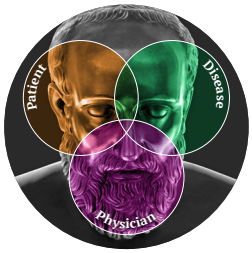
BASS
British Association of Spine Surgeons

Britspine 2023 *Abstracts*
Glasgow

The Journal of the British Association of Spine Surgeons

Column & Cord



Produced by Openbox

www.columnandcord.com

Illustration by A.Maddever

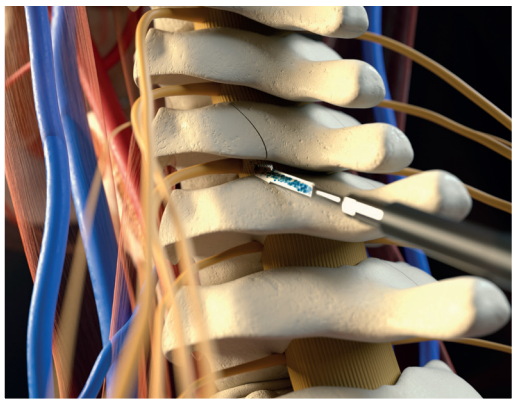
We believe the Hippocratic principles that medicine is governed by logic, that disease is governed by rules and that he or she who gives treatment should know the whole person

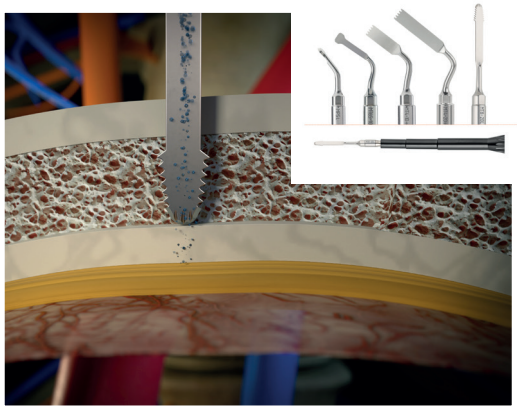
Piezosurgery PLUS

The new Piezosurgery Medical PLUS unit from General Medical brings together speed and safety in spinal surgery. Selective cutting action protects soft tissues but makes short work of even large osteotomies. For a demonstration or trial please contact General Medical, details below.

mectron
medical technology

NEURO&SPINE EXCELLENCE





generalmedical

Order Online at www.generalmedical.co.uk
Telephone 01380 734990
or email info@generalmedical.co.uk

Contents

Introduction

Original articles

Abstracts

Column & Cord is the Journal of the British Association of Spine Surgeons
Edited by Tim Germon, Sashin Ahuja & Pal Lakshmanan. Special thanks to Henry Dodds for his invaluable assistance.

BASS
British Association of Spine Surgeons (BASS), RCSEng, 38-43 Lincoln's Inn Fields, Holborn, London, WC2A 3PE

Open Box Media & Communications
- **Director** Stuart.Walters@ob-mc.co.uk
- **Director** Sam.Skiller@ob-mc.co.uk
- **Studio Manager** Mark.Lamsdale@ob-mc.co.uk
- **Production** Matt.Hood@ob-mc.co.uk
- **Advertising Sales** Mandy@ob-mc.co.uk
- **Advertising Sales** Wendy@ob-mc.co.uk

Column & Cord is produced on behalf of BASS by Open Box Media & Communications, Premier House, 13 St Pauls Square, Birmingham B3 1RB.
T: 0121 200 7820.

For sales or design services, please discuss your requirements with a member of our team.

Openbox

AON

Future Proof Your Medical Indemnity

Switching to Aon is straightforward.

Consultants can future proof their private practice with protection from regulated insurance.

We arrange medical indemnity insurance that gives private doctors, consultants, and surgeons comprehensive cover with expert support.

Cover includes:

- long-term protection against claims,
- complications cover,
- tailored pricing, and
- 24/7 medico-legal support.

Come and visit us at **Stand 34 at BASS 2024**

Call **03308 286 435**
Search: **Aon Medical Indemnity**

Introduction

What is the point of Column & Cord?

Tim Germon

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

Aprajay Golash

Consultant Neurosurgeon Lancashire Teaching Hospitals NHS foundation trust

Pal Lakshmanan

Consultant Spine Surgeon, Sunderland Royal Hospital

Sashin Ahuja

Consultant Spine Surgeon, University Hospital of Wales & Noah's Ark Children's Hospital for Wales, Cardiff

To answer this we must first ask, what is the point of BASS? The long answer is to fulfil the objectives stated in the Constitution. The short answer is, in common with all societies, to facilitate communication between people who have a common interest; in our case disorders of the spine and their treatments. Constant questioning of our practice and open discussion is how progress is made. The main forum for this is our annual meeting.

It didn't take long for the Royal Society to recognise that to achieve a broader audience and have a more enduring impact, their meetings needed to be recorded. Thus, "Philosophical Transactions" were first published in 1665. A journal is a publication which deals with a particular subject or professional activity and is generally published regularly. No other criteria need to be met for a publication to be called a journal. Column & Cord is our society's journal. We have started with a blank canvas and attempted to re-define our niche in an overprovided market.

In the four editions so far, we have tried to harness the content of meetings and the society's members to provide material which we hope will be of value to the membership and beyond. We have learnt a lot over the last 4 years, principally, the value of editorial independence. We would never have dreamed that this apparently simple objective would be such a challenge to achieve. We are still at a very early stage in the development of our journal and we have to be committed to navigate the path forward by answering several unresolved questions:

- How do we engage the membership as much as possible?
- Who should be responsible for making executive decisions?
- How do we make sure articles are identified by search engines?
- Can we, or should we, register with Medline so that we can be quoted in Pub med and/or Google scholar?
- Does/should citation rating matter?

If you have thoughts or ideas or would like to discuss an idea, please email us at **journal@spinesurgeons.ac.uk**. ■

Original articles

The new national pathway for suspected Cauda Equina Syndrome: How it can improve early diagnosis and optimise quality of life for patients, while reducing litigation

Ingrid Hoeritzauer[1,2], **Mike Hutton**[3]
[1]Department of Clinical Neurosciences, Royal Infirmary Hospital, Edinburgh
[2]Centre for Clinical Brain Sciences, University of Edinburgh
[3]National Clinical Lead for Spinal Services, Getting it Right First Time Programme, NHS England

Conflicts of interest:
IH has an NRS Clinical Research Fellowship and does non cauda equina syndrome medicolegal work.
MH undertakes medicolegal work including opinions on cauda equina syndrome.

The National Suspected Cauda Equina Syndrome (CES) pathway, launched in England in February 2023, aims to create a clear and comprehensive patient journey and reduce variations in care across England for those with suspected CES. The aim is early diagnosis and management to prevent morbidity and follow up care that optimises quality of life even if deficits remain after CES despite timely care.

The need for a national pathway had become increasingly clear following the risks and variation in practice identified by the NHS England Healthcare Investigation Safety Branch and the GIRFT national report for spinal services (2019). These identified a large variation in the management of CES across the UK. These variations in care can be thought of as procedural, diagnostic and treatment variations. Procedural issues such as the threshold for symptoms that warrant referral for emergency scanning, who gets safety netting advice and what that advice is, and time from A&E arrival to MRI all have significant variation. Timing of surgery, particularly whether patients should be operated on overnight or first on list the following day, as well as what surgical approach is utilised and management of post operative problems, all have significant variation throughout the country. As a consequence, there is significant variation in ligitation costs for CES cases, with an estimated cost to the NHS in England of £121m between 2015 and 2020 (NHS Resolution data). Hospital departments, clinicians and professional organisations have tried to address these variations[1–4]. However, the previous guidance has been in silos and not agreed in conjunction with all stakeholders along the journey of the patient with CES, leading to criticism from the Healthcare Safety Investigation Branch.

Pathway development was organised by GIRFT and involved consensus with a large group of cross speciality clinicians including GPs, physiotherapists, emergency care physicians, radiologists, radiographers, orthopaedic surgeons, neurosurgeons, urologists, neurology and rehabilitation specialists. Importantly, pathway development was in conjunction with patients with lived experience and patient supporting charities. Further details about pathway development are available online[5].

NHS England, nine professional organisations (including BASS) and two patient organisations were involved in the development and had sign-off on the findings, all of which co-badged the pathway. With this support it will be embedded across as many NHS platforms as possible e.g. NHS 111. The pathway will also guide the local and Integrated Care Boards discussions on commissioning services. The pathway provides commissioning support for early access to imaging, early specialist review and rehabilitation.

The pathway puts patient care and safety at its heart and is based on a wide range of data and expert opinion with key stakeholders involved in the patient journey invited and listened to. Some of the key concerns about how to ensure early and equitable diagnosis have been answered via this pathway. For example, the same safety netting advice is available in 32 different languages via the pathway. Additionally, there is an interactive version of the pathway which supports decision making around when to refer patients for CES investigations. This interactive version is widely available on the same public website as the pdf version, ensuring easy access for clinicians who are seeing patients frontline with possible CES (e.g. physiotherapists, GPs, emergency care doctors and surgeons). GIRFT has also created a QR code to simplify access further (see Fig 3: QR code).

Key Points

There are some key messages that we would like to highlight from the pathway.

1. New or deteriorating bladder/bowel/sexual dysfunction symptoms (within 2 weeks)

Unfortunately, despite its importance both clinically and medicolegally, CES is both poorly defined and poorly studied[6,7].

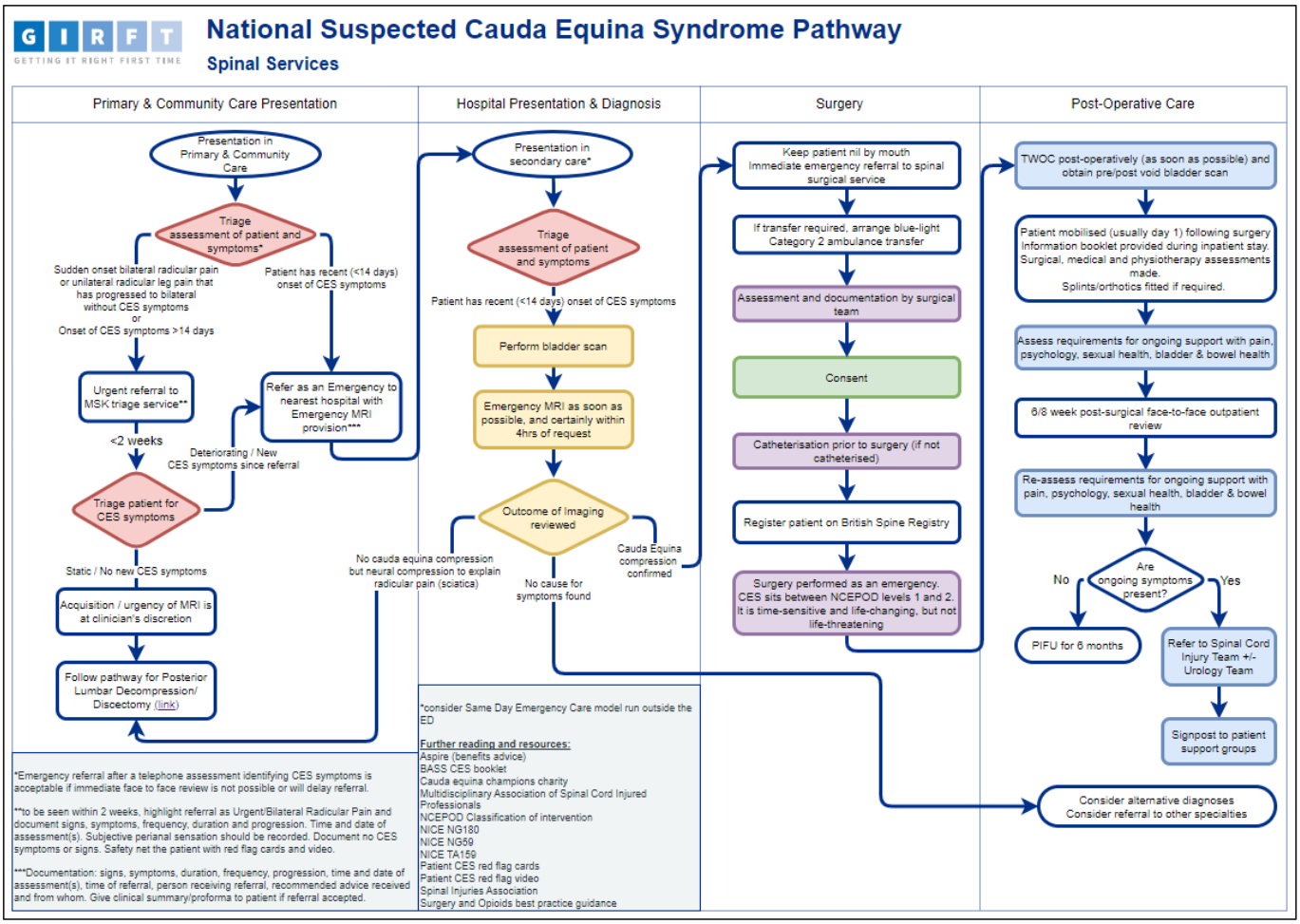


Figure 1: Pathway

Diagnostically, although surprising given the risk of long-term damage, there is disagreement about what constitutes CES. There are at least 17 definitions of CES and multiple papers on varying subclassifications[8]. The subclassification of CES into categories such as CES-incontinent (CES-I), CES-retention (CES-R), CES Impending etc have poor inter- and intra-observer reliability[9]. These have demonstrated that there is little agreement between clinicians on what CES subclassifications patients have (even when provided with the definitions before reviewing case notes). These subclassifications therefore cannot be used to accurately decide which patients should be prioritised for emergency surgery or imaging.

The symptoms of CES in the GIRFT diagnostic criteria were chosen based on a published definition created by a literature review of cauda equina definitions[8] and also by consensus of the professionals involved in the GIRFT pathway. Isolated bilateral sciatica without bladder, bowel, sexual function or neurological deficit in the lower limbs was included as a warning sign (requiring assessment within two weeks) but not as a sign of CES.

As a group, referral for urgent investigation if symptoms had started less than two weeks previously was felt to be the cut off. Given the time specific nature of cauda equina syndrome, unfortunately, after two weeks it is unlikely that an urgent operation will be able to reverse visceral symptoms from CES. However, patients can improve if operated on late[10]. Therefore, patients who have a suspected very late presentation of CES should still be referred to MSK triage services for review *within two weeks* but do not require urgent imaging via the emergency department.

2. **There is no need for digital rectal examination in primary care** (evidence based).

Digital rectal examination has been found in several studies to be an unreliable exam without good diagnostic utility[11–13]. Additionally, as we know most patients with CES symptoms will have normal or nonexplanatory imaging, minimising avoidable distress to all patients on the pathway is important. However, subjective or objective perianal sensory loss is a helpful diagnostic adjunct. External perineal examination in the emergency department is advised.

3. **When a patient with possible CES attends the emergency department, the MRI imaging should be done as soon as possible, within 4 hrs** (consensus based).

One of the biggest drivers of litigation is the delay to MRI once CES symptoms have started. A four hour aim from *request of imaging to MRI* is ambitious, but a condition that cannot be diagnosed without imaging requires an ambitious target.

There are two practical reasons for making this cut off, the first and most important is that there is the potential to salvage visceral function in young people if imaging and operation are done quickly. Even patients with CES and retention have the potential to improve post-operatively[14] and CES subdivisions have poor inter-rater reliability so imaging and surgery should not be delayed for any patients with CES. There is not enough evidence to make a definite cut off time, so a four-hour time aim from request to imaging was decided upon based on practicality, familiarity with other four-hour A&E targets and the experience of all those contributing to the CES pathway. This ambitious target has been agreed with national radiographer and radiology services. The second reason is that this pathway will be used for commissioning. This target will feed into commissioning of emergency department clinicians, radiographer and radiology services with an aim for full implementation by June 2024. No discussion is required with the spinal team before imaging is requested; if a clinician is concerned about CES urgent imaging should be the priority. An implementation plan enabling 24/7 MRI has been drawn up by the Royal College of Radiologists working party (see Figure 2, excerpt from GIRFT CES pathway).

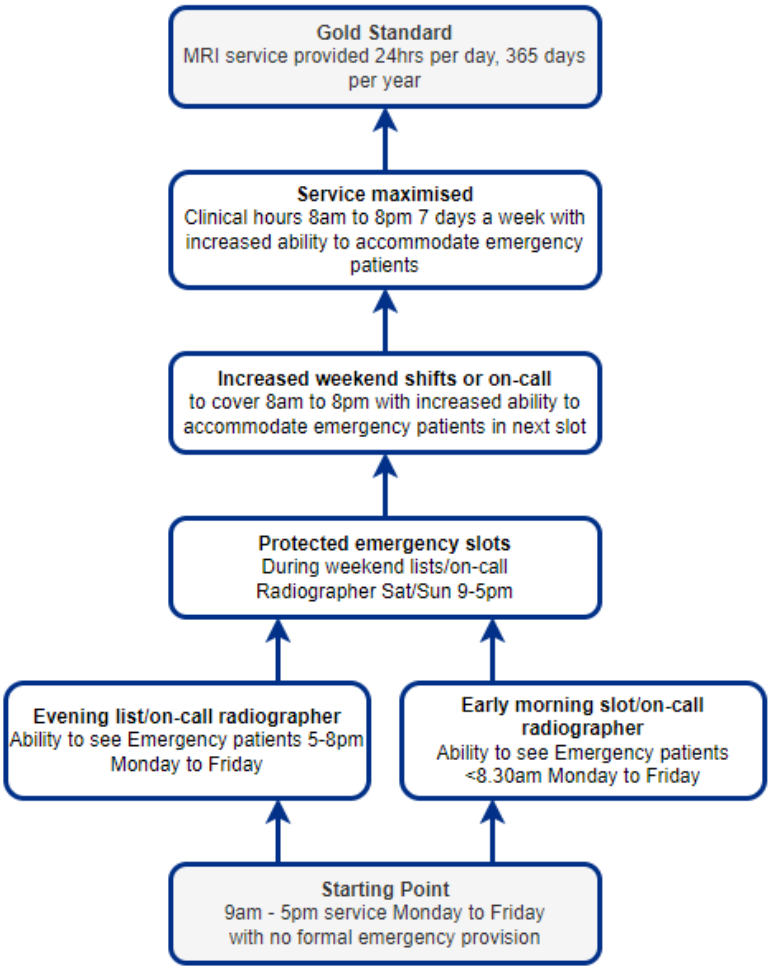


Figure 2: Progress pathway to enable 24/7 MRI service for CES

4. A bladder scan should not to be used for triage, it is however a useful adjunct in assessment (evidence based).
Differences of opinion exist on whether isolated signs or tests such as a bladder scan can be used as part of triage to decide who needs urgent imaging. Bladder scanning to assess post void residual volume is helpful. If a post void residual is >200mls in a patient with suspected CES, it makes a CES diagnosis 20 times more likely[15]. However, in a prospective study, 60% of patients who underwent emergency surgery for CES had a post void residual of less than 200mls[14]. Medicolegal case studies have found similar results[16]. Therefore, whilst it is a useful adjunct, a normal bladder scan should not delay imaging in anyone suspected of having CES[16].

