in this way. The Oswestry Spinal Risk Index (OSRI) is an elegant yet simple method to calculate survivorship without the delay of extensive investigations.

Aim

The aim of this study is to perform an external validation of the OSRI and assess its accuracy at predicting survivorship in patients with spinal metastases (SM).

Methods

The cohort includes 28 consecutive patients presenting to the local cancer centre with various primary cancers, diagnosed with spinal metastases. Patients' general condition and primary tumour site were used to calculate their OSRI (OSRI=Primary Tumour Pathology + (2–General Condition score)). Their survival times were compared to their predicted survival times for each subgroup of OSRI score. These were then plotted on a survival curve to illustrate the results.

Results

Overall median survival times of patients closely matched predicted survival times set out in the original study which devised the OSRI. Spearman's Rank Correlation showed a strong correlation between the actual survival of patients in this study and the predicted survival set out in the original study (p=0.037 and rs=0.900). Lower OSRI scores correlated with longer survival times, and vice versa.

Conclusion

The OSRI is a valid and easily accessible scoring system for predicting survivorship in patients with spinal metastases. The results replicate those achieved in previous validations, supporting its effectiveness as a predicting tool.

Bilateral recurrent laryngeal nerve palsy following anterior cervical surgery on the background of apical lung radiotherapy

Timothy Woodacre[1], Nooshin Jahromi[1], David Dillon[1], Edward Baddour[1], Thomas Clifton[1], Peter Woodland[1], Simon Mahoney[1]
[1]*Royal Perth Hospital, Perth, Australia*

Introduction
Unilateral recurrent laryngeal nerve palsy is a recognised potential complication of anterior cervical surgery and a rare but potential complication of radiotherapy to the neck. Only one case has been documented following radiotherapy for an apical lung cancer.

Case
We report a case of immediate stridor and bilateral vocal cord paralysis following a right-sided anterior cervical approach and C5/6 ACDF for trauma. The suspected diagnosis was acute post-operative right recurrent laryngeal nerve palsy on the background of pre-existing, undetected and asymptomatic left recurrent laryngeal nerve palsy following radiotherapy for left apical lung cancer.

Outcome
The consequences were significant, including Takotsubo cardiomyopathy and subsequent tracheostomy.

Discussion
The possibility of recurrent laryngeal nerve palsy should be considered in patients with previous apical lung cancer and/or radiotherapy. Patients undergoing subsequent anterior cervical surgery should be considered for the appropriate precautions in the form of same-side surgery or pre-operative investigation of vocal cord function.

Adverse events in en bloc resection in spine tumours

Shreya Srinivas[1], Raphaele Charest-Morin[2], Charles Fisher[2], Tamir Ailon[2], Marcel Dvorak[2], Brian Kwon[2], Scott Paquette[2], John Street[2], Michael Boyd[2], Nicolas Dea[2]
[1]*Alder Hey Children's Hospital NHS Trust, Liverpool, UK* [2]*Vancouver General Hospital, Vancouver, Canada*

Introduction
En bloc resection is uncommonly performed around the spine and this study aims to determine adverse event (AE) profile in those undergoing en bloc resection for primary or metastatic spine bony tumours.

Methods
This is a prospective cohort study in a quaternary care centre of consecutive patients (Jan 2009–July 2017) who underwent en bloc resection for primary or metastatic spine bony tumours. We collected patient demographics, primary tumour histology, neurological status, surgical intervention details, marginal status, Enneking appropriateness in addition to all AE according to a standardised form (Spine AdVerse Events Severity System, [SAVES Version 2]).

Results
One-hundred-and-seven patients (64 female, 40 male, median age 51 years, 110 procedures) with primary bone tumor (92) and metastatic lesions (15) were included. Eighty patients (70.6%) had at least one AE with nil 30-day mortality. Intraoperative AEs (27.7%) were commonly massive blood loss (23%), dural tear (19.5%), visceral or neurovascular injury (20.7%). Post operative AE (65.5%) was due to systemic infection (39.5%); cardiac event (35.5%); delirium (23.6%) and thromboembolic events (10.5%). Postoperative AE occurrence increased length of stay. Risk factors included female gender, malignant subtype, staged procedure and EI resection margin. Wound-related complications (22.4%) were higher in lesions around occiput or sacrum (64%) than mobile spine (10%).

Conclusion
En bloc resection in spine is associated with high incidence of AE and should be confronted to the curative intent of the procedure. A better understanding of AE profile will benefit the surgeon/oncologist in developing preventative strategies.

Characteristics of spinal pathology in patients with neurofibromatosis type 1 (NF1): a systematic review

Midhun Mohan[1], Mueez Waqar[1], Joshi George[1]
[1]*Department of Neurosurgery, Salford Royal NHS Foundation Trust, Salford, UK*

Introduction
Spinal pathology is common in patients with NF1. Existing studies have not yet comprehensively described the spectrum of spinal pathology that can arise. The aim of this systematic review was to describe the characteristics of reported spinal pathology in NF1 patients.

Methods
This systematic review was conducted as per PRISMA guidelines and registered on the PROSPERO database of systematic reviews. Systematic searches were performed on a range of databases. Studies with n>1 describing any spinal abnormality in NF1 patients were included. Each pathology was described with a rate: number of positive cases/total number of cases evaluated for pathology.

Results
Twenty-three studies were included from 1,253 unique results. The evidence levels were as follows: I (n = 1), II (n = 2) and IV (n = 19). Data were available in 1,809 patients with a mean age of 22.5 years and equal gender distribution (49.3% male). Reported spinal pathology included: dural ectasia–93/290 (32.1%); scoliosis:

326/748 (43.6%); meningocele: 5/31 (16.1%); syrinx: 10/97 (10%); cord signal abnormalities in the absence of tumour compression: 33/97 (34%); intramedullary tumour: 7/82 (8.5%): spinal nerve root tumour: 276/1,350 (20.4%); and spinal plexiform tumour: 167/364 (45.9%).

Conclusion

Spinal pathology is common in patients with NF1 though existing literature is heterogeneous in how findings are presented. Most existing studies are of low quality. There is a need for more prospective studies on this theme to aid the establishment of a core outcome set for spinal disease in NF1 patients.

The management of type 2 odontoid fractures in Western Australia

Timothy Woodacre[1], James Larkin[1], Peter Woodland[1], Edward Baddour[1], Eammon McCloskey[1], David Dillon[1]
[1]Royal Perth Hospital, Perth, Australia

Introduction

The management of type 2 odontoid fractures remains controversial. Both operative and non-operative intervention is advocated. Current evidence for best practice is derived from relatively small cohort studies. We assessed patient outcome following management of type 2 odontoid fractures in Western Australia.

Methods

A retrospective cohort study was conducted of all consecutive patients with a type 2 odontoid fracture managed by the Western Australia State Spinal Unit at the Royal Perth Hospital between 1 January 2009 and 31 December 2014. Minimum follow up was 12 months with radiographs performed at three, six and 12 months. A Neck Disability Index score was calculated at a minimum 12 months post injury.

Results

Three-hundred-and-ninety-three consecutive patients with type 2 odontoid peg fractures were managed. Age range 14–105. Forty-three died during follow up (equal to the age-matched death rates in Western Australia). All were initially managed non-operatively in a Halo-vest (n=102, younger cohort) or short cervical orthosis (n=291). 99% (n=390) were successfully managed non-operatively: 59% (n=232) achieved bony union, 40% (n=158) achieved a stable fibrous non-union and all 390 demonstrated low NDI scores at 12 months of injury. One patient (0.25%) deteriorated neurologically requiring operative intervention. Two patients (0.5%) underwent operative intervention for persistent pain with mild instability.

Conclusion

Our study demonstrates that type 2 odontoid peg fractures can be managed safely without surgery, with stable radiological and good clinical outcomes. This is the largest consecutive series of non-operatively treated patients in the world and we believe this study provides practice changing evidence.

Paper Session 5

Long-term safety and clinical performance of kyphoplasty and SpineJack procedures in the treatment of osteoporotic vertebral compression fractures

David Noriega[1], Ruben Hernandez Ramajo[1], Israel Sanchez Lite[1], Borja Toribio[1], Francisco Ardura[1]
[1]University Hospital Valladolid, Valladolid, Spain

Aim

Patient follow up rarely exceed two years in trials comparing vertebral augmentation procedures for the treatment of painful osteoporotic vertebral compression fractures (VCFs). This pilot, investigator-initiated, prospective study aimed to compare long-term results of SpineJack (SJ) and balloon kyphoplasty (BKP).

Methods

Thirty patients (80.0% female; 68.1±5.3 years old) were randomised to SJ (n=15) or BKP (n=15). Clinical endpoints were analgesic consumption, back pain intensity (Visual Analogue Scale), Oswestry Disability Index (ODI), and quality of life (EQ-VAS score). They were recorded pre-operatively, at five days (except EQ-VAS), one, three, six,12 and 36 months post-surgery. Spine X-rays were taken 48 hours prior to procedure and five days, six,12 and 36 months after.

Results

Clinical improvements were observed with both procedures over the three-year period without significant inter-group differences, but the final mean EQ-5D index score was significantly in favour of the SJ group (14.4±7.2 vs. 25.0±9.0, p=0.002 and 0.93±0.11 vs. 0.81±0.09; p=0.007). Vertebral height restoration/kyphotic correction was still evident at 36 months with a greater mean correction of anterior (10±13% vs. 2±8% for BKP, p=0.007) and central height (10±11% vs. 3±7% for BKP, p=0.034) and a larger correction of the vertebral body angle (-5.0 degrees ± 5.1 degrees vs 0.4 degrees ± 3.4 degrees; p=0.003) for SJ group.

Conclusion

Both techniques displayed very good long-term clinical efficiency and safety in patients with osteoporotic VCFs. Over the three-year follow-up, vertebral body height restoration/kyphosis correction was better with the SJ procedure.

Computer-assisted pedicle screws using intraoperative cone beam CT—a cost-effectiveness study

Anisa Tariq[1], Anjum Qureshi[2], Yu Chao Lee[2], Robert Lee[2]
[1]University College London, London, UK [2]Royal National Orthopaedic Hospital, Stanmore, UK

Pedicle screw malposition may lead to adverse events with increased length of stay and further revision surgeries. Computer-assisted surgery (CAS) improves screw placement accuracy rates. However, this technology is expensive with substantial acquisition and maintenance costs. This study evaluates the cost of revision surgery from symptomatic pedicle screws malposition to justify whether the medical equipment costs justify the expected benefits.

This is an observational study of consecutive patients treated with the aid of computer-assisted surgery (CAS) compared with patients treated with freehand pedicle screw at our institution over four years. The increased costs associated with symptomatic pedicle screw malposition were calculated using the following parameters from both groups: increased length of stay, cost of increased theatre and anaesthetic time, cost of revision surgery and extra outpatient appointments.

A total of 43 patients had screws malposition and 21 patients were symptomatic requiring revision surgery. Financial data were available in 19 patients. None of these patients had CAS. Screw malposition in these 19 patients accounted for an extra 324 bed days costing £88,524. The cost of revision surgery (not taking into account implant costs) was in excess of £50,000. The total extra annual spend was £205,800.

When compared to the costs of the navigation hardware and software, there is a potential saving of £75,000 per year. In conclusion, CAS reduces re-operation rates for symptomatic screw malposition and is cost-effective in high volume centres with significant healthcare savings.

Core outcome set for cauda equina syndrome: international delphi survey and consensus meeting

Nisaharan Srikandarajah[1], Simon Clark[1], Martin Wilby[1], Adam Noble[2], Paula Williamson[2], Tony Marson[2]
[1]The Walton Centre, Liverpool, UK [2]University of Liverpool, Liverpool, UK

Introduction
A core outcome set (COS) is the minimum set of outcomes that should be researched in any future research study within a specific disease area. Through a published systematic literature review we have shown there are significant differences in the reporting of the outcomes for cauda equina syndrome (CES). We intended to develop a COS for patients with CES to be used for future research studies, officially registered on the COMET database.

Methods
Outcomes were combined from the systematic literature review and from the semi-structured qualitative interviews with CES patients. These were grouped into a shortened list for rating through two rounds of an international Delphi survey. An international consensus meeting would discuss the "no consensus" outcomes and decide the final core outcome set. Ethical approval for the study was granted.

Results
Nine-hundred-and-ninety-seven verbatim outcome terms from the systematic literature review and patient interviews were reduced by the study team to 37 outcomes for rating in the Delphi survey. The Delphi had 172 participants (104 patients, 68 healthcare professionals) complete two rounds of the Delphi. The results were discussed at an international consensus meeting attended by 34 key stakeholders (16 patients and 18 healthcare professionals). 16 outcomes were decided for inclusion in the core outcome set.

Conclusion
The core outcome set has been decided through a transparent international consensus process involving healthcare professionals and patients as key stakeholders. These are recommended to be used in future CES studies as the minimum set of outcomes to be collected.

Preliminary analysis of fluoroscopically inserted pedicle screws in thoracolumbar fractures vs. robotic assisted pedicle screws in 3D printed fracture models

Ahmed-Ramadan Sadek[1], Roozbeh Shafafy[1], Alex Carr[1], Alex Alamri[1], Jonathan Bull[1], Suresh Pushpananthan[1], Rajesh Mangattil[1], Fady Sedra[1], Syed Aftab[1], Arun Ranganathan[1], Alexander Montgomery[1]
[1]Department of Spinal Surgery, Barts Health NHS Trust, London, UK

Introduction
With the emergence of three-dimensional (3D) printing and advancement in robotic assisted surgery the placement of pedicle screws in the stabilisation of the spine following trauma is likely to evolve. Early adoption of these rapidly advancing technologies is essential to guarantee assimilation into surgical practice and subsequent potential improvement in operative outcomes.

Design
Proof of concept study investigating the use of robotic assisted pedicle screw insertion in 3D models of thoracolumbar fractures at a single centre.

Aim
Evaluate whether robot assisted pedicle screws inserted in replica 3D printed thoracolumbar fractures heralds better or comparable screw placement to freehand fluoroscopically guided screws.

Methods
Twelve models were printed using an Axial 3D device. Operative planning was performed using the Brainlab navigation system. The Cirq robot arm was used for pedicle screw insertion into 3D fracture model replicas.

Results
A total of 12 pre-operative 3D models of thoracolumbar fractures were printed (six lumbar and six thoracic). Utilisation of both navigation and robotic assistance facilitated at least comparable pedicle screw position relative to those inserted percutaneously under fluoroscopic guidance. Minimal displacement was observed within the pedicle.

Conclusion
The adoption of navigation guided robotic arms for the insertion of pedicle screws is as effective as freehand fluoroscopically guided insertion. 3D fracture models can be used to optimise pre-operative planning. The combination of both technologies may be utilised to trial surgical strategies without posing risk to the patient. Robotic assistance in the management of spinal cases will result in a paradigm shift in planning and execution of operations.

Combined scoliosis correction and selective dorsal rhizotomy for neuromuscular scoliosis

Daniel D'Aquino[1], Oded Hershvovich[1], Aaron Hilis[1], Darko Stipic[1], Michael Vloeberghs[2], Masood Shafafy[1]
[1]Centre for Spinal Studies and Surgery, Queen's Medical Centre, Nottingham, UK [2]Department of Neurosurgery, Queen's Medical Centre, Nottingham, UK

Introduction
There is growing evidence in the literature recognising selective dorsal rhizotomy (SDR) as an effective treatment option for the management of spasticity. Although the mechanisms are not clearly understood, SDR has been shown to relieve limb and truncal spasticity in a manner comparable—and perhaps even superior—to oral and intrathecal baclofen (ITB). We present a case series of four children with neuromuscular scoliosis managed in a manner not previously reported. In all instances, there were coincident treatment goals of managing spinal deformity and severe spasticity.

Methods
Scoliosis correction and selective dorsal rhizotomy (SDR) were performed in a combined procedure. Through a common exposure, laminectomy and SDR at the level of the conus was performed followed by instrumentation and correction. Other than additional time of 1–2 hours required of an SDR, no adjustments to the preparation, intra-operative setup or post-operative scoliosis protocol were required.

Results
Mean age was 13.5 (range 8–19) with a mean pre-operative Cobb angle of 76 degrees (range 62–86). All patients were of Gross Motor Function Classification System (GMFCS) levels 4–5. There were no complications from the scoliosis or SDR procedures. The mean postoperative stay (seven days). SDR conferred no additional bedrest or mobilization restrictions. A mean correction of 54 degrees (range 44–62) was achieved. At up to four-year follow up, sitting balance and costo-pelvic impingement improvement were reported, a significant and durable improvement in limb spasticity (Ashworth score reduction of at least 2 points).

Conclusion
This series illustrates the benefit of a combined procedure to correct deformity and manage spasticity.

Bedding in of intervertebral fusion cages vs. subsidence: can acoustic emission help us?

John Afolayan[1,2], John McCrory[1], Davide Crivelli[1], Rhys Pullin[1], Sam Evans[1], Sashin Ahuja[3]
[1]Cardiff University School of Engineering, Cardiff, UK [2]Trauma & Orthopaedic, Kent, Surrey and Sussex Deanery, UK [3]University Hospital of Wales, Cardiff, UK

Introduction
Differentiating the expected initial settling in/bedding-in (BI) of Intervertebral Fusion Cages (IFCs) from unwanted endplate failure is challenging.

Aim
To use acoustic emission technology to better understand the real-time IFC/endplate response to compressive loading and try to identify the BI point.

Methods
A rectangular highly porous metallic cage was compressed within sections of Sawbones blocks. AE sensors were secured to each Sawbones block. Load-displacement data and AE data was captured from the cephalad and caudad block. The process was repeated four times for two different block densities.

Results
Analysis was focused between 2mm (potential bedding-in point) and 6mm (significant subsidence). At 2mm displacement, mean loads were 1200N and 2500N with the 15PCF (0.24cm^3) and 20PCF (0.32cm^3) blocks respectively. AE events noticeably started around 2mm and were less in the denser block. An additional 500N and 600N was required for 6mm displacement in the 15PCF and 20PCF blocks respectively (comparatively, *in vivo* studies reported spinal segmental forces up to 1650N in activities of daily life). AE events were significantly increased at 6mm of displacement and

this was more apparent in the less dense block. Just after 2mm of displacement there is a significant increase in the cumulative energy graph tracing.

Conclusion
Observed significant increase in cumulative energy after 2mm displacement suggests end of bedding-in phase and beginning of true endplate failure. This is supported by the load-displacement data. Further study of this field could lead to improved instrumentation and techniques that will optimise IFC/endplate contact whilst limiting iatrogenic damage.

Square pegs and round roles—do we fully understand endplate morphology?

John Afolayan[1,2], John McCrory[1], Davide Crivelli[1], Rhys Pullin[1], Sam Evans[1], Sashin Ahuja[3]
[1]Cardiff University School of Engineering, Cardiff, UK [2]Trauma & Orthopaedic, Kent, Surrey and Sussex Deanery, UK [3]University Hospital of Wales, Cardiff, UK

Introduction
Posterior Intervertebral Fusion Cages (IFCs) are made from diverse materials and range in design including cylindrical, boxed, rectangular, banana/curved, biconvex, bullet and anatomical shapes. Common complications include non-union and IFC subsidence. Whilst such complications are multifactorial, the IFC/endplate interface and contact surface area may contribute. Few studies have tried to define the morphology of the weight-bearing vertebrae endplates.

Aim
The aim of this study is to use modern imaging techniques to analyse the three-dimensional morphology of human vertebrae endplate.

Methods
A high-resolution three-dimensional scanner (Artec Spider) based on blue light technology was used to scan 10 randomly selected dry disarticulated lumbar vertebrae bones. Each vertebra was placed on a rotating platform and scanned from four different perspectives. A post scan processing software (Artec Studio 12) was used to digitally process each group of four images to produce anatomically accurate three-dimensional images. The superior and interior endplates of each vertebrae were further analysed.

Results
There is a consistent difference in the morphology of a lumbar vertebrae superior and inferior endplate. The superior endplate is consistently flat and occasional convex. The inferior endplate is consistently concave with a lipped periphery rim and a posterior slope. Furthermore, there is an average centre-edge depression of 2mm. Most commercial cages do not account for these variables.

Conclusion
Failure to appreciate the morphological subtlties of the endplates may be contributing to non-union (poor IFC/endplate contact) and subsidence (point loading leading to fracture). Further studies to further analyse endplate morphology are encouraged to optimised IFC design.

Can radiological findings predict the outcome of spinal cord injury?

Aaron Hilis[1], Daniel D'Aquino[1], Amer Eisa[2], Nasir Quraishi[1]
[1]Centre for Spinal Studies and Surgery, Queen's Medical Centre, Nottingham, UK [2]Department of Orthopedic Surgery, Assiut University Hospital, Assiut University, Assiut, Egypt

Introduction
Systematic review and meta-analysis of studies exploring the predictive role of acute Magnetic Resonance Imaging (MRI) findings with neurological outcome following spinal cord injury (SCI).

Aim
To evaluate whether quantitative or qualitative features on MRI performed acutely following traumatic cervical SCI correlate with neurological status or carry predictive value for long-term outcome.

Methods
Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, 15 studies exploring the relationship between radiological findings and neurological outcome following SCI were identified from the literature. Following review and author consensus, seven studies met inclusion criteria for the study.

Results
Cord oedema without haemorrhage was the most common MRI abnormality (45%) followed by intramedually cord haemorrhage (26%), epidural haematoma (6%). The cord appeared normal in 23% of SCI cases. The majority of MRI findings correlated well with clinical stratification of the patient according to the American Spinal Injuries Association (ASIA) impairment scale. The size of cord haemorrhage and associated cord oedema corresponded with a more severe ASIA impairment scale and poor recovery at follow up. While severity of cord compression was also associated with poor neurological outcome, it was not statistically significant.

Conclusion
There is a strong correlation between MRI appearances of traumatic spinal cord injuries in the acute phase and long-term prognosis and recovery.

Paper Session 6

Evaluation of nationwide referral pathways, investigation and treatment of suspected cauda equina syndrome in the United Kingdom

Daniel Fountain[1], Simon Davies[2], Julie Woodfield[3], Mohammed Kamel[4], Paulina Majewska[5], Ellie Edlmann[6], Aimun Jamjoom[7], Ingrid Hoeritzauer[8], Mueez Waqar[9], Dominic Mahoney[10], Dillon Vyas[11], Moritz Schramm[12], Georgios Solomou[13], Francesca Dawkes[14], Heidi Grant[15], Jonathan Attwood[16], Alexandros Boukas[16], Dominic Ballard[17], Emma Toman[18], Matthew Sanders[19], John Lawrence[20], Beverly Cheserem[21], Saurabh Sinha[22], Patrick Statham[3]

[1]Neurology and Neurosurgery Interest Group, Society of British Neurological Surgeons, UK [2]Barts Health NHS Trust, London, UK [3]Department of Clinical Neurosciences, NHS Lothian, Edinburgh, UK [4]Nottingham University Hospitals Foundation Trust, Nottingham, UK [5]Queen's Hospital, Romford, UK [6]Academic Division of Neurosurgery, Cambridge, UK [7]Department of Clinical Neuroscience, Western General Hospital, Edinburgh, UK [8]Centre for Clinical Brain Sciences, University of Edinburgh, Edinburgh, UK [9]Division of Academic Neurosurgery, Manchester Academic Health Sciences Centre, University of Manchester, Manchester, UK [10]University of Bristol, Bristol, UK [11]University of Leeds, Leeds, UK [12]Leeds General Infirmary, Leeds, UK [13]Keele University Medical School, Stoke-on-Trent, UK [14]University of Leicester, Leicester, UK [15]Brighton and Sussex Medical School, Brighton, UK [16]Oxford University Hospitals NHS Foundation Trust, Oxford, UK [17]King's College Hospital NHS Foundation Trust, London, UK [18]Department of Neurosurgery, Queen Elizabeth Hospital, Birmingham, UK [19]Sheffield Teaching Hospitals, Royal Hallamshire Hospital, Sheffield, UK [20]Cambridge University Hospitals NHS Foundation Trust, Cambridge, UK [21]Brighton and Sussex University Hospital, Brighton, UK [22]Sheffield Teaching Hospitals, Sheffield, UK

Introduction

Cauda equina syndrome (CES) is a spinal emergency with clinical symptoms and signs that have low diagnostic accuracy. National guidelines in the United Kingdom (UK) state that all patients should undergo an MRI prior to referral to specialist spinal units and surgery, if required, should be performed at the earliest opportunity. We aimed to evaluate the current practice of investigating and treating suspected CES in the UK.

Methods

A retrospective, multicentre observational study of the investigation and management of patients with suspected CES was conducted across the UK, including all patients referred to a spinal unit over six months between 1 October 2016 and 31 March 2017.

Results

A total of 28 UK spinal units submitted data on 4,441 referrals. Over half of referrals were made without any previous imaging (n=2,572, 57.9%). The majority of referrals were made out-of-hours (n=2,229/3,517, 63.4%), of which 2.9% (n=45/1,529) underwent surgical decompression. Patient location and pre-referral imaging were not significantly associated with time intervals from symptom onset or presentation to decompression. Patients investigated outside of the spinal unit experienced significantly longer time intervals from presentation and from referral to undergoing the MRI scan.

Conclusion

This is the largest known study of the investigation and management of suspected CES. We found that the majority of referrals were made without adequate investigations. Most patients were referred out-of-hours and many were transferred for an MRI without subsequently requiring surgery. Cases not transferred experienced delays if undergoing an MRI scan outside of the spinal unit.

Blood transfusion in elective spinal surgery: is it the time to change our practice?

K H Sunil Kumar[1], Kanishka Wattage[1], David Cumming[1], Robert Lovell[1], Shaishav Bhagat[1], Alister Hudd[1], Saajid Kaleel[1]

[1]Ipswich Hospital, Ipswich, UK

Introduction

Blood transfusion has a potential for transmission of infection in addition to the cost associated with it. The aim of this audit was to evaluate the need for blood transfusion following elective spinal surgery and also look at which procedures were at risk for potentially needing blood transfusion.

Methods

There were 633 major spinal surgery cases performed between January 2017 and July 2017. Sixty-one emergency cases were excluded leaving a total of 572 elective cases for analysis. We identified all the cross-match requests and the actual transfusions from the blood transfusion department database.

Results

There were 22 transfusion requests but only 15 patients underwent blood transfusion. None of the patients who underwent single-level lumbar discectomy or decompression and ACDF (328/572 =57.7%) required any blood transfusion. The current cost for a Group and Save (G&S) request=£19.60 and that of cross-match=£38.79. This meant a potential saving of £6,468 (330x£19.60) during the study period and approximately £11,088 over a year.

Conclusion

Our study showed that there was no need for blood transfusion in patients undergoing ACDF, single-level posterior lumbar discectomy or decompression. The potential cost saving was identified and departmental policy was changed to only one G&S sample for the above procedure. In the current NHS such

Cost Improvement Programmes (CIPs) are essential to ensure that savings are made in order to have funds available for other resources, which would potentially help with improved patient care.

Malpractice litigation and spinal surgery in the National Health Service: a single-centre perspective over 12 years

Daniel D'Aquino[1], Aaron Hilis[2], Tim Hammett[3], Khalid Salem[2], Nasir Quraishi[1]
[1]Centre for Spinal Studies and Surgery, Queen's Medical Centre, Nottingham, UK [2]The Centre for Spinal Studies and Surgery, Nottingham University Hospitals NHS Trust, Nottingham, UK [3]Department of Neurosurgery, Queen's Medical Centre, Nottingham, UK

Aim
To evaluate the incidence and burden of successful litigation relating to the management of spinal disorders within a National Health Service (NHS) tertiary-level spinal unit.

Methods
A retrospective review of the Nottingham University Hospitals NHS Trust litigation database, retrieving all closed claims relating to the spinal unit's management of spinal disorders between January 2006 and July 2018—a total of 65 claims.

Results
The vast majority of claims over the last 12 years were ultimately withdrawn without incurring cost to the trust (n=46; 70%). Only 19 of the 65 total claims (30%) resulted in successful litigation. In three instances, the costs incurred and sums paid to claimants were undisclosed. In the remaining 16 cases, the value of claims totalled £6.2 million—comprising £4.2 million in damages and £2 million in legal costs (29% relating to NHS legal costs, the remainder claimant costs). The majority of successful litigation related to claims of poor or unacceptable surgical outcomes (n=15). With over 12,000 spinal procedures recorded by the department over the equivalent period, this represents approximately one in 800 cases resulting in a successful claim. A significant proportion of the overall litigation burden also related to a perceived delay in management at a cost to the trust of £1.6 million.

Conclusion
Despite the majority of claims ultimately being withdrawn, spinal litigation remains a source of significant burden to the NHS as reflected in the sizeable costs involved. Furthermore, the high legal costs associated with these claims reflect the complexity of resolving these cases.

Consenting for major vascular injury during lumbar microdiscectomy and interbody fusion following the recent BASS/SBNS statement.

Wassim Merzougui[1], Samuel Hall[1], Alexander Dando[1], Ahmed-Ramadan Sadek[1], Nicholas Brooke[1], Emad Shenouda[1], Colin Griffith[1], Chris Dare[2], Evan Davies[2], Steve McGillion[2], Ali Nader-Sepahi[1]
[1]Wessex Neurological Centre, Southampton, UK [2]Department of Orthopaedics, University Hospitals Southampton, Southampton, UK

Introduction
The risk of a major vascular injury during a lumbar microdiscectomy is approximately 1 in 4,000. The Society of British Neurosurgeons and the British Association of Spinal Surgeons recommend that all patients having a lumbar microdiscectomy are consented for the risk of major vascular injury. The aim of this study was to determine the consenting practice of a tertiary spinal service for procedures incorporating a lumbar discectomy.

Methods
A retrospective audit was conducted on all patients who underwent either lumbar microdiscectomy or posterior/transforaminal lumbar interbody fusion between January 2016–October 2018. Patients were identified from theatre logbooks and case notes were reviewed for demographics, symptoms, consent form details and complications.

Results
Two-hundred-and-twenty-two operations with available consent forms were identified during the study period. Two out of the 80 (2.5%) consent forms for microdiscectomy completed before the BASS statement (31 July 2017) referenced major vessel injury. This rose significantly to 31 out of 101 (30.7%) consent forms after the statement ($p<0.0001$). Of the 14 interbody fusions before the statement, two (14.3%) were consented for vascular injury which was not significantly different than the six out of 29 (20.7%) after the statement.

Conclusion
The number of consent forms for microdiscectomy documenting major vascular injury rose significantly after 31 July 2017 although it remains the minority of consent forms. Despite the same surgical step being incorporated in lumbar interbody fusion the change in consenting practice has not been adopted for this procedure.

AP or PA lumbar spine radiograph (APPAL) study

Chris Green[1], Ashok Subramanian[1], Guru Karnati[1]
[1]*Musgrove Park Hospital, Taunton, UK*

Introduction
Traditionally lumbar spine X-rays are performed as AP view. There are evidences from phantom studies of up to 53% effective dose reduction when lumbar spine radiographs are acquired PA instead of AP. Since November 2017 we acquired all standing lumbar spine radiographs as PA. The aim of this study was to locally evaluate dose and image quality both before and after the change in practice and survey current national practice.

Methods
Eighty outpatients between 60–100kg having a standing lumbar spine radiograph (40 AP; 40 PA) had their Dose Area Product (μGym^2) recorded at a constant KV (80mV) and Focus Film Distance (110cm). Effective dose (mSv) was calculated using PCXMC software. Each blinded radiograph was scored by two consultants against an optimal reference image using the European Guidelines criteria. The data were analysed using Mann-Whitney-U tests and linear regression. Eighty radiologists nationally were sent an anonymous survey to establish their current practice.

Results
A lumbar spine radiograph acquired PA instead of AP reduced effective dose by 41% ($p<0.001$) with no difference in image quality ($p=0.9$). Twenty-six radiologists completed the survey (32% response); only one NHS Trust is currently using PA.

Conclusion
Standing PA lumbar spine radiograph reduces patient's radiation risk significantly without affecting the image quality, acquisition time and investigation cost. Majority of NHS Trusts nationally are still performing this investigation AP and it's time to standardise to PA with its associated benefits.

Surgical Outcome Risk Tool (SORT) validation in spinal surgery.