If a patient is unable to void and has a bladder volume of >600mls a catheter should be immediately inserted. Once a diagnosis of CES has been confirmed a catheter should be inserted. Both of these measures are to avoid insensate bladder causing irreversible dilation and damage. Insertion of a catheter pre-operatively in all patients with CES will be a change of practice. There is little evidence about pre-surgery catheterisation in CES. In patients undergoing elective spinal surgery there is a study suggesting close post void residual monitoring to avoid pre-operative catheterisation[17]. The argument brought forward by the consensus group was that patients with CES are not representative of an elective spinal surgery list. They are at high risk of neurogenic bladder and complications thereof, especially insensate bladder and urinary retention causing irreversible detrusor failure. Short term catheterisation once compression of the cauda equina nerve roots has been confirmed on imaging may avoid this catastrophic situation.

5. Surgical Timing (consensus based).
The subclassification of CES into categories such as CES-incontinent (CES-I), CES-retention (CES-R), CES Impending etc have poor inter- and intra-observer reliability[9]. These subclassifications therefore cannot be used to accurately decide which patients should be prioritised for emergency surgery. CES decompression should occur as soon as is reasonably possible once a diagnosis is made. CES is time sensitive and life-changing but not life threatening. It therefore sits between NCEPOD levels 1 and 2.

6. Post operative care (consensus based).
The post operative care is clearly defined and includes bladder management, physiotherapy, information and assessment for often missed parts of CES rehabilitation. These include pain, psychology and sexual health. This holistic care is re-emphasised at the post operative outpatient review six to eight weeks post surgery. If patients have ongoing symptoms they are to be referred to a spinal cord injury team+/- urology team and signposted to support groups. This allows patient to access resources and basic management of their condition quickly and ensures that they have support and holistic care in place from discharge or from six to eight weeks post operatively if symptoms persist.

A core outcome set for CES has been developed through patient and healthcare professional consensus[18]. Patient outcomes for conditions such as lower back pain, sciatica, bladder dysfunction, and spinal cord injuries[19] are often improved by rehabilitation. It is therefore likely that long term outcomes for patients with CES may be improved by rehabilitation services as well as initial management. The effects of rehabilitation type, design, or delivery on CES outcomes have not previously been investigated and referral pathways will depend on local services.

Discussion

Cauda equina syndrome (CES) can be a devastating condition with the potential for major long-term dysfunction in bladder, bowel, sexual dysfunction and lower limb neurology in people of working age[5,20,21]. Studies of CES have been largely retrospective and single centre[22]. Most of the literature comes from the UK but population studies demonstrate that CES is a problem elsewhere. Due perhaps in part to the UK's smaller number of MRI scanners per population, it may have less medicolegal ramifications in other countries[23].

In the last few years some larger CES datasets[14,24] and systematic reviews[25,26] have been published. A nationwide audit[24] and a nationwide prospective study of CES[14] have provided some important information about CES. However, these studies have again demonstrated the variation in practice of diagnosis, treatment and follow-up of patients with CES.

The GIRFT CES pathway was designed to enhance care for patients with CES. It seeks to do this by providing clear guidance agreed upon by the multidisciplinary team who may encounter those with suspected CES in hospital and healthcare management. This should reduce variation in decision making and establish best practice across the country.

Medicolegally, issues such as judgement/timing, interpretation of results/clinical picture and unsatisfactory outcome after surgery are some of the main factors driving litigation in spinal surgery in the UK[6]. Whilst any pathway has at its core an improved service to patients with suspected CES, there is also the hope that by reducing variability, through standardising procedural, diagnostic and treatment decisions, the GIRFT pathway will reduce the need for litigation.

The CES pathway was the GIRFT programme's most visited resource in 2023 with more than 20,000 combined views of the pdf (launched February 2023) and interactive versions (launched October 2023), and feedback from patient groups and professional stakeholders has been predominantly positive. For example, at Britspine 2023 the pathway was debated and an overwhelming majority of >95% of the audience ended the session believing the pathway will improve patient care. Despite the efforts of many individuals and organisations, patients with CES have had not had the care they deserve. We believe that excellent patient care cannot be created unless it is deemed necessary by a national

pathway with commissioning and multi-speciality clinical support. However, it needs to be a living pathway that is updated following experience of its implementation and with availability of new evidence.

Figure 3: QR code to the CES interactive pathway

Bibliography

1. Germon, T., Ahuja, S., Casey, A. T. H., Todd, N. V & Rai, A. British Association of Spine Surgeons standards of care for cauda equina syndrome. *Spine Journal* **15**, 2S-4S (2015).
2. Todd, N. V. & Dickson, R. A. Standards of care in cauda equina syndrome. *Br. J. Neurosurg.* **30**, 518–522 (2016).
3. Domen, P. M., Hofman, P. A., Van Santbrink, H. & Weber, W. E. J. Predictive value of clinical characteristics in patients with suspected cauda equina syndrome. *Eur. J. Neurol.* **16**, 416–419 (2009).
4. Hussain, M. M., Razak, A. A., Hassan, S. S., Choudhari, K. A. & Spink, G. M. Time to implement a national referral pathway for suspected cauda equina syndrome: review and outcome of 250 referrals. *Br. J. Neurosurg.* **32**, 264–268 (2018).
5. NHS England. Spinal Surgery: National Suspected Cauda Equina Syndrome (CES) Pathway part of the Getting It Right First Time initiative. *Gettingitrightfirsttime.Co.Uk* **2023**, (2023).
6. Machin, J. T., Hardman, J., Harrison, W., Briggs, T. W. R. & Hutton, M. Can spinal surgery in England be saved from litigation: a review of 978 clinical negligence claims against the NHS. *Eur. Spine J.* **27**, 2693–2699 (2018).
7. Lavy, C., Marks, P., Dangas, K. & Todd, N. Cauda equina syndrome—a practical guide to definition and classification. *International Orthopaedics* **46**, 165–169 (2022).
8. Fraser, S., Roberts, L. & Murphy, E. Cauda equina syndrome: a literature review of its definition and clinical presentation. *Arch. Phys. Med. Rehabil.* **90**, 1964–8 (2009).
9. Hoeritzauer, I. *et al. Acta Neurochirurgica Cauda Equina Syndrome: What is the agreement on classification in diagnostic categories? Order of Authors Secondary Information: Powered by Editorial Manager® and ProduXion Manager® from Aries Systems Corporation.*
10. Tien Chau, A. M. et al. Timing of Surgical Intervention in Cauda Equina Syndrome - a Systematic Critical Review. *World Neurosurg.* **81**, 640–50 (2013).
11. Curtis Lopez, C. et al. Evaluation of the role of anal tone and perianal sensation examination in the assessment of suspected cauda equina syndrome. *Br. J. Neurosurg.* **0**, 1–5 (2021).
12. Sherlock, K. E. et al. The evaluation of digital rectal examination for assessment of anal tone in suspected cauda equina syndrome. *Spine (Phila. Pa. 1976).* **40**, 1213–1218 (2015).
13. Gooding, B. W. T., Higgins, M. a & Calthorpe, D. a D. Does rectal examination have any value in the clinical diagnosis of cauda equina syndrome? *Br. J. Neurosurg.* **27**, 156–9 (2013).
14. Woodfield, J. et al. Presentation, management, and outcomes of cauda equina syndrome up to one year after surgery, using clinician and participant reporting: a multi-centre prospective cohort study. *Lancet Reg. Heal. - Eur.* **24**, 100545 (2023).
15. Boktor, J. et al. Predictive value of post-void residual volume as an adjunctive tool in the clinical evaluation of cauda equina syndrome A SYSTEMATIC REVIEW AND META-ANALYSIS. *Bone Jt. J.* **105-B**, 487–495 (2023).
16. Todd, N., Dangas, K. & Lavy, C. Post-void bladder ultrasound in suspected cauda equina syndrome—data from medicolegal cases and relevance to magnetic resonance imaging scanning. *Int. Orthop.* **46**, 1375–1380 (2022).
17. Leitner, L. et al. Bladder management in patients undergoing spine surgery: An assessment of care delivery. *North Am. Spine Soc. J.* **6**, 100059 (2021).
18. N, S. et al. Cauda Equina Syndrome Core Outcome Set (CESCOS): An international patient and healthcare professional consensus for research studies. *PLoS One* **15**, (2020).
19. Parent, S., Barchi, S., LeBreton, M., Casha, S. & Fehlings, M. G. The impact of specialized centers of care for spinal cord injury on length of stay, complications, and mortality: A systematic review of the literature. *J. Neurotrauma* **28**, 1363–1370 (2011).
20. Planty-Bonjour, A. *et al.* Cauda Equina Syndrome: Poor Recovery Prognosis Despite Early Treatment. *Spine (Phila. Pa. 1976).* **Publish Ah**, (2021).
21. Korse, N. S., Jacobs, W. C. H., Elzevier, H. W. & Vleggeert-Lankamp, C. L. a M. Complaints of micturition, defecation and sexual function in cauda equina syndrome due to lumbar disk herniation: a systematic review. *Eur. Spine J.* **22**, 1019–29 (2013).
22. Hoeritzauer, I., Wood, M., Copley, P. C., Demetriades, A. K. & Woodfield, J. What is the incidence of cauda equina syndrome? A systematic review. *J. Neurosurg. Spine* **1**, 1–10 (2020).
23. Halliday, K., Maskell, G., Beeley, L. & Quick, E. Getting It Right First Time (GIRFT) Radiology Report. *GIRFT Program. Natl. Spec. Rep.* 81 (2020).
24. Fountain, D. M. et al. Evaluation of nationwide referral pathways, investigation and treatment of suspected cauda equina syndrome in the United Kingdom. *Br. J. Neurosurg.* **33**, 624–634 (2019).
25. Kumar, V., Baburaj, V., Rajnish, R. K. & Dhatt, S. S. Outcomes of cauda equina syndrome due to lumbar disc herniation after surgical management and the factors affecting it: a systematic review and meta-analysis of 22 studies with 852 cases. *Eur. Spine J.* (2021). doi:10.1007/s00586-021-07001-0
26. Kumar, V., Baburaj, V., Rajnish, R. K. & Dhatt, S. S. Outcomes of cauda equina syndrome due to lumbar disc herniation after surgical management and the factors affecting it: a systematic review and meta-analysis of 22 studies with 852 cases. *European Spine Journal* **31**, 353–363 (2022). ■

Original articles

Cauda Equina Syndrome – The Pathology And The Politics

Tim Germon
Spinal Neurosurgeon, Plymouth, United Kingdom

"Denoting or relating to a procedure or process carried out purely to satisfy convention, rules, or regulations' is the Oxford English dictionary definition of a tick box exercise. Most, if not all, doctors, rail against the overwhelming and pervasive tick box culture of the NHS. However, we contribute to the exponential growth in guidelines and pathways that form the substrate for such a culture. In my view, the creation of guidelines and pathways reflects a lack of knowledge rather than poor education and is an attempt to create certainty where there is none. The CES pathway is a prime example.[1]

1. What Is The Problem That The Pathway Is Supposed To Address?

In the previous article Hutton & Hoeritzauer state that the aim of the CES pathway is to, "reduce variations in care", and achieve, "early diagnosis and management".[2] Neither claim is supported by objective data and even if there were objective measures demonstrating significant variation in care, that does not necessarily mean that care is inappropriate, or more importantly, results in differences in outcome. In fact, a recent observational study of UK practice, including 621 people undergoing surgery for CES, 99% had surgery within 1 day of admission and 90% within one day of referral.[3] For a condition which can be difficult to diagnose, has a very variable natural history and which we do not fully understand, these figures suggest a generally effective service, at least in terms of secondary care. If management is to be improved the key lies in a better understanding of the problem and the impact of potential interventions.

2. The Cause Of Neural Dysfunction

The cause of neural dysfunction from compression, is ischaemia. Human and animal studies have shown that the most important determinant of whether neurological dysfunction occurs is the pressure at the site of compression. If the pressure exceeds mean arterial pressure (MAP), there is a very high risk of dysfunction and irreversibility.[4] Duration is a less important factor but pressure greater than MAP for more than an hour is very likely to cause irreversible damage. Because the plot of function lost against the product of pressure and duration of compression is a sigmoid shape, people can go from normal perineal function to irreversible loss of function with very small changes in pressure and in a short time (Fig 1). This explains the well documented observation that people who present with a full blown CES, with perineal numbness and an inability to void their bladder, with overflow incontinence, do not often make a good recovery following surgery, even if it is undertaken at an early stage.[5]

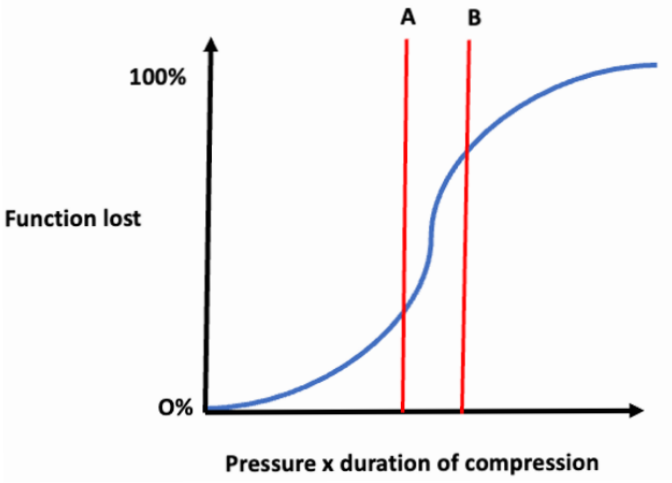


Figure 1: The change from most function intact to lost, from A to B, may occur in response to a small change in pressure or time.

3. Imaging

From a strategic perspective, the overwhelming problem is that a vast number of patients complain of back and/or leg pain with some form of sphincter disturbance but only a tiny fraction will have acute compression of the nerves of the cauda equina. In these circumstances no one knows how to reliably, determine whether a person has compression of the nerves of the cauda equina or not without an MRI scan. To try and address this, in 2016 BASS and SBNS published very simple guidance which simply stated that an MRI scan is essential to determine whether the person does have critical compression of the nerves of the cauda equina, whether there is an explanation of a person's pain but no compression of the sacral nerves to explain their sphincter disturbance or whether the scan is completely normal in which case other explanations need to be sought.[6]

Interpretation of the MRI is of fundamental importance in the management of people with lumbar pain and sphincter disturbance. Specifically, is CSF visible around the roots of the central canal? If so, the roots cannot be compressed and therefore cannot explain any perineal symptoms which may be present. In the UK observational study only 47% had no visible CSF on axial MRI images.[3] Presumably, they did not have CES because of nerve root compression. Inclusion of such patients is ubiquitous in studies of CES which inevitably distorts results. It also means that people are being incorrectly diagnosed with CES because of nerve root compression. Radiological findings, fundamental to the radiological diagnosis of cauda equina compression are not addressed in the pathway.

If there is compression of the nerve roots of the central canal the nature of the compression is also important. It is a common observation in neurosurgery that a sudden major compressive force causes irreversible harm very quickly but that neural structures can continue to function despite being severely compressed if that compression has evolved over a long period. An acute extra-dural haematoma is very different from a meningioma. Rate of compression is also an important variable in considering the management of CES. Bilateral sciatica with perineal symptoms from severe stenosis secondary to chronic compression from facet joint hypertrophy and spondylolisthesis has evolved over years. It is not an emergency, and it requires more challenging surgery. The same symptoms in the presence of compression from an acute disc prolapse is very different. There is no explicit reference to this in the guidance and thus an opportunity to decrease levels of anxiety for patients and people managing this condition, by explaining these important differences has been missed.

4. Natural History Of Disc Prolpapse & The Role Of Intervention

Acute disc prolapse may cause people to go from minimal symptoms to irreversible signs, (that is, bottom left to top right of the sigmoid plot) in a very short time. At the same time, disc prolapse is common and we know that most people will make a complete recovery without surgical intervention, particularly in the presence of a sequestered or extruded fragment. It is hard to find evidence that surgical decompression of nerve roots reliably improves motor and sensory deficit, but it often dramatically improves pain. For the best management of CES we want to identify people who are going to develop irreversible neural damage before they do.

An attempt to achieve this has been made by the creation of subclassifications of CES such as CES-incontinent (CES-I), CES-retention (CES-R), CES Impending etc.[7] However, I am not aware of any way of predicting inevitable progression as opposed to spontaneous resolution for any of these subgroups. So called red flags are listed in the pathway with no evaluation of their positive predictive value. For example, in the original iteration, bilateral sciatica is a red flag for CES but in our unit 25% of elective lumbar decompressions are for bilateral sciatica. It is hard to see how this symptom really helps in identifying people likely to be at risk of CES.

Somehow, we must identify people who we think have a risk of progression greater than the risk of a significant complication from surgical intervention. The risk of a complication is considerable. GIRFTs own data states that complication rates in CES decompressive surgery are 6 times higher than non-CES decompressive surgery.[8] The UK observational study reveals a 12% dural tear rate and neurological worsening post-operatively in 12% of people.[3] Why is surgery for CES so much more hazardous than other disc surgery? How many people made worse by surgery would have improved spontaneously without intervention and can surgery be made safer? The pathway does not advise on surgical approaches, but related GIRFT advice suggests that all approaches are reasonable.[2] There is no evidence to support this. In the UK observational study only 28 % of cases was the primary surgeon was a consultant and 59% of patients were operated upon using an interspinous approach.[3] Could it be that inexperienced surgeons and unsafe surgical approaches are a significant cause of poor outcomes? My empirical view is that interspinous approaches to a central disc prolapse are fundamentally dangerous. Why would you enter the spinal canal where the already compromised nerves of the cauda equina are being pushed up towards your sharp instruments when you can approach from the side using a standard microdiscectomy approach?

Once an MRI scan has been obtained a decision about further management can be made in the light of the history, the examination, and the scan findings. This is a complex process. The history, examination and scan findings all contain multiple continuous variables. For example, onset. What was the time of onset, has there been progression and if so, over what time course? How did the symptoms and signs change over that time course? How much pain is the patient in? Is it getting better or worse? What are the co-morbidities, how difficult is the operation likely to be? There is an infinite number of combinations. It is the sum of these variables which is used to decide on the potential benefits of surgery and its timing. The pathway does not contribute anything useful to this complex decision-making process which is best done by appropriately trained and experienced surgeons.

The occurrence of an established CES is undoubtedly a disaster for the individual involved. The question then becomes how best to help them manage their disability. I have found nothing in the literature that supports any intervention or therapy as being helpful. Empirical observation suggests advice on the management of continence and reproductive function would be essential but, in our locality, even that is hard to access in a timely fashion. The pathway makes recommendations on rehabilitation but with absolutely no evidence that anything is effective.

5. Pathways & Litigation

Even if there were systemic problems in the provision of services for people with potential CES would a "pathway" be the most effective means of effecting change? It seems unlikely. In 2005, "one quiet medical take saw 18 patients with a total of 44 diagnoses." The guidelines/pathways that the on-call physician should have read remembered and applied correctly for these conditions came to 3679 pages.[9] It is an impossible task for a human being to read and retain all this information and yet, since the publication of this finding that torrent of guidelines and pathways has multiplied. It is hard to see how the CES pathway helps. In fact, it could make things worse. For example, the completely arbitrary use of a 2-week time window to determine whether a person should be seen as an emergency or in a clinic. This means that whereas people with a history of 15 days would have had an emergency scan it will now be delayed. How does this help expedite timely management? Would any ensuing delay with the development of established CES be negligent? Do guidelines and pathways trump common sense? Would it not be better to give general practitioners access to MRI (which needs precise reporting)? The other consequence of pathways and guidelines is that they are inevitably used to create even more tick box exercises, and this has already happened in our local spinal network.