Antonia Isaacson[1], Vinay Jasani[1], Edward Kim[1], Younus Hanif[1]
[1]*University Hospital of North Midlands, Stoke-on-Trent, UK*

The Surgical Outcome Risk Tool (SORT) is a risk prediction scoring system developed to assess the risk of 30-day postoperative mortality. It has been validated in UK patients undergoing inpatient non-cardiac, non-neurological surgery. SORT uses simple, easily available variables that do not require extensive laboratory data or radiological results for its calculation and is therefore felt to be ideal for use during pre-operative assessment and assist in the consenting process.

The aim of this study is to validate SORT in a population of patients undergoing spinal surgery at a tertiary spinal centre. One-hundred-and-forty-two patients underwent spinal surgery between 1 June 2018 and 27 September 2018. Patient data for all six SORT variables were collected retrospectively. The SORT variables include: Patient age and ASA physical status, urgency of surgery (NCEPOD classification), severity of surgery (all "Xmajor/complex"), risk of surgery ("thoracic, gastrointestinal or vascular surgery") and presence of cancer (last five years). The SORT value was then calculated together with the observed 30-day 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. An AUROC of 0.5=no better than chance, >0.9=good accuracy.

A comparison of predicted and observed 30-day mortality in spinal surgery gave an AUROC of 0.613 ($p<0.351$), therefore determining that the SORT prediction tool has poor accuracy and is unable to predict 30-day mortality in patients undergoing spinal surgery.

BASS 2019 Poster Abstracts

Cervical Degenerative

Cervical arthroplasty after five years: mobile and pain free? Long-term results with the Baguera C

Patrick Fransen[1], Vincent Pointillart[2]
[1]IM2S, Monaco [2]CHU Bordeaux, France

Introduction
Cervical total disc replacement (TDR) with disc prostheses, having been widely used for years, now face reimbursement challenges from different health authorities. We present an observational, multicentre study evaluating long-term safety and potential complications related to the use of a semi-constrained cervical prosthesis.

Methods
Seventy-eight patients were enrolled in four different hospitals. Five years' postoperative controls were performed. All had been treated by one or two-levels TDR using Baguera C between 2009 and 2011. All were assessed clinically, neurologically, by questionnaires (NDI, SF12) and radiological controls were performed by lateral X rays in neutral, flexion and extension positions.

Results
There were no reported surgical revisions at the arthroplasty levels and no implant-related complications. Sixty patients (76.9%) took no pain medication at all. Sixteen patients took level I, I level II, and I level III painkillers. All subjects had normal clinical examinations. One presented with new C6 paresthesia, possibly related to adjacent level degeneration. NDI showed an average functional disability of 18.9%. However, five subjects (6.4%) noted at least 50% functional disability. The average ROM on flexion/extension X-rays was 8.8 degrees. Motion was considered preserved in 87.2%. Lack of motion (ROM<2°) was observed in 12.8%. Thirteen patients had signs of adjacent level degeneration.

Conclusion
Cervical arthroplasty after five years with the Baguera C prosthesis scores well for safety, clinical results, long term motion preservation and index or adjacent level re-operation. Radiological progression of adjacent level degeneration was seen in a significant minority of cases, without clinical expression.

Outcomes from 3- and 4-level ACDF surgery

Aaron Rooney[1], Saajid Kaleel[1], Robert Lovell[1], Shaishav Bhagat[1], David Cumming[1], Alastair Hudd[1]
[1]Ipswich Hospital, Ipswich, UK

Introduction
Multi-level (3- and 4-level) anterior cervical discectomy and fusions (ACDFs) are carried out in those with extensive cervical disc disease. We looked at the change in the patient reported outcome measures (PROMs) postoperatively.

Methods
There was an analysis of all 3- and 4-level ACDFs over an 18-month period in our centre.

Results
There were 26 patients identified. Visual analogue scale (VAS) scores improved at two, six, and 12 months for neck pain (by 2.25, 2.90, and 2.83 points respectively), and also for worst arm pain (by 3.95, 3.16, and 3.49 points). EQ5D scores improved by a mean of 16.21% at two months, which improved to a mean improvement of 16.45% at six months, but declined to 12.67% at one year. We found clinically significant improvements using the myelopathy disability index in 2/8 patients at two months, and 1/5 patients at six and 12 months; for the neck disability index this improvement was in 7/17 patients at two months, 6/14 at six months, and 7/13 at 12 months. These results compared very favourably to the data for 1- and 2-level ACDFs that we hold.

Conclusion
Multi-level ACDFs are currently accounting for 11% of our total ACDF workload. There were overall improvements in VAS scores for both neck and arm pain. Maximum EQ5D improvements were seen at six months, followed by a decline at 12 months. Few patients showed an improvement in the Myelopathy Disability Index, and half the patients showed an improvement in the Neck Disability Index.

Does removal of hypertrophic posterior longitudinal ligament (HPLL) along with cervical discectomy affect surgical outcome In ACDF?

Surath Sanjaya Kumara Munasinghe Arachchige[1], Buddhika Mahesh[1], Himashi Kularatna[1]
[1]*National Hospital Colombo, Colombo, Sri Lanka*

Introduction
It is still controversial to determine whether associated HPLL should be removed or not during ACDF for cervical-spondylotic-mywelopathy (CSM).

Methods
Retrospective study including 56 patients presenting with cervical disc herniation (CDH) and associated HPLL with CSM to a single institution during four years. The presence of thickened HPLL was confirmed by T2-weighted MRI. Pre-operative neurological function evaluated using the modified Japanese Orthopaedic Association (mJOA) cervical spine myelopathy functional assessment scale. All patients were treated by single/two level ACDF performed by a single surgeon. Removal or preservation of HPLL was decided upon the degree of satisfactory decompression intraoperatively following removal of disc-osteophyte complex. Surgical outcome was evaluated at the end of 12 months according to Odom's criteria. Postoperative mJOA scores and spinal canal diameters were compared in the two groups.

Results
Out of 56 patients who underwent ACDF, HPLL was removed in 29 (57.8%) and preserved in 27 (48.2%). At the end of 12 months, 26 (89.6%) patients who underwent removal of HPLL revealed excellent or good outcome scores according to Odom's criteria, although 18 out of 27 (74.1%) patients for whom HPLL was preserved were found to have similar outcomes. The difference in outcome was statistically significant at a p value of 0.036. The improvement of mJOA scores in removal group is statistically significant at six and 12 months follow up compared to the preserved group (p=0.041). No significant postoperative increase in spinal canal diameters observed between the two groups at follow up.

Conclusion
Removal of HPLL has a significant effect on surgical outcome when performed along with cervical discectomy during single/two level ACDF.

Evidence supporting anterior cervical endoscopic spine surgery

JN Alastair Gibson[1]
[1]*Spire Murrayfield Hospital, Edinburgh, UK*

Introduction
In the UK, the majority of surgeons choose either anterior cervical discectomy and fusion (ACDF) or cervical disc replacement (CDR) for patients presenting with anterior spinal cord and/or nerve root compression not responsive to conservative therapies. Cervical endoscopic surgery (CESS) is now commonly performed in the Far East yet it has not been widely adopted in the West.

Aim
To review the current evidence supporting CESS and compare the costs relative to ACDF and CDR.

Methods
Data from RCTs, controlled trials and cohort studies were identified by computer searching and citation tracking. Cost data were calculated from inclusive care pricing of a national provider (Spire H/C, UK).

Results
Seventy-four papers and proceedings abstracts were identified relating to CESS (12 in 2018) of which 18 provided substantive clinical comparative data for anterior surgery. One single-blind RCT compared CESS to ACDF and one cohort study compared CESS via anterior and posterior approaches. Nine included use of laser to augment decompression. Excellent or good outcomes were reported at up to 24 months in 90% of the 1,213 patients with a 3.8% incidence of complications and 2.7% incidence of revision surgery. Comparative costs were £5,750 CESS, £12,900 ACDF and £16,000 CDR inclusive of disposables/hardware.

Conclusion
CESS is associated with similar outcomes to those expected after ACDF or CDR yet minimises surgical insult, has a lower cost base and potentially a lower rate of associated complications. Long-term outcome data are required.

Cervical nerve root blockade for diagnosis and treatment of acute cervical disc herniation

Will Kieffer[1], Richard Myatt[1], Christopher Wakeling[1], Andrew Hatrick[1], Sri Chatakondu[1]
[1]*Frimley Park Hospital, Camberley, UK*

The natural history of cervical disc herniation is uncertain with some evidence in the literature that although self-limiting, symptoms can take two to four years to resolve. A variety of techniques are utilised to perform diagnostic and therapeutic nerve blockade for patients suffering from radiculopathy associated with a cervical disc herniation. We present a novel combined fluoroscopic and ultrasound guided nerve blockade technique.

Three-hundred-and-eight patients were identified across a two-year period with radicular arm pain and a concordant disc bulge to explain their symptoms. Patients with neurological deficit or progressive symptoms were excluded. Seventy-seven patients

had acute symptoms (<12/52), one had acute-on-chronic symptoms and 203 patients had chronic symptoms (>12/52). Seventy two per cent of patients with acute symptoms had complete resolution or improvement of symptoms at first follow up and maintained to one-year and did not require surgery. Forty six per cent of patients with chronic symptoms had the same outcome. Nine per cent of patients with acute symptoms proceeded to surgery within one year with a mean time to surgery of 168 days from blockade to surgery, whereas 23% of patients with chronic symptoms proceeded to surgery within one year with a mean time from blockade to surgery of 311 days. There were no complications of any nerve blockades. The most commonly affected levels were C5/6 and C6/7.

We have shown that symptom duration is an important factor in the effectiveness of nerve blockade and offer prognostic data for surgeons and patients to guide likelihood of symptom improvement for those electing to undergo cervical nerve blockade.

Surgical treatment for anterior cervical osteophytes causing dysphagia: the Leeds experience

Louise Saukila[1], Alex Smedley[1], Gerry Towns[1], Debasish Pal[1]
[1]Leeds General Infirmary, Leeds, UK

Introduction
Cervical osteophytosis is a well-recognised aetiology of dysphagia, with degenerative cervical disease, ankylosing spondylosis, and diffuse idiopathic skeletal hyperostosis (DISH) causing osteophyte formation. We present our practice of anterior cervical osteophyte surgery for dysphagia, evaluating indications for surgery, and surgical safety and efficacy.

Methods
Retrospective review of a 10-year practice at one institution. Patient demographics, symptom duration/investigation, surgery type, and complications were recorded, with outcome measured by the functional outcome swallowing scale (FOSS) (0 normal to 5 nil-by-mouth).

Results
Nine cases reviewed (eight male, one female). Median age: 63 (ranging 48–79). Mean duration of symptoms: 40 months. All had pre-operative barium swallow demonstrating oesophageal impingement. Four patients had previous cervical surgery (three degenerative, one trauma), and one osteophyte recurrence (primary surgery elsewhere). The most affected cervical levels were C3/4, C4/5 and C5/6. Five patients had multi-level operations, with four surgeries including anterior cervical discectomy and plating. Pre-operative mean FOSS score was 2.6 compared to postoperative score of 0.6, with mean improvement of two points (significant at $p<0.05$). There were no serious surgical complications; two patients had transient dysphagia, one had hoarse voice secondary to unilateral vocal cord paralysis, and one had neck pain with C5 radiculopathy. Median length of admission was one day. Mean follow up was 18 months, with none requiring further surgery.

Conclusion
Anterior cervical osteophytectomy is safe and effective treatment for dysphagia, with all our patients demonstrating clinical improvement and long-term satisfaction. Larger studies are needed to evaluate different surgical types and impact of previous cervical surgery/trauma.

Return to sport following surgical vs. conservative treatment for cervical disc herniation: a systematic review and meta-analysis

Mutaz Yousef[1], Daniel D'Aquino[2], Venkatesan Muralidharan[3], Nasir Quraishi[2]
[1]University of Nottingham, Nottingham, UK [2]Centre for Spinal Studies and Surgery, Queen's Medical Centre, Nottingham, UK [3]Apollo Hospitals, Chennai, India

Introduction
A cervical disc herniation (CDH) can constitute a career-ending injury for a professional athlete. In such a context, the treatment dilemma hinges on whether or not the disc herniation is best managed conservatively or operatively. This study reviews the recent literature on return to sports (RTS) in professional athletes following either conservative or operative treatment for CDH.

Study design
The Preferred Reporting Items protocol for Systematic Review and Meta-analysis (PRISMA) was employed.

Methods
An electronic literature search was performed to retrieve articles published between 1970 and August 7, 2017 relating to 'cervical disc herniation' and 'return to sports or play.' The Downs and Black scale was used to assess the methodological quality of included studies.

Results
The search strategy retrieved six articles. Four studies were rated as 'moderate' and two as 'low quality.' Three studies focused on RTS following surgery whilst the other three compared RTS following surgical vs. conservative treatment. Rate of RTS across both surgical (n=150) and non-surgical (n=62) groups was high (72.2%). However, RTS in the surgical group (76.7%) was comparatively higher than the conservative group (61.2%). With all six studies pooled, those undergoing surgery showed approximately twice the odds (2.08; 95% CI 1.1–3.92) of RTS compared to those managed conservatively (p=0.029 Chi-squared).

Conclusion
The comparison between surgical and non-surgical treatments for CDH in professional athletes showed significant differences regarding RTS favouring surgical treatment. This study would be useful to those treating professional athletes with CDH and help with prognostication of return to professional sports.

Commissioning, Governance & Patient Pathways

Can postoperative physiotherapy advice for single-level lumbar decompressions be given in a group environment without affecting patient outcomes and satisfaction?

Tom Watt[1], Michelle Angus[1], Anna Fletcher[1], Joshi George[1], Rajat Verma[1], Saeed Mohammad[1], Irfan Siddique[1], Roberto Carasco[2]
[1]Salford Royal NHS Foundation Trust, Salford, UK [2]The University of Manchester, Manchester, UK

Aim
To assess patient-reported outcomes of patients undergoing single-level lumbar spine decompression or discectomy comparing one-to-one physiotherapy postoperatively or attending a pre-operative, physiotherapy-led, education and prehabilitation class—spinal prehab class (SPC).

Method
Consecutive patients over a four month period listed for single level lumbar spine decompression were included before and after introduction of the SPC. The first group were reviewed on an individual basis postoperatively—assessed for neurology and/or mobility deficits, and issued with written and verbal advice. The second group attended SPC whereby verbal and written advice was given, and core exercises demonstrated. The Core Outcome Measures Index (COMI) questionnaires of two groups of patients were analysed retrospectively. Data was analysed using t-test and Fischer exact test to assess statistical significance.

Results
The average age of those attending the class was greater by 10 years ($p<0.0001$) and their pre-operative COMI scores were higher ($p=0.04$). Results showed that those who attended the SPC (n=108) had a greater reduction in back pain post-surgery (mean difference 3.1) compared to those who had individual physiotherapy input (n=148; mean difference 1.9, $p=0.01$). Improvement in overall COMI scores was greater in patients who attended SPC than individual review (mean difference 4.0 and 2.7 respectively, $p=0.007$). The postoperative satisfaction levels were similar though not clinically significant ($p=0.6$), with over 90% reporting "somewhat satisfied" or "very satisfied".

Conclusion
We have demonstrated that the implementation of a pre-operative, education and prehabilitation class can be delivered safely and cost-effectively, having satisfactory clinical outcomes including overall COMI score improvement.

Patient compliance with the British Spinal Registry patient-rated outcome questionnaires

Greg Cunningham[1], Dan Wright[1], Colin Nnadi[1]
[1]Nuffield Orthopaedic Centre, Oxford, UK

Introduction
The British Spinal Registry (BSR) is fast becoming an integral part of recording spinal surgical activity and its outcomes. The most recent report from the BSR identified a complete data set collection of only 30% of recruited patients.

Aim
To better understand these low feedback rates and to identify which groups of patients were more likely to respond or not.

Methods
We analysed a single surgeon's BSR database identifying response rates for patients recruited from 2016–2018. In subset analysis we considered response rates by patient age, gender, postcode, prior responses and date of surgery.

Results
Two-hundred-and-ninety-seven patients were analysed. Of all patients that completed the pre-operative baseline questionnaire only 33% of them responded at six weeks and 25% at six months. Those who responded at six weeks were much more likely to respond to subsequent questionnaires, OR 29.9 (95% CI=9.3-95.7 $p< 0.0001$). Women, and the millennial generation were more likely to respond OR 2.0 (95% CI 1.2-3.4 $p=0.012$) and OR 1.79 (95% CI 1.2-2.6 $p=0.003$) respectively. Response rates at six weeks decreased year on year from 2016. Analysis of Oswestry Disability Index (ODI) scores showed patients at the extremes were more likely to respond.

Conclusion
Response rates are low and continue to drop each year. Those responding are most likely to be female millennials with either very high or very low ODI scores. These results should stimulate discussion around improving patient engagement and instil caution when using these registry outcomes to guide future practice and funding distribution.

Virtual spinal clinic: the Glasgow experience

Ignatius Liew[1], Odhran Murray[1]
[1]Queen Elizabeth University Hospital, Glasgow, UK

Introduction
In the climate of increasing waiting times and referrals within the NHS, virtual clinics offer a modern and dynamic avenue to meet current patient demands. The efficacy of virtual vetting was determined and since the introduction of virtual spinal clinic, we aim to establish the clinical outcomes of the Glasgow experience.

Methods
5,956 patients were included in the study period. All patients referred to West of Scotland Orthopaedic Spinal Service were prospectively analysed from October 2016 to July 2018. Primary outcomes include patient outcomes, discharges, MRI scans requested and return clinics. Prospective data collection from Bluespier International (Droitwich, UK) and TrakCare.

Results
The average referrals since October 2016 increased from 200 to 310 at July 2018 (155%). 2,703 (45%) patients were reviewed in the virtual spinal clinic, of which 29% of patients were managed with virtual discharge. Fifty-nine per cent of patients obtained MRI scans prior to clinical assessment, with further 9% being listed for surgery and 69% brought to return clinic for follow up. Virtual clinics were able to accommodate 15 new patients compared to five in face -to-face consultation (a 300% increase in productivity).

Conclusion
Virtual spinal clinics provide a dynamic process in evaluating patients with the added value in socioeconomic savings for the NHS and patients. Further evaluation is required with discrete event simulation, patient satisfaction. Virtual spinal clinic improves productivity in vetting new referrals, prioritisation for potential surgical candidates with MRIs and is effective at discharging patients, with potential socioeconomic benefits.

Attitudes of orthopaedic trainees to a career in spinal surgery

Hui-Ling Kerr[1,2]
[1]Southmead Hospital, Bristol, UK [2]London Health Science Centre, Canada

Introduction
A career in spines is not known to be a popular choice amongst orthopaedic trainees with only 3% choosing it as a career and evidence of gender disparity.

Aim
The aim of the study was to determine the current level of interest in spines as a career and the gender ratio of those interested, amongst orthopaedic trainees.

Methods
An anonymous paper questionnaire was given out to orthopaedics trainees at the British Orthopaedic Trainees Association (BOTA) Annual Meeting on 16 November 2017.

Results
There was a 75% response rate (113/150, 64% male, 36% female). Eighty per cent were registrars and 20% pre-registrar grade. Twelve per cent (14/113) were considering a career in spines. The three chosen most common negative factors against spines were: 'not enough operative exposure to spines' (16%), 'patients considered too difficult/complex' (19%) and 'put off by low success rate' (20%). Only one respondent considering a career in spines was female (0.9%). The three chosen most important factors to increase attractiveness of spines to women were 'more part time work options at consultant level' (18%), 'more operative exposure to spines at a junior level' (20%) and 'more opportunities for operative exposure to spines during training' (23%).

Conclusion
A career in spines may have improved in popularity amongst orthopaedic trainees but still remains an unpopular choice for women. Encouraging orthopaedic trainees to do spines at an earlier stage of training may increase understanding of the profession and in turn increase the attractiveness of the profession to both male and female trainees.

Challenges of spine surgery in neurofibromatosis and current operative strategies

Joshi George[1], Anant Tambe[1], Tina Karabatsou[1]
[1]Salford Royal Foundation Trust, Salford, UK

Introduction
Neurofibromatosis poses significant challenges for the spine surgeon. Poor neurological state, increased anaesthetic risk from comorbidities, dystrophic bone, dural ectasia, spinal deformities, multiple neurofibromas and poor bone fusion make spine surgery more risky and prone to failure.

Methods
The neuroradiological notes of 378 complex NF-1 patients were reviewed from 24 months of multidisciplinary team meetings (Manchester is one of the two nationally commissioned complex NF1 centres in the UK). Patients who had previous spine surgery were selected. Details of the surgery performed and outcomes were collated.

Results
Sixteen patients had previous spine surgery. Eight patients had

instrumentation and seven patients had repeated operations. Multiple neurofibromas, deformity and presence of severe dural ectasia were associated with repeat surgery.

Conclusion
Spine surgery in Neurofibromatosis type 1 is challenging and associated with significant risks. Based on our results we have developed an operative algorithm for dealing with neurofibromas and deformity.

A prospective audit on factors influencing peri-operative delays in operating theatres

Saisunder Shashank Chaganty[1], Himanshu Sharma[2]
[1]*Peninsula Medical School, University of Plymouth, Plymouth, UK*
[2]*University Hospitals Plymouth, Plymouth, UK*

Introduction
Delays in and around the operating theatre serve a major detriment for patient flow and resource utilisation. By looking to lessen peri-operative delays, we can look towards optimising theatre efficiency. This provides an opportunity to improve quality of healthcare delivered.

Aim
The aim of this prospective quality improvement project is to determine the prevalence and identify human errors as possible cause of peri-operative delays.

Methods
A prospective quantitative and qualitative audit analysing elective spinal surgery and non-spinal surgery cases performed from 1st September to 14th November 2018 in neuro theatres.

Results
A total of 302 elective neurosurgery cases were scheduled, 39 of these were cancelled. The average downtime percentage and utilisation rate were 34.8% and 67.4% respectively. The most common reason cited for delays (66.2%) were pre-operative delays in patient preparation, contributing to an average 64-minute delayed start. Other delaying factors included emergency case prioritisation (8%), turnaround time delays (5%), medical personnel delays (5%), equipment issues (2%) and unknown factors (13.8%). Upon acquisition of qualitative feedback, the following areas were highlighted as potential for intervention: pre-operative delays in patient readiness with change in list order due to level-1 bed availability issues and emergency case prioritisation. Postoperative turnaround time delays and intraoperative delays due to equipment issues were cited.

Conclusion
We found 13% last minute cancellation and 67% theatre utilisation. Meticulous documentation of peri-operative delays allows for identification of obstacles that hinder theatre efficiency. Implementing management strategies for ameliorating these clinical and corporate factors helps in optimising theatre efficiency.

Evidence-based spinal surgery: how safe is 'safe'?

Gabrielle Scicluna[1], Alexander Augustithis[1]
[1]*Queen Elizabeth University Hospital, Glasgow, UK*

Introduction
Safety is at the forefront of modern surgical practice. Most surgeons adopt an evidence-based approach. Recently published work highlighted issues in the paediatric orthopaedic literature which is blighted by small number series. Studies are often powered to show statistical differences between treatment groups but are not adequately powered to assure safe outcomes. We hypothesised that spinal surgery literature may be equally afflicted and elected to perform a similar analysis.

Methods
We searched for the term "safe" appearing in the title or abstract of any paper published in three established spinal surgery journals over a one year period. Any paper not describing their studied intervention as "safe" was then excluded. The remaining papers were examined and their declared complication rates recorded. Using simple, easily accessible statistical tools, the 95% upper limit confidence interval was calculated for major complications and compared to the published rates.

Results
Of the 44 papers examined, 33 had too few events to have any chance of statistically proving a major complication rate of <5%. The mean published Major Complication Rate was 2%; (range: 0–30%). This compared unfavourably with the calculated mean 95% upper limit confidence interval which was 52.3%; (range: 1.7%–300%). Only six papers were able to demonstrate a 95% upper limit confidence interval of <5%.

Conclusion
Contemporary spinal publications suffer from small number series. Published work may be able to show a statistical difference in treatment outcomes but is poorly powered to accurately predict safety.

Setting the standard in spinal surgery postoperative care documentation

Raveen Jayasuriya[1,2], Lucy Amos[2], Rye Yap[1,2], Michael Athanassacopoulos[1], Lee Breakwell[1], Neil Chiverton[1], Ashley Cole[1], Marcel Ivanov[1], Antony Louis Rex Michael[1], James Tomlinson[1]
[1]*Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, UK*
[2]*University of Sheffield, Sheffield, UK*

Introduction
The increasing numbers of junior doctors cross-covering, use of locum medical and nursing staff, and regular shift changes mean clear communication is critical. Comprehensively documented postoperative care instructions are imperative to ensure patient safety and deliver high quality care. The value of surgical registry data is emerging, and will shortly become mandated, but the completeness of postoperative care documentation is not held to the same standard.

Methods
A consensus opinion was sought, identifying the minimum dataset expected in postoperative care documentation including important negatives. Current practice was then audited against this dataset, before changing to a standardised co-designed post-op template department wide. A re-audit was then performed to assess use of the newly designed template.

Results
Group consensus from all seven consultant spinal surgeons identified 14 criteria deemed as essential in post-op care documentation. The pre-intervention audit (n=50 case notes) observed >75% compliance in only 4/15 criteria, and <33% compliance for 8/15 criteria. This unexpectedly poor completeness of documentation supported the implementation of a postoperative care template. Following the introduction of the template, re-audit (n=50) showed compliance to be dramatically improved. Feedback from ward staff (doctors/nurses/physiotherapists) was highly positive due to clear communication and reduction of unnecessary workload.

Conclusion
The use of a standardised template acts as a prompt to the operating surgeon to provide critical information, improving communication and patient care. The RCS standards on operation notes simply state 'detailed postoperative instructions must be written'. A national consensus on minimum postoperative instruction would be a useful next step.

Deformity

Comparison of Cobb angle measurement on digitised radiographs (DR) with and without endplate extrapolation

Nakulan Kumar[1], Dylan Thomas[1], Ian Harding[1], Alex Torrie[2]
[1]Southmead Hospital, Bristol, UK [2]Gloucester Royal Hospital, Gloucester, UK

Aim
Cobb angle remains a primary radiological assessment of spinal deformity. Variability in Cobb angle measurement with and without endplate extrapolation has not been established. The objective was to identify whether Cobb angle measurements, with and without endplate extrapolation, provides variation in results when using PACS Synapse V4.4.200.

Method
Fifty three spinal curves on digitised radiographs of 43 consecutive patients with adolescent idiopathic scoliosis were measured with and without endplate extrapolation. Curves subtypes were identified by senior author (IJH). All curves were measured independently on two separate occasions (datasets 1&2) by three assessors (NK, DT and IJH).

Statistical analysis
Intraobserver reliability testing was conducted using Cronbach's Alpha test. Interobserver variation was assessed with ANOVA. Datasets were assessed for normality using D'Agostino and Pearson. Cobb angle techniques with and without extrapolation were compared using a two-way students' unpaired t-test. $p<0.05$ was accepted as significant.

Results
Thirty females and 13 males were included with a mean age of 15.9 years. All datasets passed normality. All intraobserver reliability was excellent (>0.9). The mean Cobb in dataset 1 was 48.4 degrees (95%CI 46.0-50.9) without extrapolation and 48.1 degrees (95%CI 45.7–50.5) with extrapolation (p=0.859). The mean Cobb in dataset 2 was 48.0 degrees (95%CI 45.6-50.5) without extrapolation and 48.1 degrees (95% CI 45.7–50.5) with extrapolation (p=0.968).

Conclusion
Cobb angle measurement with and without endplate extrapolation produces results that are not significantly different. The techniques can be used interchangeably.

Vertebral body tethering for adolescent idiopathic scoliosis

Asad Ali[1], Ary Phaily[2], Julian Leong[1]
[1]Royal National Orthopaedic Hospital, Stanmore, UK [2]Oxford University Hospitals NHS Foundation Trust, Oxford, UK

Introduction
Vertebral body tethering (VBT) has been reported in pre-clinical studies and now a handful of case series and retrospective studies. It is a growth modulation technique that can be utilised to treat adolescent idiopathic scoliosis (AIS) traditionally treated with fusion. The technique attempts to maintain normal spine mobility. Its uses an endoscope and the concept of minimally invasive surgery. This paper aims to highlight an innovative technique that will define AIS surgery in the next generation.

Methods
A literature search of PubMed/Medline, SCOPUS and Google Scholar from 2010 to present was performed to analyse current evidence. In depth analysis was performed using the latest

available research published in this field.

Results
Studies show promising results in this technique. Several studies have shown statistically significant improved curve correction. Studies do not show follow-up data for greater than two years. Over correction is the most commonly discussed complication with a large range in the reported complication rates. None currently have compared quality of life and cost-effectiveness. This systematic review showed a paucity of high-level evidence in this topic and significant heterogeneity in currently available data.

Conclusion
Studies of VBT in the treatment of AIS show promise. Further developments in this field with dissemination of knowledge and expertise will help to establish VBT for the future. In light of the current lack of evidence, more work needs to be undertaken to assess results from VBT. We propose a multicentre prospective comparative trial and the collaboration of a national database for VBT.

Intraoperative ultrasound in adult spinal deformity surgery

Daniel D'Aquino[1], Aaron Hilis[1], Ameet Kulkarni[1], Luca Boriani[1], Nasir Quraishi[1]
[1]Queen's Medical Centre, Nottingham University Hospitals, Nottingham, UK

Introduction
Intraoperative ultrasound (IUS) has previously been described as an effective tool in spinal surgery. In particular, the utility of IUS in the real-time localisation of intradural. However, little attention has been paid to the use of IUS in surgery for adult spinal deformity. We herein describe our experience of the use of IUS across a number of spinal pathologies—inclusive of adult spinal deformity correction—and describe certain surgical scenarios during which this technique might be useful.

Methods
A retrospective review of cases where IUS was applied in patients undergoing spinal surgery at the Queen's Medical Centre, Nottingham (August 2017–September 2018). Intraoperative standard B-mode images were acquired using a 3–11 MHz linear US probe. The contribution of IUS to the final outcome of the case was defined.

Results
Ten representative cases were identified covering the range of cervical, thoracic and lumbar pathology. The traditional use of IUS to determine the adequacy of surgical decompression is described. Furthermore, the extension of IUS to visualise a safe working corridor, ventral to the theca, while performing a posterior subtraction osteotomy (PSO) is introduced as a novel application of IUS.

Conclusion
Based on our surgical experience, we advocate the use of IUS, not only for the identification of spinal pathology, but also to confirm the adequacy of neural decompression where indicated. Moreover, the real-time visualisation of anatomy around and ventral to the theca using IUS lends itself well to establishing safe and satisfactory corridors during deformity correction procedures.

Intraoperative cord monitoring signal (IOM) changes during spinal deformity correction: can we streamline intraoperative decision-making?

Himanshu Shekhar[1], Peter Loughenbury[1], Almas Khan[1], Peter Millner[1]
[1]Leeds General Infirmary, Leeds, UK

Methods
We reviewed the IOM reports and clinical records of patients with adverse changes in IOM signals—somato sensory evoked potential (SSEP), motor evoked potential (MEP)—during correction of their spinal deformity. Clinical outcome, factors affecting IOM (blood pressure, change in anaesthesia, surgical stage and core temperature) and remedial measures were noted.

Results
Out of a total of 360 IOM reports for the period January 2012–July 2018, 16 were noted to have adverse change in SSEP/MEP. The IOM signal was lost in seven patients and nine patients had only a signal drop. The adverse change was noted in MEP for 12 (seven universal, five lower limbs only), SSEP for two and both MEP and SSEP for two patients. Surgical remedial measures were taken in eight patients (reverse deformity correction manoeuvre in four, remove pedicle screws in four). The depth of anaesthesia was lightened in five patients. Blood pressure was increased in two patients. All of these three measures were used in one patient. The IOM change recovered for 14 patients during the surgery but continued beyond closure in two patients. None of the studied patients had a postoperative neurological deficit.

Conclusion
Using the remedial measures early in deformity correction patients with adverse IOM changes, we avoided postoperative neurological deficit for all the patients. We are introducing an IOM adverse change protocol in our institution to emphasise the remedial measures and help with intraoperative decision making in this situation.