6. How Did We Get Here?

The need for this pathway was proposed by the Health Services Safety Investigations Body (HSSIB) – yet another NHS related quango. Based on one case report where a person had a bad outcome from CES, a group of anonymous people, including one spinal surgeon was detailed to investigate services for CES. They found variations in care which they concluded must mean poor care. One conclusion of the report was that GIRFT should produce a pathway to try and standardise and thus improve management, despite the absence of evidence of poor outcomes or why they might occur. A cynical view might conclude that an imprecise piece of work by one quango has generated some unnecessary work for another quango and in doing so generates more box ticking exercises for NHS management whilst at the same time making an informed and logical approach to a particular patient's problem less likely to occur.

References

1. https://gettingitrightfirsttime.co.uk/pathway-supports-clinicians-to-diagnose-and-treat-cauda-equina-syndrome-without-delay/
2. Hoeritzauer & Hutton, Column & Cord 2024;7-11
3. Woodfield, Julie, Ingrid Hoeritzauer, Aimun AB Jamjoom, Josephine Jung, Simon Lammy, Savva Pronin, Cathal J. Hannan et al. "Presentation, management, and outcomes of cauda equina syndrome up to one year after surgery, using clinician and participant reporting: A multi-centre prospective cohort study." *The Lancet Regional Health–Europe* 24 (2023).
4. Pronin, Savva, Chan Hee Koh, Edita Bulovaite, Malcolm R. Macleod, and Patrick F. Statham. "Compressive pressure versus time in cauda equina syndrome: a systematic review and meta-analysis of experimental studies." *Spine* 44, no. 17 (2019): 1238.
5. Planty-Bonjour, Alexia, Gaelle Kerdiles, Patrick François, Christophe Destrieux, Stephane Velut, Ilyess Zemmoura, Ann-Rose Cook, Louis-Marie Terrier, and Aymeric Amelot. "Cauda equina syndrome: poor recovery prognosis despite early treatment." *Spine* 47, no. 2 (2022): 105-113.
6. Germon, Timothy, Sashin Ahuja, Adrian TH Casey, Nicholas V. Todd, and Am Rai. "British Association of Spine Surgeons standards of care for cauda equina syndrome." *The Spine Journal* 15, no. 3 (2015): S2-S4.
7. Fraser, Stuart, Lisa Roberts, and Eve Murphy. "Cauda equina syndrome: a literature review of its definition and clinical presentation." *Archives of physical medicine and rehabilitation* 90, no. 11 (2009): 1964-1968.
8. https://gettingitrightfirsttime.co.uk/wp-content/uploads/2023/10/National-Suspected-Cauda-Equina-Pathway-UPDATED-V2-October-2023.pdf
9. Allen, D., and K. J. Harkins. "Too much guidance?." *The Lancet* 365, no. 9473 (2005) ■

Original articles

Commentary on the **Cauda Equina Syndrome Pathway (CES) articles**

Pal Lakshmanan[1], **Sashin Ahuja**[2]
[1]Consultant Spine Surgeon, Sunderland Royal Hospital
[2]Consultant Spine Surgeon, University Hospital of Wales & Noah's Ark Children's Hospital for Wales, Cardiff

The new National Suspected Cauda Equina Syndrome (CES) pathway which launched in England last year, has sparked an intriguing debate reflected in two contrasting articles. These articles highlight the complexity and challenges in managing CES, a condition that can have profound implications on patients' quality of life.

Article 1: "The new national pathway for suspected Cauda Equina Syndrome: How it can improve early diagnosis and optimise quality of life for patients, while reducing litigation"

In this article Hoeritzauer and Hutton outline the pathway with emphasis on the pathway's comprehensive approach as it was developed in collaboration with a range of specialists and stakeholders, including patients. Key aspects include standardised referral and diagnostic criteria, expedited MRI imaging, and post-operative care. The aim is to provide uniformity in treatment, which has been, and continues to be, a significant issue across the UK.

The strengths of this article lie in its detailed pathway description, focusing on the collaborative and consensus-driven approach to its inception. It addresses key issues in CES management, such as the need for timely surgery, the utility of diagnostic tools like MRI and bladder scans, and the importance of holistic post-operative care.

However, the article does not extensively discuss any potential limitations of the pathway or the challenges faced by organisations when attempting its implementation. While it acknowledges the need for ongoing evaluation and adaptation, the specifics of how this will be achieved are not detailed. The provision of round the clock MRI service is currently hindered by issues with infrastructure and workforce shortages across numerous district general hospitals in the UK. This shortfall not only challenges service provision but also risks increasing litigation rates rather than mitigating them, especially during out of hours when patient transfer may be required. Moreover, the justification for the 4-hour MRI window lacks robust clinical evidence. The guideline also falls short in addressing surgical timing for exceptional cases, notably patients on anticoagulants like clopidogrel, necessitating further guidance to manage these complex scenarios effectively.

Article 2: "Cauda Equina Syndrome – The Pathology and the Politics"

The second article presents a more critical viewpoint, questioning the effectiveness of the CES pathway and arguing that it may represent an oversimplified solution to a complex problem. The author raises concerns about the pathway's potential to contribute to a "tick-box" culture in the NHS, arguing that it may not effectively address the variability in CES presentations and outcomes.

This article emphasises the need for, and importance of, individualised patient care and highlights the risks of over-standardisation. A significant strength of this article is its critical examination of the pathway's potential drawbacks, particularly in relation to the variability of CES symptoms and the natural history of disc prolapse. It highlights the importance of clinical judgment and the potential dangers of a blanket approach.

However, this article could be perceived as somewhat dismissive of the efforts to standardise care and improve outcomes. While it rightly points out the limitations of a standardised pathway, it may underestimate the potential benefits of having a structured approach, especially in a condition with historically significant variations in care.

The article is critical about the GIRFT advice that all surgical approaches are reasonable in cauda equina syndrome surgery, while anecdotally describing the interspinous approach being fundamentally dangerous. Each surgeon has got their own independent technical expertise and that should be allowed to be practised as the pathway suggests, rather than thrusting a one-approach fits all philosophy.

Opinion:

The debate between these two articles demonstrates historic discrepancies in healthcare between standardisation and individualised care. Although the new CES pathway represents a significant effort to address a condition with high variability in treatment and outcomes, with a collaborative approach which is commendable and could lead to more consistent and improved care for CES patients, there is a risk that such pathways can oversimplify complex clinical scenarios. Consider the 4-hour wait for MRI scan for example, one could be forgiven for relying too heavily on that aspect of the guideline which could unfortunately lead to that rare 1-3:100,000 population of true clinical cauda equina compression syndrome patient waiting for 4 hours longer than pre-guideline for diagnostic imaging which can subsequently delay time to theatre. The importance of individualised patient assessments and the nuanced understanding of CES hence cannot be overstated.

Facilities and availability of imaging machinery on the frontline remains a significant issue. We have to consider, is expecting huge volumes of this patient group to have MRI scan within 4 hours achievable with the current accessibility to services? A question arises as to what considerations have been given to breaches of the pathway and how that will affect organisations from a litigation standpoint. Caution should be taken when adopting a pathway without adequate support in place.

In conclusion, the new CES pathway is a step forward in addressing a challenging medical condition. It brings much needed structure and consistency to the management of CES. However, its implementation should be flexible, allowing for individualised care and continuous adaptation based on emerging evidence and clinical experience. This balance is crucial in ensuring the best outcomes for patients with CES. The pathway, while a valuable tool, should not replace clinical judgment but rather serve as a guide. ■

Original articles

A year in spinal surgical medicolegal (Defence) practice – an idiots' guide

Alex Torrie
Consultant Spinal Surgeon
Gloucestershire Hospitals NHS Foundation Trust

Receiving a cheery notification email from your trusts' legal department to notify you of the recent arrival of a potential negligence claim against you is commonplace and recognisable to us all. In my trust I had noticed an increasing frequency of such emails, albeit none knowingly successful, sufficient enough in volume to concern me as to the potential implications that this may have upon my future capacity to practice unimpeded as a spinal surgical consultant in the UK.

I therefore have obtained some basic medicolegal training and have actively engaged in providing medicolegal advisory reports predominantly defending cases for NHS resolution. In this report I will provide my summary of findings of these cases and the tentative conclusions that I have derived thus far. No claimant, hospital nor surgeon specific data will be identifiable in this report.

Medical negligence has a vast and entirely different vocabulary to the familiar spinal surgical lexicon we trade in. Nevertheless, this language can be distilled into 2 sentences.

1. Has there been a breach of duty (BOD)?

2. On the balance of probability (more likely than not – 51%), has that breach of duty causally led to measurable harm/ damage to the claimant?

A breach of duty (BOD) is when a patient is exposed to substandard care. In the UK patients are only entitled to standard care and not optimal care. Standard care is not necessarily care supported nor delivered by the majority, and can be defined as 'care/practice supported by a body (including minority body) of responsible and competent practitioners in that area of practice'. 'Harm' includes but is not limited to; unnecessary pain suffering and loss of amenity (PSLA), substandard clinical outcome and loss of the opportunity to be disease free.

The medicolegal process is long and protracted. It is initiated with a 'letter of claim' (LOC) sent to the defence trust or surgeon. This LOC will detail a series of allegations (BODs) that are ultimately causal for the harm that the claimant has allegedly suffered (i.e. negligence). The defence will then instruct a solicitor to represent them. The solicitor/instructing party (IP) will then instruct an independent expert(s), sometimes via an intermediary case management company, with a letter of instruction (LOI) to provide impartial advice regarding the allegations.

The expert's duty is only to the court, and not to the claimant, the surgeon nor the instructing party. You are NOT a hired gun. The expert then provides the IP with an advisory report addressing all allegations and whether they should be individually accepted or denied. The report concludes with the expert's opinion on whether the case is 'defendable'. The defence IP (on behalf of the trust/surgeon) will then formally reply to the claimant's IP, including all, some or none of your expert impartial advice. This advisory report will cascade a series of 'clarifications' and 'supplementary reports', from the expert, confirming the contents of the original report and repeating the original allegations in a subtly yet not entirely different format.

A minority of cases will then require a remote case conference, where the IP and involved parties discuss what is needed to progress their case most favourably. After this stage the majority of cases are settled between defending IPs. As an expert you are not routinely informed of the outcome, only being intermittently reinstructed with ongoing cases that have failed to settle. A court date in practical terms is tantamount to the childhood game of 'Chicken' and is set infrequently, with medical expert's receiving summons (not to be ignored), and acts as a catalyst for a frenzy of offer and counter offer by competing adversarial IP's.

There are broadly three types of report that can be requested by the IP. Type 1 is a preliminary report. This is where an initial complaint has been received by the defending trust/surgeon, and the IP (acting on behalf of the trust/surgeon) want a short report (approximately 500 words or less) considering the potential validity of the initial allegations. In essence 'has this case got legs?'.

Type 2 advisory reports are a much more detailed report whereby you are required to review the medical records and radiology and provide specific retort and commentary to a series of allegations. These can be extensive and require a response that culminates in justifying either the acceptance or denial of each allegation. The report typically concludes with whether the case is 'defendable' and what lessons can be learnt. Finally, type 3 reports are effectively extended Type II reports with substantial evidential support from the literature and are required to be CPR (Civil Procedure Rules 35) compliant (admissible evidence for the court). These reports need to be accurate, impartial and ultimately a document that the claimant's barrister will scrutinise and may culminate in your merciless cross-examination and reputational challenge.

During the last 12 months I have completed 66 reports; including 4, 36 and 5 stage 1, 2 and 3 advisory reports respectively. Additionally, I completed 12 clarification and 9 supplementary reports. For the remainder of this report, I will discuss my findings from the 40 stage 1 and 2 reports that I completed. In 22 (55%) cases the claimant was female and 18 male. The mean age of the claimant was 52.2 (25 - 87) years at the time of the alleged negligence. There was a mean delay of 1272 days (188 – 5752) or 3.5 years between the alleged negligence and receiving the LOC. The mean number of allegations per claim was 5 (2 - 11).

The allegations centred around three themes; missed diagnosis, delay to diagnosis/treatment or substandard/negligent care. There were 8, 19 and 13 missed, delayed and substandard claims respectively. Of the 220 allegations included in the 40 cases, in my opinion 96 (43.6%) should be accepted, 114 (51.8%) denied, 4 had insufficient records to answer and 6 were outside my scope of practice. Overall, 25 (62.5%) cases were defendable and 15 were not.

Subcategories of Stage 2 Allegations	Number Cases (%)	Accept Allegations (%)	Defendable
Missed Diagnosis	8 (20)	26 (55.3)	13 (68.4%)
Delay to diagnosis/ treatment	19 (47.5)	33 (39.7)	4 (50%)
Substandard/ negligent care	13 (32.5)	37 (46.2)	8 (61.5%)
Total	40 (100)	96 (43.6)	25 (62.5%)

Table 1: Stage 2 Advisory Report Allegation by Subcategory

The 'missed' allegations were equally split between fractures and spinal infection both (+/- neurological injury). Of the 'delay' cases half (20% of all cases) were predictably related to cauda equina syndrome (CES), of which the majority were related to delay to diagnosis rather than to delay to or incompetence with the subsequent surgery.

In both primary and secondary care (including specialist spinal care), there was often an omission to communicate to patients the need to represent in a timely manner should their symptoms and signs evolve (i.e. to adequately objectively 'safety net'). Any delays in the prescribed treatment pathway as defined by GIRFT (whether supporter or detractor) are therefore best documented in the medical record to avoid (much) later questioning and culpability.

The remainder of the 'delay' cases included 2 infections, 2 fractures, 1 cerebral meningioma and the rest related to elective spinal conditions (including lumbar disc prolapse, cervical and lumbar stenosis and idiopathic scoliosis) all that were pursing their natural history and had been reasonably and satisfactorily managed (in my opinion).

The 'substandard/negligent' cases were distributed equally across 3 subthemes; consent, incorrect surgical level and poor surgical technique. The standard of consenting was highly

variable, the incorrect surgical level cases (although easily committed) were all deemed 'undefendable' whilst the poor surgical technique cases were typically within 'a range of accepted opinion' and 'defendable'. All cases of 'incorrect level' surgery were committed in cases where no preoperative standing spinal radiograph had been obtained and the level check had relied solely upon a needle placed as a skin marker (or so the records reflected).

In summary, the conclusions that I can derive from my early spinal medicolegal experience and the changes to my practice are intuitive, not radical, but remain pertinent in a medical environment of high 'tech' noise but low clinical resolution.

1. Ignore your patients at your peril! – the pertinence of an accurate history remains 90% of the diagnosis (as it ever was), but the threshold to image continues to fall. Before discounting a patients symptoms consider strongly whether infection, fracture or tumour is clinically more likely than not.

2. Any spinal patient being admitted acutely should have baseline observations and bloods including a FBC and CRP (helping exclude acute fracture and infection).

3. If the clinical picture does not comfortably fit the working diagnosis, despite your cognitive dissonance, then think again or ask a friend. Don't be comfortable with a misfit diagnosis. Your gut feeling will reliably inform you.

4. Include 'objective safety netting advice' in your ward round and clinic letters for patients with significant spinal canal stenosis as readily detailed by the AccessAble Cauda Equina QR code (see below).

5. Consenting needs to be electronically standardized (albeit with the ability for patient and case specific annotation) with digital copies universally available to all stakeholders. In the interim my quoted risks, as a minimum, replicate those quoted by BASS (British Association of Spinal Surgeons).

6. Never list a patient for an open elective spinal operation before they have had a reasonable opportunity to reflect upon all options including the natural history, outside of the primary consultation, and subsequently 'chosen' their preferred treatment. In the NHS this is decided at follow-up, privately they email my practice manager their 'choice' if 'self-funding' which is documented in the records.

7. Include a paragraph in your clinic letters referring patients to review and digest the 'patient booklets' for their spinal diagnosis on www.spinesurgeons.ac.uk, so they are fully informed as part of the 'consent journey'.

8. Consider a standing preoperative radiograph for open cases as it provides a comparator radiograph for your intraoperative fluoroscopy (it avoids confusion with lumbosacral transitional vertebrae and additional discal material seen on MRI – note you have NO intraoperative MRI). I recommend a final intraoperative radiograph, with a radio-opaque marker, at the end of the case to confirm the correct level has been operated upon – it also may alert you to an incorrect level error at an earlier stage. Standardized level checking is an onward project for consideration by the spinal societies.

9. Observe and scrutinize what radiographs are sent to PACS and ensure they reflect what operation was conducted.

10. When you haven't done something in clinic or theatre that the majority of practising surgeons would do, then explain why in the medical record. This may provide mitigating circumstances to subsequently deny latter allegations. ■

CES QR code:

Original articles

Commentary on **A year in spinal surgical medicolegal (Defence) practice – an idiots' guide** by Alex Torrie

Pal Lakshmanan
Consultant Spine Surgeon
Sunderland Royal Hospital

This article by Alex is not just informative but also serves as a cautionary tale for us as spinal surgeons underlining the importance of understanding the medicolegal implications of our clinical work and encourages a proactive approach to mitigate potential legal challenges. It also serves as a stark reminder of the complexities and challenges that medical professionals face beyond patient care. The author has nicely highlighted the necessity for continuous professional development, not just in medical skills but also in understanding legal implications of clinical practice.

Moreover, the article is a call to action for systemic changes in the way medical professionals are trained and supported in dealing with medicolegal issues and underlines the need for comprehensive medicolegal education as part of medical training. Also, the author's candid sharing of personal experiences and learnings is commendable, and the practical advice provided add significant value.

I would also like to add that the article raises some important ethical issues that should be considered. For example, the article states that patients are only entitled to "standard care" and not "optimal care." This raises the question of what constitutes "standard care" and how this should be determined. The article also suggests that a breach of duty can occur if a patient is exposed to "substandard care." However, it is not always clear what constitutes "substandard care." These are complex issues that there are no easy answers to. However, it is important to be aware of these issues and to consider them carefully when making decisions about medical care.

Articles like this are needed more as the number of letters of claim are on the rise even though eventually do not materialise, they still put a significant mental and reputational strain on the treating spinal surgeon. In essence, this article is not just a guide for those entering the complex realm of spinal surgical medicolegal defence but a reflective piece that prompts seasoned practitioners to reconsider and enhance their own practices. ■

Original articles

British Scoliosis Society (BSS) Standards of Care for Bracing in Adolescent Idiopathic Scoliosis (AIS)

Ashley Cole
BSS President & Consultant Spinal Surgeon,
Sheffield Children's Hospital

1. Aims

This document gives guidelines to spinal surgeons, orthotists and NHS providers for delivering care to patients with adolescent idiopathic scoliosis who may benefit from brace treatment. Bracing hopes to reduce the risk of curve progression in Adolescent Idiopathic Scoliosis (AIS) and avoid surgery.

2. Who

All patients with AIS with curves 20-40 degrees, Risser 0-2 (significant growth potential) and apex below T7 should be offered brace treatment. The evidence from the BrAIST Study shows that 72% of braced patients avoid curve progression to 50 degrees (a surrogate marker of surgery) whilst only 48% of non-braced patients avoid surgery (1). There is no scientific evidence to support bracing outside these parameters.

3. Management in Primary Care

The US Preventive Services Task Force were satisfied with the evidence supporting the benefit of bracing in AIS patients. However, they found inadequate evidence to show that reducing spinal curvature in adolescents would improve long-term health outcomes as an adult. They also found inadequate evidence regarding the harms of treatment. They concluded 'that the current evidence is insufficient to assess the balance of benefits and harms of screening for adolescent idiopathic scoliosis in children and adolescents aged 10 to 18 years (2). The benefits of potentially reducing the number of patients requiring surgery was not considered. The BSS supports:

1. All patients who may benefit from bracing should be given the opportunity to be braced as early as possible without overtreatment (no bracing in curves less than 20 degrees where progression risk is lower).

2. GP and First Contact Practitioner (FCP) education on clinical detection of scoliosis.

3. Raised public awareness of scoliosis.

4. Management in Secondary Care

1. Delays from primary care referral to first clinic appointment must be minimised to reduce the chance of curve progression beyond that suitable for bracing resulting in surgery being the only option. Suggestions include:

   a. Initial outpatient x-ray to prioritise those with curves suitable for bracing.

   b. Extended Scope Specialist Nurses and Physiotherapists to see these patients initially in clinic and refer suitable patients for bracing.

2. The waiting time from the spinal team making a bracing referral to the brace fitting should be no longer than 8 weeks.

3. In-brace PA spinal radiograph either on the day of brace fitting or ideally 2-6 weeks later to assess reduction in brace and allow brace adjustment. This is the best method to assess brace 'quality' accepting that it will also be dependent on curve flexibility. This is also predictive of bracing success (3–9).

4. Out-of-brace PA spinal radiographs should be performed every 6 months to assess curve progression. These are used to predict bracing success (10,11). Patients should be advised to remove the brace 2-4 hours before the radiograph but must bring the brace with them if they are seeing the clinical team. Radiographs should include T1 to sacrum and the iliac crests to assess Risser stage. Patients should be positioned looking straight ahead with arms by their side. All radiographs should have any leg length discrepancy corrected especially if it is large enough for the patient to wear a shoe raise. If a lateral radiograph is required, the arms should be positioned with 'knuckles on clavicles' or 'hands on cheeks' (12–16).

5. Using left hand and wrist radiographs should be assessed for skeletal maturity using Sanders' stage (17) and/or the Distal Radius and Ulna classification (18–22) and/or Tanner-Whitehouse 3 bone age in conjunctions with Risser stage to assess skeletal maturity. These are especially valuable:

   a. In those patients at the borderline for bracing (Risser 2) to avoid overtreatment and inform shared decision making.

   b. To determine the optimal time for brace cessation (Risser 4 and Sanders 7 in girls; Risser 5 and Sanders 7 in boys)

6. Standing height and ideally sitting height should be recorded at each visit (23).

7. Patients should be encouraged to wear a full-time brace 20 hours per day as success is related to adherence (1,24,25).

8. The potential psychological problems from bracing should be considered (26,27) although there are no recognised screening tools. Establishing local links to a Paediatric Clinical Psychologist is recommended (28).

9. Patients and parents should be given information regarding bracing (see BSS bracing information). This should include information about wearing the brace and advice for schools.

5. For consideration:

10. There is no current evidence that one type of rigid spinal brace is any better than another although soft braces are probably less effective (29).

11. Brace compliance (adherence) could be monitored with an electronic sensor (23) to recognise non-adherence and try to address any psychological issues to optimise compliance to a level where bracing may be effective or to agree to discontinue bracing if wear time is not adequate enough for benefit.

12. All centres should ideally be recruiting to the NIHR HTA Bracing Adolescent Idiopathic Scoliosis (BASIS) study comparing full-time bracing versus night-time bracing in AIS.

6. References

1. Weinstein SL, Dolan LA, Wright JG, Dobbs MB. Effects of Bracing in Adolescents with Idiopathic Scoliosis. N Engl J Med. 2013 Oct 17;369(16):1512–21.

2. US Preventive Services Task Force, Grossman DC, Curry SJ, Owens DK, Barry MJ, Davidson KW, et al. Screening for Adolescent Idiopathic Scoliosis: US Preventive Services Task Force Recommendation Statement. JAMA. 2018 Jan 9;319(2):165.

3. Alvarez I, Poppino K, Karol L, McIntosh AL. Lack of in-brace x-rays in compliant AIS patients wearing full-time TLSO braces associates with failure. J Orthop Surg. 2021 Dec;16(1):540.

4. Aulisa AG, Galli M, Giordano M, Falciglia F, Careri S, Toniolo RM. Initial In-Brace Correction: Can the Evaluation of Cobb Angle Be the Only Parameter Predictive of the Outcome of Brace Treatment in Patients with Adolescent Idiopathic Scoliosis? Children. 2022 Mar 2;9(3):338.

5. Babaee T, Kamyab M, Ganjavian MS, Rouhani N, Khorramrouz A, Jarvis JG. Coronal deformity angular ratio as a predictive factor for in-brace curve correction and long-term outcome of brace treatment in adolescents with idiopathic scoliosis. Spine Deform [Internet]. 2022 Jan 16 [cited 2022 Jan 27]; Available from: https://link.springer.com/10.1007/s43390-021-00452-x

6. Clin J, Aubin CÉ, Sangole A, Labelle H, Parent S. Correlation Between Immediate In-Brace Correction and Biomechanical Effectiveness of Brace Treatment in Adolescent Idiopathic Scoliosis: Spine. 2010 Aug;35(18):1706–13.

7. Kawasaki S, Cheung PWH, Shigematsu H, Tanaka M, Suga Y, Yamamoto Y, et al. Alternate In-Brace and Out-of-Brace Radiographs Are Recommended to Assess Brace Fitting and Curve Progression With Adolescent Idiopathic Scoliosis Follow-Up. Glob Spine J. 2021 Jul 15;219256822110325.

8. Peeters CMM, van Hasselt AJ, Wapstra FH, Jutte PC, Kempen DHR, Faber C. Predictive Factors on Initial in-brace Correction in Idiopathic Scoliosis: A Systematic Review. Spine. 2022 Apr 15;47(8):E353–61.

9. Wong LPK, Cheung PWH, Cheung JPY. Curve type, flexibility, correction, and rotation are predictors of curve progression in patients with adolescent idiopathic scoliosis undergoing conservative treatment: a systematic review. Bone Jt J. 2022 Apr 1;104-B(4):424–32.

10. Stefano N, Di Felice F, Francesco N, Giulia R, Fabio Z, Sabrina D. Predicting final results of brace treatment of adolescents with idiopathic scoliosis: first out-of-brace radiograph is better than in-brace radiograph—SOSORT 2020 award winner. Eur Spine J [Internet]. 2022 Apr 4 [cited 2022 Apr 10]; Available from: https://link.springer.com/10.1007/s00586-022-07165-3

11. Negrini S, Di Felice F, Negrini F, Rebagliati G, Zaina F, Donzelli S. Predicting final results of brace treatment of adolescents with idiopathic scoliosis: first out-of-brace radiograph is better than in-brace radiograph—SOSORT 2020 award winner. Eur Spine J [Internet]. 2022 Apr 4 [cited 2022 Jun 2]; Available from: https://link.springer.com/10.1007/s00586-022-07165-3

12. Faro FD, Marks MC, Pawelek J, Newton PO. Evaluation of a Functional Position for Lateral Radiograph Acquisition in Adolescent Idiopathic Scoliosis: Spine. 2004 Oct;29(20):2284–9.

13. Horton WC, Brown CW, Bridwell KH, Glassman SD, Suk SI, Cha CW. Is There an Optimal Patient Stance for Obtaining a Lateral 36" Radiograph?: A Critical Comparison of Three Techniques. Spine. 2005 Feb;30(4):427–33.

14. Pasha S, Capraro A, Cahill PJ, Dormans JP, Flynn JM. Biplanar spinal stereoradiography of adolescent idiopathic scoliosis: considerations in 3D alignment and functional balance. Eur Spine J. 2016 Oct;25(10):3234–41.

15. Kaneko K, Aota Y, Sekiya T, Yamada K, Saito T. Validation study of arm positions for evaluation of global spinal balance in EOS imaging. Eur J Orthop Surg Traumatol. 2016 Oct;26(7):725–33.

16. Sieh KM, Chan YY, Ho PY, Fung KY. What is the best lateral radiograph positioning technique for assessment of sagittal balance: A biomechanical study on influence of different arm positions. J Orthop Surg. 2018 May 1;26(2):230949901877093.

17. Sanders JO, Khoury JG, Kishan S, Browne RH, Mooney JF, Arnold KD, et al. Predicting Scoliosis Progression from Skeletal Maturity: A Simplified Classification During Adolescence: J Bone Jt Surg-Am Vol. 2008 Mar;90(3):540–53.

18. Cheung PWH, Cheung JPY. Sanders stage 7b: Using the appearance of the ulnar physis improves decision-making for brace weaning in patients with adolescent idiopathic scoliosis. Bone Jt J. 2021 Jan 1;103-B(1):141–7.

19. Cheung JPY, Cheung PWH, Samartzis D, Cheung KMC, Luk KDK. The use of the distal radius and ulna classification for the prediction of growth: peak growth spurt and growth cessation. Bone Jt J. 2016 Dec;98-B(12):1689–96.

20. Cheung JPY, Cheung PWH, Samartzis D, Luk KDK. APSS-ASJ Best Clinical Research Award: Predictability of Curve Progression in Adolescent Idiopathic Scoliosis Using the Distal Radius and Ulna Classification. Asian Spine J. 2018;12(2):202.

21. Cheung JPY, Samartzis D, Cheung PWH, Leung KH, Cheung KMC, Luk KDK. The distal radius and ulna classification in assessing skeletal maturity: a simplified scheme and reliability analysis. J Pediatr Orthop B. 2015 Nov;24(6):546–51.

22. Yamamoto Y, Shigematsu H, Cheung PWH, Okuda A, Kawasaki S, Tanaka Y, et al. How do we follow-up patients with adolescent idiopathic scoliosis? Recommendations based on a multicenter study on the distal radius and ulna classification. Eur Spine J. 2020 Aug;29(8):2064–74.

23. Roye BD, Simhon ME, Matsumoto H, Bakarania P, Berdishevsky H, Dolan LA, et al. Establishing consensus on the best practice guidelines for the use of bracing in adolescent idiopathic scoliosis. Spine Deform [Internet]. 2020 Feb 5 [cited 2020 May 28]; Available from: http://link.springer.com/10.1007/s43390-020-00060-1

24. Hawary RE, Zaaroor-Regev D, Floman Y, Lonner BS, Alkhalife YI, Betz RR. Brace treatment in adolescent idiopathic scoliosis: risk factors for failure—a literature review. Spine J. 2019 Jul;S1529943019308782.

25. van den Bogaart M, van Royen BJ, Haanstra TM, de Kleuver M, Faraj SSA. Predictive factors for brace treatment outcome in adolescent idiopathic scoliosis: a best-evidence synthesis. Eur Spine J. 2019 Mar;28(3):511–25.

26. Wang H, Tetteroo D, Arts JJC, Markopoulos P, Ito K. Quality of life of adolescent idiopathic scoliosis patients under brace treatment: a brief communication of literature review. Qual Life Res [Internet]. 2020 Oct 24 [cited 2021 Mar 6]; Available from: http://link.springer.com/10.1007/s11136-020-02671-7

27. Lin T, Meng Y, Ji Z, Jiang H, Shao W, Gao R, et al. Extent of Depression in Juvenile and Adolescent Patients with Idiopathic Scoliosis During Treatment with Braces. World Neurosurg. 2019 Jun;126:e27–32.

28. Negrini S, Donzelli S, Aulisa AG, Czaprowski D, Schreiber S, de Mauroy JC, et al. 2016 SOSORT guidelines: orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. Scoliosis Spinal Disord. 2018 Dec;13(1):3.

29. Costa L, Schlosser TPC, Jimale H, Homans JF, Kruyt MC, Castelein RM. The Effectiveness of Different Concepts of Bracing in Adolescent Idiopathic Scoliosis (AIS): A Systematic Review and Meta-Analysis. 2021;16. ■

Review Date: 1 September 2025

Original articles

Which cervical cage?

DePuy -Synthes EIT titanium cage

Tim Germon
Spinal Neurosurgeon, Plymouth, United Kingdom

I am not aware of any evidence that any interbody device confers any great advantage when performing anterior cervical discectomy and fusion when compared to performing a discectomy alone. However, it seems sensible to me that some form of spacer be used to try and 1. maintain foraminal height and 2. prevent or minimise any kyphosis which may otherwise occur. The problem is that subsidence of the cage into the end plates inevitably occurs in some cases. This may lead to re-stenosis of the exit foramina and a degree of kyphosis in some people. My choice of cage aims to minimise these potential complications.

The large footprint EIT cage has the largest footprint of any cage I am aware of. It will fill the disc space with a very large contact area. There is no none weight bearing space within the cage. Fusion depends on integration between the bone and the 3D printed meshwork of the titanium cage. The surface of the cage feels smooth but once inserted and the distraction is removed it sits very firmly with in the disc space.

I have been pleased with the outcomes I have had using these cages over the last 3 or 4 years. The slight disadvantage is metal artefact if post op scans are required but my empirical observation is that results are better than with cages with minimal weight bearing surfaces and certainly better than cages with additional screws, which I have previously used.

Globus Coalition cage with DBX

Mike McCarthy
Orthopeadic Spinal Surgeon, Cardiff, United Kingdom

For the last 10 years, for 1 and 2 level degenerative necks I have used the **Globus Coalition** cage with DBX (and any local bits of bony osteophyte excised). To date I have not had to revise any cages and I am not aware of any symptomatic nonunion / pseudarthroses. It is a PEEK cage and utilizes 2 screws that fix the cage into the endplates. For 3 and 4 level anterior cervical fusions I use **Globus Colonial or Sustain PEEK** cages (with a Globus Assure plate) and will consider posterior instrumentation to improve fusion. In 2017 I reviewed 5 years of my 1 and 2 level ACDF cases and found no significant difference in the attainment of fusion between cage and plate constructs and the standalone fixable cages. The standalone cages achieved a significantly greater degree of lordosis at final follow up. Cage and plate led to significantly greater levels of anterior soft tissue swelling as measured on post operative XR at the C5/6 level immediately and at <3 months post- op. I believe it is quicker to site a fixable cage (plates can be a fiddle) and they cause less post operative swelling and dysphagia. It gives immediate stability and is unlikely to displace compared to a non-fixable stand-alone cage. I like the idea of 3D printed metallic fixable cages and would be happy to use them when and if they become available and if priced appropriately.

Globus Hedron & Globus MIS coalition cage

Mark Nowell
Spinal Neurosurgeon, Bristol, United Kingdom

In my practice the interbody cage is used to 1) promote bony fusion, 2) effect indirect foraminal decompression and 3) restore some degree of lordosis. For single level degenerative disease my ‘go to’ cage is the **Globus Hedron** cage. This is 3D printed to promote bony ingrowth and has a rough surface to minimise the risk of cage migration. I opt for the largest footprint possible to minimise subsidence. For two or more levels I like additional support, either with a plate or with integrated plates i.e. **Globus MIS coalition cage** with screws. I do not like the anchor system as the anchors are difficult to remove if needed. For a mobile spondylolisthesis, especially at C3/4, I opt for the most rigid fixation as possible. This would be interbody cage (hedron) and separate plate.

4Web Medical titanium

Oliver Stokes
Orthopeadic Spinal Surgeon, Exeter, United Kingdom

For anterior cervical discectomy and fusion I use the **4Web Medical** titanium 3D printed cage roughened external structure

and a truss construct, it is shown to have good fusion rates in animal models and I've been very happy with it, it comes in a range of sizes but only 2 lordosis options 0 and 7 degrees, it's useable as a fixable cage or with a plate, we don't put the screws in, the screws have got 5 degree range of freedom, they're easy to put in and it's low profile. I have been very happy with it, and I haven't had any issues with non-union, subsidence or implant migration.hesis, especially at C3/4, I opt for the most rigid fixation as possible. This would be interbody cage (hedron) and separate plate.

Stryker AVS Anchor C.

Riaz Mohammed
Orthopeadic Spinal Surgeon , Gloucester, United Kingdom

It is an integrated hollow PEEK cage with a titanium screw locking mechanism. It has two foot-print options, versatility with 0°, 4°, 8° lordotic angle options and 7 height options. Self-tapping and self-drilling 3.5 and 4mm screw options are available, and ease of insertion via the low-profile cage inserter. A tantalum marker permits identification of the depth of cage insertion intra-operatively. The implant teeth facing the endplates also allows additional stability. Bone graft can be placed in the hollow of the cage.

The benefits I favour in this are the of avoidance of any anterior profile of implant, ease of insertion and the low impedance if an MRI scan is required for any reason. The only downside I have noted is the starting height is 6m, may not be suitable in smaller cervical spines. I feel this cage system allows the best of stable fixation without additional anterior pre-vertebral prominence to permit fusion to occur in a stable environment.

DePuy Synthes Cervios Cage with Chronos Insert

Pal Lakshmanan
Consultant Spine Surgeon, Sunderland Royal Hospital, United Kingdom

This cage is made of PEEK material and hence nearly isoelastic to the bone. It comes in two shapes; curved and wedged, allowing utilisation according to specific endplate morphology, increasing the contact surface area between the endplate and the cage for a better load-sharing surface which helps with osseointegration. The cage has metal markers to confirm its location in intra and post-operative X-rays which does produce some imaging metal artefact but to a lesser extent than titanium cages.

The Chronos insert inside the cage has both macropores (100-500 µm) to facilitate bone in-growth, and micropores (<10 µm) to allow supply of nutrients, avoiding the use of autologous bone graft and avoiding donor-site morbidity. Cage assembly is inserted with a threaded rod that helps to position where desired with the option to reposition as needed intraoperatively, lending itself to easy removal of the implant if later required. Sharp teeth on the cage provide the primary stability reducing migration and the rough surface allows bone growth providing secondary stability.

This cage is simple to use with fewer complications. Although literature shows equivocal results between cases where there was cage subsidence compared to cases without cage subsidence, I prefer to maintain height and therefore use plate and screws to prevent any chance of subsidence; unless there is extensive osteophytosis and change in the external shape of the vertebral body and I would use cage and insert alone.

Stryker Solis cage

Guy Wynne-Jones
Consultant Spinal Surgeon from Royal Victoria Infirmary, Newcastle-Upon-Tyne, United Kingdom

I currently use the Solis cage by Stryker and have been using it as my go-to cage for 15 years. It is made from polythereth erketone (PEEK), with two titanium spikes and retentive teeth on the superior and inferior surfaces. This allows for instant stability when inserting negating the need for an anterior buttress plate if appropriate over multiple levels. Almost 60% of the cross-sectional area is available as a bone window; though I currently use a biphasic calcium phosphate insert designed for the Solis cage, rather than bone graft. The benefits of PEEK regarding a cervical cage include reduced artifact in post-operative imaging, a low elastic modulus which reduce stress shielding leading to maintained long-term health of the adjacent bone. The strength and stiffness of PEEK provides immediate structural support in the cervical spine in the immediate post-operative period.