Health-related quality of life improvement following complex adult spinal deformity surgery

Aaron Hilis[1], Daniel D'Aquino[1], Nasir Quraishi[1]
[1]Centre for Spinal Studies and Surgery, Queen's Medical Centre, Nottingham, UK

Introduction
The health-related quality of life (HRQoL) after complex adult spine deformity (ASD) surgery has only infrequently been reported in the literature. The objective of this study was to assess the HRQoL in patients undergoing complex spinal surgery

Methods
This was a retrospective review of prospectively collected data — pre-operatively, three months, six months and one postoperatively. Operative data, complications and HRQoL measures were analysed including Oswestry Disability Index (ODI) and Scoliosis Research Society–30 (SRS–30).

Results
A total of 53 ASD patients were included (41 female, 12 male) with mean age of 62.3 years (34.6–78.2), and average follow up was 2.9 years (1–9years). Of these, 41 patients underwent T10-pelvis and 12 patients had T2/4-pelvis instrumentation. These procedures included pedicle subtraction osteotomies (PSO) in 23 patients and posterior column osteotomies (PCO) in 14 patients. Twenty-one patients had anterior/posterior approaches and 32 patients had a posterior approach only. A total of 20 (38%) complications occurred: broken rods requiring revision surgery (four), wound infection (five) with two patients requiring metalwork removal, excessive bleeding (four), neurological injury (two) and proximal junctional failure (five). Forty-seven patients (89%) reached a minimum clinically important difference in the ODI scores. Significant improvements were also observed in all SRS-30 domains: pain: +0.7 ($p<0.001$); self-image: +1.2 ($p<0.001$); function: +0.41 ($p<0.001$); satisfaction: +1.7 ($p<0.001$); and mental health: +0.24 ($p=0.04$).

Conclusion
Patients undergoing complex spinal surgery in ASD significantly improved HRQoL scores with a total complication rate of 38%.

Adult degenerative spinal deformity correction: does the SVA improve at early postoperative out-patient review?

Cyril Dubois[1], John Andrews[1], Andrew Bowey[1]
[1]Royal Victoria Infirmary, Newcastle Upon Tyne, UK

Aim
Sagittal and coronal imbalance of severe adult degenerative deformities require surgical correction of a stiff spine to improve pain, mobility and quality of life. A good sagittal balance is assessed overall through the sagittal vertical axis (SVA). A poor SVA is one of the reasons to proceed with revision surgery and as this is best done before any fusion starts, our study was to assess if the SVA can improve a few weeks following surgery.

Methods
Eight Patients with a mean age of 56.5 years who underwent corrective surgery for painful low thoracolumbar and lumbar degenerative deformities between February 2016 and February 2018 were included. All patients were submitted to X-ray screening at one week postoperatively and at seven weeks follow up.

Results
Patients were operated by a mixture of anterior, oblique, extreme lateral and transforaminal interbody fusions and Ponte or pedicle subtraction osteotomy with posterior correction of their deformity and fusion down to the pelvis. Mean operated levels were 11.8. Mean SVA at one week was +4.6 cm ($0.9 \leq SVA \leq 7$) and at seven weeks, mean SVA was +1.5 cm ($-2 \leq SVA \leq +5.9$), with a p-value of 0.04, and a mean improvement of 100%.

Conclusion
In every case in this small sample, due mostly to improvement in pain, the SVA improved when measured at seven weeks compared to one week postoperatively. This suggests that an aggressive approach to revision surgery based on the SVA in the very early postoperative period is not necessarily required, unless there are other over-arching reasons.

Rocket incision and approach: a novel surgical approach in posterior correction of neuromuscular scoliosis

Saurabh Kapoor[1], Ciaran Oboyle[1], Masood Shafafy[1]
[1]Queen's Medical Centre, Nottingham, UK

Introduction
Surgical treatment of neuromuscular scoliosis is associated with high risk of infection from nappy area. We describe the safety and efficacy of a new approach developed to reduce these risks.

Methods
Data was prospectively collected for a cohort of patients with neuromuscular scoliosis requiring posterior correction in which this novel surgical approach was utilised.

Technique
Patient is positioned as standard for a posterior approach. Both Posterior Superior Iliac Crests (PSIS) are marked on the skin. The positions of the superior Gluteal arteries (SGA) are marked bilaterally using their pulsations located approximately 1 inch below and at the junction of outer and middle third of the iliac crest. A semilunar line is drawn from one PSIS to the other curving upward with the apex centred at L2/L3. From the apex a vertical line centred on the spine is drawn to the proximal thoracic spine. The overall shape of this looks similar to a rocket or inverted wine glass. The Semilunar line is incised directly to through the tissues. This is followed by usual paravertebral muscle dissection to expose bony landmarks.

Results
Study cohort included four male and one female, with average age of 16.2 years (range 8–19) and follow up was 15 months (range 3–24). Four patients had cerebral palsy and one Duchenne muscular dystrophy. All surgical wounds healed with no complications.

Conclusion
Rocket incision and approach appears to provide a safe and effective alternative approach in posterior correction of neuromuscular scoliosis

Infection

The Royal London spinal tuberculosis stability scoring system: a novel tool to assess the need for surgical intervention

Ahmed Ali[1], Vishvas Shetty[2], David Ensor[2], Ahmed-Ramadan Sadek[2], Roozbeh Shafafy[2], Suresh Pushpananthan[2], Jonathan Bull[2], Fady Sedra[2], Rajesh Mangattil[2], Syed Aftab[2], Arun Ranganathan[2], Veronica White[3], Heinke Kunst[3], Alexander Montgomery[2]
[1]Barts and The London School of Medicine, London, UK [2]Department of Spinal Surgery, Barts Health NHS Trust, London, UK [3]Barts Health NHS Trust, London, UK

Introduction
Tuberculosis of the spine is a heterogenous condition. The mainstay of treatment is medical but surgery is indicated in select individuals with predicted or established instability; which may lead to deformity and neurological injury.

Aim
The aim of this study was to create a scoring system to guide clinicians as to which patients may need surgery.

Methods
A literature review was conducted to establish variables characterised as potential risk factors for instability in spinal tuberculosis (sTB). A retrospective analysis of patients presenting to our institution with a diagnosis of sTB was performed. Logistic regression was performed to evaluate the predictors of instability and a prediction model was created. The prediction model was validated on a second series of patients. The predicted odds were calculated for every patient in the dataset. Receiver operating characteristics (ROC) curves were created and the area under curve (AUC) was calculated

Results
Number of infected vertebrae, anatomical location, degree of pain, degree of kyphosis, neurological status and number of columns affected were identified as the most consistent predictors of instability.

Conclusion
A new scoring system has been developed which can help guide clinicians as to when surgical intervention may be required in sTB. Further prospective studies are required for larger scale validation of the scoring system.

Innovation

Current status of cell-based transplant in spinal cord injury and future directions

Alice Willison[1], Sam Smith[2], Ben Davies[3], Mark Kotter[4]
[1]School of Medicine, University of Dundee, Dundee, UK [2]The University of Cambridge School of Clinical Medicine, Cambridge, UK [3]Cambridge University Hospitals NHS Foundation Trust, Cambridge Biomedical Campus, Cambridge, UK [4]Department of Clinical Neurosciences, Cambridge Biomedical Campus, Cambridge, UK

Introduction
Despite decades of research, no regenerative treatment for spinal cord injury (SCI) has entered clinical practice. Stem and precursor cell transplantation are considered to have significant potential. However, as outlined by the James Linda Alliance SCI, research priorities, their efficacy in humans is uncertain. Our objective was to synthesise all cell-based trials in human spinal cord injury in order to consider the current state of the field.

Methods
A search strategy of Medline returned 1,513 results. A review of the Clinicaltrials.gov database returned 45 results. Results were hand-screened for relevance and data were extracted from eligible studies.

Results
From the Medline search, a total of 1,068 patients were treated using cell transplantation therapy. Mostly, cells were taken from the bone marrow or the olfactory bulb. Lumbar puncture was the preferred methodology. Cell transplantation is safe in the short-term, with no serious adverse effects being reported. Clinicaltrials.gov demonstrated that many clinical trials had been completed but were unpublished. Mostly, cell type and transplant methodology were similar to those in previous trials. However, one trial is using the novel NeuroRegen Scaffold. We have not identified an emerging cell type or technique.

Conclusion
Cell-based transplantation translation remains in its infancy and a number of questions remain unanswered: whilst short-term safety is apparent, what is the long-term safety? How should stem cells be delivered? But, most importantly, are they effective? Further robust clinical research is required.

The essential role of intraoperative cone-beam CT and navigation for sacroiliac joint fusion

Vijay Rajamani[1], Yu Chao Lee[1], Robert Lee[1]
[1]Royal National Orthopaedic Hospital, Stanmore, UK

Sacroiliac joint (SIJ) fusion can be challenging using fluoroscopy, especially where there is transitional anatomy. Recent CT studies of the SIJ have changed our understanding of the true SIJ articular surface, and the recommended cage position under fluoroscopy may on occasion lead to cages being placed in the extra-articular portion of the SIJ, even in patients with "normal" anatomy.

The use of intraoperative cone-beam CT (O-arm) and navigation allows accurate assessment of SIJ anatomy and allows safer approach to SIJ fusion. We present our experience in a series of 35 patients (38 fusions) who underwent SIJ fusion using O-arm navigation with both simple and complex anatomy. We compared cage position inserted under O-arm navigation to the recommended fluoroscopy position. All patients had repeat O-arm scans intraoperatively after cage insertion to confirm accurate and safe positioning. In 80% of cases the position of the most cranial cage was more dorsal than the recommended position for fluoroscopy while the middle and most caudal cages were more ventral. Five patients who had challenging anatomy with deformities (not possible using fluoroscopy) had successful fusion using O-arm. There were no misplaced cages.

In conclusion, O-arm and navigation can overcome anatomical challenges in the SIJ and allow more accurate insertion of fusion cages. Even in 'simple cases', the placement of sacroiliac fusion cages may not be what would be expected using fluoroscopy alone and had the typical placement of the cages been performed, nerve damage would have resulted due to too anterior placement of the cage.

Pre-operative spinal marking to facilitate intraoperative localisation

Joshi George[1]
[1]Salford Royal Foundation Trust, Salford, UK

Introduction
Up to half of spinal surgeons admit to operating at the wrong level. Obesity, transitional vertebrae and mid thoracic pathology are some situations where localisation is especially difficult. Various methods of pre-operative marking have been employed in the past including fiducial implants, coil implants, spinal needle implant, methylene blue and cement injection. They all have various disadvantages including heavy cost, complications, pain and heavy resource utilisation. We describe a novel gold marker used for pre-operative spinal marking and report our experience.

Methods
The notes and scans of patients who had gold marker for pre-operative spinal marking over the period from June 2016–November 2018 were analysed. The accuracy, complications and resource utilisation including cost were analysed.

Results
Eighteen patients had pre-operative spinal marking using the gold marker. The accuracy was 100% and there were no complications.

Conclusion
We report the use of a novel way of pre-operative spinal marking using a gold marker which is cheaper than many alternatives, with hardly any complications and is easy to use. Gold is visible on X-ray, CT and MRI and so can be seen in multiple modalities of imaging.

Safety and effectiveness of the SpineJack versus the KyphX Xpander for the reduction of vertebral compression fractures: SAKOS study

David Noriega[1], Stefano Marcia[2], Nicolas Theumann[3], Alexandre Simon[4], Frank Hassel[5], Stéphane Fuentes[6], Ginaluca Maestretti[7], Antoine Petit[8], Andres Gonzalez Mandly[9], Jean-Marc Kaya[10], Adamou Touta[10], Kévin Buffenoir[11], Benjamin Blondel[6], Robert Pflugmacher[12], Patrick Weidle[13]
[1]University Hospital Valladolid, Spain [2]Ospedale SS, Trinita , Italy [3]Clinique Bois-Cerf, Switzerland [4]CHU Brest Cavale Blanche, France [5]Chefarzt Wirbelsäulenchirurgie, Germany [6]CHU La Timone , France [7]Hôpital Cantonal de Fribourg, Switzerland [8]Hôpital Jean Minjoz, France [9]Hospital Universitario Marqués de Valdecilla, Spain [10]AP-HM Hôpital Nord, France [11]CHU Nantes Hôtel Dieu, France [12]Universitätsklinikum Bonn Klinik und Poliklinik für Orthopädie und Unfallchirurgie, Germany [13]Krankenhaus NEUWERK Sankt Augustinus Kliniken, Germany

Aim
Given that balloon kyphoplasty (BKP) is the most commonly performed VAP in painful osteoporotic vertebral compression fractures (VCFs), this study aimed to support a non-inferiority finding for the use of the SpineJack (SJ) vs. BKP.

Methods
A total of 141 patients (78.7% female; 73.3±9.5 years old) were randomised to SJ (n=68) or BKP (n=73) and 126 patients completed the 12-month follow-up period (SJ=61; BKP=65). The primary composite endpoint was the 12-month responder rate (responder if "reduced pain intensity>20mm"+"ODI unchanged or improved"+"absence of device-related AEs or surgical re-intervention"). An additional composite endpoint (including "absence of adjacent level fractures") and midline target height restoration at six and 12 months were tested for SJ superiority.

Results
Bayesian analysis of primary endpoint demonstrated non-inferiority of the SpineJack to the predicate (posterior probability of 0.09969

meeting the criteria for study success ≥0.987). Frequentist analysis of responder rates using "observed case" method confirmed non-inferiority (SJ=89.8%; BKP=87.3%; p=0.0016). Analysis of the additional composite endpoint demonstrated the superiority of SJ over BKP (p<0.0001) at six months (88.1% vs. 60.9%) and 12 months (79.7% vs. 59.3%). Midline target height restoration was superior with SJ at six months (1.14±2.61mm vs 0.31±2.22 mm; p=0.0246) and 12 months (1.31±2.58mm vs 0.10±2.34 mm; p=0.0035).

Conclusion

Compared to BKP, this study demonstrated non-inferiority for overall success and superiority for additional composite endpoint of success with freedom from adjacent fractures and midline vertebral height restoration.

Safety of anterior vertebral body tethering in management of moderate adolescent idiopathic scoliosis

Sandesh Lakkol[1], K H Sunil Kumar[2], Athar Siddiqui[1], Mark Harris[1]
[1]Great Ormond Street Hospital, London, UK [2]Princess Alexandra Hospital, Harlow, UK

Introduction

The moderate adolescent idiopathic scoliosis (AIS) curves (20–40 degrees) in skeletally immature patients are managed using bracing or guided /growth sparing techniques. Recently anterior vertebral body tethering (AVBT) has been introduced as viable surgical alternative technique that not only controls the curve progression but also maintains motion at operated segment. This study reports safety of AVBT in management of moderate AIS curves.

Methods

A detailed literature (hand and electronic) search was performed using keywords 'anterior vertebral body tethering', 'AVBT', 'tethering', 'adolescent Idiopathic scoliosis', 'scoliosis'. The electronic search was performed using PUBMED MEDLINE using Web of Science platform from 1946–2018.

Results

Initial search included 52 papers and 10 papers were identified following reading the abstracts. Ultimately, six relevant peer reviewed articles were selected. Study with duplicate results were excluded. There were 40 patients who underwent AVBT surgery. Overall, there were nine complications (22.5%) which included one atelectasis, one distal junctional kyphosis leading to further fusion, one segmental arterial injury, one patient with unresolved intercostal neuralgia and five patients with transient thigh pain/numbness. There were two patients (5%) who underwent revision surgery for loosening of the tether secondary to overcorrection.

Conclusion

Authors acknowledge that the actual number of AVBT cases performed may be higher than the reported numbers in literature. However our review suggests that AVBT has slightly higher rate of complications than the traditional posterior fusion surgery (5%). Nonetheless, no significant implant related complications were identified in the current literature.

Synthetic osteoconductive bone substitute to augment occipitocerivcal instrumentation in children

Younus Hanif Khan[1], Stewart Tucker[1], Dominic Thompson[1]
[1]Great Ormond Street Hospital, London, UK

Introduction

Children undergoing occipitocervical fixation (OCF), particularly the very young and those with bone dysplasias, autologous bone graft (iliac crest or rib) may be immature or of poor quality. Bone substitutes offer an alternative means of augmenting fixation but their use in a large cohort of children has not been reported. Our aim was to audit the efficacy of bone substitutes in children undergoing instrumented OCF. The primary outcome measure was radiological evidence of stability at last follow up.

Methods

A single institution retrospective case note review was performed of children undergoing instrumented occipitocervical fixation. Occipito-cervical instability due to trauma and children above 16 years at the time of surgery were excluded. Last available radiology was assessed for evidence of stabilisation and bone formation.

Results

One-hundred-and eighteen children, with mean age 8.23 years, operated between 1993–2017, satisfied the inclusion criteria. Underlying diagnoses comprised Downs Syndrome (n=21) Morquio Syndrome (n=11) Achondroplasia (n=20) etc. Mean follow up was 11.6 years (range 1–24 years). Six out of 118 patients had died during follow up for reasons unrelated to the surgical procedure. Extent of fixation was O-C2 (n=99), O-C3 (n=08), O-C4 (n=11). Bone substitutes were used in all patients at the time of fixation. Overall complication rate was 10%, with revision rate of 2.5% and fusion rate of 100%.

Conclusion

Osteoconductive bone substitutes can be safely used to augment O-C fixation procedures in the paediatric population. Rates of successful fusion and wound related complications are comparable to contemporary series using autologous bone graft.

Lumbar Degenerative

Understanding cauda equina syndrome (UCES) study update

Julie Woodfield[1,2], Ingrid Hoeritzauer[1,2], Aimun Jamjoom[2,3], Savva Pronin[4], Nisaharan Srikandarajah[5], Michael Poon[1], Holly Roy[6], Andreas Demetriades[1], Philip Sell[7], Niall Eames[8], Patrick Statham[1], British Neurosurgical Research Collaborative[9]
[1]Department of Clinical Neuroscience, Western General Hospital, Edinburgh, UK [2]Centre for Clinical Brain Sciences, University of Edinburgh, Edinburgh, UK [3]Department of Neurosurgery, Aberdeen Royal Infirmary, Aberdeen, UK [4]The University of Edinburgh, Edinburgh, UK [5]Department of Neurosurgery, Walton Centre NHS Foundation Trust, Liverpool, UK [6]South West Neurosurgery Centre, Derriford Hospital, Plymouth, UK [7]Centre for Spinal Studies and Surgery, Queen's Medical Centre, Nottingham, UK [8]Trauma and Orthopaedics, Royal Victoria Hospital, Belfast, UK [9]British Neurosurgical Trainee Research Collaborative, UK

Pathways for assessment, investigation, and management of patients presenting with cauda equina syndrome (CES) vary across the UK with each centre managing a small number of cases each year. We are undertaking a prospective observational UK-wide study of adults with clinical and radiologically confirmed CES. This aims to describe presentation, management and outcomes of patients with CES.

A network of trainee surgeons co-ordinated through the British Neurosurgery Trainee Research Collaborative (BNTRC) and the British Orthopaedic Trainee Association (BOTA) are identifying and recruiting emergency admissions with CES. The study uses both clinician reported data and patient reported data. Trainees enter data about admission, investigation, management, and initial outcomes in a secure online database. Patients report admission pathways plus outcome measures at discharge, six months and 12 months using secure emailed questionnaires. Outcome measures include visual analogue scales for back and leg pain, the Oswestry Disability Index, the neurogenic bowel dysfunction score, the short form incontinence questionnaire, and the Arizona sexual experiences scale.

At the end of October 2018 there were 24 UK centres recruiting patients, nine centres with research approvals who have not yet recruited their first patient, and nine centres awaiting local approval. There were 152 patients recruited to the study. Ninety six patients (63%) had completed both admission and discharge surveys. Recruitment will continue until May 2019. We plan to check discharge coding to improve recruitment and ensure case ascertainment, and send questionnaire reminders to increase the response rate further.

A comparison of large and small footprint cages for transforaminal lumbar interbody fusion—a biomechanical, radiological and clinical study

Elena Provaggi[1], Galateia Katzouraki[2], Yu Chao Lee[2], Lester Wilson[2], Mehran Moazen[3], Claudio Capelli[4], Deepak Kalaskar[1], Robert Lee[2], Zin Mon[2]
[1]UCL Institute of Orthopaedics and Musculoskeletal Science, Division of Surgery & Interventional Science, University College London, London, UK [2]Royal National Orthopaedic Hospital, Stanmore, UK [3]UCL Mechanical Engineering, University College London, London, UK [4]Institute of Cardiovascular Science, Great Ormond Street Hospital for Children, London, UK

Transforaminal lumbar interbody fusion (TLIF) is a common technique used to achieve circumferential fusion across a spinal segment. TLIF features a small working window through the Kambin's triangle; therefore a small cage design, typically 10mm width or less, is utilised. As 80% of axial load is supported anteriorly by the vertebral column, the surface area of an interbody cage is an important factor that contributes to the stability of the fused segment, fusion rates and stress distribution across bone-implant interface.

We hypothesised that a larger, 14mm, TLIF cage width (LC) can be safely implanted with improved results compared to 10mm cage (SC). A finite element (FE) model of an L5-S1 segment was developed to simulate *in vitro* the performance of the two cages. In addition, a retrospective study was undertaken on a prospectively collected data of a single surgeon case series, to compare the clinical and radiological outcomes on patient who underwent TLIF using SC (n=17) and LC (n=33). Our FE model showed a 6% reduction in the segmental range of motion (ROM) using LC compared to SC. There was a higher incidence of radiological subsidence (30%, mean=3mm) in SC group compared to LC group (9%, mean=2mm). There was one case of nonunion in SC group while all LC group went on to unite. There was a trend towards better clinical outcome (VAS and ODI) in the LC group.

In conclusion, TLIF using the larger 14mm is safe, with less radiological subsidence and nonunion, with a trend towards better clinical outcome.

Prognostic indicators of surgical outcome in foot drop from lumbar degenerative disease—a systematic review and meta-analysis

Fozia Saeed[1], Soumya Mukherjee[1], Joel Kerry[1], Debasish Pal[1]
[1]Leeds General Infirmary, Leeds, UK

Introduction
Painful foot drop is a rare presentation of lumbar degenerative

disease and there is a paucity of evidence (no meta-analyses or randomised-controlled trials) in the literature assessing surgical treatment and potential factors influencing outcome.

Aim
This systematic review and meta-analysis aimed to determine the effectiveness of lumbar decompression on the resolution of painful foot drop and the factors that influence 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. Data were pooled using a random effects model.

Results
Seven-hundred-and-ninety-seven studies were screened, eight observational studies met the inclusion criteria, and a total of 248 patients were included. Pooled rates of outcome for improvement in foot drop Medical Research Council (MRC) grade were 83.1% (range, 65.2%–94.1%). Sub-group meta-analyses revealed a significant association between outcome and i) duration of foot drop ≤6 weeks vs. >6 weeks (pooled OR 5.38 [95% CI 1.29-22.38]); ii) severity of pre-operative weakness of MRC grade 0-1 versus 2–3 (pooled OR 0.34 [95% CI 0.12-0.92]).

Conclusion
This is the first meta-analysis to evaluate the prognostic indicators of lumbar decompression surgery for painful foot drop. Shorter duration of symptoms and greater pre-operative MRC grade of foot drop strongly predicted a positive outcome. A prospective multi-centre trial on early surgery is proposed.

A comparison of unilateral—over the top—laminotomy with bilateral laminotomy for lumbar spinal stenosis

Anthony Marino[1], Osama Mahmoud[1], Athanasios Papachristou[1], Saravanam Ramaswamy[1]
[1]New Cross Hospital, Royal Wolverhampton NHS Trust, Wolverhampton, UK

Introduction
Both unilateral—over the top—laminotomy and bilateral laminotomy have gained widespread use as alternatives to conventional laminectomy for bilateral decompression of central canal stenosis for neurogenic claudication.

Aim
Direct comparison of surgical outcome measures between unilateral over the top laminotomy and bilateral laminotomy.

Study design
Retrospective cohort study.

Patient sample
We present a consecutive series of 50 patients undergoing uninstrumented lumbar decompression surgery for central canal stenosis at our hospital.

Outcome measures
Operative time, hospital in-patient stay, improvement in walking tolerance and dural tear rate.

Methods
Consecutive series of 25 patients undergoing unilateral over the top lumbar laminotomy and 25 patients undergoing bilateral lumbar laminotomy followed up for an average of eight months.

Results
Unilateral over the top lumbar laminotomy procedures took on average 20 minutes less operative time per case, with average in-patient stay two days compared to five days with bilateral laminotomy (for single level surgery). Average improvement in walking time was comparable between the two techniques (unilateral OTT laminotomy 32 minutes, bilateral laminotomy 34 minutes). Dural tear rate for single level decompression was 4% with unilateral OTT lumbar laminotomy and 8% for bilateral laminotomy.

Conclusion
At average follow up of eight months, the clinical outcome was similar with walking time improvement to over 30 minutes in both groups but with lower average operative time, lower in hospital stay and lower dural tear rate with unilateral over the top laminotomy.

Lumbar fusion in elderly patients—a systematic review and meta-analysis of clinical and functional outcomes

Mahesh Akula[1], Jetan Badhiwala[2], Ajay Asokan[1], Yeswanth Akula[3], Michael Fehlings[2]
[1]Basildon & Thurrock University Hospital, Basildon, UK [2]Krembil Neuroscience Centre, University of Toronto, Canada [3]Brighton & Sussex University, Brighton, UK

To evaluate the justification of performing instrumented lumbar arthrodesis in elderly patients; comparing the quality of life, reduction in disability and pain, against overall morbidity, mortality, and complications. Resulting in information to aid surgeons, anaesthetists, and hospital administrators in planning patient care and resources.

This systematic review of the literature was performed using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines. Clinical and functional outcomes data using Oswestry Disability Index, Japanese Orthopaedic Association scores and pain intensity using visual analogue scale extracted and subjected to meta-analysis.

Mortality rate was 2.5%. Mean estimated blood loss was 491mL

and operative duration 195.5 minutes. Systemic complications: arrhythmia, 4.6%; CHF, 3.1%; pneumonia/respiratory distress, 5.4%; delirium, 7.1%; stroke, 2.1%; UTI, 5.0%; renal failure, 3.8%; DVT, 2.2%; PE, 2.7%; ileus, 7.1%; MI, 2.7%. SIADH, 1.8%; Spinal complications include neurological deficit, 3.6%; PJKs, 4.0%; pseudoarthrosis, 8.5%; seroma/dehiscence, 3.7%; wound infection, 4.2%; adjacent segment degeneration, 5.4%; dural tear, 6.7%; hardware failure, 2.8%; epidural hematoma, 5.0%. Postoperative functional/clinical outcomes: mean reduction in VAS for the pain of 3.7; reduction in the disability index (ODI) of 37.1 and an improvement in the JOA of 10.6.

Lumbar fusion surgeries improve the quality of life in the elderly population, evidenced by the reduction in disability and improvement of function and pain. However, in view of the high rates of morbidity; we recommend a balanced approach for each case. This study provides additional information to guide operative staff in planning peri- and postoperative care in a challenging demographic.

Transforaminal epidural steroid injections for lumbar radiculopathy—a comparison of conventional fluoroscopic and CT guided injections

Mahesh Akula[1], Jozef Kamp[1], Yeswanth Akula[2], Amr Fahmy[1], Rumana Hossain[1]
[1]Basildon & Thurrock University Hospital, Basildon, UK [2]Brighton and Sussex Medical School, Brighton, UK

Patients with lumbar radiculopathy with a corresponding lateral recess or foraminal stenosis routinely undergo steroid injections prior to considering surgery. This study aims to compare the safety, efficacy, and cost-effectiveness of transforaminal nerve root injections between conventional fluoroscopy (FGI) and CT guided (CTGI) techniques.

We retrospectively collected data on 92 consecutive transforaminal nerve root injections. 42 FGI and 50 CTGI were included. A successful outcome was considered when the patient was discharged from the service at 6–12 weeks or scheduled for routine yearly follow up. Baseline demographics were similar between each group with a mean age of 56.17 and 53.30, and BMI of 29.53 and 29.97 in the FGI and CTGI groups respectively. We found a significant difference in the mean effective radiation dose with 0.64 mSv in the FGI and 8.44 mSv in the CTGI group ($p = 0.0001$). No complications were reported.

Successful outcome as per methodology criteria was found in 34% of the FGI compared with 40% in the CTGI group, however, this result was not significant using the fisher exact test ($p=0.4865$). The average cost of FGI was found to be 3.6 times that of CTGI with £1,330 and £370 respectively.

Although CTGI has significantly greater radiation dose per procedure than FGI, the technique is associated with at least equivalent efficacy at a significantly reduced cost. Efforts should be made by proceduralists to minimise radiation exposure to further improve the benefit: risk ratio of CTGI.

Rotational capsular tissue shaving and controlled thermal energy ablation system in lumbar facet joint syndrome: a prospective study

Pranaw Kumar[1], Harsha Haraluru Jayanna[1], Vikas Kapoor[1]
[1]Stepping Hill Hospital, UK

Lumbar facet joint syndrome (FJS) has been estimated to account for as many as 30% of chronic low back pain cases. A minimally invasive system of rotational capsular tissue shaving and controlled thermal energy ablation of the facet joint to get more extensive pain control could result in sustained pain relief and improve the health indices of mobility.

This study included patients who had failed conservative treatment for chronic intractable low back pain resulting from FJS. Patients treated between July 2017 and June 2018 were evaluated for joints treated, pain and quality of life as measured by the visual analogue scale (VAS), Oswestry Disability Index (ODI), EQ-5D-5L and analgesic use. Follow up done at one, three and six months post-treatment and the corresponding data reported. A total of 33 patients (39.3% males) with an average age of 50.7 years were evaluated.

Prior to treatment 17.2 % patients regularly used one or more prescribed analgesics and most had undergone either physiotherapy or spinal injections or both to alleviate pain. The minimum follow up was four weeks (33; 100%), 25 had three months follow up, 16 (48 %) had six months follow up and eight had one year follow up. Majority of patients underwent Bilateral (six joints) L3/L4, L4/L5 & L5/S1. VAS scoring improved significantly with average being 70% compared to initial scores, back pain scored higher with 80% improvement and activities of daily living showed remarkable improvement. EQ-5D-5L scores post-treatment remained significantly below baseline values.

Early results of the BANDAIDE shared consultation programme for back and neck pain

George Ampat[1]
[1]Talita Cumi, UK

Introduction

Bandaide—Back and neck discomfort relief with altered beliefs, intelligent postures, dynamic movement and exercises—is a group /shared consultation programme that involves exercise and information dissemination to decrease fear and increase activity in

patients with back and neck pain.

Methods
The programme can be delivered over four to 12 contact sessions either over a period of six weeks or over a period of three months. Each patient has an individual private consultation followed by multiple shared consultations. Outcome was analysed by comparing the pre and post intervention, numerical rating scales of back and neck pain, Roland Morris low back disability score, Northwick Park neck disability score, global rating of change and an 11-point Likert scale of confidence gained in using exercise to address their spinal pain.

Results
We report interim results of the standard 12 contact sessions completed by nine participants. The results are as follows: NRS scale of back pain (before=7.9, after=5.7); Roland Morris (before =13/24, after=10/24); Northwick Park neck disability (before= 44, after=30), global rating of change (before=0.7, after=4.3); confidence (before=4.4, after=7.3).

Conclusion
Our results show moderate improvement in outcomes over a six week period with information and exercise to address back and neck pain. Though exercise in an integral part of our programme, more focus is placed on information dissemination. Patients are encouraged to self manage and avoid surgical intervention.

To drain or not to drain? A comparison of the peri-operative outcomes in instrumented lumbar spinal fusions

Tirun Joshi[1], Himanshu Sharma[2]
[1]University of Plymouth Faculty of Medicine and Dentistry, Plymouth, UK [2]Plymouth Spinal Services, South West Neurosurgery Centre, Plymouth, UK [3]Derriford Hospital, Plymouth, UK

Introduction
There is no published literature on using or not using a wound drain in instrumented lumbar spinal fusion procedures. The aim was to assess the peri-operative outcomes with regard to surgical site infection (SSI) and need for blood transfusion in patients with and without a closed suction wound drain in patients undergoing postero-lateral instrumented lumbar spinal fusions.

Methods
Retrospective analysis of 149 patients under care of two spinal surgeons between 2013–2015. Patient demography, haemoglobin level, blood transfusion, infection, revisit to theatre for wound haematoma or infection and peri-operative outcomes were extracted from medical records on consultant A (no drain used; 74 patients) or consultant B (drain used; 75 patients). Revision spinal fusion procedures were excluded.