The cage ranges in height from 4-9mm with two widths of 12 and 14mm which covers all patient sizes that I have come across. However, it is not a lordotic cage which does limit its use if trying to generate a cervical lordosis when compared to other cages on the market. In the main I have been pleased with the outcomes of using this cage, there have been occasional revisions due to non-union and I have had less subsidence and foraminal narrowing with this cage compared to others that I have tried. ■

Original articles

Perioperative management of anticoagulants and antiplatelets in Spine Surgery

Vinay Jasani
BASS policy and guidelines lead

Contributors:
BASS executive 2022-2023
British Society for Haematology 2022-2023
BSS executive 2022-2023
SBNS executive 2022-2023

Executive Summary

- The aim of this document is to provide guidance on the management of anticoagulants (ACT) and antiplatelets (APT) in patients undergoing spine surgery.
- This guidance does not replace local policy.
- This guidance does not replace a patient specific management plan following discussion with involved clinicians, taking into account specific risks and the surgical procedure itself.
- The risk of bleeding in spine surgery includes neuro-compressive haematoma, excessive blood loss and soft tissue complications including infection.
- The risk of stopping ACT / APT includes thromboembolic risk, ischaemic events, stent occlusion and valve thrombosis.
- Evidence is low for stopping or continuing NSAIDs. When NSAIDs are to be stopped they should be stopped according to the individual drug half-life.
- Evidence suggests that continuation of aspirin may not lead to significant problems particularly in low / intermediate risk procedures. When aspirin is to be stopped, 7 days minimum preoperative cessation is satisfactory.
- Evidence suggests that continuation of clopidogrel, Plavix may lead to problems. These agents should be stopped a minimum of 5-7 days preoperatively.
- Evidence suggests that continuation of DOACs / NOACs can lead to problems. These agents should be stopped a minimum of 5 half-lives preoperatively (24 -72 hours).
- Evidence suggests that continuation of warfarin can lead to problems. Warfarin should be stopped a minimum of 5 days preop until INR < 1.5.
- Evidence suggests that continuation of heparin and fractionated heparin can lead to problems. These agents should be stopped minimum 6-24 hours preoperatively depending on the agent.
- Evidence suggests that bridging therapy is not needed universally and should only be used in patients with high risk of thromboembolic events.
- Plan for recommencing ACT / APT agents will be dependent on the agent, the underlying surgical bleed risk and the patient's risk of stopping the agent.
- Inform patients about the risk of continuation or cessation of ACT / APT (in addition to other complications) during the consent process.
- Preparation for cases with a high risk of stopping ACT / APT should include individualised discussion with the appropriate treating clinicians to ascertain the risks and benefits of delaying surgery or ACT / APT cessation.
- All patients undergoing spine surgery should be screened for ACT / APT use and a clear visible plan documented for the perioperative period.
- All personnel involved in managing the patient should be aware of the decision making to reduce the risk of variance from the preoperative plan and prevent adverse consequences.
- The plan for recommencement of ACT / APT should be clearly outlined in the postoperative notes.
- Reversal in emergency scenarios should be performed with haematology advice.

Who does this update affect?

Patient group
This guidance affects all patients undergoing spine surgery on ACT or APT agents.

Clinical staff
Spine surgeons and surgical team, preassessment teams, spine practitioners, theatre and recovery personnel, anaesthetic teams, nursing and pharmacy teams.

Managerial staff
Responsible ward managers, matrons, clinical leads / directors in spine surgery and RSN.

What is the update trying to achieve?

The guidance is trying to reduce the risks associated with managing ACT / APT in the perioperative phase of spine surgery.

Spine surgery whilst on ACT / APT agents carries a risk of neuro-compressive haematoma, excessive blood loss and soft tissue complications including infection.

The risk of stopping ACT / APT includes thromboembolic risk, ischaemic events, stent occlusion and valve thrombosis.

Recognising the use of anticoagulants and antiplatelets

Any patients undergoing elective or non-elective spine surgery should be screened for the use of ACT / APT.

At the time of writing in the UK, these drugs are used to reduce the risk of venous and arterial thromboembolic events, protect stents and mechanical valves from thrombosis.

Ideally patients should be screened for the use of ACT / APT at the time of listing for any spine intervention so that the appropriate enquiries with respect to cessation can be made and a perioperative plan established. Any preassessment pathway for spine surgery should ensure screening questions for ACT / APT are asked and that this triggers a perioperative plan to be detailed.

The patient and admitting team should be made aware of the perioperative plan to ensure complications related to ACT / APT use and cessation are minimised.

Most cases can revert to a default plan, although more complex cases should have an individualised MDT discussion with the appropriate medical specialty to ensure the optimal perioperative plan.

Abbreviations used

ACT – anticoagulant
APT - antiplatelet
EBL – estimated blood loss
POD – post operative drainage
POBL – perioperative blood loss
SEH – spinal epidural haematoma
TE – thromboembolic
ACS – acute coronary syndrome
CrCl – creatinine clearance
VTE – venous thromboembolism
NSAIDs – nonsteroidal anti-inflammatories
DOACs / NOACs – direct / novel oral anticoagulants

Considerations

Considerations in managing ACT / APT perioperatively include:

1. Risk of stopping ACT / APT (thromboembolic events)

- The risk of having a thromboembolic event resulting in a stroke, stent occlusion, valve thrombosis or other consequence needs to be considered
- Risk calculators such as the CHA2DS2-VASc score can be used to assess the risk of stroke and stopping medication (low level of evidence for perioperative use)
- The acuity of a recent event or intervention (e.g. stroke or percutaneous coronary intervention) needs to be considered. In general the risk of another event is felt to be higher within the first 3 - 6 months
- Patients with high risk of having a thromboembolic event from stopping ACT / APT must be considered for deferring surgery when possible OR an individualised plan outlined after multidisciplinary discussion

High	Low
Mechanical heart valve (target INR 3.0-4.5)	Aortic bi-leaflet valve (target INR 2.0-3.0) with no other thromboembolic risk factors
Percutaneous coronary angioplasty < 2 weeks	Primary prevention antiplatelet therapy
Myocardial infarction / ACS < 6 weeks	Myocardial infarction / ACS > 6 months
Bare metal stent < 6 weeks	Bare metal stent > 6 weeks
Drug eluting stent < 12 months	AF with CHA2DS2-VASc score ≤4 and no stroke or TIA in last 3 months
Stroke < 3 months	Unprovoked VTE > 3 months
Stroke with high CHA2DS2-VASc score (≥5)	
VTE < 3 months	
VTE that occurred on ACT	
High risk pro-thrombotic conditions such as anti-phospholipid syndrome and thrombophilia	
Patients on dual ACT or APT	
Any condition requiring warfarin with a target INR range above 2.0-3.0	

Table 1: Risk of stopping ACT / APT

2. Risk of bleeding and consequences

- Spinal surgery is generally considered a high risk category in terms of the consequence of bleeding perioperatively when considering stopping ACT / APT
- Epidural haematoma is a serious concern with excessive bleeding and can result in disastrous neurological deficits. Any canal invasive procedure result in a higher risk of this happening
- Perioperative bleeding can result in physiological instability and the need for transfusions which are not without risk
- Soft tissue haematomas can result in postoperative infection as well as discomfort
- Some spine surgical interventions could be considered lower risk than others (expert opinion)
- Patients who have a high risk of bleeding (uncontrolled hypertension, age > 65 y, liver disease, renal disease, >8 alcohol drinks per week), prior major bleeding or predisposition to bleeding will need to be considered high risk. Consider using the HEMSTOP questionnaire to evaluate bleeding predisposition.

Procedure	Risk of spinal epidural haematoma^	Risk of increased perioperative blood loss^
Any surgery involving the spinal canal and contents	High	Low if purely decompressive procedure < 3 levels Intermediate if purely decompressive procedure > 3 levels Intermediate if + spinal instrumentation High if + complex reconstruction
Complex reconstruction (including osteotomies)	High	High
Bony stabilisation > 3 levels (no canal opening procedure)	Low	High
Bony stabilisation < 3 levels (no canal opening procedure)	Low	Intermediate
Epidural /nerve root blocks or intradural infiltration / injection (SEH)	Intermediate	Low
MBB / facet injections	Low	Low

^Patients who have a high risk of bleeding (uncontrolled hypertension, age > 65 y, liver disease, renal disease, >8 alcohol drinks per week, prior major bleeding or predisposition to bleeding will need to be considered high risk

3. Need for bridging therapy

- Although evidence is mixed, the use of bridging therapy may be considered particularly for warfarin
- This involves replacing ACT / APT with treatment dose low molecular weight heparin (LMWH) or unfractionated heparin (UFH) to reduce thromboembolic risk in the perioperative period
- Patients with a recent thromboembolic event, recent stent or mechanical valve may be candidates for bridging therapy
- Patients with higher risk scores may be candidates for bridging therapy
- Several studies have actually shown no clear benefit of bridging compared to placebo and higher bleeding risk

4. When to recommence treatment

- The operative procedure, intraoperative bleeding and postoperative drain output all need to be considered
- The risk of omitting ACT / APT will influence the timing of re-establishing ACT / APT therapy as well as pharmacological considerations

Anticoagulant / antiplatelet recommendations for Elective Surgery

The following recommendation is based on the available evidence and guidance at the time of writing. Individualised multidisciplinary risk assessment and perioperative management plan is advised for complex cases or patients at high risk of thromboembolic events (TE) from stopping ACT / APT or high surgical risk from continuing. Discussion with the key prescribing clinician is valuable in devising a patient specific plan.

Although it is recognised that spine surgery can be time sensitive even in elective practice (e.g. cervical myelopathy), consideration should be given to deferring surgery for patients at high risk of thromboembolic events due to recent interventions or events where that risk can be reduced by waiting (see table 1).

The recommendations relate only to the risk of TE and consequences of bleeding. No other benefits or disadvantages of the drug have been considered.

The evidence cited is on the basis of spine specific literature review or evidenced benefit of continuation of drugs for thromboembolic risk.

NSAIDs	High risk of TE	Low risk of TE	Surgical risk^	Discontinuation pre-op (minimum)	Recommence post-op
Diclofenac	Can stop	Can stop	Stop to reduce POBL in high risk (Evidence very low)	I day	24-48 hours
Ibuprofen Ketorolac	Can stop	Can stop	Stop to reduce POBL in high risk (Evidence very low)	I day	24-48 hours
Etodolac Indomethacin	Can stop	Can stop	Stop to reduce POBL in high risk (Evidence very low)	2 days	24-48 hours
Meloxicam Naproxen	Can stop	Can stop	Stop to reduce POBL in high risk (Evidence very low)	4 days	24-48 hours
Nabumetone	Can stop	Can stop	Stop to reduce POBL in high risk (Evidence very low)	6 days	24-48 hours
Piroxicam Oxaprozosin	Can stop	Can stop	Stop to reduce POBL in high risk (Evidence very low)	10 days	24-48 hours

^Patients who have a high risk of bleeding (uncontrolled hypertension, age > 65 y, liver disease, renal disease, >8 alcohol drinks per week, prior major bleeding or predisposition to bleeding will need to be considered high risk

NSAIDs	High risk of TE	Low risk of TE	Surgical risk^	Discontinuation pre-op (minimum)	Recommence post-op
Aspirin	Do not stop Consider deferring surgery Discuss with prescribing clinician for individualised plan	Can stop	Stop in high surgical risk low TE risk Do not stop if high TE risk. There is supportive evidence to operate and inject on low dose aspirin (<1g) but if concerns - defer surgery or discuss with prescribing clinician for individualised plan (Evidence to continue moderate-high; evidence to stop low)	7 days if stopping	24-48 hours
ADP receptor blockers **Clopidogrel Ticagrelor**	Do not stop Consider deferring surgery Consider Aspirin cover	Can stop	Stop where possible for all categories except low for both SEH and POBL For high TE risk defer surgery or use Aspirin cover if no option to defer (< 12 months drug eluting stents discuss with cardiology) If surgery cannot be deferred and ADP blocker cannot be stopped consider MDT decision and short acting IV agents as bridging therapy (tirofiban or eptifibatide) For low TE risk ADP blocker can stop. (Evidence moderate-high)	5 days (up to 7 days in some studies)	48 hours
ADP receptor blocker **Prasugrel**	Do not stop Consider deferring surgery Consider Aspirin cover	Can stop	Stop where possible for all categories except low for both SEH and POBL For high TE defer surgery or use Aspirin if no option to defer (< 6-12 months drug eluting stents dw cardiology) If surgery cannot be deferred and ADP blocker cannot be stopped consider MDT decision and short acting IV agents as bridging therapy (tirofiban or eptifibatide) For low TE risk ADP blocker can stop (Evidence moderate-high)	7-10 days	48 hours

^Patients who have a high risk of bleeding (uncontrolled hypertension, age > 65 y, liver disease, renal disease, >8 alcohol drinks per week, prior major bleeding or predisposition to bleeding will need to be considered high risk

Vit K antagonists	High risk of TE	Low risk of TE	Surgical risk^	Discontinuation pre-op (minimum)	Recommence post-op
Warfarin	Stop Warfarin 5 days preop and use bridging therapy with treatment dose LMWH 72 hrs before surgery Stop bridging 24 hours preoperatively Aim for INR <1.5 on day of surgery	Stop Warfarin 5 days preop No bridging required Aim for INR <1.5 on day of surgery	Stop Warfarin 5 days preop Check INR <1.5 before day of surgery If INR ⩾ 1.5 on day before surgery use Vitamin K 1-2 mg orally and recheck INR (Evidence – high)	5 days Bridging therapy with treatment dose LMWH for high TE risk For high TE and high surgical risk consider intermediate dose LMWH e.g. dalteparin 5000 u bd Stop bridging 24 hours preop No bridging therapy required for low risk TE Check INR <1.5 before day of surgery If INR ⩾ 1.5 on day before surgery use Vitamin K 1-2 mg orally and recheck INR	Start prophylactic LMWH dose 24 hours postop and then treatment dose LMWH 48 hrs post op if high surgical risk and high TE risk Start treatment dose LMWH 24 hrs postop for low surgical risk high TE risk For low TE risk start prophylactic dose LMWH 24-48 hrs postop Usual dose Warfarin to restart 24 hrs postop (unless POBL concerns) and continue bridging / prophylaxis until INR therapeutic.

Heparin	High risk of TE	Low risk of TE	Surgical risk^	Discontinuation pre-op (minimum)	Recommence post-op
Unfractionated Heparin (UFH)	Can stop if surgery cannot be delayed	Can stop	Stop agents preoperatively (Evidence – high)	4-6 hours	24 hours if low surgical risk 48 hours for high surgical risk
LMWH – therapeutic doses	Can stop if surgery cannot be delayed	Can stop	Stop agents preoperatively (Evidence – moderate)	24 hours For od regimen omit dose 24 hours preoperatively For bd regimen omit dose 12 hours preoperatively	24 hours if low surgical risk 48 hours for high surgical risk
LMWH – prophylactic doses	Can stop if surgery cannot be delayed	Can stop	Stop agents preoperatively (Evidence - moderate)	12 hours	24 hours if low surgical risk 48 hours for high surgical risk

^Patients who have a high risk of bleeding (uncontrolled hypertension, age > 65 y, liver disease, renal disease, >8 alcohol drinks per week, prior major bleeding or predisposition to bleeding will need to be considered high risk

DOAC / NOAC	High risk of TE	Low risk of TE	Surgical risk^	Discontinuation pre-op (minimum)	Recommence post-op
Apixaban Rivaroxaban Edoxaban	Can stop	Can stop	Stop agents preoperatively No bridging therapy required (Evidence – high)	If CrCl ⩾30ml/min 36 hrs preop (omit for 1 day preop) if low surgical risk If CrCL <30ml/min 60 hrs preop (omit for 2 days preop) if low surgical risk If CrCl ⩾30ml/min 60 hours preop (omit for 2 days preop) if intermediate / high surgical risk If CrCL <30ml/min 84 hrs preop (omit for 3 days preop) if intermediate / high surgical risk	If high risk TE start prophylactic dose LMWH 24-48 hrs post op until NOAC restarted Restart NOAC 24 hrs postop if low surgical risk and 48 hrs if high surgical risk
Dabigatran	Can stop	Can stop	Stop agents preoperatively No bridging therapy required (Evidence – high)	If CrCl ⩾50ml/min 36 hrs preop (omit for 1 day preop) if low surgical risk If CrCL <50ml/min 60 hrs preop (omit for 2 days preop) if low surgical risk If CrCl ⩾50ml/min 60 hours preop (omit for 2 days preop) if intermediate / high surgical risk If CrCL <50ml/min 108 hrs preop (omit for 4 days preop) if intermediate / high surgical risk	If high risk TE start prophylactic dose LMWH 24-48 hrs post op until NOAC restarted Restart NOAC 24 hrs postop if low surgical risk and 48 hrs if high surgical risk

^Patients who have a high risk of bleeding (uncontrolled hypertension, age > 65 y, liver disease, renal disease, >8 alcohol drinks per week, prior major bleeding or predisposition to bleeding will need to be considered high risk

		High stop risk	Low stop risk
NSAIDs	High surgical risk	Omit 1 – 10 days preop	Omit 1 – 10 days preop
	Low surgical risk	Do not stop	Do not stop
Aspirin	High surgical risk	Do not stop – if concerns defer surgery or discuss with prescribing physician	Omit 7 days preop
	Low surgical risk	Do not stop	Do not stop
Clopidogrel Ticagrelor	High surgical risk	Defer surgery OR use aspirin cover	Omit 5-7 days
	Low surgical risk	Defer surgery OR use aspirin cover	Omit 5-7 days
Prasugrel	High surgical risk	Defer surgery OR use aspirin cover	Omit 7-10 days
	Low surgical risk	Defer surgery OR use aspirin cover	Omit 7-10 days
Warfarin	High surgical risk	Omit 5 days preop and bridge with LMWH	Omit 5 days preop
	Low surgical risk	Omit 5 days preop and bridge with LMWH	Omit 5 days preop
UFH	High surgical risk	Omit 6 hours	Omit 6 hours
	Low surgical risk	Omit 6 hours	Omit 6 hours
LMWH therapeutic	High surgical risk	Omit 24 hours (consider IVC filter)	Omit 24 hours
	Low surgical risk	Omit 24 hours (consider IVC filter)	Omit 24 hours
LMWH prophylactic	High surgical risk	Omit 12 hours	Omit 12 hours
	Low surgical risk	Omit 12 hours	Omit 12 hours
Apixaban Rivaroxaban Edoxaban	High surgical risk	Omit 2 days if CrCl ⩾ 30 no bridging Omit 3 days if CrCl < 30 no bridging	Omit 2 days if CrCl ⩾ 30 Omit 3 days if CrCl < 30
	Low surgical risk	Omit 1 day if CrCl ⩾ 30 no bridging Omit 2 days if CrCl < 30 no bridging	Omit 1 day if CrCl ⩾ 30 Omit 2 days if CrCl < 30
Dabigatran	High surgical risk	Omit 2 days if CrCl ⩾ 50 no bridging Omit 4 days if CrCl < 50 no bridging	Omit 2 days if CrCl ⩾ 50 Omit 4 days if CrCl < 50
	Low surgical risk	Omit 1 day if CrCl ⩾ 50 no bridging Omit 2 days if CrCl < 50 no bridging	Omit 1 day if CrCl ⩾ 50 Omit 2 days if CrCl < 50

Anticoagulant / antiplatelet recommendations for Emergency Surgery

Where surgery can be safely delayed, this is the recommended action to reduce the bleeding risk. The following recommendations are for scenarios whereby surgery cannot be delayed.