Results
There was no statistically significant differences in the incidence of SSI in patients without drain compared to with drain (4.05% vs 5.33%, p=0.712). There was statistically significant greater mean pre- to postoperative change of Hb levels, -4.48g/L (95% confidence interval, -8.73 to -0.23) between the patients without drain compared to with drain (-38.95g/L vs -34.47g/L, p=0.039). There was statistically significant increase in the incidence of peri-operative blood transfusion in patients without drain compared to with drain (22.97% vs 10.67%, p=0.044).

Conclusion
The incidence of SSI with and without drain was similar. This study showed statistically significant difference in the incidence of post-haemorrhagic anaemia and need for peri-operative blood transfusion in patients without drain compared to with drain. Use of a wound drain in instrumented lumbar surgery could be left at the surgeon's discretion.

Prevalence of degenerative hip, sacroiliac, L5-S1 facet joints and L5-S1 intervertebral disc changes in CT imaging of the general population

Alex Pearce[1], Abdul Moideen[2], Sanjit Singh[2], Chris Woodward[2], Simeon Holland[2], Samantha Leong[2], Kueniemugh Igbagiri[2], Zayd Jawad[2], Sashin Ahuja[2], [3]
[1]Cardiff University Medical School, Cardiff, UK [2]Trauma and Orthopaedics, University Hospital of Wales, Cardiff, UK [3]Welsh Centre for Spinal Surgery, Cardiff, UK

Introduction
This study sought to determine the prevalence of degenerative changes of: hip joints; sacroiliac joints (SIJ); L5-S1 facet joints (FJ); and of L5-S1 intervertebral disc (IVD) in CT imaging of the general population. Although previous studies have determined the incidence of degeneration for each of these joints individually, this is the first such study investigating degeneration of all four joints and correlation between them.

Methods
We analysed 525 pelvic CTs (performed as part of the trauma series or tumour screening). The extent of degeneration of: hip, SIJs, FJs and IVDs were graded according to the: Kellgren; Eno ***et al*** (currently unvalidated); Weishaupt; and Lane classifications respectively. Combinations of degenerated joints were also recorded.

Results
In this sample, degenerative changes (grade ≥1 degeneration) were found in: 58.76% of hips; 58.67% SIJs; 57.90% FJs; and 54.48% IVDs. Results also showed the prevalence of degeneration for different age ranges (20–29, 30–39, 40–49, 50–59, 60–69, 70–79, 80–89, 90–99,100+), both left and right joints (where applicable), and both males and females. Combinations of degenerated joints were also analysed for correlation.

Conclusion
Expectedly, unilateral and bilateral degeneration increase with age. IVD and SIJ degeneration appears to show relatively high prevalence in the younger age ranges. Uniquely, this study suggests that incidence of multi-joint degeneration spikes at 50–59 (incidence of no multi-site degeneration plummets from 69.49% to 35%). Significant prevalence of degeneration of all four joints (25.88%) and of the FJ+SI+HIP (20%) also appears to emerge at 60–69. Furthermore, the results also suggest that combinations involving the SIJ develop early (at 30–39).

The treatment of dural tears in the literature: drowning in information but starving for a clear message

Zeiad Alshameeri[1], Ahmed El-Mubarak[1], Ed Kim[1], Vinay Jasani[1]
[1]University Hospital North Midlands, Stoke-on-Trent, UK

Introduction
The reported treatment of dural tears in degenerative spinal surgery has varied significantly in the literature and therefore the aim was to review the reported methods and compare their outcome.

Methods
A systemic literature search was conducted on PubMed database using specific mesh words. Articles reporting on the treatment and outcome of dural tears were selected and reviewed based on specific inclusion and exclusion criteria.

Results
All the identified studies were level 4 evidence; retrospective case series or case control studies. The ported methods of dural tear repair varied significantly amongst studies and many used combination of surgical techniques. The failure rate of Dural repair (regardless of the treatment) ranged from 0%–38.1%, given and unadjusted pooled failure rate of 7.9% (95% CI4.1–11.7%). The failure rate varied significantly among the surgical techniques with no clear pattern and no association to the complexity of the repair.

Conclusion
The outcome of dural tears more likely to be determined by the complexity of the original tear rather than the technique employed in repairing the dura. The significant variation in the reported treatments makes it imperative to classify these tears and standardise the treatment approach in order to facilitate future comparison studies.

Spinal Injuries

Limited sequence magnetic resonance imaging to improve standards of care for suspected cauda equina syndrome

Ramal Gnanasekaran[1], Nicolas Beresford Cleary[1], Tariq Aboelmagd[1], Karim Aboelmagd[1], Katherine Butler[2], Daniel Rolton[1], Richard Hudges[2], Edward Seel[2], Stuart Blagg[2]
[1]Royal Berkshire Hospital, UK [2]Stoke Mandeville Hospital, UK

Introduction
Early cases of cauda equina often present with non-specific symptoms and signs and therefore, it is recommended that patients undergo an emergency MRI regardless of the time. However, this leads to significant pressure on resources with many scans being performed to rule out cauda equina rather than confirm it. We hypothesise that compression of the cauda equina should be apparent with a limited sequence that takes significantly less time.

Methods
Patients with suspected cauda equina underwent a limited sequence lumbosacral MRI between the beginning of September 2017 and end of July 2018. These images were read by a consultant musculoskeletal radiologist. All images took place on a 3T or 1.5T MRI scanner at Stoke Mandeville Hospital, Aylesbury, UK and the Royal Berkshire Hospital, Reading, UK.

Results
There were 239 patients that underwent 247 limited lumbar-sacral MRI scans for suspected cauda equina. Of these patients, 20 had a cauda equina compression and underwent an emergency decompression. No cases of cauda equina were missed. Patients spent 9.94 minutes on average in the MRI scanner.

Conclusion
A limited sequence lumbosacral MRI can be used to diagnose cauda equina safely and take considerably less time to perform. Further research is needed to assess if limited sequence MRIs can be used throughout the spine and there must be a low threshold to consider repeated imaging with a full sequence MRI if alternative pathology is being considered.

Risks and benefits of prolonged bed rest: are we misinformed?

Wisam Selbi[1], Jason Yuen[1], Tim Germon[1]
[1]South West Neurosurgery Centre, Derriford Hospital, Plymouth, UK

Aim
Instrumentation to stabilise the spine enables early mobilisation and avoids complications of prolonged bed rest. Surgeons are well known to underestimate the complication rate of surgery but could they also over-estimate the risks of bed rest. We identified patients treated with prolonged bed rest to manage spinal instability and recorded outcome and complications.

Methods
Single centre retrospective case series from 2010–2016. Patients identified through clinical coding. Inclusion criteria were patients with spinal pathology who were managed with prolonged bed rest. We recorded demographics, underlying diagnosis, reason for preference for conservative management, traction, duration of bed rest, complications and outcomes (clinical and radiological).

Results
Twenty patients were identified (14 male, six female, mean age 53.5). The mean duration of bed rest was 48.3 days. Underlying diagnosis was 15 traumatic, four infection and one tumour. One patient had delayed diagnosis. Five had new neurological deficit on presentation. Reasons for opting for bed rest were osteoporosis (four), significant comorbidities (four), severe head injury (one) and patient choice (11). Radiological follow up was completed for 16 patients with evidence of satisfactory healing and no worsening of deformity in three–four months. One patient deteriorated neurologically 10 months post-injury because of new discitis. Four patients developed chest infection, two had paralytic ileus and 0 had thrombo-embolism or significant pressure sores. One mortality after 60 days from admission.

Conclusion
Conservative management of spinal instability does not appear to have a high complication rate and outcomes are good. Perhaps we are undertaking surgery based on erroneous assumptions?

Trauma

Length of survival after conservative management of type II odontoid fractures in older adults: a cross-sectional observational study

Suzanne McIlroy[1], Gordan Grahovac[1], Jordan Lam[2], Asfand Mirza[1], M Faheem Khan[1], Jerry Philip[1], David Bell[1]
[1]King's College Hospital NHS Foundation Trust, London, UK [2]University College London, London, UK

Introduction
Type II odontoid fractures are the most common cervical spine fractures in the elderly. Lower osseous-union is reported in those treated conservatively compared to surgically, however, the clinical relevance of the non-union is not known.

Aims
To compare length of survival in older adults (≥65years) with non-union vs. union, and stable versus unstable non-union conservatively managed type II odontoid fractures.

Methods
Electronic records were searched from 2008–2018 for adults ≥65 years with type II odontoid fracture, managed with a hard collar at a single tertiary London hospital. Clinical and demographic data was retrieved from electronic patient notes. Radiological reports were used to determine osseous-union and stability. Kaplan Meier curves were plotted to compare length of survival, the log-rank test was calculated to determine significance.

Results
One-hundred-and-twenty-seven subjects were identified (52 male), 53 had deceased. Mean age at fracture: 82.8 years (standard deviation (SD)7.4). 20 (15.7%) demonstrated osseous-union; 13 (10.2%) partial-union; 94 (74%) had established non-union of which 56.3% were stable non-unions. Mean survival (months (SD)): osseous union 77.1 (8.9); non-union 53.7(4.5) (stable 49.5 (4.0); unstable 45.0 (5.1)). Length of survival was statistically significant (p=0.04) with osseous-union versus non-union. There was no statistical significant difference in stable vs. unstable non-union or in younger (65–79 years) or older (≥80 years) age group.

Conclusion
In older adults managed conservatively for type II odontoid fractures those with osseous-union demonstrate a statistically significant longer length of survival vs. those with non-union. Stable vs. unstable of established non-union of type II odontoid fractures does not affect length of survival.

Management of C2 odontoid peg frailty fractures—a UK survey of spinal surgeons

Anna Watts[1], Michael Athanassacopoulos[1], Lee Breakwell[1], Neil Chiverton[1], Ashley Cole[1], Marcel Ivanov[1], Antony Louis Rex Michael[1], James Tomlinson[1]
[1]Sheffield Teaching Hospitals, Sheffield, UK

Frailty fractures are a major challenge to current healthcare systems. Fractures of the odontoid peg have poor outcomes with similar morbidity and mortality as hip fractures. However, unlike hip fractures, management of odontoid peg fractures is varied with little consensus on best practice.

A 10-item questionnaire was distributed via the BOA, SBNS and email to UK surgeons (consultants and fellows). All items concerned the management of a hypothetical 80-year-old male with a type II peg fracture. Questions included treatment modality, follow up regime, and use of imaging.

One-hundred-and-seven responses were received. There was marked variation in multiple domains of management. Treatment varied from conservative (analgesia 8%, soft collar 14%, hard collar 72%) to operative management (halo 3% and internal fixation 3%). Time to first follow up ranged from one–six weeks, or in some cases never. Multiple investigations were suggested throughout follow up: Plain AP radiographs (77%), flexion/extension views (18%) and CT (10%). In 30% of responses radiographic non-union at final follow up would be treated. Those who would provide further treatment were split between operative intervention (25%) and further immobilisation with a collar (5%).

This survey demonstrates marked variation in the treatment of type II peg fractures, an injury shown to have high morbidity and mortality. Robust research and standardisation of practice have improved outcomes from hip fractures. There is therefore a strong case for randomised controlled trials to define best practice and improve outcomes from these injuries.

Functional outcome of kyphoplasty in osteoporotic vertebral fractures

Taher Yousri[1], Awaiz Ahmed[1], Matthew Smith[1], Michael Kotrba[1]
[1]*Croydon University Hospital, UK*

Vertebral osteoporotic fractures are a worldwide problem and can be the cause of significant morbidity. This was a planned retrospective analysis of a group of patients who underwent kyphoplasty over a period of 10 years, between August 2007 and February 2017. Data was populated into a database for analysis, including pre- and postoperative ODI scores. A total of 250 patients were retrieved off the spinal database, of those it was only possible to retrieve the phone numbers of 177 patients.

Average time to review post surgery was 2.4 years ranging from 0.2–8 years follow up. Data normality was tested using the Shapiro-Wilk test and was of normal distribution. Paired t-test was used to compare the pre-operative and postoperative OD. The pre-operative mean was 28% and the postoperative mean was 17.7%. Paired t-test showed this change not to be statistically significant ($p>0.05$). Clinically however the mean score changed from medium to minimal disability according to the validated ODI (eight). Sixty-five patients constituting the majority had a severe disability pre-operatively. The pre-operative mean changed from 68.7% pre-operatively to 40.2 postoperatively. Paired sample t-test showed this change to be statistically significant.

We have shown that balloon kyphoplasty can significantly improve patients' functional outcome in the short and medium term, consistent with results from the literature. Kyphoplasty can help improve patients' treatment journey at time of severe pain and disability.

The role of coccygeal injections and coccygectomy in treating coccydynia

Dinnish Baskaran[1], Saajid Kaleel[1], David Cummings[1], Alistair Hudd[1], Robert Lovell[1], John Powell[1], David Sharp[1]
[1]*Ipswich Hospital, Ipswich, UK*

Introduction
Coccydynia is a condition characterised by pain affecting the terminal segment of the spinal column and has a predisposition for female and obese patients. Non-operative treatment has been reported to be successful in 50–90% of patients. Operative treatment includes steroid injections or coccygectomy. We wanted to assess the role of operative intervention in treating coccydynia refractory to conservative measures.

Methods
We retrospectively reviewed operatively managed coccydynia patients at a regional tertiary spinal unit from 2010–2017 using referral letters, outpatient clinic correspondences, radiological records and discharge letters.

Results
Forty-six patients (seven males, 39 females) with an age range from 16–80 were included. No pathological causes were identified on MRI imaging studies. There was an average of 2.7 injections per patient and the average period of symptomatic relief was three months. Five patients were treated successfully with coccygeal injections, four patients had ongoing symptoms, 23 patients underwent coccygectomy and 14 patients were lost to follow up. In the operated group two developed wound complications and seven had ongoing pain at three months follow up.

Conclusion
Our experience demonstrated that coccydynia is a difficult condition to manage non-operatively and steroid injections only provide temporary relief in most patients. Patients should be counselled that coccygectomy does not always provide symptomatic relief.

Tumour

Five-year single-centre experience in management of multi-compartmental nerve sheath tumours: a case series

Ardalan Zolnourian[1], Ahmed-Ramadan Sadek[1], Khaled Amer[2], Ali Nader-Sepahi[1]
[1]*Wessex Neurological Centre, Southampton, UK* [2]*University Hospital Southampton, Southampton, UK*

Introduction
Primary spinal tumours are relatively uncommon. Those extramedullary tumours that involve multiple compartments can be technically challenging. Surgical management of these patients will therefore require a multi-disciplinary approach with comprehensive surgical planning.

Methods
Electronic and medical notes of all patients who underwent surgical resection of tumours from 2014–2018 were screened retrospectively. Only those tumours requiring a multi-disciplinary surgical approach were included.

Results
Twelve patients fulfilled the inclusion criteria, six thoracic, five lumbar and one sacral. Thoracic tumours required an experienced cardiothoracic surgeon to remove the tumour anteriorly after posterior disconnection. This was performed over two stages in three patients, and in single-stage for the rest. All lumbar tumours were resected with the aid of an access general/urological surgeon. The only sacral case in the series was completed using the expertise of a urologist. Eleven cases were diagnosed with schwanomma and one with a neurofibroma. Length of stay ranged between 1–15 days (median five days). Eight patients had no complications, three had mild sensory disturbances and one suffered motor weakness which improved with time. Only one patient has shown signs of radiological recurrence.

Conclusion
Management of patients with multi-compartmental nerve sheath tumours is a challenging aspect of spinal surgery. Careful appraisal of the extent of the tumour by both the radiologist and surgeons is an essential component of pre-operative planning and facilitates complete resection in a single operation. Large and more complex lesions may require a two-stage procedure.

Staging investigations employed in the diagnosis of chordomas

Inga Usher[1], Paul O'Donnell[2], David Choi[1]
[1]*The National Hospital for Neurology and Neurosurgery, London, UK*
[2]*The Royal National Orthopaedic Hospital, Stanmore, UK*

Introduction
Chordomas are rare primary tumours of the spine. These tumours affect the axial skeleton and 40% reportedly metastasise. Guidelines based on expert consensus were published in 2015 making recommendations regarding radiological investigations to be undertaken for staging patients, however adoption of the guidelines at centres is variable. We sought to capture current practice at our centre, which is a specialist centre, by documenting the radiological examinations performed in our patient population and whether these yielded positive results.

Methods
We identified our cohort of patients with chordoma by searching electronic hospital systems using free and ICD-10/OPCS-4 codes. We then reviewed the records of the patients on our picture archiving and communication system.

Results
We identified a cohort of 42 patients with chordomas. Eight of 42 (19.5%) underwent whole spine magnetic resonance imaging; none had evidence of a coexistent benign notochordal cell tumour. seven of 42 (17.1%) underwent a computed tomography chest scan, revealing metastases in two of these seven patients (28.6%). Positron emission tomography was performed in five of 42 (12.2%) and a radionuclide bone scan in four of 42 (9.8%) of patients.

Conclusion
Although the guidelines recommend magnetic resonance imaging of the whole spine, this was rarely performed at our centre. Chest computed tomography is not recommended in the guidelines but detected chest lesions in a third of our patients in whom the test was employed for specific clinical reasons. The number of patients who had full staging investigations was low but the yield was relatively high and may influence clinical management.

L5 corpectomy and reconstruction: a systematic review of outcomes following conventional two-stage posterior-anterior, anterior-only or posterior-only approaches

Daniel D'Aquino[1], Aaron Hilis[1], Nigil Sadanandan[2], Kedar Deogaonkar[2], Nasir Quraishi[1]
[1]*Centre for Spinal Studies and Surgery, Queen's Medical Centre, Nottingham, UK* [2]*PD Hinduja National Hospital, Mumbai, India*

Introduction
L5 corpectomy constitutes a significant surgical challenge on account of the anatomy of the lumbosacral junction. A combined posterior-anterior stabilisation and reconstruction is conventionally employed. There are acknowledged problems, however, with 360-degree surgical strategies in terms of higher complication risk, blood loss and length of stay in comparison to anterior or posterior-only procedures.

Aim
To compare the efficacy and safety of conventional two-stage posterior-anterior, anterior-only and posterior-only approaches to L5 corpectomy and reconstruction.

Methods
A systematic review of the English language literature was undertaken for all articles relating to L5 corpectomy published between 1970–March 2018. Findings were presented following Preferred Reporting Items for Systematic Reviews and Meta-

Analyses (PRISMA) guidelines. Level of evidence was evaluated according to Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria.

Results
Five articles meeting inclusion criteria were identified (n=74). All surgical approaches shared high fusion rates (94%) and relatively low complication rates. However, surgical strategies incorporating an anterior approach were notable for vascular complications (4–7%) as well as peri-operative mortality (9%) not seen in the posterior-only surgery group. The burden of peri-operative complications almost exclusively related to the anterior surgical approach.

Conclusion
Although limited by strength of evidence, the review shows a consistent finding of good fusion rates and relatively low complication rates across all surgical strategies. However, accepting anatomy and pathology as paramount determinants, there may be an advantage in the posterior-only strategy in terms of lower complication rates, blood loss and time to mobilisation without apparent compromise to fusion and construct stability.

Expected metastatic spine outcomes (EMSO): a four-year review of patients' survival and neurology

Sheweidin Aziz[1], Vaarun Burgula[1], Ali Shetawi[1], Partha Basu[1], Wai Weng Yoon[1]
[1]*University Hospitals of Leicester NHS Trust, Leicester, UK*

Aim
Identify survival rates and neurological outcomes of operatively and non-operatively managed patients presenting with metastatic spinal cord compression.

Methods
Prospective data collection/analysis over a four-year period. A total of 397 patients identified; all of whom were discussed in a multidisciplinary forum. Minimum follow up of six months. Non-operatively managed patients that were placed on a palliative pathway or those who died within 72 hours were excluded from the analysis.

Results
A total of 397 patients were identified in the study, 59.2% were males (235/397) and 40.8% were females (162/397). A mean age of 66.8 years (Median 69, mode 72 and range 18–94 years). A greater proportion of patients were managed non-operatively representing 62.2% (255/397). Prostate, lung, breast, myeloma, renal cell carcinoma (RCC) and lymphoma accounted for over 75% of all primary tumours (n=305). The commonest occurring tumours were included in the analysis. The overall 90-day survival amongst these patients was 97.2% and 84.4% for operative management and non-operative management respectively ($p<0.0001$). Operatively managed patients showed maintenance or improvement in function (weight bearing or ambulatory status) in 72.5% (103/142) of cases compared to 68.6% (175/255) in the non-operatively managed group (p=ns). There was a deterioration in functional outcome (bed bound but moving or paralysed) in 19.7% (24/142) in the operative group and 10.6% (27/255) in the non-operative group ($p=0.0024$).

Conclusion
Operative intervention certainly maintains/improves neurological function in patients with MSCC where a multi-disciplinary team approach is adopted.

Britspine 2018 Podium Abstracts

Paper Session 1 – Paediatric Spine

What is an acceptable failure rate for a new spinal implant?

Tom Joyce[1], Simon Smith[1], Paul Rushton[2], Andrew Bowey[2], Mike Gibson[2]
[1]Newcastle University, Newcastle, UK [2]Royal Victoria Infirmary, Newcastle, UK

Introduction
Magnetically controlled growing rods (MCGRs) are increasingly the treatment of choice for early onset scoliosis. However, failures of MCGR have been reported clinically, sometimes with metallosis surrounding the rods.

Methods
Fifty explanted MCGR, from seven UK spinal centres, were visually assessed before being cut open to allow internal components to be evaluated. Any internal debris was identified using energy-dispersive X-ray spectroscopy (EDX).

Results
Externally, all MCGR rods showed localised marks, termed 'growth marks' as they indicated growth of the rod *in vivo*, on the extending bar component. After cutting open, titanium wear debris was found inside all 50 (100%) MCGR. Eighty-eight per cent (44/50) of MCGR showed measurable wear of the extending bar, towards the magnet end. Substantial damage to the radial bearing was seen inside 74% (37/50) of MCGR rods, O-ring seal failure was seen in 56% (28/50) of cases and 46% (23/50) of the MCGR had a fractured drive pin.

Conclusion
The combination of high volumes of titanium wear debris alongside O-ring seal damage likely accounts for the metallosis reported clinically around some MCGR. Based on this explant data, a failure mechanism in MCGR due to the natural off-axis loading in the spine is proposed. This is the largest dataset reporting a complete analysis of explanted MCGR to date. While conventional growing rods fail, and the British Spine Registry is nascent so we can only estimate how many MCGR have been implanted, the amount of damage seen with explanted MCGR is of concern.

Risk factors for proximal junction kyphosis (PJK) in Scheurmann's kyphosis (SK)

Vishal Sarwahi[1], Jesse Galina[1], Stephen Wendolowski[1], Sara Gargent[2], Sean Molloy[3], Hai Ming Yu[4], Adam Benton[3], Alex Gibson[3], Darren Lui[2]
[1]Cohen Children's Medical Center, New York, USA [2]St. George's Hospital, London, UK [3]Royal National Orthopaedic Hospital, London, UK [4]The Second Affiliated Hospital of Fujian Medical University, Fujian China

Introduction
In SK, PJK has been reported with hybrid fixation in the presence of shorter fusions. The literature is deficient about PJK in SK with all pedicle screw constructs.

Methods
X-ray and chart review of all SK patients operated with all pedicle screw (PS), hybrid fixation (HF), and anterior/posterior fusions with hybrid fixation (AP) were reviewed. Fusion length, per cent correction, UIV, LIV, pre and postop PJK, sagittal balance, and demographic data was collected. PJK was defined as more than 10 degrees.

Results
Eighty-four total patients: PS (n=29), HF (n=24), and AP (n=31). Pre-operative kyphosis was significantly higher in the AP compared to PS and HF (89 vs. 77 vs. 81.5, $p<0.001$). Postoperative kyphosis was significantly higher for PS (50.3 vs. HF: 45.5 vs. AP: 43, $p=0.048$). Per cent correction was highest for AP (51.8 vs. HF: 43.8 vs. PS: 32.9, $p<0.001$). Pre and post sagittal balance was similar. Postoperatively, 47.6% of patients had PJK, and at final, 70.2%. Postoperative PJK was significantly higher in PS (13.4 vs. HF: 7.8 vs. AP: 8, $p=0.008$). However, final PJK was similar (PS: 19 vs. HF:15 vs. AP:14, $p=0.07$). Most common UIV was T2 for AP (71%) and HF (71%) compared to T3 for PS (59%), $p<0.001$). Significantly higher postop-PJK was seen with UIV below T3 (13.7 vs 9.4, $p=0.043$).

Conclusion
Incidence of PJK appears to be higher in SK compared to that reported in AIS. PS patients appear to be at the highest risk. UIV at T3 or proximally has significantly lower PJK.

Neurophysiological wake-up test in spine cord monitoring—use of the spectral edge frequency

Vinay Jasani[1], Mushtaq Shaikh[2], Abdul Kader Hamad[1]
[1]University Hospitals of North Midlands NHS Trust, Stoke-on-Trent, UK
[2]Bespoke Healthcare, UK

Interoperative neurophysiological monitoring (IOM) is mandatory in deformity surgery with the use of motor evoked potentials (MEP) providing a warning for adverse neurological events. Recording the electroencephalogram (EEG) and calculation of the spectral edge frequency (SEF) is a standard part of IOM. The SEF guides depth of anaesthesia with a depth of 15–17 ideal for IOM. Loss of MEP amplitude to less than 50% of baseline is accepted as a significant event with the risk of a clinical deficit.

The clinical wake up test remains the gold standard to assess if an actual event has occured. This manoeuvre risks breaching sterility and can be stressful for the patient. The delay to full wake up can be considerable and results can be variable resulting in equivocal results or even false positives.

We describe five cases where the MEP amplitude was less than 50% and the usual steps were taken to reverse the event. Due to persistent low amplitude, the patient was lightened to a SEF of 20 indicating light anaesthesia but the patient remained asleep. The repeated MEP response returned to baseline at this SEF. No postoperative clinical deficit was seen despite completion of the procedure. In one case the MEP improved but deteriorated temporarily on repeated attempts at deformity correction. The procedure was abandoned and no clinical deficit was noted.

We believe this neurophysiological wake up to be easier, more accurate and elegant and discuss its place in the protocol responding to loss of MEP during surgery.

Spinal neurofibromatosis type 1: a cross-sectional study

Gayathri Suresh[1,2], Joshi George[2], Mueez Waqar[2], Calvin Soh[2], John Ealing[2], Tina Karabatsou[2]
[1]University of Manchester, Manchester, UK [2]Salford Royal NHS Foundation Trust, Salford, UK

Introduction
Spinal abnormalities are common in neurofibromatosis type 1 (NF1). Spinal NF1 (SNF1) describes an NF1 subgroup with extensive spinal neurofibromas and limited cutaneous findings. The literature surrounding SNF1 is currently sparse. The aim of this single-centre study was to describe spinal findings in a large cohort of NF1 patients with and without SNF1.

Methods
Review of referrals to a national NF1 referral centre (May 2016 to April 2017). Inclusion criteria: adults (≥17 years) with NF1 and at least one spinal abnormality detected on an MRI spine. SNF1 was defined as the presence of bilateral spinal neurofibromas involving the cervical, thoracic and lumbosacral spine, with limited cutaneous findings.

Results
One-hundred-and-forty-nine patients were included of which 26 patients (17.4%) had SNF1. The median age was 37 years (range 17–78 years) with no gender discrepancy (M:F, 77:72). Back pain (52%) was the most commonly reported symptom and significantly associated with abnormal spinal curvature (p=0.048). Scoliosis (66%) of the thoracic spine (71%) was the most common abnormal curvature present. Dural ectasia (28%) was most commonly present in the lumbosacral spine (51%). Most NF1 patients (64%) had spinal neurofibromas. Neurofibromas commonly extended beyond the margins of the intervertebral foramen in the cervical (44%), thoracic (44%) and lumbar spine (47%). The SNF1 subset was significantly associated with intradural tumours (p<0.001), cord compression (p<0.001) and spondylolisthesis (p=0.037).

Conclusion
Patients with SNF1 have a high incidence of mechanical spinal column dysfunction and neurofibroma related complications. This cohort therefore requires close surveillance.

Paper Session 2 – Clinical Science

Lumbar shape is a biomarker of lumbar disc degeneration but does this matter to patients with recurrent low back pain?

Janet Deane[1], Anastasia Pavlova[2], Adrian Lim[3], Richard Aspden[2], Alison H McGregor[1]
[1]MSK LAB, Imperial College London, London, UK [2]Institute of Medical Sciences, University of Aberdeen, Aberdeen, UK [3]Imaging Department, Charing Cross Hospital, Imperial College Healthcare NHS Trust, London, UK

Introduction
Lumbar disc degeneration (LDD) is associated with recurrent low back pain (LBP). Current management paradigms are ineffective. The aim of this study was to evaluate lumbar shape as a biomarker and potential treatment target for LDD patients.

Methods
70 subjects participated (mean 49 years (SD 11)). 3T MRI was used to acquire T2 weighted sagittal images (L1-S1) from asymptomatic volunteers (with LDD (n=24), no LDD (n=19)) and symptomatic LLD patients as part of usual care (n=27). LDD was determined using Pfirrmann grading. Statistical shape modelling (SSM) was used to model the lumbar spine. SSM identified variations in lumbar shape as 'modes' of variation and quantified deviation from the mean. The relationships between lumbar shape, LDD, LBP (VAS) and function (Oswestry, STarT Back) were examined.

Results
The first seven modes of variation explained 91% of variance in lumbar shape. LDD was associated with a larger lumbar lordosis (Mode 1 (55% variance), p=0.02), even lumbar curve distribution (Mode 2 (12% variance), p=0.05), larger vertebral depth (Mode 3 (10% variance), p=0.007) and smaller L4-S1 disc spaces (Mode 7 (2% variance), p≤0.001). LBP did not correlate with LDD or lumbar shape but was highly associated with Oswestry and STarT Back scores (p≤0.001). There were no significant differences in lumbar shape between symptomatic and asymptomatic LDD groups.

Conclusion
Lumbar shape is a suitable biomarker of LDD. LDD related shape differences are not associated with LBP and function. Targeted treatments based upon lumbar shape biomarkers are unlikely to affect LDD patient pain and function.

High-field MR for higher resolution imaging of intervertebral disc (IVD) structures

Nagitha Wijayathunga[1], Steve Tanner[2], John Ridgway[2], Ruth Wilcox[1]
[1]University of Leeds, Leeds, UK [2]Leeds Teaching Hospitals NHS Trust, Leeds, UK

The IVD consists of multiple tissue constituents organised in a complex structural arrangement. Degeneration and pathological processes have significant effect on the IVD structure, resulting in many changes to its arrangement, morphology and composition. MRI is a preferred modality to image soft tissues in the spine. However there are challenges in fully identifying these changes in MRI which can hinder diagnosis. Therefore the aim of this study was to investigate the potential of high-field (3T) MRI to obtain higher quality 2D and 3D volumetric MRI scans of the IVD for better visualisation of soft tissue structures.

Three potentially suitable protocols were investigated (2D Proton-Density Turbo-Spin-Echo (PD), 2D T2-Weighted Turbo-Spin-Echo, 3D Gradient-Echo (GE)), initially on animal tissue and then on cadaveric spines. The acquisition time was kept within clinically comparable levels throughout. Finally transverse acquisitions were compared with high-resolution photographs. These tuned sequences were able to highlight a variety of structural features, including some of the major lamellae in the IVD annulus, due to the combined effect of resolution, signal-to-noise, and relative-contrast. These structural features, including fissures observed on axial acquisitions, matched well with the details seen on IVD section photographs. The contrast and definition of the high-intensity-zone characterising the fissures in T2-weighted images depended on the size and the progress (or severity) of the fissure. The PD sequence captured the gross structure well, while the endplate cartilage layer was hyper-intense on the GE images. These observations, albeit under ***in vitro*** conditions, indicate the potential advantages of these sequences for clinical diagnostics.

Improved biomechanical testing for nucleus augmentation devices

Marlene Mengoni[1], Ruth Coe[1], James Warren[1], Danielle Miles[1], Sebastien Sikora[1], Ruth Wilcox[1]
[1]University of Leeds, Leeds, UK

Intervertebral disc (IVD) degeneration is one of the major causes of back pain. A number of emerging treatments for the condition have failed during clinical trial due to the lack of robust methodologies for biomechnaical testing during the device design stages. The aim of this work was to develop improved *in vitro* testing methods to enable new therapeutic approaches to be examined pre-clinically. It forms part of a wider programme of research to develop a minimally invasive nucleus augmentation procedure using self-assembling hydrogels.