Reversal in emergency scenarios should be performed with haematology advice.

Agent	Reversal
NSAIDs	None advised – continue with procedure
Aspirin	Continue without reversal and use 1 g tranexamic acid intraoperatively If risk of bleeding concerns are high, then use 2 pools of donor platelet transfusion at least 2 hours after last dose
Clopidogrel	2 pools of donor platelet transfusion at least 12-24 hours after the last dose 1g Tranexamic acid intraoperatively (repeat if necessary)
Warfarin	5mg Vit K intravenously if 6-8 hours delay is acceptable If no delay possible also infuse 25–50 u/kg of four-factor prothrombin complex concentrate (PCC) OR fresh frozen plasma (10-20 ml/kg) (This does increase thrombotic state)
Dabigatran	1g Tranexamic acid intraoperatively (repeat if necessary) 5g IV infusion of idarucizumab followed by another 5g if required (evidence is low) PCC use for dabigatran is controversial
Rivaroxaban, apixaban, edoxaban	1g Tranexamic acid intraoperatively (repeat if necessary) PCC use is controversial but can be considered if bleeding risk is high The evidence for use of Andexanet alfa as a specific reversal agent is also unclear. NICE currently do not recommend its use as a reversal (If last dose > 12 hours and normal renal function there is limited value in a prothrombotic reversal agent)
UFH and LMWH	For UFH stopping the agent may be sufficient Protamine can be used for both UFH and LMWH If last dose UFH > 4hrs nothing further may be required If last dose UFH ⩽ 4 hours then use protamine 1mg per 100u heparin slowly (especially if subcut regimen UFH; IV regimen stopped > 2 hrs may not need protamine) If last dose LMWH ⩾ 12 hours (and CrCl normal) nothing further may be required If last dose LMWH 8-12 hours consider protamine 0.5mg per 100 u heparin slowly If last dose LMWH < 8 hours give protamine 1mg per 100u heparin slowly

Disclaimer

The advice in this guidance is correct at the time of writing. Always consult with the appropriate clinician involved in the prescribing of the ACT / APT to confirm that the agent can be stopped safely for surgery. If the risk of TE events is high, deferring surgery until the drug can be stopped is recommended where this is safe and reasonable to do so. Multidisciplinary discussions will aid safe decision making. This guidance is not meant to be comprehensive nor a tool for management decisions on specific patients.

Reversal in emergency situations should always take place with haematology involvement and guidance.

This guidance does not replace established local policy. It is not intended to be medical advice or a substitute for the medical advice, diagnosis, or treatment of a health care provider based on the health care provider's examination and assessment of a patient's specific and unique circumstances. Patients must speak with a health care provider for complete information about their health, medical questions, and treatment options, including any risks or benefits regarding use of medications. This information does not endorse any treatments or medications as safe, effective, or approved for treating a specific patient.

While the advice and information in this guidance is believed to be true and accurate at the time of going to press, neither the authors, nor BASS accept any legal responsibility for the content of this guidance.

References

1. Zuckerman SL, Berven S, *et al*. Management of Anticoagulation/Antiplatelet Medication and Venous Thromboembolism Prophylaxis in Elective Spine Surgery: Concise Clinical Recommendations Based on a Modified Delphi Process. Spine (Phila Pa 1976). 2023 Mar 1;48(5):301-309. doi: 10.1097/BRS.0000000000004540. Epub 2022 Nov 14. PMID: 36730667.

2. Keeling D, Tait RC, Watson H; British Committee of Standards for Haematology. Peri-operative management of anticoagulation and antiplatelet therapy. Br J Haematol. 2016;175(4):602-613. doi:10.1111/bjh.14344 (also see addendum Saja K; Haemostasis and Thrombosis Taskforce of the British Society for Haematology. Addendum to the guideline on the peri-operative management of anti-coagulation and anti-platelet therapy. Br J Haematol. 2022;197(2):188-189. doi:10.1111/bjh.18114).

3. Polania Gutierrez JJ, Rocuts KR. Perioperative Anticoagulation Management. In: StatPearls. Treasure Island (FL): StatPearls Publishing; January 26, 2022.

4. Uehara M, Ikegami S *et al*. Is Blood Loss Greater in Elderly Patients under Antiplatelet or Anticoagulant Medication for Cervical Spine Injury Surgery? A Japanese Multicenter Survey. Spine Surg Relat Res. 2021 Dec 27;6(4):366-372. doi: 10.22603/ssrr.2021-0183. PMID: 36051672; PMCID: PMC9381072.

5. Porto GBF, Jeffrey Wessell DO, Alvarado A, Arnold PM, Buchholz AL. Anticoagulation and Spine Surgery. Global Spine J. 2020;10(1 Suppl):53S-64S. doi:10.1177/2192568219852051.

6. Prather JC, Montgomery TP, Crowther D, McGwin G, Ghavam C, Theiss SM. Elective spine surgery with continuation of clopidogrel anti-platelet therapy: Experiences from the community. J Clin Orthop Trauma. 2020;11(5):928-931. doi:10.1016/j.jcot.2020.06.007.

7. Ehsanian R, Rosati RM, Kennedy DJ, Schneider BJ. Antiplatelet and Anticoagulant Risk for Select Spine Interventions: A Retrospective Cohort. Pain Med. 2020 May 1;21(5):910-917. doi: 10.1093/pm/pnaa009. PMID: 32361741.

8. Epstein NE. When to stop anticoagulation, anti-platelet aggregates, and non-steroidal anti-inflammatories (NSAIDs) prior to spine surgery. Surg Neurol Int. 2019;10:45. Published 2019 Mar 26. doi:10.25259/SNI-54-2019.

9. Douketis JD, Spyropoulos AC, Duncan J, *et al*. Perioperative Management of Patients With Atrial Fibrillation Receiving a Direct Oral Anticoagulant. JAMA Intern Med. 2019;179(11):1469-1478. doi:10.1001/jamainternmed.2019.2431.

10. Narouze S, Benzon HT, Provenzano D, *et al*. Interventional Spine and Pain Procedures in Patients on Antiplatelet and Anticoagulant Medications (Second Edition): Guidelines From the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American Academy of Pain Medicine, the International Neuromodulation Society, the North American Neuromodulation Society, and the World Institute of Pain. Reg Anesth Pain Med. 2018;43(3):225-262. doi:10.1097/AAP.0000000000000700.

11. Banat M, Wach J, Salemdawod A, *et al*. Antithrombotic Therapy in Spinal Surgery Does Not Impact Patient Safety-A Single Center Cohort Study. Front Surg. 2022;8:791713. Published 2022 Jan 26. doi:10.3389/fsurg.2021.791713.

12. Cheng A, Poon MTC, Demetriades AK. Aspirin therapy discontinuation and intraoperative blood loss in spinal surgery: a systematic review. Neurosurg Rev. 2018;41(4):1029-1036. doi:10.1007/s10143-018-0945-1.

13. Lewis SR, Pritchard MW, Schofield-Robinson OJ, Alderson P, Smith AF. Continuation versus discontinuation of antiplatelet therapy for bleeding and ischaemic events in adults undergoing non-cardiac surgery. Cochrane Database Syst Rev. 2018;7(7):CD012584. Published 2018 Jul 18. doi:10.1002/14651858.CD012584.pub2.

14. Oprea AD, Popescu WM. Perioperative management of antiplatelet therapy. Br J Anaesth. 2013;111 Suppl 1:i3-i17. doi:10.1093/bja/aet402.

15. Peeters SM, Nagasawa D, Gaonkar B, *et al*. Perioperative dual antiplatelet therapy for patients undergoing spine surgery soon after drug eluting stent placement. Surg Neurol Int. 2021;12:302. Published 2021 Jun 28. doi:10.25259/SNI_337_2021.

16. Shin WS, Ahn DK, Lee JS, Yoo IS, Lee HY. The Influence of Antiplatelet Drug Medication on Spine Surgery. Clin Orthop Surg. 2018;10(3):380-384. doi:10.4055/cios.2018.10.3.380.

17. Cheng A, Poon MTC, Demetriades AK. Aspirin therapy discontinuation and intraoperative blood loss in spinal surgery: a systematic review. Neurosurg Rev. 2018;41(4):1029-1036. doi:10.1007/s10143-018-0945-1.

18. Steib A, Hadjiat F, Skibba W, Steib JP; French Spine Surgery Society. Focus on perioperative management of anticoagulants and antiplatelet agents in spine surgery. Orthop Traumatol Surg Res. 2011;97(6 Suppl):S102-S106. doi:10.1016/j.otsr.2011.07.005.

19. Douketis JD, Spyropoulos AC, Kaatz S, *et al*. Perioperative Bridging Anticoagulation in Patients with Atrial Fibrillation. *N Engl J Med.* 2015;373(9):823-833. doi:10.1056/NEJMoa1501035.

20. Bonhomme F, Boehlen F, Clergue F, de Moerloose P. Preoperative hemostatic assessment: a new and simple bleeding questionnaire. Can J Anaesth. 2016 Sep;63(9):1007-15. English. doi: 10.1007/s12630-016-0688-9. ■

BritSpine 2023 Oral Abstracts

Paper Session 1: Best of the Best

Incidence of cardiac anomalies in congenital vertebral deformity: systematic review and meta-analysis of 3088 patients

Gonzalo Mariscal, Paloma Bas, Fernando Bonilla, Miquel Bovea, Pedro Rubio, Silvia Pérez, Jorge Morales, Jose Luis Bas, Teresa Bas
La Fe University and Polytechnic Hospital of Valencia, Valencia, Spain

Introduction
Few studies report on the incidence of cardiac anomalies associated with congenital scoliosis and whether there are risk factors that increase incidence. Awareness of these data could mean an appropriate conversation with patients and families.

Objective
The objective of this meta-analysis was to determine the overall incidence of cardiac anomalies in patients with congenital scoliosis and to describe the potential influencing factors.

Methods
We searched PubMed, EMBASE and Cochrane Library for potentially relevant studies. The following data were extracted from the included studies: bibliometric data, number of patients, number of patients with cardiac anomalies, gender, types of deformity, diagnostic method, type of cardiac anomaly, location and other associated anomalies. Review Manager 5.4 software was employed.

Results
This meta-analysis included 13 articles, and identified that 526 of 3088 patients with congenital vertebral deformity presented cardiac anomalies (22.56% CI 95% 18.63-26.49). Mitral valve prolapse was the most frequent cardiac anomaly (48.45%) in the postnatal group and double outlet right ventricle (27.27%) in the prenatal group. The diagnosis of cardiac anomalies was highest in North America, followed by Europe and China (27.98%, 23.19% and 15.33% respectively). Female sex and formation defects were factors that significantly increased the incidence of cardiac anomalies: (40.76% CI 95% 28.63-52.89) and (57.37% CI 95% 50.48-64.27) respectively. Finally, 27.11% had associated intramedullary anomalies.

Conclusions
This meta-analysis revealed that the overall incidence of cardiac anomalies in patients with congenital vertebral deformity was 22.56%. Female gender and formation defects were increased the incidence of cardiac anomalies.

A systematic review of the certainty of neuropathic pain in medication trials for LBP or sciatica; meta-analysis of efficacy subgrouped by certainty of neuropathic pain

Jennifer Ward ORCID iD[1], Colette Ridehalgh ORCID iD[1], Paula Kersten ORCID iD[2], Annina Schmid ORCID iD[3]
[1] *University of Brighton, Brighton, United Kingdom.*
[2] *Canterbury Christ Church University, Canterbury, United Kingdom.*
[3] *University of Oxford, Oxford, United Kingdom*

Neuropathic pain medications are often prescribed for people with low back pain and sciatica. Their effectiveness remains however controversial. High levels of clinical heterogeneity in pain mechanisms (i.e., nociceptive or neuropathic) might contribute to poor efficacy.

Our purpose was to determine how neuropathic pain is identified in clinical trials of participants taking first line neuropathic pain medication. We also aimed to determine whether subgrouping studies based on the Neuropathic Pain Special Interest Group (NeuPSIG) grading system (possible, probable or definite) influences the efficacy of medications.

This systematic review was registered on Prospero CRD42022342027. Databases were searched from inception to May 2022 for randomised and crossover trials comparing medication to placebo or usual care.

Primary outcome measures were any methods used to identify neuropathic pain as well as short, medium and long term pain and disability scores. Overall meta-analyses and subgroup analyses based on certainty of neuropathic pain were performed using Revman 5.4.1.

2106 studies were identified. 24 studies with 3161 participants were included. 66% of trials either failed to report on or recruited participants unlikely to have neuropathic pain. Subgroup analysis showed small effects across different certainties of neuropathic pain, with high levels of heterogeneity.

There is currently inadequate evidence on the effectiveness of neuropathic pain medication for people with low back pain and/or sciatica as studies have failed to report on neuropathic pain or recruited people unlikely to have it. Future studies should aim to reduce clinical heterogeneity and document the certainty of neuropathic pain in trial participants.

PCRX-201, a novel gene therapy treatment approach for intervertebral disc degeneration

Joseph Snuggs ORCID iD[1], Rebecca Senter[2], Joshua Whitt[2], Christine Le Maitre ORCID iD[1]
[1]*University of Sheffield, Sheffield, United Kingdom.*
[2]*Flexion Therapeutics, Burlington, USA*

Introduction

Low back pain affects 80% of the population during their lifetime, with half of cases attributed to intervertebral disc (IVD) degeneration. However, no treatments target the underlying pathophysiological causes of IVD degeneration. Gene therapy presents novel and exciting possibilities for the treatment diseases, and we hypothesis that by using such an approach we can target the underlying mechanisms of IVD degeneration and modify disease progression. We aimed to determine the efficacy of an investigational gene therapy, PCRX-201, to infect degenerate human IVD cells and tissue, upregulate interleukin-1 receptor antagonist (IL-1Ra) and modify downstream degenerate pathways.

Methods

Human nucleus pulposus (NP) cells were infected with PCRX-201 to determine viability and the production of IL-1Ra. The long-term release profile of IL-1Ra and the effect on matrix and catabolic protein expression was determined in PCRX-201-infected cells. Degenerate human, *ex vivo* NP tissue explants were injected with PCR-X201 to determine virus distribution and downstream effects on protein production.

Results

NP cells remained viable when infected with PCR-X201. A significantly increased IL-1Ra release, compared to controls, in NP cells was observed up to 10w post initial infection. Degenerate NP cells and tissue infected with PCR-X201 showed an increase in the production of healthy matrix proteins and a decrease in catabolic proteins.

Conclusion

At present, no treatments for IVD degeneration target the underlying cellular causes. The ability of PCRX-201 to elicit anti-catabolic responses in degenerate NP cells and tissue is promising and warrants further investigation to determine the efficacy of this promising, novel gene therapy.

Preliminary Results of Biphasic Calcium Phosphate with Submicron Surface Topography as Standalone Alternative to Autograft in Posterolateral Fusion: A Prospective, Multi-center, Randomized, Intra-patient Controlled Trial

Alwyn Jones[1], Lukas van Dijk[2], Diyar Delawi[3], Eric Hoebink[4], Diederik Kempen[5], Job van Susante[6], Moyo Kruyt[7]
[1]*University of Wales, Cardiff, United Kingdom.* [2]*Kuros Biosciences, Bilthoven, Netherlands.* [3]*St. Antonius Hospital, Utrecht, Netherlands.* [4]*Amphia Hospital, Breda, Netherlands.* [5]*OLVG Hospital, Amsterdam, Netherlands.* [6]*Rijnstate Hospital, Arnhem, Netherlands.* [7]*University Medical Center Utrecht, Utrecht, Netherlands*

Introduction

Synthetic calcium phosphate bone grafts with submicron surface topographies have been demonstrated in preclinical studies to be osteoinductive, i.e. the ability to induce de novo bone formation. A multicenter trial was initiated to determine non-inferiority of a biphasic calcium phosphate with submicron needle-shaped surface topography (BCP<µm) as compared to autograft in instrumented posterolateral spinal fusion. For registration purposes, the safety and fusion rates in the first 50 patients was analyzed.

Methods

Adult patients indicated for instrumented posterolateral spinal fusion of one to six levels from T10-S2 were enrolled at five participating centers. One side of the spine was grafted with 10 cc of autograft per level containing a minimum of 50% iliac crest bone. The other side was grafted with 10 cc of BCP<µm granules standalone (without autograft or bone marrow aspirate). Fusion was determined by fine-cut (<1mm) CT after 1 year of follow-up by two spine surgeons blinded for the allocation. Clinical outcomes were assessed by Oswestry Disability Index (ODI) score.

Results

The fusion rate for BCP<µm was 76.1% (54/71 levels), which compared favorably to the fusion rate of 43.7% for autograft (31/71 levels). ODI score decreased from a mean of 46.0 (±15.0) to a mean of 31.7 (±16.9), and 52.4% of patients improved with at least 15-point decrease.

Discussion

These preliminary data, aiming to determine non-inferiority of standalone BCP<µm as compared to autograft for posterior spinal fusions, are promising. Ongoing studies to increase the power of the statistics with more patients is forthcoming.

The Glasgow Vertebral Artery Anatomical Study

Mohamed Abdelsadg[1], Eva Wardlow[2], Tasnim Al-sinani[2], Samih Hassan[1], Wazim Izzath[1], Mustafa Elsheikh[1], Christopher Barrett[1], Calan Mathieson[1], Anthony Amato-Watkins[1], Likhith Alakandy[1]
[1]Institute of Neurosciences- Glasgow, Glasgow, United Kingdom. [2]University of Glasgow, Glasgow, United Kingdom

Objectives
To identify and quantify variation in the vertebral artery (VA) course (V1-V3) in the Scottish population.

Design
Review of CT Angiograms from carotid arch to vertex performed in NHS Greater Glasgow and Clyde Health board during 11 months period.

Subjects
Over 3000 patients included, 6000 individual vertebral artery course reviewed.

Methods
Data collected from CT-Angiograms (CTA) retrieved from the centre for national medical imaging archive (Regional PACS office).

These CTAs ordered chronologically and the first 3000 patients included, minimising selection bias.

The data points were collected and python computer program used for analysis.

Data points per VA: Origin, level of entrance to cervical spine Transverse Foramen (TF), aberrant V2 course into the disc, relation of the VA to the C2 lateral mass, C1/2 joint, whether the VA courses above or below the posterior arch, passage of the VA through the C1 TF, dominance, fenestration, duplication.

Results
The study revealed the origin of the VA in Scottish population shows minimal variation.

The commonest level for VA to enter TF was C6 followed by C5.

The study identified a unique triad of V3 anomalous course ''The Glasgow triad'' which is of importance in planning C1/2 instrumentation.

The rates for duplication and fenestration of the VA are extremely low in the study population.

Conclusions
This is the largest vertebral artery study in the literature.

It identified a unique association of anomalous V3 course at the craniocervical junction.