Previous static testing on extracted IVDs have shown large inter-specimen variation in the measured stiffness when specimen hydration and fluid flow were not well controlled. In this work, a method of normalising the hydration state of IVDs prior-to and during compressive testing was developed.

Excised adult bovine IVDs underwent water-pik treatment and a 24-hour agitated bath in monosodium citrate solution to maximise fluid mobility. Specimens were submerged in a saline bath and held under constant pressure for 24 hours, after which the rate of change of displacement was low. Specimens were then cyclically loaded, from which the normalised specimen stiffness was determined.

Compared to previous static tests, the improved method reduced the variation in the normalised specimen stiffness, and enabled longitudinal testing of the same specimen before and after interventions. In addition, statistically significant differences were seen before and after enzymatic degradation to simulate degeneration, thus providing controls against which to evaluate treatments.

This method is now being applied to examine the biomechanical efficacy of hydrogel nucleus augmentation.

Size does not matter: relationship between size of disc prolapse and VAS and ODI scores

Robert Dunsmuir[1], Elaine Wakeham[1], Theresa Hollas[1], Peter Loughenberry[1]
[1]Leeds General Infirmary, Leeds, UK

This project was devised to determine if there is any relationship between the size of a disc prolapse and the pain and disability experienced by each patient. We assumed that a larger disc prolpase would produce greater symptoms.

We obtained a list of microdiscectomy operations in our hospital during 2017. From this list we extracted the data for those patients who had completed there pre-operative VAS and ODI scores. This data was extracted from the British Spine Registry database.

Where complete data was available the MRI for these patients was examined. We used the scan to see which axial section showed the largest cross section of the disc prolapse. We used the Markup Freeform tool on our PACS system (Agfa IMPAX) to determine the cross sectional area of the spinal canal and disc prolapse. From this we measured the cross section area of the spinal canal at this level. We then measured the cross sectional area of the disc prolapse. From these measurements we could determine what percentage of the cross sectional area of the spinal canal was filled with disc. This gave us an assessment of disc size. A Pearson correlation coefficient was determined for percentage space occupied vs. VAS and percentage space occupied and ODI.

Results

Percentage space occupied vs. VAs r=0.21. Percentage space occupied vs. ODI r= -0.02. We conclude that the size of the disc prolapse does not determine the leg pain experienced by the patient nor does it determine the disability each patient experiences.

Paper Session 3 – System Design

Day case discectomy—retrospective analysis of 151 cases

Vishal Borse[1], Mark Nowell[1], Grzegorz Rudol[1], Almas L Khan[1], James Tomlinson[2], PR Loughenbury[1]

[1]Department of Spinal Surgery, The Leeds Teaching Hospitals NHS Trust, Leeds, UK [2]Sheffield Teaching Hospitals NHS Trust, Sheffield,UK

Introduction

Previous studies have suggested day case discectomy is a safe procedure with outcomes equivalent to inpatient procedures. Despite this large series have not been widely reported.

Aim

To assess the outcomes of day case discectomies performed in our unit and allow further development of this service going forwards.

Methods

All discectomies performed within the department over a 44 month period (January 2014–August 2017), were identified from operative databases. A retrospective review of case notes was performed to identify those cases done as a day case. All patients undergoing day case discectomy over this period were reviewed with the primary outcome being re-admission rate. Complication rate was also noted. Self reported pain levels were recorded, and where available ODI scores at postoperative follow up.

Results

One-hundred-and-fifty-one patients were identified as attempted day case discectomy, with 134 (88.7%) being successfully discharged on the day of surgery. Eleven (7.3%) patients were unable to be discharged due to ongoing pain requiring overnight stay. One patient was discharged and re-admitted later that day with post-operative nausea and vomiting that settled overnight. Two patients developed postoperative urinary retention, one patient had a dural tear and two patients required extra physiotherapy input preventing same day discharge. Mean postoperative ODI score was 32.5 at six weeks.

Conclusion

This case series, the largest reported to date, indicates that day case discectomy is a safe procedure. It offers a potential cost saving at a time when NHS funding and capacity is under great strain.

Rehabilitation following lumbar fusion surgery for degenerative disorders

Jim Greenwood[1], Alison H McGregor[2], Fiona Jones[3], Mike Hurley[3]

[1]National Hospital for Neurology and Neurosurgery, London, UK [2]MSK LAB, Imperial College London, London, UK [3]Faculty of Health and Social Care Sciences, St Georges University, London, UK

Introduction

Following lumbar fusion surgery (LFS) many patients report ongoing back-related disability. A theoretically informed complex rehabilitation programme REhabilitation Following Lumbar Fusion Surgery (REFS) was developed in our unit, consisting of 10 consecutive weekly 90-minute sessions of education, exercise, and peer support. We conducted a prospective, randomised, controlled, feasibility study evaluating the REFS programme.

Aim

Evaluate the feasibility and clinical and economic impact of the REFS programme.

Methods

Participants (n=52) in a convenience sample were randomised (REFS programme or 'usual care'). Rehabilitation commenced following a 3-month clinical and radiological review. Quantitative outcome measures, ODI, HADS, EQ5D-5L, physical function, and pain self-efficacy, were recorded pre-operatively, and three, six, and 12 months postoperatively.

Results

Multi-level regression analyses (adjusted for depression, smoking, and BMI) were undertaken. The short-term (three–six months) adjusted mean (±SD) within group change in disability was -13.27 (±13.46) v -2.42 (±12.33) for REFS v 'usual care' respectively (p=0.014). A similar, statistically significant effect was observed for pain self-efficacy. At 12-months the adjusted mean (±SD) within group difference in disability was -14.72 (±13.34) and

-7.57 (±13.91) for REFS v 'usual care' respectively (p=0.101). Engagement with the REFS programme was good (95%), no adverse events were reported at 12-months. Economic analysis suggests the REFS programme is affordable, £275 per participant, £3,067 per QALY.

Conclusion

This study suggests the REFS programme is acceptable, affordable, and potentially effective. These findings support the need for an efficacy study.

Effects of surgical consenting methods on patient decision making & anxiety - RISCS (Risks in Spinal Consenting for Surgery) trial

Paul Thorpe[1], James Fletcher[2], Mohsin Khan[1], Pradeep Madhavan[1], Yee Leung[1], Ashok Subramanian[1]

[1]Somerset Spinal Surgical Service, UK [2]University of Bath Biomechanical Engineering Department, Bath, UK

Introduction

Surgical procedures require consent. Legally, consent enables avoidance of liability should complications arise or patient expectations not be met. Definitions of Causation (Chester v Afshar) and removal of the Bolam Principle applied to Consent (Montgomery) affect legal judgement of surgical practice. However, there is currently no research evidence investigating the impact consenting processes have on patient decisions. Our research establishes the impact on consent withdrawal rates by using a medically based or legally based consent process, and rates of anxiety with either process.

Methods

This single-centre, non-inferiority, controlled trial, randomises 220 spinal patients to a standard 'medical centred' consent process (control) involving material and frequently occuring risks, or a 'legally centred' consent process (intervention), the latter involving all associated risks found in the literature. The primary end point is rate of consent withdrawal. Secondary endpoints include State Trait Anxiety Inventory questionnaires to assess if anxiety levels increase due to either process.

Results

Results from initial analysis reveal that no patients withdrew consent for a procedure related to the risks detailed. Patients only withdrew when they clinically improved. This directly challenges current legal principle. Analysis of anxiety questionnaires revealed a non-statistically significant trend towards greater anxiety in those patients exposed to the legally based consent process.

Conclusion

Current legal assumptions of patient decision making related to consent are formed post-hoc, and appear to be incorrect. Our study defines the importance of patient-centred consent enshrined in GMC Guidance and Montgomery, and should challenge the current Chester vs. Afshar legal precedent.

A comparison of neurosurgical and orthopaedic services in managing isolated spinal trauma: five-year experience at a major trauma centre

Matthew Myers[1], Samuel Hall[1], Ahmed-Ramadan Sadek[1], Chris Dare[1], Emad Shenouda[1], Ali Nader-Sepahi[1]

[1]University Hospital Southampton NHS Foundation Trust, Southampton, UK

Introduction

The emergency spine service at the Wessex Major Trauma Centre rotates weekly between the orthopaedic and neurosurgical teams. The aim of this study is to determine if any differences exist in the management and outcomes of isolated spinal trauma between the two specialties.

Methods

A retrospective analysis of the Trauma Audit and Research Network was conducted to identify all isolated spinal traumas admitted to the trauma centre between January 2011 and December 2016. Case notes were reviewed to identify the treating team (neurosurgical or orthopaedic) and surgical management.

Results

1,408 spinal traumas were identified, 465 (266 neurosurgical and 199 orthopaedic) were isolated spinal injuries after exclusion of polytraumas. There were no significant differences between groups for age, injury severity score or survival percentage. There was no significant difference in the location of the fractures between the neurosurgical and orthopaedic team (p=0.25).The distribution of AOSpine subaxial and thoracolumbar fracture classifications was not significantly different between the neurosurgical (A n=139, B n=62, C n=4) and orthopaedic teams (A n=98, B n=51, C n=6) (p=0.44). The orthopaedic team performed fixation±decompression on 71 patients (35.7%) whereas neurosurgery operated on 66 (24.7%)(p =0.014). Length of stay (12.7 vs 11.9days, p=0.97) and the Glasgow Outcome Score at discharge (p=0.84) were not significantly different between the departments.

Discussion

The Wessex orthopaedic and neurosurgical spinal on-call services are managed independently except for MDT discussion of complex cases. The orthopaedic team operates on more of their patients however despite this the clinical outcomes are equal for both specialties.

Current state of integration of orthopaedic and neurosurgical spinal services in tertiary referral centres in the UK

Mark Nowell[1], Charlotte Waite[1], Vishal Borse[1], Almas L Khan[1], PR Loughenbury[1]

[1]Leeds General Infirmary, Leeds, UK

Introduction
The delivery of spinal services is currently in a state of flux with the development of spinal networks, and the continued integration of orthopaedic and neurosurgical services.

Aim
To provide a snapshot of the current structure and organisation of spinal services in tertiary centres.

Methods
Telephone questionnaire, on call spine referrals at tertiary centres with both orthopaedic and neurosurgery departments.

Results
There was a response rate of 25/32 (78%) units. Ten units do not share a joint orthopaedic/neurosurgical spine service, and all complex spine referrals pass through the neurosurgical service. The mean number of consultants on these rotas is 11.9. There is no joint orthopaedic/neurosurgical multidisciplinary team meeting (MDT) in these units.15 units share a joint orthopaedic/neurosurgical spine service (JONSS). The mean number of spinal neurosurgeons is five and the mean number of spinal orthopaedic surgeons is 3.8. 10/15 units organise themselves on a daily spine rota, and 5/15 organise themselves on a weekly rota. Within these units there is marked heterogeneity in case mix. The JONSS take degenerative thoracolumbar disease requiring instrumentation in 11/15 units, thoracolumbar trauma in 8/15 units, malignant compression in 9/15 units, infection in 9/15 units, degenerative cervical spine in 6/15 units, cervical spine trauma in 5/15 units and acute cauda equina referrals in 5/15 units. There are joint orthopaedic/neurosurgical MDTs in 12/15 units.

Conclusion
There remains great heterogeneity in the organisation of spinal services in the UK, with variations in the allocation of case mix between specialties.

A systematic review of pharmacological management of axial spine pain

Bilal Ahmed Mohamud[1], Epaminondas Markos Valsamis[1], Sherief Elsayed[1]
[1]Brighton, UK

Introduction
Low back pain (LBP) is defined as pain experienced in the area between the lower rib cage and the gluteal sulcus. The lifetime prevalence of low back pain is 84%. This study provides the first systematic review looking at whether different classes of analgesics are more effective than placebo for LBP.

Methods
Embase and Medline databases were searched to include articles between January 1970 and December 2016 for randomised controlled trials comparing the efficacy of paracetamol, NSAID, opioids, antidepressants, anticonvulsants, muscle relaxants, corticosteroids with placebo for LBP. Inclusion criteria included: age over 18 years and experiencing LBP. Exclusion criteria included LBP due to non-mechanical pathology. Outcome measures assessed were pain intensity: Visual Analogue Scale (VAS) or Numerical Rating Scale (NRS) and functional status: Roland Morris Disability Questionnaire (RMDQ).

Results
9,979 patients across 29 randomised control trials were included. Paracetamol alone was not found to significantly reduce NRS ($p=0.79$). A tramadol/paracetamol combination was found to significantly reduce NRS/VAS and improved RMDQ ($p<0.05$). NSAIDs were found to significantly improve NRS/VAS and RMDQ scores ($p<0.05$). Opioids significantly reduced NRS/VAS scores and improved RMDQ scores ($p<0.05$). Antidepressants significantly improved NRS and RMDQ scores ($p<0.05$). Muscle relaxants significantly reduce VAS scores and considerably improved RMDQ scores ($p<0.05$). Mixed data were found on corticosteroids. No data exists on anticonvulsants.

Conclusion
Tramadol/paracetamol combination, NSAIDs, Oxycodone ER, Hydrocodone ER, Hydromorphone ER, Oxymorphone ER, Tapentadol ER, Duloxetine and muscle relaxants are effective in the management of axial low back pain.

Paper Session 4 – Training/Complications

The importance of determining trainee perspectives on procedural competencies during spine surgery clinical fellowship

Tony Bateman[1], Jeremie Larouche[2], Christina Goldstein[3], Daniel Sciubba[4], Theodore Choma[3], Brandon Lawrence[5], Joseph Cheng[6], Michael Fehlings[7], Scott Paquette[8], Albert Yee[2,7]
[1]Derby Teaching Hospitals NHS Foundation Trust, UK [2]Sunnybrook Health Sciences Centre, Canada [3]University of Missouri, USA [4]Johns Hopkins Hospital, USA [5]University of Utah, USA [6]Yale University, USA [7]University of Toronto, Canada [8]The University of British Columbia, Canada

Aim
The Canadian Spine Society recently established a syllabus of competency based educational objectives for fellowship training. It remains important to align objectives deemed important by fellowship educators to those that are desired by their trainees. In this study we measured trainee views on the relative importance of specific procedural competencies for training. Secondarily, we measured self-perceived confidence in procedural performance at the commencement and completion of their fellowship program.

Methods
A questionnaire was administered to 68 eligible trainees at the beginning and end of their AOSNA fellowship program. A Likert

scale was used to determine trainee perspectives on the relative importance of specific procedural competencies to their training (53 general, 22 focused/advanced competencies). We also measured trainee self-perceived confidence in performing specific procedural competencies at the commencement and completion of their program. Statistical analysis was performed on fellow demographic data and their procedural responses.

Results

Our response rate was 82% (56/68) for the initial survey and 69% (47/68) for the follow-up survey. Most syllabus procedures were regarded of high importance with some differences observed comparing neurosurgical and orthopedic trainees. We identified several procedures of high importance and low confidence amongst fellows (i.e. upper cervical, thoracic discectomy surgery). Overall procedural confidence increased from 4.16 (SD=1.25) in the initial survey to 5.40 (SD=0.78) in follow-up survey ($p<0.0001$).

Conclusion

This study advances knowledge on the importance of specific procedural competencies for fellowship training. Identification of competencies considered important for training will help focus educational strategies to improve confidence.

It takes just 20 hours to do anything: including pedicle screw insertion in the normal spine

Darren Lui[1], Jan Herzog[1], Tim Bishop[1], David Morse[2], Jason Bernard[1]
[1]St George's University of London, London, UK

Introduction

In the era of European Working Time Directive (EWTD), spinal surgical trainees have less opportunity to acquire skills, for example pedicle screw insertion for Spinal Trauma. J Kauffman (The First 20 Hours) examined the K Anders-Ericsson study that 10,000 hours is required to be an expert. He suggests you can be good at anything in 20 hours. The key points are deconstruction of a skill to basic components and focused practice.

Methods

Eight junior spinal surgeons and one control candidate (physiotherapist) attended a cadaveric pedicle screw insertion course with 20 hours focused training. A competence pre-course and post-course questionnaire (Likert scale) was conducted. Examination of left/right thoracic screw, lumbosacral, cervical screw insertion. Duration per segment and pedicle breaches were recorded.

Results

Candidate mean time Thoracic(T) were: 96.8; 72.2; 61.4; 57.4 minutes with mean pedicle errors 2.6; 2; 2.1; 2.2. Mean lumbar (L): 51.9; 50.1; 42.0; 33.7 minutes with mean errors: 0.2; 0.3; 0.7; 0.2. Mean cervical (C): 43.6; 44.9 minutes and mean errors: 1.2; 0.3. Control T: 142, 134, 145, 93; L:92, 93; 65; 60. Candidates total mean pre-course competence; 5.41, post-course; 7.35 and change in score;+1.94. Control: pre; 2.4; Post; 5.0; Change; +2.6.

Conclusion

Pedicle screw insertion can cause significant morbidity, including paralysis, and therefore as a trainee this is not an easy skill to acquire or practice. This focused pedicle screw course deconstructed spinal surgery, isolated this single skill, provided a concise 20 hours and the critical tools. We show that a junior spinal surgeon can achieve improved competency in 20 hours but furthermore a complete novice can learn to be competent. With EWTD in mind procedural based specialties may be able to incorporate this philosophy for improved training.

Hypoalbuminemia—a risk factor for surgical site infection in lumbar fusion surgery

Osman Riaz[1], Ahmed Khattak[2], Sohail Nisar[1], Robert Dunsmuir[1]
[1]Department of Spinal Surgery, The Leeds Teaching Hospitals NHS Trust, Leeds, UK [2]Leeds General Infirmary, Leeds, UK

Introduction

Complications such as surgical site infection (SSI) in lumbar fusion surgery can lead to long-term morbidity. We believe it is important to identify modifiable factors in the pre-operative period to prevent SSI. Serum albumin is well known to be a biomarker for nutrition and recent studies have shown poor outcomes for patients with poor pre-operative nutritional status. The aim of this study was to determine a relationship between pre-operative albumin levels and SSIs in patients undergoing lumbar fusion surgery.

Methods

Retrospective review of 243 consecutive patients between January 2016–August 2017 who underwent lumbar fusion surgery. 26 patients developed SSI with proven microbiology result. Pre-operative albumin, age, length of surgery, and number of levels of fusion were recorded. ANOCVA and t-test analysis was used and $p<0.05$ was accepted as statistically significant.

Results

One-hundred-and-thirty-four females and 109 were male. Infected group age, mean 64.4 and 57.2 years in non-infected group ($p=0.04$). Low serum albumin levels were significantly associated with infected group mean 30.6 g/L and 38.8 g/L in non-infected group ($p=0.01$). Number of levels for fusion in infected group was 4.2 and 2.6 in non-infected group ($p=0.04$). No significant difference in length of surgery ($p=0.73$) and gender ($p=0.10$).

Conclusion

Pre-operative albumin is an independent predictor of SSI in patient undergoing lumbar fusion surgery. Nutritional status of these patients should be considered and care should be taken in the pre-operative work up. By improving the nutritional status prior to surgery, we can reduce morbidity, length of stay, and economic implications.

Using integrated positron emission tomography-computed tomography in the diagnosis and subsequent follow-up of late onset instrumentation spinal infection

Mohamed Mohamed[1], Katrina Treon[1], Joseph Alsousou[1], Radu Popa[1], Annis Prokopis[1], Sathya Thambiraj[1], Marcus De Matas[1]
[1]Royal Liverpool and Broadgreen University Hospital Trust, Liverpool, UK

Introduction
Integrated positron emission tomography-computed tomography (PET-CT) can identify spinal infection. We present the experience of using PET-CT in the diagnosis and management of late onset instrumented spinal infection and treatment response.

Methods
A five-year retrospective review was carried out of all the patients who have had instrumental spinal surgery and represented more than a year following surgery with suspected infection and have had a PET-CT scan.

Results
Eighteen patients with suspected late onset instrumented spinal infection were sent for PET-CT scan. Of these, nine were positive for suspected infection, four had surgery for adolescent idiopathic scoliosis, one neuromuscular and one syndromic scoliosis, one with fracture secondary to trauma and two for stenosis secondary to degenerative spondylolithesis. The average age of the patients was 33 years (20–67) with the average length of time from surgery to diagnosis of infection five years (3–18). Five patients had surgery for removal of metal work, four patients were treated with suppressive antibiotic therapy. Three patients with antibiotic therapy have had further PET-CT scans, in two patients no evidence of infection was present and in one patient it showed the infection load had reduced. Of the five patients operated on three patients grew propionibacterium acnes, a further patient had polymicrobial growth and one patient did not grow any organism.

Conclusion
PET-CT scan useful in the diagnosis and subsequent management and follow up of patients with instrumented spinal infections. Further studies to assess PET-CT specificity and sensitivity in surgical spinal infection are required.

Anterior location, sagittal mal-alignment and disc-height loss below operated level increases cage subsidence: review of 77 patients (95 levels) undergoing ACDF

Andrew MacCormick[1], Himanshu Sharma[2]
[1]Plymouth Peninsula Medical School , UK [2]Plymouth Hospitals NHS Trust, UK

Introduction
Degenerative cervical spine disease with myelo-radiculopathy, standalone cages are frequently used in 1 & 2-level anterior cervical discectomy & fusion (ACDF) operation with paucity of literature on factors influencing cage subsidence. The aim of this study was to analyse the variables affecting the incidence, location and severity of cage subsidence following ACDF operation.

Methods
A retrospective review of prospectively collected data of 77 patients (95 levels) undergoing ACDF was conducted. The variables analysed were age, gender, sagittal alignment, maximum disc height (superior, inferior and procedure level), cage size, shape, location, degree of subsidence (mild <2mm, moderate 2–5mm; severe >5mm), location of subsidence and progression of subsidence on serial radiographs.

Results
The incidence of cage subsidence was 34% (32 levels). We found a significantly lower mean maximum height of the inferior disc compared to the non-subsidence group (5.17 vs 5.96; p=0.0025). A significantly greater incidence of subsidence (40%) was recorded in patients with abnormal cervical spine alignment vs. 18% with normal alignment (p=0.02). A greater incidence of subsidence was recorded with more anterior positioned cages (52%; p=0.01). No statistical significance was found for age, gender, superior disc height, cage shape and size. None of the patients required revision operation for subsidence.

Conclusion
A greater incidence of cage subsidence is significantly associated with a lower maximum disc height of the disc below the operated level (<5.5mm), patients with abnormal sagittal alignment and more anteriorly positioned cages. We found no direct clinical implication of focal & minor cage subsidence.

A story of two sides: can unilateral nerve root compression cause lumbar pain?

Ahmed Chowdhury[1,2], Tim Germon[1], Wisam Selbi[1]
[1]Plymouth Hospitals NHS Trust, Plymouth, UK [2]Plymouth Peninsula Medical School, Plymouth, UK

Introduction
There is controversy as to whether lumbosacral nerve root compression can cause back pain. Anatomically the site of nerve root or dural compression is only 1–2cm from the midline; spatial resolution of the source of deep pain is inaccurate. Consequently, it is possible nerve root compression on one side may cause bilateral pain.

Aim
To determine whether unilateral nerve root compression can cause bilateral back pain.

Methods
We prospectively collected pain drawings with pre- and postoperative VAS scores of sequential people undergoing

unilateral, single level decompression from 2011–14. Those who enjoyed ³ 3-point improvement in VAS at three months follow up were included. We identified those whose pain distribution crossed the midline to the side opposite the site of the compressive lesion. The distance by which the midline was crossed was expressed as a fraction of the distance from the midline to the lateral border of the torso.

Results
One-hundred-and-seventeen patients were identified of whom we had follow-up data on X. Of these, 83 enjoyed an improved VAS ³3. 33 (40%) had pain which crossed the midline with a mean distance of 52%.

Conclusion
Our findings suggest that in some patients it is possible that unilateral nerve root compression can cause pain, the distribution of which could be labled as "non-specific low back pain" and will have important implications for their management.

Paper Session 5 – Inflammatory

Impact of MSSA screening on surgical site infections in patients undergoing lumbar spinal surgery

Mark Higgins[1], Faiz Shivji[1], Jaber Al-Shukri[1], James Billson[1], Rajendranadh Bommireddy[1]
[1]Derby Teaching Hospitals NHS Foundation Trust, Derby, UK

Introduction
MSSA carriage may confer a significant risk of surgical site infection (SSI) and is common amongst the UK population. Despite this, screening for MSSA is not routinely offered to orthopaedic patients in the UK. Primary aim was to review the impact of a MSSA screening programme on the incidence of SSIs following lumbar spine surgery.

Methods
A consecutive group of 1,307 patients during the 12 months before (phase 1) and after (phase 2) introduction of the screening programme were compared. Analysis was restricted to those with inpatient stay greater than four days, or a readmission within six weeks. SSI criteria included positive microbiology results from wound swabs or deep tissue samples within six weeks of primary operation, or persistent wound discharge with CRP >40 more than seven days following their operation. Patients were excluded if the reason for primary surgery was infection or the surgery was percutaneous. Chi-squared test was used to compare the two groups.

Results
There were 716 patients in phase 1. Rate of infection was 2.65%. Rate of MRSA colonisation was 0%. There were 591 patients in phase 2. Rate of infection was 1.02%. Rate of MSSA colonisation was 26%. Reduction in incidence of SSIs of 62% (p=0.0409).

Conclusion
MSSA colonisation is common, although surgical site infection following lumbar spinal surgery remains a rare event. A screening programme for MSSA can significantly reduce incidence of SSIs in patients undergoing lumbar spine surgery. These findings may be applicable to wider elective orthopaedic practice.

First description of γδT-cells in human spinal enthesis

Richard Cuthbert[1], Evangelos Fragkakis[2], Robert Dunsmuir[2], Peter Giannoudis[1], Elena Jones[3], Dennis McGonagle[1]
[1]Leeds Institute of Rheumatic and Musculoskeletal Medicine, University of Leeds, UK [2]Department of Spinal Surgery, The Leeds Teaching Hospitals NHS Trust, UK [3]Leeds Institute of Rheumatic and Musculoskeletal Medicine, University of Leeds,Leeds, UK

Introduction
Recent animal studies have suggested that γδT-cells accumulate at enthesis, secrete IL-17 and are responsible for driving the Ankylosing spondylitis (AS) phenotype resulting from IL-23 overexpression in mice. We have examined the immunological profile of human enthesis and determined if γδT-cells are present.

Methods
Human etheseal soft tissue (EST) and peri-entheseal bone (PEB) was harvested from normal interspinous ligament and spinous process. EST was dissected from PEB and enzymatically digested. Flow cytometry was used to determine the proportion of B-cells, NK cells and T-cells, T-cells were then sub divided based on expression of CD4 (T-helper cells), CD8 (Cytotoxic T-cells) and TCRγδ (γδT-cells).

Results
Entheseal digests contained on average a lower proportion of T-cells compared to peripheral blood (p=0.018). However, the proportion of T-cells not expressing either CD4 or CD8 was greater in entheseal tissues (p=0.021), this population was largely composed of γδT-cells. As a proportion of T-cells γδT-cells were six-fold more numerous in EST compared to peripheral blood (p=0.024), and PEB had three-fold more. 37% of EST γδT-cells expressed CCR6 this compared to 26% and 34% in PEB and peripheral blood respectively.

Conclusion
γδT-cells are present in normal human enthesis and γδT-cells constitute a greater proportion of the T-cell pool compared to peripheral blood, making it likely that they represent a tissue resident population. This is the first description of γδT-cells at the human enthesis and offers tentative confirmation of findings in mouse models where these cells play a key role in AS pathogenesis.

Litigation in acute pyogenic spinal infection—pitfalls and lessons in clinical management

James Wilson-MacDonald[1], Nick Todd[2]
[1]Oxford University Hospitals NHS Trust, Oxford, UK [2]Northern Medical Services, Sandyford, UK

We reviewed the case notes and examined 45 patients who were litigating because of complications of acute pyogenic infection of the spine. At presentation all patients were ambulant (Frankel C–E). Twenty three patients had co-morbidities. Forty four patients had a CRP greater than 50 and all patients had severe back pain. The diagnosis was confirmed in all patients with MRI scan. Eleven patients had spondylodiscitis alone and 34 spinal epidural abscess and spondylodiscitis. In 42 cases there was a delay in making the diagnosis of average 9.5 days. In 29 cases haematological investigations were delayed and in 10 cases they were not carried out or were overlooked. Neurological deterioration occurred in 37 patients (82%), Nine patients were treated with antibiotics alone and the remainder were treated with surgical drainage. Eight patients experienced neurological improvement after treatment. At final follow up 11 patients remained Frankel A. In most cases the diagnosis was not considered at the time of presentation. In a patient presenting with spinal pain and a CRP >50 acute pyogenic infection should be considered as a potential diagnosis and emergency MRI scan carried out. Most of the complications would have been avoided by timely treatment.

Frankel grades at presentation and final follow up

Final Initial	A	B	C	D	E
A	0	0	0	0	0
B	0	0	0	0	0
C	2	0	2	0	0
D	1	0	3	2	1
E	11	1	8	12	1

A finite element study of the effect of cross link stabilisation in a lumbar spine tumour model

Kyle Murdock[1], James Tomlinson[2], Lee Breakwell[2], Paul Brewer[2], Damien Lacroix[1]
[1]Insigneo Institute, Sheffield University, Sheffield, UK [2]Sheffield Teaching Hospitals NHS Trust, Sheffield, UK

Introduction
The role of surgery in metastatic cord compression is well established. Cross links confer additional stability but may disrupt adjuvant treatment—radiotherapy or proton beam therapy. The objective of this study was to develop a computational finite element model to study the effect of cross-link stabilisation on the load transfer.

Methods
A finite element (FE) model of a fixation device (DePuy Synthes) was developed using Abaqus (Dassault Systemes). The device was inserted virtually into a FE model of the lumbar spine (L1 to S1) between L2 and L4. A 300N compressive, 20 degree lateral bending and 7.5Nm torsional load were simulated onto L1 and the stress/strain distributions within the device and the vertebrae and discs were calculated.

Results
Under compression and lateral bending results indicate that the use of a cross-link has little influence on the strain and stress distributions. However, under axial torsion the cross-link reduces significantly the strain in the discs within the fixation system (L2/L3 and L3/L4). This effect is not seen in the adjacent discs. Under torsion the lack of cross-link also induced a peak von Mises stress of 218 MPa compared to 150 MPa with the cross-link.

Conclusion
This study shows that the cross-link fixation system is most effective in torsion and the lack of such system can lead to high stress within the screws that could lead to failure. Future studies will interrogate the effect of the position of the cross-link to identify an optimal position with regards to progressive anterior column degradation

Comparison of open vs. minimally invasive vertebrectomy for treatment of malignant spinal cord compression

Mark Nowell[1], PR Loughenbury[1], Vishal Borse[2], Benedict Hughes[1], Nigel Gummerson[1], Debasish Pal[1], Chris Derham[1], Robert Dunsmuir[1], Jake Timothy[1]
[1]Leeds General Infirmary, Leeds, UK [2]Leeds University, Leeds, UK

Introduction
Malignant spinal cord compression (MSCC) is a common complication of metastatic disease with neurological morbidity.

Aim
Comparison of traditional open approaches vs. the minimally invasive XLIF approach for the purpose of vertebrectomy, spinal cord decompression and anterior column reconstruction in MSCC

Methods
Retrospective case series in single centre over a five-year period.

Results
Eleven patients were identified who underwent open vertebrectomy for MSCC. 9/11 underwent posterior fixation. 8/11 (72%) had over 1L blood loss during the procedure. The mean duration of the

procedure was 7 hours 35 minutes. 1/11 (10%) avoided HDU, and the median duration of time spent in HDU was two days. The median length of stay in hospital was 27 days, and 1/11 (10%) was discharged within one week. There were 6/11 (55%) complications (four pulmonary, one surgical, one medical). Fourteen patients were identified who underwent XLIF approach vertebrectomy for MSCC. 12/14 underwent posterior fixation, and 2 underwent vertebroplasty. 3/14 (21%) had over 1L blood loss during the procedure. The mean duration of the procedure was 8 hours 3 minutes. 5/14 (36%) avoided HDU, and the median duration of time spent in HDU was 1.5 days. The median length of stay in hospital was 16 days, and 4/14 (29%) were discharged within one week. There were 4/14 (29%) complications (two pulmonary, one surgical, one medical).

Conclusion

XLIF approach for vertebrectomy is well tolerated in the treatment of MSCC, and is associated with less blood loss and a trend to shorter hospital stays than open approaches (p=0.11).

A potential injectable minimally invasive nucleus pulposus augmentation based on peptide/glycosaminoglycan hydrogels

James Warren[1,2], Ruth Coe[1], Sebastien Sikora[3], Danielle Miles[4], Paul Beales[2], Ruth Wilcox[1]

[1]Institute of Medical and Biological Engineering, University of Leeds, Leeds, UK [2]School of Chemistry, University of Leeds, Leeds, UK [3]School of Earth and Environment, University of Leeds, Leeds, UK [4]Innovation and Knowledge Centre, University of Leeds, Leeds, UK

Aim

To develop a novel, minimally invasive therapy for nucleus pulposus augmentation without the need for major surgical incision.

Methods

Two optimum patented self-assembling peptides based on natural amino acids were mixed with glycosaminoglycans (GAGs) to form hydrogels that mimic the vital biological osmotic pumping action and aid in swelling pressure. Separate peptide and GAG solutions can be switched from fluid to gel upon mixing inside the body. These gels are analysed using a series of complementary techniques (FTIR, TEM and rheometry) to determine their cross-length scale structure and properties. A fluorescent probe and a CT contrast agent are used to aid visualisation of the gels post injection into bovine caudal samples through the walls of the annulus fibrosis. A semi-automatic syringe driver rig was designed for the delivery of the solutions into the intervertebral discs.

Results

It was found the presence of the GAGs greatly increased the stiffness of the peptide gels, even upon injection through a long (~10cm) small gauge needle. The injected gels were easily visualised post injection by microCT and by eye during dissection. It was also noted that following injection, the disc height of the degenerated samples was restored to a similar level of that observed for native discs. Further tests are now underway to examine their biomechanical performance.

Conclusion

A hydrogel has been developed that is injected through a narrow bore needle using a semi-automatic delivery rig and forms a self-assembled gel *in situ*.

Paper Session 6 – Registry

An analysis of cervical disc replacement costs across the English National Health Service (NHS)

Dushan Thavarajah[1], Mike Hutton[1]

[1]Royal Devon and Exeter Hospital, Exeter, UK

Introduction

Cost efficiency within the current financial climate is paramount if we are to continue to provide procedures such as cervical disc replacement surgery.

Aim

We wanted to look at the costs of various cervical disc replacements being sold to individual trusts across the English NHS.

Methods

An analysis of data on the NHS service improvement tool looking at the year 2014–2015. Companies searched for included all sponsors from BritSpine 2016 that manufacture/distribute cervical disc replacements.

Results

There were 16 sponsors of BritSpine 2016, of which 10 manufacture/distribute cervical disc replacements. Eight of these companies provided their implants to trusts within the NHS. Three-hundred-and-ninety-three replacements were sold costing a total of £653,923. The range was between £1,086 (the cheapest) to £2,893 (the most expensive) across all companies for a single disc replacement. The biggest variance in price for an individual company was £2,893 to £1,550=£1,343. Cost saving if we went to minimum price based on current spend for that year would be £227,125.

Conclusion

Significant savings can be made in the purchasing of cervical disc replacements which will help in the financial sustainability of such procedures. This analysis highlights the variance in cost and the savings that could be made with future purchasing of cervical disc replacements.

Improving patient details & patient reported outcome measures entry onto the British Spinal Registry

Neil Upadhyay[1], Almas L Khan[1]
[1]Department of Spinal Surgery, The Leeds Teaching Hospitals NHS Trust, Leeds, UK

Introduction
British Spinal Registry (BSR) exists to improve patient safety and monitor outcomes of spinal surgery. National compliance is improving but variation among spinal units remains. Our aim was to implement a robust strategy to improve BSR data collection for patients undergoing spinal surgery at the Leeds General Infirmary.

Methods
An initial audit determined 19% of patients undergoing surgery had pre-op outcomes scores and 15% of patients had post op outcomes scores uploaded. The Leeds General Infirmary is a centralised spinal service with clinics and theatres spread across several sites within the hospital. A strategy was discussed to create a data collection system for our unit.

Results
A BSR administrator resulted in 100% patients entered. Robust patient data collection proved difficult; kiosks were considered but costs due to hospital geography excluded implementation. Computerised tablets were trialled but internal logistics resulting in paper forms becoming the default position.

Conclusion
Large patient numbers attending clinics resulted in a continued failure to robustly collect data. Ofcom 2017 published 94% of UK adults own/use a mobile phone, 88% have internet access. Thus our aim is for patients to complete their own BSR data prior to attendance. Patients will receive literature and a video was made to highlight the benefits of the BSR project. The hospital will send text messages and emails with hyperlinks to remind patients of their appointment and ask outcome forms are completed prior to hospital attendance. We are now working on an APP to support the drive.

Paper Session 7 – Trauma

Slick enough? Subaxial cervical spine classification systems: an external agreement validation study

Tobias Stedman[1], Mike Petrie[1], Morgan Jones[1], Angus Fong[1], Michael Athanassacopoulos[1], Ashley Cole[1], Neil Chiverton[1], Marcel Ivanov[1], Anthony Michael[1], James Tomlinson[1]
[1]Sheffield Teaching Hospitals NHS Trust, Sheffield, UK

An effective classification system should be all-inclusive, clinically relevant, a guide to subsequent treatment and reliable. In 2007, the Subaxial Cervical Spine Injury Classification (SLIC) system was introduced to clinical practice. In 2015, the AOSpine group developed a classification system (AO), with the intent of producing a "user friendly" classification system.

This study assessed the reliability of the SLIC system and the AO system amongst a orthopaedic surgeons in a specialist spinal surgery unit.

All patients admitted to a UK Major Trauma Centre over a six-month period February–August 2016 with a cervical spine fracture had imaging reviewed and injuries classified using the SLIC and AO systems. Clinical and radiographic data for 51 patients were reviewed by nine spinal surgeons.

SLIC: The overall inter-rater Fleiss' kappa (κ) coefficient was 0.87. Highest agreement was on grading neurologic status (0.97), with injury morphology and disco-ligamentous classification showing substantial correlation (0.65 and 0.64 respectively).AO: The overall inter-rater Fleiss' kappa (κ) coefficient was 0.43, significantly lower than that seen for the SLIC system.

The reliability of the SLIC system compares well with previously reported levels of inter-rater reliability from the authors' own internal verification study, as well as from other published external studies. The AOSpine system may be useful as a research tool but the reliability values from this study suggest that more work needs to be done. SLIC has substantial agreement for inter-rater reliability and is a useful assessment tool to help guide clinical decision making.

Clinical and radiological outcome of odontoid fractures treated with soft collar immobilisation

PR Loughenbury[1], Hitesh Dabasia[1], Richard Williams[1], Dihan Aponso[1]
[1]Princess Alexandra Hospital, Brisbane, Australia

Introduction
Non-operative treatment of odontoid fractures can be achieved with non-rigid cervical immobilisation (either hard or soft cervical collars). Hard collars are commonly used but are associated with a risk of skin breakdown. Soft collars may reduce this risk but there are concerns that they do not provide sufficient immobilisation for these injuries.

Methods
Consecutive patients presenting to a tertiary level spinal injuries unit over a five-year period (July 2010–July 2015) with non-operatively treated odontoid fractures. All patients receiving external non-rigid immobilisation were treated with soft cervical collars.

Results
Fifty-four patients (34 female, 20 male). Mean age 77 years (range 29–104). Mechanism of injury was fall (37), MVA (13), syncope (2) and blunt trauma (2). There were 28 type 3 fractures, 23 type 2 fractures and three type 1 fractures (Anderson and D'Alonzo

classification). At presentation mean angulation was 14.6o (range 0-50o) and mean displacement was 1.9mm (range 0–11mm). Two failed non-operative treatment and required fixation (one at two weeks and one at four months following injury). Radiological union was demonstrated in 25% of cases. At final follow up mean angulation was 16.9 degrees (range 0–63 degrees) and mean displacement was 2.6mm (range 0–16mm). Overall mortality was 18.5%. There were no cases of skin breakdown.

Conclusion
Clinical and radiological outcomes for soft collars are comparable to those reported in the literature for hard collars. Soft collars are a safe and effective alternative to hard collars for the treatment of odontoid fractures and reduce the risk of skin breakdown.

Anterior odontoid screw for nonunited fracture—a prospective cohort study

Debasish Pal[1], Soumya Mukherjee[2], Chris Derham[1], Senthil Selvanathan[1]
[1]Department of Spinal Surgery, The Leeds Teaching Hospitals NHS Trust, Leeds, UK [2]Leeds General Infirmary, Leeds, UK

Introduction
Controversy exists regarding the optimal surgical management of traumatic nonunited odontoid fractures especially with regard to anterior odontoid screw fixation. The risk of delayed cervical myelopathy is well reported in conservatively managed patients. With a growing elderly population, perhaps this requires careful consideration.

Methods
This prospective study includes 10 consecutive patients who underwent anterior screw fixation for non-united odontoid fractures between April 2012—April 2017 at our institute under a single surgeon. The indication of surgery was radiologically documented non united fracture of the odontoid after at least three months of conservative treatment associated with neck pain. Data on patient demographics, time to surgery, complications, fusion rate and outcome scores were collated.

Results
Mean age was 68 years with a M:F ratio of 7:3. The mean time to surgery from trauma was 33 months (range four months to 20 years). Six patients were initially treated in halo while the rest had a hard collar. Mean pre-operative Visual Analogue Score (VAS) for neck pain was 5.2 while postoperative mean score was 0.7 at follow up. One patient had halo around the screw during radiological follow up that remained unchanged during follow up at two years without neck pain. Fusion across the fracture site was noted in more than 70% patients.

Conclusion
Anterior screw is a safe and effective procedure for odontoid nonunion and may prevent delayed cervical myelopathy. Further studies maybe necessary on a larger cohort of patients.

Medium term outcomes of kyphoplasty for vertebral Insufficiency fractures—the Derby experience

Harinder Gakhar[1], Robert Zitka[1], Rajendranadh Bommireddy[1], Zdenek Klezl[1]
[1]Derby Teaching Hospitals Foundation Trust, Derby, UK

Aim
Vertebral insufficiency fractures are common and symptomatic relief with conservative therapy is often difficult to achieve. The aim of this study was to report on medium term results of kyphoplasty surgery following failed conservative management.

Methods
Three-hundred-and-nine patients underwent balloon kyphoplasty between January 2011 and December 2016 were included. This a retrospective review of a prospectively updated database. Total of 596 levels were augmented. Majority of patients were females (248).Patients age ranged from 30–98 years with an average of 72.6 years. Average follow up for our series was 13.6 months (2–63months).Pain relief was assessed using visual analogue score (VAS) and functional outcome using Oswestry Disability Index (ODI). We also looked at social drift.

Results
The average pre-operative VAS was 6.34. At six weeks postoperative stage average VAS decreased to 3.80. In our series, VAS scores showed progressive decline being an average of 3.18 at one year follow up and average of 2.85 at two years follow up. The average pre-operative ODI was 25.6. At six weeks this improved to 17.6 and further improvements were seen at one-year (ODI 14.2) and two years (ODI 12.1). In our series we did not experience any clinically significant complications.We did not notice any social drift in our series.

Conclusion
Balloon kyphoplasty should be considered in patients with vertebral insufficiency fractures that do not improve. It significantly improves pain and functional status in elderly patients. It prevents social drift as shown in our series.

Paper Session 8 – NBP-CN

Stratified care for sciatica: subgrouping algorithm and SCOPiC randomised trial

Kika Konstantinou[1], Danielle van der Windt[1], Reuben Ogollah[1], Martyn Lewis[1], Nadine Foster[1]
[1]Keele University, Stoke-on-Trent, UK

Introduction
Stratified primary care has been shown superior to usual care for non-specific low back pain. We aimed to: i) develop a new

algorithm to subgroup and match clinical management for sciatica patients and ii) test this in a randomised trial (RCT).

Methods
Data from sciatica patients in the ATLAS cohort study (n=429) were used to develop the algorithm. We identified patients referred to specialist spinal services over 12 months (n=57, 13.3%) and analysed factors that predicted referral using logistic regression. A clinical advisory group considered clinical relevance and face validity of each factor. SCOPiC (Sciatica Outcomes in Primary Care) is an RCT with 476 sciatica patients randomised to stratified care (where the algorithm guides clinical management) or usual care. Recruitment finished in June 2017 and follow up is ongoing. Analysis will compare time to symptom resolution between stratified and usual care.

Results
Combining prognostic information (STarT Back tool) and four clinical assessment findings (work interference, pain below knee, leg pain intensity, sensory deficits) provided the best prediction of referral (positive predictive value 22% (95% CI: 16%, 31%), sensitivity 51% (37%, 64%)). The algorithm has allocated SCOPiC RCT participants to one of three subgroups: those in Group 1 (22.5%) receive advice/support to self-manage in two consultations, Group 2 (44.3%) receive a course of physiotherapy, Group 3 (33.2%) are 'fast-tracked', with an MRI, to specialist spinal services.

Conclusion
This is the first stratification algorithm developed to help early decision-making for sciatica. Details of the algorithm and SCOPiC RCT will be shared.

Implementation of an Enhanced Recovery after Surgery (ERAS) programme in complex spinal surgery—is it cost effective?

Kelly Jackson[1], Irfan Siddique[1], Rajat Verma[1], Anna Jones[1], Michelle Angus[1], Saeed Mohammad[1]
[1]Salford Royal NHS Foundation Trust, Salford, UK

Aim
To assess if implementing Enhanced Recovery after Surgery (ERAS) pathway for elective complex spinal patients provides a cost effective clinical benefit.

Methods
Hospital coding data was retrospectively reviewed to assess outcomes in terms of length of stay, readmission and cost were analysed in the six months pre- and post-implementation of ERAS. Complex spinal patients are classified as those involving instrumented fusion (ACDF excluded).

Results
A total of 48 patients underwent surgery in the period prior to the ERAS pathway with 71 patients operated on following the ERAS implementation. Patients on the ERAS pathway showed a significant reduction in length of stay from 8.3 days to 5.1 days (39% reduction). Most noticeably the patients undergoing adolescent scoliosis surgery saw a 40% reduction in length of stay. At the time of implementing the ERAS pathway no other variables were identified which could have impacted on these reductions. A small reduction in readmissions (within 30 days of discharge) has been seen, these were classed as unavoidable readmissions and the change has not been statistically significant. Due to the reduced length of stay, the cost saving post-implementation of ERAS was £900 per patient, amounting to effective saving of £63,000 for the six months following implementation of ERAS.

Conclusion
The implementation of the ERAS pathway has resulted in a reduction in length of stay and, in our experience, a significant cost saving.

Northern Ireland regional spine mega clinic—a patient centered approach to tackle waiting lists

Lynn Murphy[1], Rakesh Dhokia[2], Niall Eames[3]
[1]Royal Victoria Hospital Belfast, UK [2]Musgrave Park Hospital, Belfast, UK [3]Musgrave Park Hospital, Belfast, UK

Outpatient waiting times for a first outpatient appointment with a spinal surgeon in Northern Ireland have reached 152 weeks. This falls significantly outside recommended targets and has resulted in a 6,000-patient backlog spanning three years. We designed a specialist, multi-clinician, co-located consultant led NHS clinic that would enable us to objectively and professionally evaluate the patients on this backlog waiting list.

We present a "first-of-its-kind" megaClinic model which reviewed 356 patients (160 and then 196 patients) in two four-hour clinic sessions. The megaClinic team consisted of two spinal orthopaedic consultants who were directly supervising 10 specialist clinicians (orthopaedic registrars, GPs with a specialist interest and extended practice physiotherapists). This service was rated by patients with a very high patient satisfaction rate, reported at 92% and 95% for each clinic. The discharge rate from the spinal service was recorded as 91% and 87%. Overall 33.95% of patients were discharged without any onward referral. 28.2% of patients were discharged to the pain clinic and 25.8% discharged to physiotherapy. One patient was referred to neurology and one to a shoulder surgeon.

This approach effectively reduces waiting lists and promotes a patient-centered approach to this problem whilst also appearing cost-effective. We also demonstrate an increase in confidence levels of the clinicians involved from moderate to very confident. We believe this model is transferable to other clinics and combines increased throughput with a patient centered model. It relies on pathway demarcation, education and direct consultant supervision.

Paper Session 9 – Complex Reconstruction

The lateral approach to the spine in revision lumbar surgery—a single surgeon's experience

Debasish Pal[1], Soumya Mukherjee[2]
[1]Department of Spinal Surgery, The Leeds Teaching Hospitals NHS Trust, Leeds, UK [2]Leeds Teaching Hospitals NHS Trust, Leeds, UK

In revision lumbar surgery, due to presence of epidural fibrosis, posterior approach exposes patients to neural injury and cerebrospinal fluid (CSF) leak. Extreme lateral interbody fusion (XLIF) approach offers a virgin plane to the spine and may minimise these risks.

Aim
To determine if lateral approach is associated with minimal complications and satisfactory outcome in revision lumbar surgery.

Methods
Between April 2010 and 2017, patients who had previous lumbar decompression and represented with symptomatic recurrent stenosis between L2 and L5, underwent the lateral XLIF approach by a single surgeon. Complication rate, hospital stay, Oswestry Disability Index (ODI), Visual Analogue Scores (VAS) were collected prospectively.

Results
Thirty patients were included. Mean age was 62.5 years. Sixty per cent had two or more previous lumbar procedures. Ten patients had standalone cages while the remaining twenty patients had staged minimally invasive posterior stabilszation with one of the patients requiring decompression as he continued to have leg pain. Mean pre-operative ODI was 5.5% and VAS 6.9 (leg) and 8 (back). At last follow up, mean VAS was 1.6 (leg), 4.5 (back) with ODI 34%. Mean blood loss was 50ml. The median hospital stay was 1.2 days. Two patients had loosening of screws and none with CSF leak or neural injury. Four patients had thigh paraesthesia that resolved in six months.

Conclusion
The lateral approach offers an excellent outcome to patients requiring revision lumbar spinal surgery with low morbidity and reduced hospital stay. A multicentre prospective trial comparing it to the standard posterior approach is proposed.

Trans-thoracic rib-sparing retropleural minimally invasive surgical approach for symptomatic large calcified thoracic disc herniation—a prospective cohort study

Soumya Mukherjee[1], Jake Timothy[1], Debasish Pal[1]
[1]Department of Neurosurgery, Leeds General Infirmary, Leeds, UK

Introduction
Symptomatic thoracic discs have historically been treated using open thoracotomy, with morbidity related to this approach. We present our early experience of minimally invasive surgical (MIS) approach for symptomatic large calcified thoracic discs which has not been widely reported.

Methods
This prospective cohort study included six consecutive cases operated between July 2015 and July 2017 by two surgeons at a single institution. Patient demographics, radiological findings, operative details and outcome scores were collected.

Results
Patients' mean age was 39 years with a male-to-female ratio of 1:5. All patients had progressive myelopathy over two–seven months. Levels were T9/10 (n=4), T7/8 (n=1) and T10/11 (n=1) and right-sided, central and left left-sided disc herniations occurred in two cases each. There were no intra-operative issues in four cases, whilst in two there were reduced motor evoked potentials (MEPs) in both legs. The latter cases were central discs and a transdural removal was performed. The mean blood loss was 50ml. Immediate neurological recovery was demonstrated in four cases and two had weakness that returned to baseline within two weeks. Median length of hospital stay was five days (range, four to 12 days). At six-month follow up there were mean improvements of 72% and 69% in pain VAS and ODI scores respectively, and all patients were very satisfied with the outcome of surgery.

Conclusion
MIS approach for symptomatic large calcified thoracic disc herniations is associated with good outcomes and represents a good alternative to conventional approaches.

Multi-level OLIF has superior spinopelvic harmony compared to pedicle subtraction osteotomy in complex adult spinal deformity

Darren Lui[1], Hai Ming Yu[1], Susanne Selvadurai[1], Karan Malhotra[1], Joseph Butler[1], Sean Molloy[1]
[1]Royal National Orthopaedic Hospital, Stanmore, UK

Introduction
Complex adult spinal deformity (CASD) represents a challenging cohort of patients. Restoration of sagittal parameters is associated with good outcome in standard adult spinal deformity (ASD).

Pedicle subtraction osteotomy (PSO) is an important technique for sagittal balance in ASD but is associated with significant morbidity. We aim to explore the efficacy of MOLIF technique over PSO in the restoration of sagittal balance in stiff or fused CASD only.

Methods
Prospective Cohort with retrospective review. One-hundred-and-thirty Adult Spinal Deformity Patients from a single surgeon series. Sixty-eight patients with CASD only type B & C Silva classification. Parameters investigated: Spinopelvic parameters including regional lumbar lordosis (L1–S1) RLL, PI LL mismatch (PI:LL) and SLL PI % mismatch (PI:SLL).

Results
Group 1 MOLIF mean age: 62.9, 64.7% female, Group 2 PSO 66.76, 76.5% females. MOLIF (preop, postop, p): SVA (99.5, 21.5, p<0.005); RLL (34.03, 51.1,p<0.005); SLL (22.6, 37.7, p<0.005); PILL mismatch (21.1, 4.15, p<0.005), SLL PI % mismatch (36.2%, 60.3%, p<0.005). PSO: SVA (75.8, 66.7,p=0.29), RLL (25.8, 46.1, p<0.005), SLL (24.6, 31.3, p<0.05); PILL mismatch (29.6, 9.71, p<0.005); SLL PI % mismatch (45%,57%). Postoperative SLL (MOLIF 37.7, PSO 31.3, p<0.05); postoperative SVA (MOLIF 21.53, PSO 66.7, p<0.05); postoperative Cobb (MOLIF 9.2, PSO 14.57, p<0.05); postoperative SS (MOLIF 34.3, PSO 30.6, p<0.05).

Conclusion
MOLIF is as efficacious as PSO in restoration of all spinopelvic parameters but there are some significant superior features namely Segmental Lumbar Lordosis (L4–S1) where the value should approximately 60% of the Pelvic Incidence, sacral slope, SVA, Listing and Cobb. A PSO can give an acute angular correction vs. the more harmonious cadence that multilevel ALIF can deliver.

Paper Session 10 – Oncology

Intramedullary spinal cord tumours—a single centre ten-year experience

Oliver Richards[1], Edward Goacher[2], Chris Derham[1]
[1]Leeds Teaching Hospitals NHS Trust, Leeds, UK [2]University of Leeds, Leeds, UK

Introduction
Intramedullary spinal cord tumours are relatively rare tumours of the central nervous system. Surgical outcomes are affected by many variables, including pre-operative function, use of spinal cord monitoring and tumour histology.

Aim
To retrospectively analyse the anatomical location, pre- and postoperative function and histology in primary intramedullary spinal cord tumours.

Methods
Fifty-three patients from a single institution were identified from a surgical database. Variables collected included pre-and postoperative Frankel Grade and Modified McCormick Scale assessments, tumour histology, extent of resection and length of follow up.

Results
Patient ages ranged from 12 months to 83 years. Thoracic (28), cervical (nine), cervicothoracic (nine), thoracolumbar (four), craniocervical (two) and lumbar (one) were the sites of tumour. Grade 2 Ependymoma, Haemangioblastoma and Pilocytic Astrocytoma were the commonest tumour histologies. In total 21 different histological tumours were identified in the series. Average length of follow up was 35 months. Comparing Modified McCormick Scale and Frankel Grade, 28%/19% of patients deteriorated, 15%/17% improved and 57%/64% were static.

Conclusion
Tumour histology and extent of resection are critical in understanding which patients improve or plateau post-operatively.

Survival in patients with metastatic spinal cord compression (MSCC) following establishment of a specialist network coordinator service

Lena Richards[1], Mike Anderton[2], Kamran Hassan[2], Rajat Verma[2], Vivek Misra[1]
[1]The Christie NHS Foundation Trust, Manchester, UK [2]Salford Royal NHS Foundation Trust, Salford, UK

Introduction
Clinical trials have shown surgery to be superior to radiotherapy for patients with MSCC. We present our results following the establishment of a MSCC Coordinator service in Greater Manchester & Cheshire, the aim of which is to coordinate the pathway of patients with MSCC within 15 hospitals that serve a population of 3.5 million people.

Aim
The primary aim of this study was to determine the survival time following treatment. The secondary aim was to compare our results against survival times quoted in the medical literature.

Methods
Data was prospectively collected and analysed for all patients referred with confirmed MSCC in 2014 and 2015. Patients were triaged by the oncologist and spinal surgeon, based on prognosis and performance status and categorised into four subtypes: (1) best supportive care (2) systematic anti-cancer therapy (3) spinal surgery and (4) radiotherapy alone.

Results
A total of 1,253 patients were referred to the MSCC service, of which 540 (43%) had confirmed MSCC. 73 patients (14%) received best supportive care (median survival of 32 days), 24

patients (4%) had systemic anti-cancer therapy (median survival of 637 days), 89 patients (16%) had surgery (median survival of 377 days) and 354 patients (66%) had radiotherapy (median survival of 62 days).

Conclusion

Our results of 377 days compares favourably to studies by Patchell and Fehling, which found median survivals of 126 days and 230 days respectively following surgery. Our data strongly supports the use of decompressive spinal surgery with instrumented stabilisation for MSCC in carefully selected patients.

Current epidemiology of paediatric patients presenting to the Spinal Surgeon with back pain; a review of the investigative pathway

Christopher Lodge[1], Robert Dunsmuir[1]
[1]Leeds General Infirmary, Leeds, UK

Aim

Traditionally, paediatric back pain has been perceived to be synonymous with sinister pathology. More recently the resulting diagnosis appears to be increasingly of non-specific back pain

Methods

We retrospectively assessed all paediatric patients who had presented to the Orthopaedic Spine department with back pain who underwent Magnetic Resonance Imaging (MRI) and Single Photon Emitting Computed Tomography (SPECT) as part of our protocol.

Results

One-hundred-and-three patients underwent analysis. 21.4% (n=22) of patients were found to have identifiable radiological pathology. Ten patients had abnormal SPECT scans. All 22 patients had abnormal MRI scans. The commonest pathologies identified were Spondyolysis (n=8), Degenerative discs (n=5) and Schueurmann's disease (n=3). 78.6% of paediatric patients presenting with back pain had no radiologically identifiable pathology.

Conclusion

SPECT and MRI imaging have been previously debated as to which is more sensitive and specific for investigation spinal pathology. SPECT and MRI in combination is our first line imaging regime. SPECT can be advantageous for the early detection of osteoid osteoma, osteoblastoma and early discogenic infection. MRI is advantages for soft tissue abnormalities including discogenic disease and detecting early spondylolysis. Our study identified a significant proportion of musculoskeletal back pain with 78.6% having no identifiable pathology. Sedentary lifestyle and increasing paediatric BMI can be associated with this increasing trend. Despite the prevalence of sinister pathology being present in only 1% of paediatric patients in our study, we feel that a comprehensive diagnostic regime is appropriate. A missed case of an oncological vertebral pathology can have catastrophic consequences.

Should Tokuhashi scoring be age modified in women presenting with metastatic spinal cord compression (MSCC) from a primary breast cancer?

Jasmine Mallaburn[1], Mohammad Mallick[1], Grzegorz Rudol[1,2], Almas Khan[1,2]
[1]University of Leeds, Leeds, UK [2]Department of Spinal Surgery, The Leeds Teaching Hospitals NHS Trust, Leeds, UK

Introduction

Studies suggest younger women with breast cancer may have a poorer outcome. The Tokuhashi score, which guides treatment in patients with MSCC, does not take age into account.

Aim

To investigate the effect of age on survival time in breast cancer patients with MSCC. To evaluate predictive models utilising age in this group of patients.

Study design

Retrospective cohort study. Patient Sample: 28 female patients with a primary breast carcinoma and MSCC, presenting between 2010–2015. Outcome Measures: overall, one-year and six-month survival.

Methods

Factors influencing survival—Tokuhashi score, factors in the score, age, histological and TNM grading and presence of hormonal receptors—were investigated. Cox-proportional hazard model, Kaplan-Meier, logistical regression, ROC-curve methods were utilised.

Results

Median survival: <55 y/o: 17 months. 55–60: 21 months. 60y/o: 15 months (p=0.197). Cox-modelling showed age (p=0.01), progesterone receptors (p=0.029), palsy (p=0.04) and performance status (p=0.04) as significantly influencing overall survival. One-year survival: Tokuhashi score is significant predictor with age showing significant trend (p=0.057). ROC-curve analysis identified 55y/o as 'optimal' cut-off age with potential to predict poor outcome, however sensitivity was 0.43 and specificity 0.25. Six-month survival: age and Tokuhashi score were trending as independent factors (p=0.057). Three-month survival: only Tokuhashi score was significant (p=0.04).

Conclusion

Survival in breast cancer patients with MSCC seems to be influenced by age. Younger patients may have more aggressive malignancy with older patients having a lower physiological reserve. Observed relationships require larger population for a more powerful analysis—64 participants based on our results. BSR data could be utilised for a multicentre study.

Britspine 2018 Poster Abstracts

Degenerative Spinal Conditions

How commonly are patients with spinal pathologies referred to hip clinic? Study from a Scottish regional specialist hip clinic

Anna Leerssen[1], Andraay Leung[2], Roland Ingram[2], Andrew Stark[2]
[1]Royal Alexandra Hospital, Glasgow, UK [2]Glasgow Royal Infirmary, Glasgow, UK

Introduction
A third of presentations to primary care are musculoskeletal, and within these hip and spine complaints are common. Hip and spinal pathologies share some common symptoms and may even co-exist.

Study design
Retrospective cohort study in outpatient population. Outcome Measures: diagnosis, onward referral to spinal services.

Methods
Electronic patient records were accessed for new patients to the Hip clinic at the GRI for six consecutive months. Two-hundred-and-twenty-seven patient records were investigated, and 169 of these were included for analysis. Data analysis was performed using SPSS statistics software. Referral letters and clinic letters were analysed for symptom descriptions.

Results
71.6% (n=121) of referrals listed “Hip” as the main site of pain. Clinic letters used “Hip” as main site in 33.2% (n=55) cases, although this was always further elaborated on with specific sites such as groin or buttock. Cramer V coefficient test identified strong, significant relationship ($\phi c = 0.376$; $p<0.001$) between pain site in clinic and diagnosis; with groin pain associated with hip osteoarthritis, and back and buttock pain associated with spinal pathology. Overall, 23.6% (n=40) had a final diagnosis of a spinal pathology and 3% (n=5) were referred for spinal surgery opinion.

Conclusion
Nearly a quarter in our cohort had spinal pathology. This highlights an area for potential service improvement. Moreover, the larger number of pain-site descriptors identified in clinic illustrates greater emphasis on pain history in clinic and the importance of a thorough pain history to arrive at a correct diagnosis.

Back in action and staying there. Improving perceived disability and sustaining activity after back group—a cost-effective model

Ruth Newsome[1], Ashley Cole[1], James Tomlinson[1], Michael Reddington[1], Neil Chiverton[1]
[1]Sheffield Teaching Hospitals NHS Trust, Sheffield, UK

Introduction
Back groups are recommended by National Institute for Health and Care Excellence (NICE) guidelines and widely used. Adherence to exercise after discharge is a recognised problem. Functional restoration has been shown to have some positive effects but is costly. This back group has evolved with patient input and shown positive improvements in self-reported disability together with sustained activity following discharge, at low cost.

Methods
Patients receive a personal exercise plan within groups, taken by a specialist physiotherapist and fitness instructor. One group is delivered at a sports centre, the other at the hospital. ODI and physical measures are taken. Patients are encouraged to continue exercise after discharge. A post-discharge back group runs at the sports centre. Attendance is monitored through the sports centre. 123 patients were retrospectively reviewed with 98 completing the programme and outcome measures. Cost per patient was calculated by dividing the total cost of sessions over two and a half years by 98

Results
Pre-treatment, mean ODI was 39 (range 72–6, SD=19) and on completion, mean 24 (range 62–0, SD =17), a significant improvement ($p<0.01$). Minimal important clinical difference (MICD) improvement of 10 or above (ODI) was achieved by 66% of the patients. Of patients followed-up through the sports centre, 66% were still active 1–2 years after discharge. Cost of the back groups for all participants was £14,600 (£148 per patient).