The study results can aid informing clinical practice.

Taking action to mitigate vulnerability: a qualitative study of why people attend the emergency department for low back pain

Clare Ryan ORCID iD[1], Lisa Roberts[2], Catherine Pope[3]
[1]Musculoskeletal Service, Solent NHS Trust, Portsmouth, United Kingdom. [2]Faculty of Health Sciences, University of Southampton, Southampton, United Kingdom. [3]Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, United Kingdom

Background
Each month in the UK around 50,000 people attend the emergency department (ED) for low back pain. This is in tension with clinical guidelines that suggest back pain should, for most, be managed in primary care, and UK health policy that prioritises reducing ED attendances. To enable healthcare provision to be informed by patients' priorities and experiences, this study aimed to explore why people attend the ED for low back pain.

Method
Participants were recruited from four NHS EDs and included 47 people (21 female; aged 23-79 years) who in the past six weeks, had attended the ED for low back pain (all types and durations). We collected data using individual semi-structured telephone interviews (median 45mins). Interviews were audio-recorded, transcribed verbatim, and analysed thematically.

Findings
The overarching explanation was 'mitigating perceived vulnerability'. Low back pain presented a threat to peoples' ability to cope and function and resulted in concern about cause and consequences. People sought urgent help, but issues arose with access to and confidence in primary care and this exacerbated perceived vulnerability. The ED offered the potential to mitigate vulnerability and, for many, was recommended by a healthcare professional. Whilst participants understood the ED's emergency remit, mitigating vulnerability was understood to be a right and responsibility and regaining health capital was their priority.

Implications
Our findings suggest the need to consider how perceived vulnerability might be addressed in urgent and primary care and, as health inequalities likely intersection with perceived vulnerability, how health equity might be fostered.

Associations between Osteoarthritis, back pain and sagittal spine shape in the UK Biobank

Fiona Saunders ORCID iD[1], Jon Parkinson[2], Richard Aspden ORCID iD[1], Jenny Gregory ORCID iD[1], Paul Bromiley ORCID iD[2]
[1]*University of Aberdeen, Aberdeen, United Kingdom.*
[2]*The University of Manchester, Manchester, United Kingdom*

Statistical Shape Modelling (SSM) can quantify variation in spine shape, including vertebral-structure and whole-spine curvature, across a cohort in a single model described by a series of "modes of variation". We used DXA images from the UKBiobank to explore links between spine shape, back pain and osteoarthritis (OA).

A 341-point SSM, describing the vertebral body shapes from T7 to the top of L5, was applied to iDXA scans from the UK Biobank imaging enhancement study. Associations between OA (self-reported) and back pain (greater than 3 months) and the first 10 modes of variation were examined using adjusted binary logistic regression (adjusted for age, sex, height, weight, and total spine BMD). We report odds ratios (OR) with 95% confidence intervals (CI) for each standard deviation change in mode.

Complete data were available for 4784 participants (52.1% women). Mean age was 62.2 (±7.5) years. 537 participants self-reported osteoarthritis (not site specific) and 630 participants reported back pain for 3 months or more. The first ten modes of variation accounted for 88.9% of the total model variation. Three modes were associated with OA (modes 3, 9, 10), and 1 mode was associated with back pain (mode 3). Mode 3 (6.5% total variation), describing vertebral height, was negatively associated in both OA [OR 0.88 95% CI 0.80-0.97 p=0.007] and back pain [OR 0.81 95%CI 0.81-.70-0.94, p=0.005].

We have shown that reduced vertebral height was associated with increased reports of both osteoarthritis and back pain of greater than 3 months.

Surgical management of cerebrospinal fluid-venous fistula: UK's first and largest case series

David Rowland[1], Dwij Mehta[2], Sanjay Cheema[2], Indran Davagnanam[3], Ayman Qureshi[3], Salwa Kamourieh[2], Manjit Matharu[2], Parag Sayal[1]
[1]*Department of Neurosurgery, National Hospital for Neurology and Neurosurgery, London, United Kingdom.*
[2]*UCL Queen Square Institute of Neurology, London, United Kingdom.*
[3]*Department of Neuroradiology, National Hospital for Neurology and Neurosurgery, London, United Kingdom*

Cerebrospinal fluid-venous fistula (CVF) is an extremely under recognised pathology, particularly in the UK. Most neurologists, neurosurgeons and spinal surgeons are not aware of this diagnosis. It was first described in the literature in 2014. The increased recognition is primarily due to improvement in myelography techniques. Treatment includes blood/fibrin patching, endovascular and surgical techniques.

We describe the first and largest UK series of surgical treatment of CVF and our MDT approach for diagnosis and subsequent endovascular or surgical treatment. Conventional surgical techniques involved a midline approach with a laminectomy and potential post-operative spinal cord complications. We describe a paraspinal, extrafacetal approach to directly approach the nerve root and CVF.

Clinical and radiographic information were collected including symptoms, surgical technique and radiographic imaging with calculation of Bern score. 10 patients, diagnosed through a specialist headache MDT, underwent surgical management of CVF over an 18-month period. The most common presenting symptom was orthostatic headache. All patients underwent decubitus CT myelogram for identification and confirmation of location of CVF. All CVF were located in the thoracic spine. We describe (with intra-operative imaging and videos) the development of a paraspinal, extrafacetal surgical approach to disconnect the CVF. Disconnection was achieved with a combination of CVF ligation, nerve root ligation and perineural cyst reconstruction. All patients with follow up have shown clinical and radiographic improvement, with reduction in Bern score on post-operative MRI scans. There were no surgical complications. Here we have described the development of a successful pathway for surgical treatment of CVF.

Paper Session 2: Innovation & technology

Implant Free Double Door Cervical Laminoplasty with clinical and radiological outcomes at a minimum 3-year follow-up.

Aashish Ghodke, Birender Balain
Robert Jones, Agnes Hunt Orthopaedic Hospital, Oswestry, United Kingdom

Introduction
The implant-free technique includes splitting the spinous process in the midline with a burr, preserving muscle attachments at C2 & C7, using of iliac crest graft as a spacer & a rigorous postoperative neck ROM exercise regimen. Laminoplasty as described in our study showed similar neurological improvement to other studies but preserving

the muscle attachments at C2 and C7 and early postoperative mobilization showed better stability & better-preserved ROM in comparison to earlier studies.

Methods
44 patients with cervical myelopathy with a minimum FU of 3 years. PROMs, radiological & clinical parameters and complications were evaluated.

Results
Mean mJOA score improved from 11.1 to 13.4 with a recovery rate of 34%. Nurick grade enhanced from 3.9 to 2.7 and NDI improved by 15%. The mean C2-C7 lordosis angle changed from 18.5° to 12.0° only, 3 patients having loss of lordosis of 20 degrees or more, two clinically doing well & 1 patient needing ACDF for worsening myelopathy, C3/4 instability and pain. 1 patient had neck pain and stiffness. 4 patients had a C5-palsy, two improved to Grade 5 and two to Grade 4. A total of 296 hinges were created, with 90.5% fully united. 20 (6.8%) were ununited but un-displaced. 2.7% of hinges were displaced with no clinical concerns.

Conclusion
This technique provides excellent clinical and radiological outcomes, and is a safe and inexpensive way to achieve a good result & a good functional ROM.

Using Mesendoderm Progenitor Cells Seeded in Biomaterial to Regenerate the Intervertebral disc

Rebecca Williams[1], Georgina Targa[2], Julie Warin[3], Ronak Janani[4], Anne Camus[3], Marianna Tryfonidou[5], Chris Sammon[4], Joseph Snuggs[1], Christine Le Maitre[1]
[1]University of Sheffield, Sheffield, United Kingdom. [2]University of Galway, Galway, Ireland. [3]University of Nantes, Nantes, France. [4]Sheffield Hallam University, Sheffield, United Kingdom. [5]Utrecht University, Utrecht, Netherlands

Introduction
It has been proposed that cells therapy can be utilized for mediating disc regeneration, as they have the potential to additionally restore disc biomechanics through matrix synthesis. This study investigates using generated Mesendoderm progenitor cells (MEPCs) from induced pluripotent stem cells (IPSC; IPS-MEPCs), as a cellular treatment for the disc regeneration. IPS-MEPCs are seeded into a biomaterial system and assessed for characteristic and behavioural changes during culture over a four-week period.

Methods
After differentiating IPSC into MEPCs through monolayer culture, the IPS-MEPCs were seeded into NPgel (a L-pNIPAM-co-DMAc hydrogel), then cultured for upto 4 weeks under disc physiological conditions. The constructs were fixed and stained with histological stains: H+E, Alcian blue and Masson trichrome. Immunohistochemical staining was further used to analyse the MEPCs viability (caspase 3, Ki67), MEPCs marker (FoxA2), endoderm marker (Sox17) and Notochordal cell (NC) phenotypic markers (Brachyury and cytokeratin) and extracellular matrix (collagen type II and aggrecan).

Results
iPS-MEPCs were visible within NPgel at all time points, however, they were mainly present as single cells. At 4-week time point IPS-MEPCs was observed positive for caspase3, Ki67, Brachyury, Cytokeratin and Sox9. Extracellular matrix staining was observed in the Alcian blue and collagen type II staining.

Conclusion
iPS-MEPCs cultured within NPgel did not express the early MEPC marker FOXA2 but did express a number of NC markers and matrix proteins during 4 weeks of culture. The IPS-MEPCs and NPgel constructs hold potential for continued development and could be further applied into injectable treatments for disc degeneration.

Early NHS Experience of a Novel Robotic Assisted Navigation Platform in Spinal Surgery

Zacharia Silk ORCID iD, Daniel Wright, Nicolas Beresford-Cleary, Chrishan Thakar, Nikolaos Pyrovolou, Roy Chaudhary, Sean Grannum, Jeremy Reynolds, Colin Nnadi
Oxford University Hospitals NHS Foundation Trust, Oxford, United Kingdom

Introduction
In the next decade, Robotic-Assisted Navigation (RAN) is expected to play a larger role in spinal surgery due to growing evidence of its benefits, including improved accuracy, shorter operative-time and reduced cognitive-load. This retrospective study provides insights into the first experience of a novel RAN platform in a National Health Service setting.

Methods
A service evaluation was conducted on the first 172 robotic-assisted screws. Data from the software was analyzed to determine the number of screws placed with / without RAN and compared to electronic medical and PACS records. The primary outcome was the rate of successful conversion from planned-to-delivered screw. Secondary outcomes included the rate of unplanned conversion to freehand, rate of screw misplacement, and impact of user experience with image-guided (IG) surgery.

Results
RAN was used in 16 deformity (13 pediatric, 2 adult) and 3 degenerative (2 lumbar, 1 cervicothoracic) cases. The median age was 16.2 years (9.8 – 72). A total of 269 screws were placed: 172 (63.9%) with RAN, 31 (24.5%) freehand-planned,

and 66 (11.5%) freehand-unplanned. Of 211 screws planned with RAN, the rate of planned-to-delivered screw insertion was 81.5% (172/211), with variations based on user experience with IG surgery (70.1% for none or limited experience, 88.8% for extensive experience).

Two screws (1.16%) of the 172 placed with RAN were mispositioned due to navigation error.

Conclusion
This study provides real-world evidence of RAN adoption in adult and pediatric spinal surgery. The findings suggest that prior experience with IG surgery significantly reduces the rate of unplanned freehand conversion.

Assessing the Reproducibility of the PCr Recovery Time Constant at 3T when Examining Spinal Muscle Function

Salman Alharthi, Jonathan Fulford, Judith Meakin
Exeter, Exeter, United Kingdom

Background
Spinal muscles are important in controlling balance, movement, and stability. A method for assessing muscle function is provided by 31P-MRS which is non-invasive and safe and can provide a measure of oxidative capacity.

Objective
To examined changes in PCr concentration in the spinal muscles following exercise bouts and determine the PCr recovery time constant as an index of oxidative capacity.

Methods
Magnetic resonance phosphorus spectroscopy was performed during and after exercise on twelve healthy participants (10 males and 2 females). The exercise was similar to the Biering-Sorensen test and was performed within the bore of a 3T scanner (Siemens, Prisma) using a 31P/H coil (RAPID Biomedical GmbH) with a spectra acquired every 6s. The PCr recovery time constant was determined by fitting a single exponential to the PCr signal intensities post exercise.

Results
The PCr recovery time constant had an average group value for the first visit of 27.27s and for the second visit of 28.82s. It revealed a high reliability with an ICC of 0.882 for average measurements and 0.789 for single measures. The Bland Altman plot for the PCr recovery time constant showed a high level of agreement, with mean differences of -1.55 s and 95 % confidence intervals of 10.5 and -13.6s.

Conclusions
Overall, the study suggests that the PCr recovery time constant obtained from MRS exercise protocols is reliable and sensitive enough to detect potential changes in muscle function that may arise following an exercise intervention training program specifically tailored to the spinal muscles.

Transforaminal Endoscopic Surgery for Symptomatic Lumbar Disc Herniation: Durotomy, Recurrence and Reoperation - Is It Superior To A Tubular Approach?

João Luís Silva ORCID iD, Hugo Ribeiro, José Miguel Sousa
Orthopedic Surgery, Centro Hospitalar de Lisboa Ocidental, Lisbon, Portugal

Transforaminal endoscopic discectomy (TED) and tubular microdiscectomy (TMID) are both minimally invasive procedures. Controversy around their effectiveness and clinical outcomes still remain a hot topic in literature. Our purpose was to compare durotomy ocurrence, recurrence of symptoms, reintervention rate and the clinical outcomes between transforaminal endoscopic lumbar discectomy versus tubular lumbar microdiscectomy for symptomatic lumbar disc herniation treatment.

Our methods were to retrospectively analyze 49 patients who were treated surgically for lumbar disk herniation between November 2015 and March 2020 (TED, 23 cases; TMID, 26 cases) by the Spine Unit of our departement. All patients had a minimum follow up of 12 months.

The mean age was 49.3 ±15 years old (19–75) and mean follow up time was 26.9 ±14.3 (12–60) months. We had 6 durotomies in TMID, and one in TED, all of them contained. There were 2 cases of recurrence in TMID, none in TED. And yet no reinterventions in TMID but 2 reinterventions in TED group. The mean improvement of VAS leg was 7.8 ±2.4 for TED and 8.4 ± 1.1 for TMID (p= 0.284). The mean improvement of VAS back was 6.5 ± 2.3 for TED and 6.7 ± 2.2 for TMID (p=0.851). The mean improvement in ODI scores was 37.3 ± 8.7 for TED and 39.6 ± 7 for TMID (p=0.262).

To conclude, durotomy and recurrence happend more often in TMID, altough the need of reintervention happends more on TED. There is no significant difference between both groups on clinical outcomes. Our sample size is small.

Does chemical shift Magnetic Resonance Imaging (MRI) improve visualization of pars interarticularis defect

Emily Smith[1], Neha Nischal[2], Jennifer Murphy[2], Christine Azzopardi[2], Jwalant Mehta[2], Shahnawaz Haleem ORCID iD[2], Karthikeyan Iyengar[3], Rajesh Botchu[2]
[1]Russell Hall Hospital, Birmingham, United Kingdom.
[2]Royal Orthopaedic Hospital, Birmingham, United Kingdom.
[3]Southport and Ormskirk Hospital, Southport, United Kingdom

Introduction
A unilateral/bilateral fracture of pars interarticularis (Spondylolysis) is a frequent cause of axial back pain in active young and middle aged persons. Identification by suitable imaging (MRI gold standard) is the first step in management. The aim of this study was to compare the accuracy of chemical shift sequence (MRI) technique to conventional MRI sequences in the detection of pars defects.

Patients and Methods
Conventional T1, T2- and STIR sagittal, axial as well as 'in' and 'out' phase chemical shift sagittal MRI sequences of 70 consecutive patients referred for low back pain were reviewed. Demographic details, clinical indication and presence/diagnosis of pars defects using a 5- point Likert Scale on both conventional and chemical shift MRI Sequences. Spearman correlation was used for statistical analysis. Intraclass correlation coefficient (ICC) was evaluated to assess the intraclass reliability between observers. Data was analysed using DATAtab software (2022).

Results
70 patients (average age - 54.3) years with a female predominance were included. There were 11 pars defects in the cohort. Both in and out phase of chemical shift imaging were able to identify pars defect and intact pars. However, out phase was relatively better in delineating pars defects whilst the 'in' phase was superior in identifying an intact pars though this was not statistically significant. There was good intra and interobserver reliability.

Conclusion
Chemical shift MRI sequence is a quicker, complementary technique to assess and analyse pars interarticularis confidently than conventionally utilized MRI sequences in patients being evaluated for axial back pain.

Paper Session 3: Spinal Degenerative

The Hitchhiker's Guide to Spine Awake Surgery. The Oxford SAS protocol and early outcomes

Murtuza Sikander, Helen Hann, Paolo Rizzo
John Radcliffe Hospital, Oxford University Hospitals NHS Foundation Trusts, Oxford, United Kingdom

Spine awake surgery is a new and novel way of operating on with lumbar spine conditions. This technique utilises regional anaesthetic methods which have been proven to improve patient outcomes in other surgical procedures. This is especially relevant within the elderly population and in those with co morbidities.

The surgical and anaesthetic community internationally performing this technique is very small but growing at a rapid rate. The technique has been proven to be safe and effective in a number of small series. The understandable hesitancy to adopt this technique among the surgical community is due to the novelty and lack of published protocols.

Our narrative provides a roadmap to setting up a whole service around spine awake surgery and outlines basic protocols , technical notes and novel ways to engage and train the medical and allied health teams to achieve the best outcomes.

Our paper describes a change in the paradigm of spine surgery. It is a narrative designed to guide teams who wish to take up this technique and describes technical aspects, human factors, change management and team training approaches.

Our early experience using the Oxford SAS protocol reinforce our drive to push forward and expand on this process. It aligns with the international literature which highlights this approach as safe, efficient, and economical.

The influence of subcutaneous fat thickness on outcomes following lumbar spine surgery

Aaron Robertson[1], Mohamed Draz[2], Omar Kouli[2], Likhith Alakandy[2]
[1]University of Glasgow, Glasgow, United Kingdom.
[2]NHS Greater Glasgow and Clyde, Glasgow, United Kingdom

Introduction
The effects of increasing body mass index (BMI) on outcomes following surgery are well documented. Subcutaneous fat

thickness (SFT) at the surgical site, however, is less studied as a predictor of outcomes. A small number of studies have described a potential role for SFT measurement as a predictor of outcomes following lumbar spine surgery. This study aimed to assess the relationship between SFT and outcomes, namely surgical site infection (SSI) and need for reoperation, following lumbar spine surgery.

Methods
This was a retrospective study of 195 patients who had undergone lumbar spine surgery in a single Scottish Health Board. Patients' BMIs and SFT at the surgical site were measured using electronic health records and pre-operative MR imaging respectively. Outcomes were recorded, including SSI requiring antibiotic therapy, SSI requiring reoperation, and same-level redo of operation. Comorbidities including smoking, diabetes, and ASA were also recorded.

Results
SFT was not a predictor of any measured outcomes. BMI was found to be a predictor of SSI requiring reoperation on univariate analysis but not on multivariate analysis. BMI was also found to be a predictor of SSI requiring antibiotic therapy on both univariate and multivariate analysis. Neither BMI or SFT were found to be predictors of all-cause redo operation (excluding for infection), however multilevel lumbar spine surgery was a predictor on both univariate and multivariate analysis.