Conclusion
This back rehabilitation group model appears extremely cost effective with significant health benefits. A future trial to determine the full healthcare economics and benefits is planned.

A review of 571 radiographs on Tuffier's inter-cristal line and its application in lumbar spinal surgery

Ahmed Chowdhury[1], Himanshu Sharma[2]
[1]Plymouth Peninsula Medical School, Plymouth, UK [2]Plymouth Hospitals NHS Trust, Plymouth, UK

Introduction
Tuffier's line (TL) is an anatomical landmark used to identify the L4/5 interspace by palpating inter-cristal level in lumbar spinal surgery. The routine use of pre-operative pre-incision radiographs for level check by spinal surgeons is variable due to reliance on this palpation. The anatomical violation of neighbouring normal levels in microscope assisted lumbar surgery is unknown.

Aim
To evaluate the effects of patient-related demographic factors and radiographic parameters on TL in a cohort of patients undergoing lumbar spinal procedures.

Methods
One-hundred-and-eighty-seven patients (571 radiographs) identified from a spinal database, were retrospectively analysed. Procedures included nerve root injections, decompressions, micro-discectomies and instrumented fusions. Radiographs were analysed with regard to age, gender, radiographic views (AP & lateral), weight-bearing (wb vs. non-wb) and dynamic radiographs (flexion vs. extension).

Results
The mean age was 61.25 years (range, 23–88 years). The most common level of TL was L4 vertebra (40% <60; 44% >60 years). The most common level in females was L5, while in males L4 vertebra. In 186 radiographs, 68% displayed a difference of at least one vertebral level on AP vs. lateral planes. In 22 patients, there was at least one level vertebral difference between weight bearing and non-weight bearing radiographs.

Conclusion
TL can be affected by age, gender, radiographic views and weight bearing status variably. We recommend employing pre-incision radiographs in all microscope assisted lumbar spinal procedures to eliminate the clinical variations in inter-cristal line and thereby avoiding anatomical violation of neighbouring normal levels in microscope-assisted lumbar surgery.

Long-term outcomes with activC cervical total disc replacement (cTDR)

Shreya Srinivas[1], Susan Cadman[2], Michael O Malley[3], Lorcan Mcgonagle[4], Clare Morgan[2], Ian Shackleford[2]
[1]Vancouver General Hospital, Vancouver, Canada [2]Warrington and Halton NHS Hospitals Trust, Warrington, UK [3]Orthopaedics Southland, New Zealand [4]Royal Adelaide Hospital, Australia

Aim
This study reports on patient outcomes at long-term follow up for the activC prosthesis used for cervical TDR.

Methods
Patients who underwent cTDR for degenerative disc disease at NHS district general hospital between 2007 and 2009 were followed up at regular postoperative intervals (six, 12 ,24 and 105 months). Outcomes recorded were visual analogue score (VAS) Neck Disability Index questionnaire (NDI) and Centre for Epidemiologic Studies Depression questionnaire (CES-D)

Results
There were 61 patients who underwent cTDR (28 men, 33 women, Average age 48 years) and 45 (73%) were available for long-term follow up . Mean VAS for neck pain improved from 6–2 at 12 and 24 months and comparable at 105 months (VAS=3) [p<0.006]. Mean VAS scores for arm pain (pre-op=7) showed periodic improvement at 12 (VAS = 5) and 24 months (VAS=4) [p =0.1 and 0.05] and significantly better at 105 months (VAS=3) [p<0.006]. NDIQ (average) improved significantly [preop:12m:24m:105m=51:30:35:26 (p<0.0001)]. Similarly CES-D was significantly better [preop:12m:24m:105m=20:13:24:14 (p<0.0001)]. No revisions were performed at the same level and three patients had further adjacent level cTDR (two at two years, one at nine years) and median survival time was 8.62 years (7.22–10.05 95% CI).

Conclusion
cTDR improves pain and function in patients with degenerative disc disease both in the early and long term. We are able to report a median survival time of 8.6 years with the activC prosthesis.

Physiotherapy in non-operative management of degenerative cervical myelopathy—a patient perspective

Abdul Badran[1], Benjamin Davies[1], Heidi-Marie Bailey[1], Sukhvinder Kalsi-Ryan [2], Mark Kotter[1,2,3,4]
[1]Academic Neurosurgery Unit, Department of Clinical Neurosurgery, University of Cambridge, Cambridge, UK [2]Toronto Western Hospital, University Health Network & University of Toronto, Toronto, Canada [3]WT MRC Cambridge Stem Cell Institute, Anne McLaren Laboratory, University of Cambridge, Cambridge, UK [4]John van Geest Brain Repair Centre, University of Cambridge, Cambridge, UK

Introduction
The role of physiotherapy in conservative management of Degenerative Cervical Myelopathy (DCM) is controversial. New international guidelines suggest it may have a role in the management of mild DCM.

Aim
To determine patient experience of physiotherapy in non-operative management of DCM.

Methods
An online survey was designed using SurveyMonkey and advertised to patients through a DCM charity (Myelopathy.org), social media (Facebook and Twitter) and Google AdWords. Duplicate responses were limited by respondent IP addresses and identifiable data points. Data were compared using summary statistics.

Results
A total of 1,075 DCM patients completed the survey. Of these, 62% had not yet undergone surgery. Non-operative patients were less disabled (Nurick 1.9±1.5) than patients who had undergone surgery. Forty-eight per cent of non-operative patients had undergone physiotherapy and subjective benefit was found in only 23%. Patients who received physiotherapy as non-operative management of DCM were similarly affected (Nurick 1.9±1.4 vs. 2.0±1.4; p=0.714), and similarly likely to be unemployed (40% vs. 35%) and needing a carer (39% vs. 39%) as those that had not received physiotherapy.

Conclusion
Few patients undergo physiotherapy as part of non-operative management and fewer still perceive it of benefit. Objective measures of DCM functional status are the same between groups who have and have not undergone physiotherapy.

Wear and damage of CrN coated cervical disc replacements in spine simulator tests

Susan Partridge[1], Kinga Pasko[2], Joanne Tipper[2], Richard Hall[1]
[1]University of Leeds, Leeds, UK [2]Institute of Medical and Biological Engineering, University of Leeds, Leeds, UK

Cervical total disc replacement (CTDR) is a surgical intervention for patients suffering from painful degeneration of the cervical disc. It is an alternative, motion preserving treatment to anterior cervical discectomy and fusion (ACDF). Bearing combinations for CTDR include metal on ultra-high molecular weight polyethylene (MoP) and less commonly metal on metal (MoM). Wear debris from MoP bearings in orthopaedic implants has been associated with osteolysis and subsequent loosening of the implant, while the cytotoxic effects of MoM wear debris are of clinical concern. Coated implants can be very low wearing and offer the potential of improved biocompatibility through a reduction in metal ions.

Three CoCr bearings for CTDRs were coated with CrN and tested in a six-axis spine simulator for four million cycles (Mc) using an ISO testing protocol (ISO-18192-1). The components were weighed every 1Mc to determine wear and damage was assessed using optical and SEM microscopy and energy dispersive x-ray analysis (EDX).

The mean wear rate for the CrN-on-CrN bearings at 4Mc was 0.005mm^3/Mc (SD=0.003), which is lower than previously reported for MoM CTDRs and MoP CTDRs. The components gained weight between 3Mc and 4Mc. Damage indicative of edge loading was observed on the bearing surface of the convex component and the rim of the concave components. The presence of cobalt in these areas, which may suggest exposure of the substrate, was detected with EDX analysis. These findings suggest that CrN coatings for CTDRs are very low wearing but adverse loading may compromise the integrity of the coating.

Navigation and Spinal Cord Monitoring Events in Adult Spinal Deformity

Darren Lui[1], Adam Benton[1], Susanne Selvadurai[1], Sean Molloy[1]
[1]Royal National Orthopaedic Hospital, Stanmore, UK

Introduction
Intra operative navigation (O-Arm) allows three dimensional real time assessment and has many documented benefits including lower radiation dose to the surgeon and assistant, more accurate pedicle or lateral mass screw placement and ability to aid minimally invasive surgery. Utilisation of the O-Arm allows accurate and precise single pass screw insertion. To our knowledge O-Arm has not been investigated for adult posterior spinal surgery in relation to SCM events.

Methods
Retrospective study between 2005–2015, a single surgeon in two centres was analysed for adult posterior spinal surgical cases. Cases prior to O-Arm use and cases with O-Arm. Spinal cord monitoring included somatosensory evoked potentials (SSEPs) and motor evoked potentials (MEPs). Events were categorised as Green (no events), Amber (events occured but resolved), Red (events occured and did not resolve during operation) and Black (technical difficulty)

Results
A total of 669 consecutive adult posterior spinal surgical cases were identified. Age and sex were well matched (57y vs. 59y). Pre- O-Arm approximately over five years: 355 (53%) cases had 10.3% SCM events (Green 89.2%, Amber 6.4%, Red 3.9%, Black 0.002%). Utilising the O-Arm in approximately five years: 314 (47%) cases had 6.3% SCM events (Green 86.2%, Amber 2.8%, Red 3.5%).

Conclusion
The Scoli-RISK-1 study showed a 26.2% peri-operative neurological deterioration in the first six weeks following surgery. Intraoperative navigation has allowed the development of accurate and precise single pass pedicle screw insertion. There is a decrease from 10.3% spinal cord monitoring events to 6.3% with O-Arm use.

Shifting the compression: adjacent segment disease with interspinous devices—a case series

Richard Dimock[1], Guy Paremain[1]
[1]Royal Surrey County Hospital, Guildford, UK

Bony decompression (laminectomy) has been the mainstay of surgical treatment of spinal stenosis since its inception in 1800s

and may be combined with spinal fusion to increase stability. However, spinal fusion can result in increased stress levels and movement at adjacent non-fused level and lead to symptomatic adjacent segment disease (ASD) in up to 18.5% of cases. For over 50 years ago, inter-spinous spacer devices (ISDs) (e.g. Wallis ligament, X-STOP, DIAM, Coflex), have been used to treat lumbar spinal stenosis, restoring foraminal and spinal cross-sectional area, unloading facet joints and providing stability in extension, whilst allowing movement. Through providing such semi-rigid fixation, ISDs aim to provide symptomatic relief and improve functional outcome, whilst reducing the risk of ASD. More recently, ISDs have been used in "topping off" techniques to reduce the rate of ASD in spinal fusion, with positive results. Despite this, use of ISDs has been overshadowed by high rates of complications, including re-operation rates of up to 85%. However, follow-up studies have mostly been limited to two years and re-operations predominantly at the index level. Although incidents of ASD with ISDs have been recorded, the incidence of ASD requiring surgical intervention has Been seldom documented.

We report on a single surgeon case series of 36 patients treated with a Wallis ligament at L4/5, five of whom required further procedure for ASD at the level above ISD insertion, four to nine years post insertion of the ISD (Wallis ligament). This hitherto rarely reported complication of ISDs further questions their ongoing usage.

The mechanical fatigue of vertebroplasty treatment in a bovine model

Ruth Coe[1], Sebastien Sikora[1], Gavin Day[1], David Barton[1], Ruth Wilcox[1]
[1]*University of Leeds, Leeds, UK*

Osteoporotic vertebral fractures are prevalent in post-menopausal women, and can result in pain and a reduced quality of life. Surgical interventions, such as vertebroplasty, have had varied outcomes with work still needed to optimise materials and procedures. Biomechanical analysis has previously provided insight into the mechanisms of vertebroplasty, however this typically investigated short term responses. Therefore the purpose of this study was to investigate the fatigue response of fractured vertebrae treated with vertebroplasty to gain further insight into its efficacy.

Thirty-one bovine tail vertebrae were loaded axially to 9.5kN or failure. Eleven specimens were then injected with PMMA bone cement, and 20 left untreated. Untreated vertebrae were cyclically tested in four groups at loads of 60%–90% of the initial failure load. Treated specimens were tested at 80% failure load, all were tested up to 10000 cycles or failure.

A relationship was seen between initial strength and fatigue performance, with significant differences between the 60% load group and other groups ($p<0.05$). No significant difference was seen in fatigue performance between treated and untreated specimens, however a smaller reduction in mechanical stiffness was seen in the augmented group after testing. MicroCT scan data provided information about the location and severity of fractures.

This study demonstrates variation in the outcome of vertebroplasty even in a comparatively controlled environment, and shows the difference in response of fractured vertebrae under different levels of loading. It provides new testing methods and useful data for computational modelling, where the reasons for the variation can be further examined.

Can we accurately predict the likelihood of cauda equina syndrome in the emergency department?

Michelle Angus[1], Irfan Siddique[1], Naveed Yasin[1], Saeed Mohammad[1], Rajat Verma[1]
[1]*Salford Royal NHS Foundation Trust, Salford, UK*

The pressures faced by the clinician in the emergency department (ED) are well established and predicted to continue (NHS England, 2017). EDs therefore rely heavily on clinical guidelines; yet there is little to help the ED clinician when it comes to ruling out CES with a clinical assessment as the guidelines are vague (BASS 2015, NICE CKS 2017).

This paper presents the largest retrospective study to date, reviewing imaging and case notes of 307 consecutive patients (181 male and 126 female) in a 12-month period attending the ED of a regional spinal hospital undergoing an emergency MR scan for possible CES.

All patients with CES had leg pain, bilateral pain more frequent than unilateral. Significantly more CES patients reported saddle anaesthesia (57%) than those without compression (45%); although commonly not found on clinical examination in the CES group. Faecal incontinence was not present in any of the CES patients, but in a small number of the non CES group (16%). Motor function was similar between the groups, abnormal in almost half.

The majority (91%) of the MR scans showed no CE compression, 9% of scans confirmed the presence of radiological cauda equina compression and these patients went on to have emergency surgery.

The results concur with previous smaller studies, no single or combination of clinical symptoms or signs is a strong enough indicator of the presence or otherwise of CES. Hence a low threshold for MR scan and a significant number of negative scans is an inevitable reality.

Developing methods of modelling vertebroplasty in experimentally-augmented human lumbar vertebrae

Gavin Day[1], Alison C. Jones[1], Ruth Wilcox[1]
[1]*University of Leeds, Leeds, UK*

Osteoporotic vertebral compression fractures affect large percentages of the population, with up to 27% of women over 70 years of age experiencing such a fracture. These fractures

are associated with reduced quality of life, pain and risk of adjacent level fracture. Vertebroplasty is a method of treating such fractures, however, questions about the efficacy of the procedure have been raised, suggesting a need to understand how patient and procedure variation affect the mechanical outcomes of the procedure.

Fourteen lumbar vertebrae from four cadaveric spines were isolated and experimentally tested under axial load to determine their initial stiffness. Vertebrae were augmented through an oblique approach and loaded again to determine a post-augmentation stiffness. Finite Element (FE) models were created from μCT scans of the vertebrae pre and post augmentation.

Experimentally, large variation was found in the post-augmentation stiffness (-39%–48% change from pre-augmented), even for specimens injected with similar quantities of cement. Variation was also found in the cement volume (4%–55% fill) and shape, with a relationship between stiffness and cement fill only found for non-dispersed volumes. FE models of non-augmented vertebrae show good agreement (concordance correlation coefficient, (CCC)= 0.84), and were then used to investigate different methods of modelling the important bone-cement interface.

The variation in experimental results highlights the need for a parametric analysis of vertebroplasty and the FE models are now being used to identify the patient characteristics that influence the mechanical outcome of the procedure.

Risk factors for developing recurrent discs after microdiscectomy within five years

Jarnail Bal[1], D.M Ridwan[1], Georgios Prezerakos[1], Babak Arvin[1], Karoly David[1], Ahmed Ibrahim[1]
[1]*Department of Neurosurgery, Queens Hospital, Romford, UK*

Aim
To identify risk factors for developing disc recurrence following microdiscectomy within five years.

Design
Retrospective case note study.

Subjects
All patients who had a microdiscectomy between 2010–2015.

Methods
Operative records were interrogated from 2010 to 2015. Those patients who had an index operation and revision operation within the five years were selected. Age, weight , height, occupation, smoking, level and number of levels operated and type of index/revision surgery performed were analysed.

Results
Five-hundred-and-fifty-five patients had a microdiscectomy between 2010–2015. Twelve patients had a recurrent disc herniation requiring surgery with two patients requiring two revisions. The mean age was 47. The time from index operation to revision surgery was on average 12 months, levels affected were L3/4 (18%), L4/5 (41%), L5/S1 (41%). Males and females were equally affected and average BMI was 27.2. Sixty per cent of the patients worked in the building trade.

Conclusion
All patients who had recurrent disc disease requiring surgery presented with recurrent symptoms. They tending to have be overweight and have a physically demanding job. Their presentation was usually with 12 months of their index surgery. This may help in pre-operative counselling in this group of patients when discussing risk of recurrence.

The management of symptomatic lumbar disc herniation in pregnancy—a systematic review

Emily Whiles[1], Epaminondas Markos Valsamis[1], Oliver Stokes[1], Sherief Elsayed[1]
[1]*Brighton, UK*

Introduction
Lumbar disc herniation (LDH) is defined as a localised or focal displacement of disc material beyond the limits of the intervertebral disc space. One in 10,000 pregnant women are reported to be affected by this condition. Despite there being established guidelines to manage LDH in the non-pregnant population, there is limited evidence to guide the optimal management in pregnancy. This study assessed the efficacy of different management options in managing LDH in pregnancy by critically appraising the available literature.

Methods
Medline, Embase, PubMed, Science Direct and the Cochrane Library databases were searched from their inception to February 2017 using pre-determined search terms. All peer-reviewed studies were included in this study.

Results
Thirty case reports or case series involving 52 patients met inclusion criteria. Patients treated conservatively had a higher rate of full resolution of symptoms when compared to surgically treated patients (61.54% vs. 56.41%), and a lower rate of prolonged symptoms post-management (30.77% vs 38.54%). Patients who were treated surgically for sciatica had a higher full recovery rate compared to patients being treated for cauda equina syndrome (80.95% vs. 27.78%) and reported a lower rate of persisting symptoms (14.29% vs. 66.67%). One-hundred per cent of patients managed conservatively had a successful birth with no maternal or fetal complications compared to 93.55% of surgically managed patients.

Conclusion
Pregnancy does not contraindicate the use of MRI, anaesthesia or surgical management. Careful assessment of the risks and benefits for each patient need to be undertaken in conjunction

with the obstetric team.

Lumbar interbody fusion rates in 3D printed lamellar titanium cages using a silicate substituted calcium phosphate bone graft

Michael Mokawem[1], Robert Lee[1], Clare Harman[1]
[1]*Royal National Orthopaedic Hospital, Stanmore, UK*

Introduction
Successful outcomes of lumbar interbody cages are dependent on achieving a solid fusion. We present a case series of 78 patients who had a combination of either transforaminal (TLIF) or lateral (LLIF) interbody 3D printed lamellar titanium cages packed with silicate substituted calcium phosphate bone graft. We achieved a 99% fusion rate at 12 months.

Methods
Prospectively collected data. Single surgeon consecutive case series. Seventy-eight adult patients requiring anterior column reconstruction. TLIF and LLIF cases were included. All cases had 3D printed lamellar titanium cages with silicate substituted calcium phosphate bone graft. All patients had their reconstruction augmented with posterior instrumentation. Outcome measures—radiological: CT scans at 12 months to assess fusion. CT scans reported by consultant radiologist and independently reviewed by both authors. Patient reported: EuroQol-5Dimension (EQ-5D), EQ-5D visual analogue scale (VAS), VAS leg pain, VAS back pain and Oswestry Disability Index (ODI) collected at one year.

Results
Thirty-nine TLIF cases (53 cages), 39 LLIF cases (79 cages). CT showed solid fusion in all but one case. Patient reported outcomes showed significant improvements at one year: EQ-5D from 0.312–0.916, EQ-5D VAS from 47.9–80.35, VAS Leg Pain from 7.55–1.75, VAS Back Pain from 7–2.15 and ODI from 56.25–21.7.

Conclusion
Excellent fusion rates can be achieved with 3D printed lamellar titanium cages and silicate substituted calcium phosphate bone graft. The increased cost of the bone graft is justified due to increased fusion rates.

Advancing our understanding of functional distrubances in low back pain—a report on multicentre collaborations

Kevin Brownhill[1]
[1]*University College of Osteopathy, London, UK*

This presentation reports on findings from several collaborations funded by the Society of Back Pain Research Travel Fellowship whose overall aim was to investigate functional disturbances in nonspecific low back pain. Collaborating institutions are the Ecole Superieure d'Osteopathie (ESO), Paris, the Anglo-European College of Chiropractic (AECC), Bournemouth, and the MSk Lab, Imperial College, London.

The collaboration with the ESO Paris investigated the use of of the Nintendo Wii balance board for low cost clinical assessment of balance function in musculoskeletal pain, including low back pain. The aim was to make open-source software freely available to laboratories and clinics and to assess it's accuracy against a gold-standard method.

The collaboration with the AECC in Bournemouth aimed to reanalyse passive motion intervertebral motion data, of matched back pain subjects and controls, obtained from videoflouroscopy. This data is both high dimensional and not necessarily confined to a linear subspace. Hence nonlinear manifold learning techniques were employed for dimension reduction, combined with supervised learning to elicit features of intervertebral motion that distinguished back pain subjects from controls, which may not be evident from previous analyses.

The collaboration with the MSk Lab, Imperial aimed to employ advanced statistical techniques to elicit features of motion, including walking and sit-to-stand, that distinguishes back pain subjects from controls. Analysis of this type of data, consisting of 3D rotations of body segments across time, is an active area of research. Results of preliminary analysis of this data will be reported.

Patient reported satisfaction with dedicated spinal surgery consent clinics

Tobias Stedman[1], Morgan Jones[1], Anthony Michael[1], Michael Athanassacopoulos[1], Lee Breakwell[1], James Tomlinson[1], Ashley Cole[1], Neil Chiverton[1]
[1]*Sheffield Teaching Hospitals NHS Trust, Sheffield, UK*

There is a range of evidence reporting patient recall is limited following consent for surgical procedures, with increasing support for consent to be taken prior to the day of surgery. There is limited data describing patient satisfaction following attendance at designated pre-operative consent clinics in spinal surgery. We suggest such clinics improve patient experience and enhance the consent.

A 16-point questionnaire was designed using a Likert-type scale to assess perceived understanding of the risks and benefits of surgery. Free text boxes were available to assess respondents recall of the name of their surgery and satisfaction with the consent process. Data was prospectively collected after consent clinic consultations.

Fifty-six questionnaires were completed. Sixty-three per cent were able to closely or exactly recall their proposed operation title. Thirty-nine per cent took time off work to attend. Despite reported travel distances to the clinic being between 1–40 miles (or 5–120 minutes) 72% strongly agreed their appointment was worthwhile. 'Strongly agree' was the modal response in relation to

being given adequate information regarding expected outcome, treatment goals, complications, the nature of their condition and addressing concerns. Seventy-nine per cent felt that the pre-operative consent clinic visit was more useful than patient information booklets.

Patient satisfaction with pre-operative consent clinics in adult spinal surgery is high. Patients felt able to adequately discuss proposed surgery, and gained enough information to understand the risks, benefits and alternative treatments. Further work is needed to understand why 37% of patients could not name their procedure, and whether more in depth patient education is needed.

Decellularised intervertebral discs: biological scaffolds for degenerate intervertebral disc replacement

Halina Norbertczak[1], Eileen Ingham[1], Hazel Fermor[1], Ruth Wilcox[1]
[1]Institute of Medical and Biological Engineering, University of Leeds, Leeds, UK

Intervertebral disc (IVD) degeneration is a major cause of back pain. A decellularised IVD, implanted in place of a degenerate IVD, has the potential to overcome the limitations of current surgical interventions. The aim of decellularisation is to remove cellular components from tissues leaving an acellular and non-immunogenic extracellular matrix scaffold. In this proof of technical concept study, bovine bone-disc-bone units were used as the animal model. Decellularisation methods were applied to the bovine tissue and investigated for future translation to human IVDs for use in the replacement of degenerate human IVDs.

Decellularisation protocols using hypotonic buffer, low concentration sodium dodecyl sulphate, proteinase inhibitor, freeze/thaw and nuclease treatments were applied to whole bovine tail IVDs (with bony attachments). The most effective method reduced total DNA content of the nucleus pulposus (NP), inner annulus fibroses (iAF), outer annulus fibrosus (oAF) and growth plate-endplate (GP/EP) regions to 37.03 (±10.44 95% CL), 21.69 (±8.53 95% CL), 16.68 (±5.50 95% CL) and 60.56 (±17.63 95% CL) ng.mg-1 dry weight tissue respectively (n=6). DNA degradation was improved with the removal of excess vertebral bone from the samples. Whole nuclei were observed in the GP, EP and notochord cell clusters of the NP after decellularisation; these regions however would not be present in human donor IVDs. Encouragingly, the glycosaminoglycan content was preserved in the NP. Work is now being undertaken to investigate the biomechanical performance of the decellularised IVD.

Post-operative physiotherapy in degenerative cervical myelopathy: a patient perspective

Abdul Badran[1], Benjamin Davies[1], Heidi-Marie Bailey[1], Sukhvinder Kalsi-Ryan [2], Mark Kotter[1, 2, 3, 4]
[1]Academic Neurosurgery Unit, Department of Clinical Neurosurgery, University of Cambridge, Cambridge, UK [2]Toronto Western Hospital, University Health Network & University of Toronto, Canada [3]WT MRC Cambridge Stem Cell Institute, Anne McLaren Laboratory, University of Cambridge, Cambridge, UK [4]John van Geest Brain Repair Centre, University of Cambridge, Cambridge, UK

Introduction
Although rehabilitation is commonly used to support recovery after neurological damage, its efficacy or usage has not been assessed in DCM. Improving post-operative recovery is a major unmet need in DCM.

Aim
To determine usage and patient experience of post-operative physiotherapy in DCM management.

Methods
An online survey was designed using SurveyMonkey and advertised to patients through a DCM charity (Myelopathy.org), social media (Facebook and Twitter) and Google AdWords. Duplicate responses were limited by IP addresses and identifiable data. Data was compared using summary statistics.

Results
A total of 1,075 DCM patients (71% female) completed the survey. On average respondents aged 55 years (+/- 27.8) and 55% had suffered from DCM for >3 years. There was global representation, but 87% were either from the UK or USA, and 92% were Caucasian. Of those that received surgery (38%), only 22% received post-operative physiotherapy. About half (49%) of these patients found it subjectively useful, more than double the satisfaction rate of physiotherapy use in non-operative management (22%). Those that received postoperative physiotherapy were found to have on average a faster recovery compared to those that did not (4.7 months vs. 6.3 months; unpaired t-test p=0.031). There was no difference in overall disability (Nurick 2.4 vs Nurick 2.4; p=0.93).

Conclusion
Despite no level one evidence, post-operative physiotherapy is used in DCM with around half of patients derive benefit from it. Those who underwent physiotherapy had faster recovery times, though overall functional status was equivalent. As a simple and available therapy, this warrants further research.

The Dublin Spine Registry—a retrospective analysis of Oswestry Disability Index scores in 13,413 patients attending a spinal triage clinic

Antoinette Curley[1], Conor Gissane[2], Joseph Butler[3], Joice Cunningham[4], Fiona Wilson[4]
[1]Back Pain Screening Clinic, Tallaght Hospital, Dublin, Ireland [2]School of Sport, Health and Applied Science, St. Mary's University, London, UK [3]Back Pain Screening Clinic, Tallaght Hospital, Dublin, Ireland [4]Discipline of Physiotherapy, School of Medicine Trinity College Dublin, University of Dublin, Dublin, Ireland

Spinal registers have been established as a central repository of outcomes. The Oswestry Disability Index (ODI) is recommended as the measure of choice for lumbar related function.

This study aimed to characterise typical (mean and SD) ODI scores of patients with low back pain (LBP) presenting to a physiotherapist led spinal triage clinic between 2001 and 2015. At their initial appointment all patients completed an ODI (v2.1a) and subjective percentage LBP and leg pain were documented. All participants were >16 years at the time of assessment and were excluded if they had spinal deformity, spinal tumour or previous spinal surgery. Over this time, 14,644 participants attended the clinic and 13,413 patients had a completed ODI.

Mean (SD) female ODI report was 41.5 (18.8) males was 38.04 (19.58). ODI report range from 57.5 (9.1) in the 91+ age group to 31.73 (17.4) in the 16–20 age group. Females reported a significantly higher ODI score than males ($p<0.05$). Fifty-eight per cent reported back dominant symptoms; mean (SD) ODI 38.91 (17.43). A total of 29.5% reported leg dominant symptoms; (mean ODI 43.28 (19) and 12% reported equal back and leg pain (mean ODI 18.8). Thus the highest ODI was reported in those with leg dominant pain. Which differed significantly from back only pain ($p<0.05$).

Thus higher ODI scores are reported in females and in those with leg dominant pain. Increasing age is also associated with a significant increase in ODI scores. Further results will be reported.

Does the S1 pedicle and sacroiliac joint orientation correlate with the pelvic incidence?

Emily Pardington[1], Ian Harding[1], Rathnam Sundaram[2], Crispin Wigfield[1], Priyan Landham[1], Alex Torrie[2]
[1]Southmead Hospital, Bristol, UK [2]Gloucestershire Hospitals NHS Trust, UK

Aim
To identify whether a correlate between the axial orientation of the S1 pedicle and the axial and coronal orientations of the sacroiliac joint correlate with the pelvic incidence (PI).

Methods
Four-hundred pelvic CT scans were reviewed. For the S1 orientation, a mid-axial reference line was drawn at the level of the S1 pedicle using the technique described by Ho ***et al***, then the angle subtended between the mid-axial reference line and the entry point for an S1 pedicle screw was measured. The axial orientation of the SIJ was also measured relative to the same mid-axial reference line. The coronal orientation of the SIJ was measured relative to the superior endplate of S1. Reliability testing using Cronbach's Alpha test was conducted on 20 cases to assess technique validity. PI was correlated with the orientation of the S1 pedicle and the coronal and axial orientations of the SIJ. PI was correlated with all measured angles using the Spearman R test. $p<0.05$ was accepted as significant.

Results
Two-hundred-and-twenty-seven females and 173 males were included with a median age of 53 years (IQR 41-68). Median PI was 52 degrees (IQR 46-57). All reliability testing was acceptable or better (intra-observer >0.884, interobserver >0.710). PI was significantly negatively correlated with the axial SIJ orientation bilaterally ($P<0.001$ bilaterally). All other results were not significant.

Conclusion
There is a negative correlation between the PI and the axial orientation of the SIJ. As the PI increases the axial SIJ orientation tended towards the mid-axial reference line.

Does lumbar spinal surgery improve mental health outcomes?

Aleksandra Kaniewska[1], Himanshu Sharma[2]
[1]University of Exeter Medical School, Exeter, UK [2]Plymouth Spinal Services, South West Neurosurgery Centre, Derriford Hospital, Plymouth, UK

Introduction
Mental health derangement could cause or affect chronic lower back pain. There is a paucity of literature on whether lumbar spinal surgery improves mental health outcomes.

Aim
This study investigates whether lumbar spinal surgical interventions- micro-discectomy, decompression or instrumented fusion for spondylolisthesis- have measurable influences on mental health.

Methods
Two-hundred-and-thirty-one consecutive patients were selected who underwent micro-discectomies, lumbar decompression or instrumented fusion procedures between January 2014 and June 2017. Patient demography, operation type, prospectively collected PROMs (pre- and postoperative Visual Analogue Scale and Oswestry Disability Index scores) were analysed. Subsequently, participants were sent three questionnaires: a general inquiry of patients' mental health and the effect surgery had on them, a retrospective pre- and postoperative modified EQ5D-5L questionnaire and a retrospective pre- and postoperative modified Somatic perception questionnaire (MSPQ).

Results
Ninety-seven patients completed the questionnaires (42% response). Thirty-six had a diagnosed mental health condition (37%), of which 44.4% reported a positive influence of surgery on their mental health and 69.4% reported a decrease in the MSPQ scores (p=0.0953) compared to patients with no known mental health condition (56.4%). Patients with less improvement in VAS and ODI scores correlated with less improvement in mental health.

Conclusion
Our study showed that lumbar spinal surgery can play an important role in improving mental health in patients with or without known disorders. Lumbar spinal surgery should be offered to patients with mental health conditions. We found a positive impact for half of the patients with mental health conditions. Two-thirds reported reductions in MSPQ scoring.

Complications following ACDF for degenerative cervical spinal disorder - a single surgeon's experience revalidating first five years as a consultant

Adrian Zammit[1], Himanshu Sharma[1]
[1]*Plymouth Hospitals NHS Trust, Plymouth, UK*

Introduction
The mean complication rate reported in the literature is 19.3% following anterior cervical discectomy & fusion (ACDF) procedures to treating cervical myelo-radiculopathy secondary to degenerative cervical spine disorders. The aim of this study was to evaluate the type & incidence of complications following ACDF procedures performed by a single surgeon revalidating the first five years as a consultant.

Methods
This is a retrospective review of prospectively collected data on ACDF procedures performed by a single surgeon. Data was collected from electronic medical records & imaging.

Results
Seventy-three patients (89 levels) performed for radiculopathy (67.1%) and myelopathy (30.1%) showed the overall complication rate of 9.6%. Transient dysphagia and hoarseness were the two most common complications with an incidence of 2.7% and 4.1% respectively. Two patients experienced neurological deterioration postoperatively, one recovered within four hours and other one was diagnosed with multiple sclerosis. There was no 30-day mortality, incidental durotomy, nerve injury, spinal cord injury, Horner's syndrome, surgical site infections, airway compromise from neck haematomas. Cage subsidence was identified in 9.6% without needing revisions.

Conclusion
This study revalidated the first five years as a consultant for ACDF procedures with comparable complication rate to published literature. In our series, the overall complication rate was 9.6% and two most common complications were related to transient speech and swallowing disturbances. We recommend that outcomes and complication rates of all the operated cases should be reviewed at the end of first five years of consultant practice for patient safety and clinical governance.

Factors affecting incidental durotomy—a retrospective analysis of consecutive 848 patients undergoing lumbar spinal surgery

Michelle Chisvo[1], Himanshu Sharma[1], Nagarajan Sudhakar[1]
[1]*Plymouth Spinal Services, Derriford Hospital, Plymouth, UK*

Introduction
Incidental durotomies are a well-recognised intra-operative complication during lumbar spinal surgery. The aim of this study was to identify the dural tear incidence and to analyse the factors influencing it.

Methods
A retrospective analysis was conducted on 848 patients who underwent lumbar spinal operations, under two consultants in a consecutive four-year period. In patients with incidental durotomy, data relating patient demography, operator expertise, procedure duration and difficulties was collected. Other factors assessed were primary vs. revision procedures, instrumentation vs. non-instrumentation, multi-level vs. single-level operations and consultant alone vs. with a registrar.

Results
There were 44 (5.19%) unintended durotomies in this cohort. The average age was 68 years and the mean BMI was 29.2. Revision operations (n=64) had the highest incidence of durotomies (15.63%), especially when compared with primary procedures (n=784; 4.34%, p=0.001). Dural tear incidence was 8.25% in instrumented lumbar spinal surgery (n=303) and 3.49% in non-instrumented decompression surgery (n=545; p=0.003). Multi-level procedures (n=338) yielded an incidence of 7.69%, while single-level procedures (n=510) had an incidence of 3.53% (p-value=0.008). Operations performed by consultants alone had a dural tear incidence of 4.39% compared with 5.57% (p=0.41) incidence while training registrars (68.2%).

Conclusion
This study confirmed 4.3% incidence of incidental durotomy in primary and 15.6% in revision lumbar spinal procedures. There was a higher incidence of dural tears in patients with previous lumbar surgery (4x to primary), multi-level procedure (2x to single level procedures) and instrumented procedure (2x to decompressive procedures). Over two-thirds of all durotomies occurred whilst training junior grades.

Questioning NICE—is there a role for foraminal epidural injections in central lumbar spinal canal stenosis?

Nick Evans[1], Michael McCarthy[1]
[1]*Welsh Centre for Spinal Surgery & Trauma, University Hospital of Wales, Cardiff, UK*

Introduction
Recent NICE guidelines do not support the role of epidural injections for the management of neurogenic claudication in patients with central spinal canal stenosis. This study aims to see if there is a role for foraminal epidural steroid injections (FESIs).

Methods
A prospective, single surgeon case series of 115 patients who had a FESI for symptomatic lumbar canal stenosis. Children and patients with primarily disc related pathology were excluded. MRI scans were analysed and the degree of stenosis graded (A–D). The procedure was performed unilaterally at the worst affected level. Response to treatment was assessed at six weeks using PROMs and the requirement for either a repeat injection or subsequent operation assessed at least two years post-injection.

Results
Patients with grade A stenosis (n=53), B (n=20), C (n=21) and D (n=21). Mean patient age increased with degree of stenosis. Thirty-three patients had a spondylolisthesis. Symptomatic improvement was reported by 77%. VAS leg/back pain, ODI and EQ-5D VAS scores significantly improved regardless of the degree of stenosis ($p<0.001$). Repeat FESI was performed in 31% and subsequent operation in 30%. No difference between the requirement for repeat injection or subsequent operation based on the degree of stenosis or presence of spondylolisthesis (although a trend was seen for older patients and grade D stenotics not to have surgery). No complications were reported.

Conclusion
FESIs provide symptomatic relief for patients with central lumbar canal stenosis. Although no complications were reported, the authors would still advise caution in cases of severe stenosis.

Leg pain as a predictor of clinical outcome after single lumbar micro decompression surgery in young and middle age groups

Zaid Madhi[1], Muhanad Al-Jubouri[1], Frances Arnall[1], Rajat Verma[2], Saeed Mohammad[2], Irfan Siddique[2]
[1]*University of Salford, Salford, UK* [2]*Salford Royal NHS Foundation Trust, Salford, UK*

Purpose
Previous studies have stated that the higher the LP VAS the better the outcome. However, there is no quantification of this relationship. Therefore, the objective of this study was to maximise the understanding of the effect of symptom duration and intensity of leg pain on surgical outcome at one year, to ascertain whether the level of radiculopathy influences outcome, and to examine the possible factors that may lead to repeat surgery at the same level in young and middle age groups.

Methods
Retrospective collected data of patients who underwent primary, single level, lumbar decompression surgery with 12 month follow-up period. The (ROC) curve was used to identify the LP VAS cut off value, general linear models, regression analysis and bivariate correlations were used to evaluate the potential factors.

Results
500 patients were included. There was a significant improvement of LBP VAS and LP VAS after 12 months follow up (84%) and (95%) respectively. The re-operation rate was significantly related to LP VAS; P value 0.001. LP VAS (>7) is the maximum area under the curve with (92% sensitivity and 37% specificity) to predict re-operation. Pre-operative epidural injection has a significant relation with the improvement changes in the LP VAS; P value 0.014.

Conclusion
Patients (92%) presented with pre-operative LP VAS >7 are more susceptible for re-operation surgery. LP cannot be used as a predictor for surgical outcome independently from other factors. Surgeons should be more cautious in selecting patients for surgery and not basing their decision on only pre-operative leg pain.

Spinal pathways in emergency departments for rapid assessment and treatment of cauda equina syndrome—a help or hindrance?

Anne Elserius[1], Wai Soon[1], Fardad Afshari[1], Navin Furtado[1]
[1]*University Hospitals Birmingham, Birmingham, UK*

Aim
To assess the effect of a spinal pathway implemented in a major trauma centre emergency department which is designed to streamline the diagnosis and management of patients with suspected cauda equina syndrome.

Design
Retrospective single centre study.

Subjects
All patients with an emergency department diagnosis code of back pain, sciatica or suspected cauda equina syndrome were reviewed over a four month period before and after implementation of the spinal assessment pathway.

Methods
Patient records and imaging were reviewed from electronic patient data (Clinical Portal) and the picture archiving and communication system (PACS).

Results
There were a total of 683 attendances to the emergency department between March and June 2016, which increased to 738 attendances for the same months in 2017. Overall there has been reduction in emergency department waiting times for this cohort of patients following implementation of the pathway. The pathway has led to an increase in the number of patients provisionally diagnosed as suspected cauda equina syndrome resulting in an increase in the number of patients requiring MRI scans to confirm the diagnosis. Hospital admissions increased with an increased length of stay with bed days lost where no intervention was undertaken.

Conclusion
A spinal pathway for assessment and management of suspected cauda equina patients may facilitate patient flow from the emergency department but there is a significant impact on imaging and inpatient services and total financial costs remains to be seen.

Patient satisfaction of a video resource in spinal surgery

Genevieve Mullins[1], Safdar Sarwar1, Almas L Khan[2], Grzegorz Rudol[2]
[1]University of Leeds, Leeds, UK [2]Department of Spinal Surgery, The Leeds Teaching Hospitals NHS Trust, Leeds, UK

Introduction
As the use of technology becomes more widespread, video resources are being found to be an effective way of patient education.

Aim
Develop a video channel for adult spinal surgery patients guided by Leeds Spinal Surgery Team. This channel was then evaluated for patient satisfaction.

Methods
In the developmental phase, the spinal MDT was used as a focus group alongside existing patient-education resources to identify relevant topic areas. Existing peer-reviewed NHS videos were collated with originally-designed content, including a video filmed by the researchers. In the evaluative phase, 23 adult spinal surgery patients, sampled opportunistically, completed a peer-reviewed patient satisfaction questionnaire after viewing the channel.

Results
Between 87% and 100% of participants either strongly agreed or agreed that individual videos were useful. Some participants disagreed that weight-loss (9%) and smoking-cessation (4%) videos were useful and no participants strongly disagreed that any video were useful. Themes identified in the qualitative open-ended questions were: accessibility, details of surgical procedures, differences in patient's presentations and more patient journey accounts. Popular suggestions by participants for channel-viewing was on TV in outpatient clinics and online.

Conclusion
This video channel was found to be useful in informing patients about spinal surgery. Following the feedback from the patient satisfaction questionnaire, alterations can be made to improve the video channel.

Discussion
The opportunistic sampling method limited this studies' reliability; it introduces the possibility of a self-selecting bias. This study cannot evaluate the educational potential of the channel. A further case-controlled study could be done to explore this further.

Adjacent level osteophyte formation following anterior cervical surgery

Abdul Nazeer Moideen[1], Galaxy Bista[2], Iqroop Chopra[1], Sashin Ahuja[1]
[1]Welsh Centre for Spinal Surgery and Trauma, University Hospital of Wales, Cardiff, UK [2]Cardiff University Medical School, Cardiff, UK

Introduction
Anterior cervical discectomy and fusion (ACDF) is a commonly performed and favoured procedure for the treatment of cervical degenerative disc disease. ACDF is a clinically effective procedure, however long-term complications such as development of late adjacent level degenerative changes have been reported. These include osteophyte formation and ossification. This study envisages to verify if there is osteophyte formation by studying radiographs of patients before and after ACDF with either cage only, cage with plates or cage and screw implant.

Methods
Patient who had single-level ACDF were included in the study. Demographics, clinical outcome and complications were identified by looking through the clinical notes. Lateral radiographs of cervical spine of the patients were studied pre- and post-surgery.

Results
Thirty patients were identified of which there were 17 males and 13 females. Mean age at surgery was 50 years. There were 30 patients with cage-only, 10 with cage with plate, 15 with cage and screw implant. Osteophyte formation was seen in four (13.3%) patients with cage only, six (60%) in cage and plate and five (33%) in cage and screw implants.

Conclusion
In our study we found a high number of patients developing adjacent level osteophytes following ACDF surgery particularly in cage with plate implants. However, large scale studies need to be performed to obtained statistically significant results.

Genetic/Inherited Spinal Disorders

Incidence of negative plumb line in AIS

James Todd[1], Jan Herzog[2], Niv Bhamber[2], Tim Bishop[2], Jason Bernard[2], Darren Lui[2]
[1]St George's University of London, London, UK [2]Department of Trauma and Orthopaedics, St George's Hospital, London, UK

Introduction
Adolescent Idiopathic Scoliosis (AIS) is the most prevalent form of idiopathic scoliosis (90%). Emphasis has previously been on coronal deformity but the relation to sagittal balance is not fully understood.

Aim
This study investigates Sagittal Vertical Spine (SVA) and thoracic kyphosis (TK). A positive SVA is a measure of poor sagittal balance but the clinical relevance of a negative value has not been established.

Methods
This was a retrospective review of 116 AIS first presentation cases. Eighty-seven had lateral radiographs. A new classification for negative SVA was devised.

Results
82.76% patients had a (-)SVA (mean -4.19cm±2.38cm). New (-)SVA classifications A>-3.5cm, B=-3.5cm to -6.5cm, C<-6.5cm. A=43.06%, B=33.33% C=23.61%. Categorisation of TK: Hypokyphosis=39.39%, Normal=48.48%, Hyperkyphosis=12.12%. Mean TK was 24 degrees ±11 degrees (normal=20 degrees to 40 degrees). There was no correlation between (-)SVA and TK (R2=3×10-6). Twenty-seven cases underwent Posterior Spinal Fusion surgery (PSF). In patients with a (-)SVA prior to surgery (82.76%), SVA remained negative in 77.30% and mean SVA decreased from -3.64cm to -4.05cm. Of the cases with a positive SVA prior to surgery, three became negative post-operation (60.00%) and mean SVA decreased from 2.20cm to 0.95cm.

Conclusion
The majority of first presentation AIS patients have negative sagittal balance. Three categories have been devised. PSF is known to be a hypokyphotic procedure but more importantly may create a further negative SVA. Further research needs to be conducted to establish SVA in a healthy population and the association of back pain in AIS with (-)SVA.

School screening—a call to reverse NICE guidelines

Darren Lui[1], Jan Herzog[1], Nimesh Patel[2], Tim Bishop[1], Daniel Chan[2], Jason Bernard[1], Oliver Stokes[2]
[1]St George's University of London, London, UK [2]Royal Devon and Exeter NHS Foundation Trust, Exeter, UK

Introduction
Currently the UK national screening committee does not recommend screening for adolescent idiopathic scoliosis (AIS). In two tertiary spinal centres serving two different but large geographical areas, we investigated first presentation of AIS and the potential impact that introducing a school prevention programme (SPP) may have. In light of evidence for bracing as well as new technology for the growing spine including vertebral body tethering there is a real need to re-explore school screening.

Methods
Retrospective case review of first presentation AIS in two-year period (2015-16): age, aetiology, Cobb, Risser grade, and intention to treat on first consultation. Four groups of patients were identified: EOS (<10years), syndromic (any age), AIS with potential to treat in brace according to SRS bracing criteria, or adolescents too skeletally mature or with curves beyond bracing criteria.

Results
Four-hundred-and-eighty-eight cases, 286 diagnosed with scoliosis (Cobb >10°), 66% (n=189) female. Twenty-six with early onset scoliosis, mean Cobb angle of 37.7 degrees and 37 patients in the syndromic group, mean Cobb of 44 degrees respectively. We identified that of 57 patients with AIS and Risser grade 0–2 of which 11.1% (n=32) were within bracing range, and 8.7% (n=25) were beyond bracing magnitude. Fifty-eight per cent (n=166) with Risser grade 3–5. Thirty per cent (n=87) curves too large to brace.

Discussion
Only 11.1% of first presentation AIS fulfilled the SRS criteria for bracing. Following publication of level I evidence demonstrating that bracing is effective at altering the natural history of AIS, the results of this study support the need to reverse NICE guidelines.

Navigated Instrumentation for correction of juvenile scoliosis—first 18 cases

Derek Cawley[1], Vijay Rajamani[1], Dimpu Bhagawati[1], Julian Leong[1], Alexander Gibson[1], Sean Molloy[1]
[1]Department of Spinal Surgery, Royal National Orthopaedic Hospital, Stanmore, UK

Introduction
Navigation-assisted spinal instrumentation has become an integral aide to safe spinal deformity surgery. Given the relative flexibility of the spine in paediatric cases, it has been adopted with caution. Techniques for incorporating navigation into spinal surgery have been developed to facilitate enhanced accuracy and application to juvenile cases. We present a single centre

experience using spinal navigation for the first 18 cases.

Methods
Retrospective evaluation of peri-operative data with respect to the use of navigation including surgical, anaesthetic and neuromonitoring parameters. A technique specific to navigation a

Results
The first 18 patients were operated on since January 2016. Mean blood loss was 277mls (100–1000mls). Surgical time was 3.9 hours (1.5–6). Nine patients required one scan of which four required one spin (195 images), eight required two scans, one required three scans. Intra-operative scanning time was 25 minutes. Time from incision to scan was 64 minutes. Number of screws per level was 1.51. In three cases hooks were also used. Pre-operative Cobb angle was 67 degrees corrected to 30 degrees.

Conclusion
The learning curve for navigation-assisted deformity correction from this cohort of paediatric cases included additional scanning in some cases. Intra-operative objectives were achieved with an acceptable work-flow when using this additional safety measure.

Measuring thoracic aorta displacement and assessing safe pedicular screw trajectory in supine, prone and with padding positions

Orestis Karargyris[1], Nikolaos Plataniotis[2], Giuseppe Morassi[3], Spyros Koufos[1], Spyridon Pneumatikos[1]
[1]Third Department of Orthopaedic Surgery, University of Athens, KAT Hospitals, Greece [2]Radiology Department, KAT Hospital, Athens, Greece [3]Centre for Spinal Studies and Surgery, Queen's Medical Centre Nottingham University Hospitals NHS Trust, Nottingham, UK

Introduction
Malpositioning of thoracic pedicular screws may lead to catastrophic complications due to direct aortic wall injury. The aim of this study is to measure positional changes of the thoracic aorta in relation to patient setting in supine and prone position, in order to estimate a safe pedicular screw trajectory.

Methods
Two-hundred patients (99 males, 101 females, mean age: 65 years, range: 25–87 years) were submitted to thoracic CT scans in supine, prone and prone with padding position. Measurements were performed in axial views, calculating the angle between the left pedicle entry point and the aortic wall, from T4 to T12.

Results
In relation to left pedicular AP axis, the average deviation of the aortic wall from the left pedicle entry point was 30.06 degrees in supine position, 22.80 degrees in prone position and 21.84 degrees in prone with padding position. There was a statistically significant decrease ($p<0.01$) of the pedicular - aortic angle across all thoracic vertebrae levels, when comparing supine patient position to prone and prone with padding positions.

Conclusion
The present study demonstrates changes of the relative position of the aorta to the thoracic spine (T4-T12) depending on patient positioning. The results indicate that the aorta moves considerably towards the midline, when the subject changes from a supine post, to prone position. This displacement is further increased with the use of the surgical padding. The surgeon needs to be aware of these changes in order to estimate a safe pedicular screw trajectory.

A systematic review of instrumentation following decompression of spinal stenosis in achondroplasia

Beth Lineham[1], Francis Sim[1], Zaid Abual-Rub[1], PR Loughenbury[1], Jennifer Campbell[1], Almas Khan[1]
[1]Leeds General Infirmary, Leeds, UK

Introduction
Achondroplasia is a common form of dwarfism. Significant structural changes can lead to spinal stenosis. There is currently no gold standard for managing these patients. It remains unclear when instrumentation is necessary.

Methods
We performed a systematic search of PubMed, Embase, Cochrane Library, AMED and CINAHL to identify all studies evaluating outcomes of surgical management of spinal stenosis in patients with achondroplasia.

Results
Eleven studies with 383 patients were included. Patients were 6–64 years old (mean 30.8). 10 cervical and 466 thoracolumbar procedures were performed. Nine studies used decompression alone. 2 included decompressions and fusions. The intraoperative durotomy rate was 20.2%. Other peri-operative complications occurred in 18.3%. Symptoms improved in 78%. 34.7% required re-operation during follow up. There were two paediatric studies (70 procedures). In one, all patients having multi-level (5–8 levels) uninstrumented decompressions needed re-operations for progressive kyphosis within 2.6 years. In the other study, instrumentation was used in 80%; 25% had re-operations, including one revision of instrumentation at 34 months. In the eight adult studies specifying multi-level decompression, the average re-operation rate was 25%. Only one study with single-level operations provided this data (2.6%)

Conclusion
All studies reported good initial symptom improvement, but high rates of recurrence, re-operation and peri-operative complications. The literature appears to support the use of instrumentation to prevent kyphosis developing in children. However, population heterogeneity and small sample size make it difficult to base practice on these results. A registry is recommended to gather further data for these cases.

An evaluation of a complex paediatric orthopaedic and neuromuscular clinic, from a single special needs school in Cardiff

Diane Carlos[1], Abdul Nazeer Moideen[2], Sandeep Hemmadi[2], Sashin Ahuja[2]
[1]Cardiff University Medical School, Cardiff, UK [2]Welsh Centre for Spinal Surgery and Trauma, University Hospital of Wales, Cardiff, UK

Introduction
In 2006 a specialist clinic was set up for patients with neurodevelopmental disabilities within one special needs school in Cardiff, by a consultant spinal surgeon and orthopaedic surgeon. Majority of patients reviewed in clinic had cerebral palsy (CP) with hip, spine or combined pathologies.

Aim
To evaluate the services, management, whether they had surgery to both hip and spine - which was undertaken first and their outcomes over the last 10 years.

Methods
Data was collected from patient's notes, X-rays were reviewed on PACS system and was organised into a Microsoft Excel database. Those not suffering from hip or spinal problems were excluded from further analysis.

Results
Fifty-seven patients in total were included. A total of 22.8% (n=13) had scoliosis, 36.8% (n=21) had hip problems and 40.4% (n=23) had both. These patients were seen on an average of six times. They had multi-disciplinary approach to their care consisting of paediatric orthopaedic and Spinal consultant, community paediatrician and school physiotherapists.

Conclusion
Through this project, we have outlined the needs of our patient cohort, more specifically how they were managed with respect to their hip and spinal problems. Because of multi-disciplinary approach there was significant reduction in clinic visits for combined hip and spine problems. MDT approach also provides better quality of care for these complex patients.

Trauma of the Spine

Isolated spinal injuries incurred during sports: a single centre experience

Samuel Hall[1], Ahmed-Ramadan Sadek[1], Chris Dare[1], Emad Shenouda[1], Ali Nader-Sepahi[1], Matthew Myers[1]
[1]University Hospital Southampton NHS Foundation Trust, Southampton, UK

Introduction
Spinal trauma is a significant cause of morbidity in children and young adults and sporting injuries are reported as one of the commonest causes of spinal injuries. The aim of this study was to analyse the demographics and outcomes of sports related spinal injuries admitted to a tertiary spinal unit.

Methods
A retrospective case note review was conducted of all patients on the Trauma and Audit Research Network with an isolated spinal injury managed at a tertiary spinal centre between January 2011 and December 2016. Patients were excluded if; the sport was not recorded; injury was not directly related to the sport or the sport involved motor vehicles.

Results
Four-hundred-and-sixty-six isolated spinal traumas were identified of which 17% (n=79) were due to sporting activities. The average age was 43.9 years (range 18–72) and 41.8% (n=33) were male. The most common sports were: horse riding (n=42), bicycling (n=19), motor boating (n=6), rugby (n=3), trampolining (n=2) and paragliding (n=2). Skiing, jet skiing, light aircraft crash and gymnastics contributed one case each. The levels of injury were: cervical (n=18), thoracic (n=21), lumbar (n=40), and the AO classification for the subaxial and thoracolumbar fractures were: A n=54, B n=18 and C n=1. Thirty-four per cent (n=27) patients required surgical fixation of their fracture.

Discussion
Sports form a significant part of the isolated spinal injuries with horse riding being responsible for the majority of injuries. Further work is needed to compare the demographics of sporting injuries with more urbanised centres.

Treatment modalities in chronic whiplash-associated disorder: a systematic review

Rosie James[1], Christopher Horton[2], Epaminondas Markos Valsamis[3], Thomas Cosker[4], Sherief Elsayed[5]
[1]Brighton and Sussex Medical School, Brighton, UK [2]Oxford University Medical School, Oxford, UK [3]Department of Trauma and Orthopaedics, Hinchingbrooke Health Care NHS Trust, Huntingdon, UK [4]Oxford Sarcoma Service, Nuffield Orthopaedic Centre, Oxford, UK, [5]Department of Spinal Surgery, Brighton and Sussex University Hospitals NHS Trust, Brighton, UK

Introduction
In 2010, The Bone and Joint Decade TASK Force on Neck Pain identified no treatment modality that was definitively effective in the management of non-acute, traumatic neck pain, including chronic whiplash-associated disorder (WAD).

Aim
To investigate the effectiveness of different treatment modalities for the management of chronic WAD.

Study design
A systematic literature review of randomised controlled trials (RCTs) assessing the efficacy of various treatment modalities in the management of chronic WAD.

Study selection
All RCTs evaluating any treatment method for persistent symptoms of WAD in patients over the age of 18, with a diagnosis of Quebec Task Force (QTF) Grade 1–3 WAD, were included in this review.

Outcome measures
Outcome measures included post-intervention pain ratings, psychological disturbance, disability and patient functionality.

Methods
Searches of EMBASE, Cochrane Library, AMED, PubMed and MEDLINE for RCTs analysing chronic WAD treatment modalities, published from the beginning of the literature to 2016, were performed.

Results
Twelve RCTs were eligible for inclusion. These studies examined modalities including surgical cervical fusion, electroacupuncture, botulinum injections, trauma-focused cognitive behavioural therapy (CBT), neck specific exercises, multimodal rehabilitation, local anaesthetic infiltration, body awareness therapy, radiofrequency neurotomy and physiotherapy in a total of 1,067 patients across 4 countries. A range of physical and psychological modalities appear to show promise in chronic WAD management, however few modalities have been directly compared in single trials.

Conclusion
Higher quality trials with greater sample sizes are warranted to identify a reliable, efficacious treatment for persistent symptoms of WAD, as current evidence is inconclusive.

Operative management of unifacetal and bifacetal injuries in the subaxial cervical spine—anterior, posterior or both?

Jamie Wilson[1], Chris Derham[1], Simon Thomson[1], Jake Timothy[1], Gerry Towns[1], Senthil Selvanathan[1], Debasish Pal[1]
[1]*Department of Neurosurgery, Leeds General Infirmary, Leeds, UK*

Aim
To determine the management strategies with regards to uni- and bifacetal cervical fractures in one centre, and to investigate the factors involved with decisions regarding operative or conservative management.

Background
Patients with trauma to unilateral subaxial cervical facet joints can represent a challenging cohort of patients. The decisions regarding the optimum management is often not clear, with a variety of conservative and operative strategies employed.

Methods
A search of the operative database in one trauma centre was performed from 2010 until 2017 for records of the management of uni- or bifacetal subaxial cervical spine trauma. All adults 16 years and over were included. Subaxial cervical fractures involving just the vertebral body were excluded.

Results
Eighty-nine patients were identified; 62 unifacetal and 27 bifacetal injuries. Of the unifacetal injuries, 26 (42%) underwent Anterior surgery alone, 11 (18%) underwent posterior fixation alone, 20 (32%) underwent combined anterior/posterior fixation and five (8%) were managed in Halo jackets. One patient in the anterior surgery group required further surgery at 12 months (Corpectomy). 2 patients in the Halo group received further operative intervention; one after three weeks and one after 12 months. In the bifacetal group, 21 (78%) patients underwent Anterior/Posterior fixation, four patients underwent Anterior surgery alone and two underwent posterior surgery alone.

Conclusion
Anterior stabilisation alone was sufficient for the majority of unifacetal injuries in our series. Combined anterior/posterior fixation or posterior fixation were less common, in contrast to bifacetal injuries that are highly likely to require anterior/posterior fixation.

Early mortality in following tetraplegia

Sandra Sungailaite[1], Donald Buchanan[1], Anuta Pardeshi[1], Jamil Al-AJooz[1], Munawar Mecci[1]
[1]*James Cook University Hospital, Middlesbrough, UK*

Introduction
Despite clinical advances tetraplegia has a high early mortality rate.

Aim
To evaluate trends in early mortality in tetraplegia patients in a regional spinal injuries unit.

Methods
The first-year mortality in middle aged and elderly patients with tetraplegia was audited between 2002 and 2005 (Group 1). This was re-audited for the period 2008–2014 (Group 2).

Results
There were 14 patients in Group 1 with a mean age of 64.9 years and 12 in Group 2 with a mean age of 73 years ($p = 0.53$ (NS)). The mean Charlson Comorbidity index was 3.4 in Group 1 and 4.4 in Group 2 ($p = 0.26$ (NS)). Injury was due to a fall in 69% in Group 1 and 77% in Group 2. Five patients (38%) had a high cervical injury in Group 1 compared with 10 patients (77%) in Group 2, ($p = 0.74$ (NS)). Forty-six per cent of patients were ventilated in Group 1 and 61% in Group 2, ($p=0.79$ (NS)). Forty-six percent of patients in Group 1 died within four months; all deaths in Group 2 were within four months, the cause of death was respiratory failure in 69% in Group 1 and 92% Group 2.

Conclusion
Tetraplegia has a high mortality in the first year due to respiratory

problems; this should be considered when planning surgical intervention. Differences in age, ventilation status, comorbidities and level of injury were not significant because of the small sample sizes.

Spinal Oncology

Increased Incidence of Scoloiosis in patients treated for Childhood Haematopoietic Cancers

Francis Sim[1], Almas L Khan[1], PR Loughenbury[1], Peter Millner[1]
[1]Department of Spinal Surgery, The Leeds Teaching Hospitals NHS Trust, Leeds, UK

Introduction
Adolescent Idiopathic Scoliosis (AIS) is a curvature of the spine occurring during puberty. The incidence of AIS is quoted as an overall prevalence of 0.47–5.2% globally. More severe curves are less common, with a prevalence of 0.04–0.3% in curves of 40 degrees or more. There is no literature that identifies an increased risk of AIS in patients who have had childhood haematopoietic malignancy, however we observed that there were a number of these patients being referred for spinal deformity to our service.

Methods
Patients who had previously been diagnosed with lymphoma or leukaemia and were now aged between 12–16 were identified. Clinical notes and radiographic studies were then reviewed to identify patients with scoliosis, the Cobb angle and what treatment they had received (both for their previous malignancy and their spinal deformity).

Results
In total seven out of 102 patients (6.9%) had radiographic evidence of scoliotic deformity (minimum Cobb angle of 10°). Of these three (3% of total cohort) had a Cobb angle of 40 degrees or more, all of whom had corrective surgery. All of the patients with scoliosis had no other pathology as an attributable cause of their deformity, and all had been treated with high dose steroids for leukaemia (either ALL or AML).

Conclusion
Childhood leukaemia or its treatment appears to increase the risk of developing scoliosis with a greater than average curvature in adolescence. We are currently extending the scope of our search to increase the power of this study.

Effect of timing of surgery on the neurological outcomes in patients with metastatic spinal cord compression (MSCC)

Muhanad Al-Jubouri[1, 2], Zaid Madhi[1], Abdulkhaleq Alnaqeeb [3], Frances Arnall[1], Rajat Verma[2], Saeed Mohammad[2], Irfan Siddique[2]
[1]University of Salford, Salford, UK [2]Salford Royal NHS Foundation Trust, Salford, UK [3]College of Health and Medical Technology, Iraq

Aim
To investigate the effect of timing of surgery on change of Frankel grade (improvement) in MSCC patients.

Methods
Two-hundred-and-forty-three patients with MSCC underwent surgical decompression from with confirmed cord compression on MRI scan. Date and time of magnetic resonance imaging (MRI) scan confirming cord compression, date and time of surgical decompression, Frankel grade at MRI, Frankel grade at discharge, level of cord compression, and number of fixed levels were collected. Frankel grading was used to evaluate the patient's pre-operative (at MRI scan) and post-operative (at discharge from tertiary centre).

Results
Twenty-one per cent underwent surgical intervention within 6–46 hours, 46.9% between 47–188) hours, 23.5% within 189–385 hours, and 8.6% had surgery more than 385 hours. In total, 61.7% had "same" Frankel grade outcome, 21% had "better", while 17.3% cases had "worse" Frankel grade outcome across the four timing of surgery groups. Only 54 (22%) had surgery less than 48 hours, 189 (78%) had their surgery more than 48 hours. the percentage of patients who had "better" change in Frankel grade went down from 35% in the <48 hours group, to 17% in the >48 hours group. The number of patients who had "worse" change in Frankel grade increased from 13% in the <48 hours to 19% in the >48 hours group.

Conclusion
Surgical intervention in MSCC patients need to be sooner rather than later. Surgery performed <48 hours in MSCC patients gives a greater chance in improvement of neurological function.

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