Conclusion
SFT does not appear to be an accurate predictor of either SSI or requiring a redo operation. BMI appears to be a reasonable predictor of SSI.

Minimally invasive rib-sparing transthoracic(MIRST) approach for giant calcified thoracic disc herniations(GCTD). A single centre's experience and review of the literature

Mikhail De Santos ORCID iD, Priyank Sinha, Jake Timothy, Debasish Pal
Leeds Teaching Hospitals Trust, Leeds, United Kingdom

Introduction
Giant calcified thoracic disc herniations (GCTD) represent a highly challenging pathology in neurosurgery. It is defined as a calcified disc herniation occupying >40% of the thoracic canal. Several techniques have been described all with various degrees of success.

Aim
It is the aim of this study to define our experience in treating GCTDs along with our MIRST approach and their outcomes.

Method
A 7-year retrospective review(2015-2022) of all thoracic disc operations performed at our tertiary institution. 14 of the 24 patients were found to have GCTDs. Demographics, clinicopathological presentation, intraoperative data, details of our technique along with outcomes at 3 months and 1 year are presented.

Results
Between 2015 and 2022, 14 patients with GCTDs were treated using the MIRST approach. The mean age was 54 with a female predominance. Clinically, all patients had progressive thoracic myelopathy, with the majority presenting between 3 weeks to 1 year. 42% were located in the mid-thoracic region(T6/7-T8/9) without other associated radiological features. All GCTDs were centrally based. Preoperative mean mJOA scores were 6.25 and improved to 7.7 and 8.3 at 3 months and 1 year postoperatively respectively.

Conclusion
GCTDs are incredibly complex to manage. Their predominately central anatomical location makes the anterior approach ideal enabling minimal retraction of the spinal cord in most cases. Here we presented our institutional experience along with our minimally invasive technique that has been adopted and reproduced by other spinal surgeons.

Does plate fixation prevent cage subsidence when using 3D-printed Tritanium cages for anterior cervical discectomy and fusion (ACDF)?

Simon B Roberts[1], Mohammed Madi[2], Muhammed Iqbal[3], George Richardson[3], Peter R Loughenbury[1], Vishal H Borse[1], Gregorz Rudol[1], Nigel W Gummerson[1], Alistair Irwin[3]
[1]Leeds Teaching Hospitals NHS Trust, Leeds, United Kingdom.
[2]Leeds Teaching Hospitals NHS Trust, Leeds, United Kingdom.
[3]The Newcastle Upon Tyne Hospitals NHS Foundation Trust, Newcastle Upon Tyne, United Kingdom

Background
Interbody cage subsidence following anterior cervical discectomy and fusion (ACDF) surgery is associated with increased pain, segmental kyphosis, accelerated adjacent segment disease, and decreased rates of fusion. This study investigated the incidence of cage subsidence following the use of cages using Tritanium technology as cage-only (CO; Tri®C, Stryker) or cage-plate (CP; Tri®C-Aviator, Stryker) constructs in patients undergoing ACDF.

Methods
This multicentre retrospective study reviewed all patients undergoing ACDF for cervical myelopathy or radiculopathy over two-year periods at Royal Victoria Infirmary Newcastle and Leeds General Infirmary. Patients were divided into two groups

by ACDF construct: CO and CP groups. Outcomes measures compared between groups included postoperative subsidence and fusion rates, and surgical complications. Cage subsidence was calculated as the decrease in intervertebral height.

Results
62 patients (mean age 56.5 years SD:11.1) were included (94 ACDFs); 37 patients underwent single-level ACDF and 25 patients underwent multilevel ACDF. Mean radiological follow-up was 7.9 months (SD:5.7). Cage subsidence rate was greater in CO group compared to CP group (CO 54% (n=7/13);95% CI:29-77%), CP 19%; χ^2 p=0.01). There was no significant difference in fusion rates between CO and CP groups. One patient underwent revision surgery for cage subsidence. Age, indication for surgery, number of levels treated, cage size, cage lordosis, and progression to fusion were not significantly associated with cage subsidence.

Conclusion
Incidence of subsidence was greater when Tritanium cages were used for ACDF surgery as cage-only, compared to cage-plate, constructs. Correlation of these results with patient-reported outcomes would be valuable.

Degenerative Spondylolisthesis: Comparison of Posterolateral and Interbody Fusion Techniques: Systematic review and meta-analysis

Arash Aframian ORCID iD, Saima Waseem, Ramsey Chammaa, Rohit Shetty, Nitin Shetty
Whittington Health NHS Trust, London, United Kingdom

Background
Degenerative spondylolisthesis remains one of the most common indications for which lumbar fusion is performed and both Posterolateral fusion and Interbody Fusion have been reported as surgical techniques that result in successful fusion and improved clinical outcomes over non-instrumented fusion techniques. There has been a discordance however about superiority between the different instrumented fusion techniques and so a systematic review and meta-analysis was performed to address this paucity of information.

Method
This study is a meta-analysis assessing the clinical and radiological outcomes of degenerative lumbar spondylolisthesis treated with either a posterolateral fusion (PLF) versus interbody fusion (IBF), including posterior (PLIF), anterior (ALIF), transforaminal (TLIF), extreme lateral (XLIF) or oblique interbody fusion (OLIF). A systematic review of PubMed, Cochrane, and Embase was performed from inception to current date (January 2023). Clinical, patient reported and radiological outcomes were assessed.

Results
This is the largest review with over 1000 patients in the meta-analysis. Specific analysis was performed with special consideration towards differences in patient reported outcomes and radiological measures. Allowances were made for heterogeneity of studies.

Conclusion
Instrumented fusion has been shown to have superior outcomes in terms of fusion rates and interbody fusion may be well suited to a subgroup of patients, particularly those with discal instability but appears to be associated with increased levels of adjacent segment disease. Due to the nature of some cohort studies there is bias in currently published data and this systematic review addresses this.

Comparison of intra-operative radiation risk in posterolateral lumbar fusions with and without a lumbar interbody fusion

Luke Simpson[1], Yasoob Syed[1], Almas Khan[2], Nigel Gummerson[2], Peter Loughenbury[2]
[1]University of Leeds, Leeds, United Kingdom. [2]Leeds General Infirmary, Leeds, United Kingdom

Introduction
Instrumented fusion in the lumbar spine can be achieved with or without an interbody fusion cage. One factor that must be considered when deciding on whether to use an interbody fusion device is the risk associated with ionising radiation. This study aims to investigate whether there is an increased risk of ionising radiation exposure to the patient when an interbody cage is used.

Methods
Retrospective single surgeon series considering estimated absorbed dose during surgery recorded on the Computerised Radiology Information System (CRIS®). Estimated absorbed dose of radiation (milligrays (mGy)) was recorded in adult patients undergoing posterolateral lumbar fusion with and without an interbody fusion cage from February 2017 to March 2021. Equivalent dose (millisieverts (mSv)) and additional cancer risk was calculated from the National Research Council data (2006).

Results
73 patients (median age 61.0 years [IQR=53.5-67.5], 50.7% males). 52 underwent posterolateral fusion (PLF) without interbody device and 21 had a lumbar interbody fusion (LIF) using an interbody cage. Mean intraoperative radiation dose was 152.38mGy (IQR 39.3- 349.7) for PLF and 347.96mGy (IQR 68.7 – 747.4) for LIF. Patients undergoing LIF were exposed to significantly higher levels of radiation intraoperatively (U=353; p=0.019).

Conclusion
In this series addition of an interbody fusion cage was associated with an increased risk of ionising radiation. This should be considered when choosing fusion strategy. Further investigation is required in order to investigate and quantify the additional risk involved.

Clinical and cost-effectiveness of lumbar fusion compared to best conservative care for patients with persistent, severe low back pain: FusiOn veRsus bEst coNServatIve Care (FORENSIC-UK)

Sashin Ahuja ORCID iD[1], Loretta Davies[2], Ashley Cole[3], Steven Blackburn[4], James Greenwood[5], Almas Khan[6], Jenny Donovan[7], Julia Wade[7], Cathy Price[8], Adrian Gardner[9], Naffis Anjarwalla[10], Sue Jowett[11], Michael Reddington[3], Ines Rombach[12], Stephen Tatton[13], Nadine Foster[14], David Beard[2]
[1]University Hospital of Wales, Cardiff, United Kingdom. [2]University of Oxford, NDORMS, Oxford, United Kingdom. [3]Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, United Kingdom. [4]Keele University, Keele, United Kingdom. [5]University College London Hospitals NHS Foundation Trust, London, United Kingdom. [6]Leeds General Infirmary, Leeds, United Kingdom. [7]University of Bristol, Bristol, United Kingdom. [8]Solent NHS Trust, Southampton, United Kingdom. [9]The Royal Orthopaedic Hospital NHS Foundation Trust, Birmingham, United Kingdom. [10]Frimley Health NHS Foundation Trust, Surrey, United Kingdom. [11]University of Birmingham, Birmingham, United Kingdom. [12]University of Sheffield, Sheffield, United Kingdom. [13]Patient Representative, Keele, United Kingdom. [14]The University of Queensland and Metro North Health, Brisbane, Australia

Introduction
Uncertainty exists over the effectiveness of lumbar fusion surgery leading to the National Institute for Health & Care Excellence stating that it should only be used in a randomised controlled trial (RCT). However, there is a concern that in specific situations spinal fusion may still be useful.

Study Objectives
Test superiority and cost-effectiveness of lumbar fusion surgery versus continued best conservative care in patients with severe persistent low back pain (LBP) due to lumbar degenerative disease.

Design
Multicentre, 2 parallel arm (surgery versus best conservative care), superiority RCT. 270 patients (135 per arm) between 18-65 years of age with persistent (duration ⩾6 months), severe LBP with recent imaging evidence of lumbar degenerative disease will be identified and recruited. All participants will have undergone core conservative therapies as per national guidance. Oswestry Disability Index at 24 month follow-up will be the primary outcome measure. Secondary measures include LBP intensity Numerical Rating Scale, global rating of change, quality of life (EQ-5D-5L), depression (PHQ9), anxiety (GAD7), fear avoidance beliefs (TSK), self-efficacy beliefs (PSEQ), days-off-work, treatment and outcome satisfaction, adverse events, healthcare use (NHS and non-NHS) including surgery, conservative care, concurrent treatments (including analgesia).

Results
This presentation will outline the trial protocol, rationale for eligibility criteria, interventions, outcomes and other key study elements.

Conclusions
FORENSIC UK and Australia will provide world-leading evidence to reduce the uncertainty about lumbar fusion surgery. The research team hope to promote active engagement of the spinal research and clinical community in this NIHR-NHMRC collaborative trial, to shape best evidence.

Paper Session 4: Spinal Degenerative: Lumbar

Does MRI morphology correlate with pre-operative neurological status in operatively treated LCS?

Akash Mane ORCID iD, Mandar Borde, Sangram Rajale, K.Venugopal Menon
Bharati Hospital and medical college, Pune, India

Introduction
It is well established that in Lumbar Canal Stenosis (LCS) radiological measures do not correlate with clinical severity of the syndrome. There is paucity of literature whether sensory-motor deficits, bladder/bowel dysfunction correlate with radiological grades of spinal stenosis. The aim of the study is to determine whether objective neurological deficits in LCS correlate with 4 of the commonly used radiological grading systems.

Material and Methods
It was a retrospective observation study, comprising of 100 consecutive cases of operated lumbar canal stenosis in a University teaching hospital. Clinical grading and neurological assessment was done by the Zurich Claudication Score and the MRC grading respectively. Four radiological scores based on axial MR images were studied for each patient- Schiza's, Lee's, Miskin's and Menon's. Statistical analysis was performed by SPSS Version 25.

Results
All 100 patients were scored as moderate or severe grade of LCS based on the Zurich claudication score. The Schiza score had a P value of 0.029 for motor deficit and 0.034 for sensory deficit; the Lee system had a P value of 0.258 for motor deficit and 0.615 for sensory deficit respectively; the Miskin & Mendel schema had values of 0.012 and 0.113 and the Menon's score had 0.1368 and 0.668 suggesting that none of these correlations were statistically significant.

Conclusion
Though various radiological schema for grading of LCS have been validated, none seem to correlate with clinically significant sensory, motor, bladder or bowel dysfunction in this cohort of operated LCS patients.

Uniportal, Full Endoscopic, Facet Joint Preserving, Selective Superior Articular Process (SAP) Resection Foraminotomy (FP-SSAP Foraminotomy) for Degenerative Foraminal Stenosis

Nitin Adsul[1], Hyeun-Sung Kim[2], Harshavardhan Raorane[2], Wu Pang Hung[2], Giovanni Glasso[2], Myung Hoon Kim[2], Jun Hyung Lee[2], Il-Tae Jang[2]
[1]Leeds General Infirmary, Leeds, United Kingdom.
[2]Gangnam Nanoori Hospital, Gangnam, Korea, Republic of

Purpose
Degenerative foraminal stenosis is often associated with lateral wedging instability, so it was difficult to obtain good results with only decompression procedures. In particular, it is estimated that better clinical results can be obtained if sufficient decompression can be performed without excessively damaging the facet joint. In this study, a good result was obtained by using a full endoscopic, selective SAP resection procedure for the purpose of a procedure that can adequately perform foraminal decompression.

Methods
The subjects of this study were patients who underwent Selective Superior Articular Process (SAP) Resection Foraminotomy due to foraminal stenosis, followed up for more than 6 months, and completed all radiologic studies. Clinical parameters of VAS and Oswestry disability index were measured. Radiological parameters of X-ray measurement of preoperative, postoperative, and final follow-up lateral wedging, disc height, and lumbar lordosis. CT measurement of preoperative, postoperative, and final follow-up foraminal volume and facet joint length.

Results
20 levels of FP-SSAP Foraminotomy, 19 patients were included. There was a statistically-significant improvement in VAS, ODI and MacNab's criteria. On the CT result, foraminal width improved significantly. Facet joint also preserved sufficiently in Length. On the X-ray result, lateral wedging and disc height did not worsen significantly. But lumbar lordosis neutral and extension improved significantly after the final follow-up.

Conclusion
Uniportal, Full-Endoscopic, Facet-Joint-Preserving, SAP Resection Foraminotomy for Degenerative Foraminal Stenosis can obtain good clinical results. This is believed to be helpful in the treatment of spinal diseases in elderly patients with rapidly increasing foraminal stenosis.

Understanding the behaviour of Notochordal cells in healthy and degenerated disc environment and their anti-catabolic properties on degenerated Nucleus pulposus cells

Shaghayegh Basatvat[1], Exarchos Kanelis[2], Joseph Snuggs[1], Rebecca Williams[1], Marianna Tryfonidou[3], Markus Templin[4], Leonidas Alexopoulos[2], Christine Le Maitre[1]
[1]University of Sheffield, Sheffield, United Kingdom.
[2]National Technical University of Athens, Athens, Greece.
[3]Utrecht University, Utrecht, Netherlands. *[4]NMI, Reutlingen, Germany*

Introduction
Low back pain associated with intervertebral disc (IVD) degeneration is a socioeconomic problem. We developed media which more closely mimics the low glucose, pH and OSM seen in the disc niche to investigate the behaviour of porcine notochordal cells (pNC) with degenerated human NP cells to further understand pNC anti-catabolic effect on degeneration process.

Methods
Human NP cells isolated from patients undergoing microdiscectomy surgery and pNCs, isolated from porcine spine encapsulated in 1.2% alginate beads were cultured in Standard (400 mOsm/kg), healthy 450 mOsm/Kg, pH:7.1) and degenerated (350 mOsm/kg, pH:6.8) media ± 100pg/ml IL-1β that mimic the native disc. The culture of human NP cells was established either alone or in co-culture with pNCs or stimulated with notochordal cell condition media (NCCM).

Results
Comparing human NP cells cultured in different healthy and degenerated disc niche showed significant higher secretion of cytokines, chemokines and matrix degrading enzymes in degenerated+ IL-1β media compared to other treatments. Co-culture of NP cells and pNC cells showed significant increase in IL-8 expression in healthy in NP+NCCM group compared to NP cells alone.

Conclusions
Development of media to mimic the healthy and degenerate niche has enabled the study of NC and NP cell behaviour in vitro in an environment closer to the disc niche as well as for testing and designing new cell-based treatments for disc degeneration-associated low back pain. This work is being translated to investigate the potential use of iPSCs differentiated into notochordal like cells as potential regenerative cell sources.

2nd & 3rd generation Fully Endoscopic Lumbar Spine Surgery-outcomes, safety & learning curve with a minimum 3yr FU

Birender Balain ORCID iD, Alok Gadkari, Davinder Beach, Aashish Ghodke, Jan Herman Kuiper
RJ&AH Orthopaedic Hospital, Oswestry, United Kingdom

Purpose
2nd and 3rd generation Endoscopic spine surgery techniques offer visualisation of familiar inter-laminar anatomy to spinal surgeons. We have prospectively evaluated the clinical outcome, complications and learning curve associated with these techniques in patients with lumbar spine radiculopathy.

Methods
This is a prospective study of first 50 consecutive patients with radicular pain from disc herniation and/or lateral recess stenosis. In 6 patients, endoscopy couldn't be done. Operating times, PROM's (VAS, ODI and EQ-5D scores) and complication rates of 44 patients were evaluated after mean FU of 52 months (range 39-65). MRI was used to divide these into protrusions (n=19), extrusions (n=17) and lateral recess stenosis (n=8). Evidence about the learning curve was gathered by curvilinear regression analyses.

Results
Using a composite clinical success criterion, 95% patients had a successful outcome, with no major complications. ODI, VAS and EQ-5D scores had a statistically significant improvement and achieved MCID. Revision discectomy was needed in only 4% cases (n=2), with a radiologic re-herniation rate of 9%. MRI based grouping and case sequence number influenced the duration of surgery, and a learning curve was found for protrusions and lateral recess decompressions, but not for extrusions. A learning curve effect was also observed with respect to functional outcomes as per the ODI.

Conclusions
Although 2nd and 3rd generation endoscopy is safe with good outcomes, our learning curve experience suggests a careful and MRI pathology based take up of this technique in clinical practice.

Are current machine learning applications comparable to radiologist classification of degenerate and herniated discs and Modic change?: A systematic review and meta-analysis

Roger Compte Boixader ORCID iD[1], Isabelle Granville Smith[1], Nathan Danckert[1], Amanda Isaac[2], Terence McSweeney[3], Frances MK Williams[2], Panagiotis Liantis[2]
[1]*King's College London, London, United Kingdom.*
[2]*Guys' and St Thomas' NHS Foundation Trust, London, United Kingdom.*
[3]*University of Oulu, Oulu, Finland*

Introduction
Lumbar disc degeneration (LDD) is the main cause of back pain. Accurate automated MRI LDD pathology identification would reduce radiology workload and error and machine learning (ML) may present an effective solution. This review aimed to identify specific ML MRI algorithms that perform consistently well in the identification and grading of LDD pathology.
Methods: A systematic review and meta-analysis protocol was developed in accordance with PRISMA guidelines. Four databases were searched, leading to 1350 studies from which 27 papers were included in the review and 25 studies in the meta-analysis. A multi-level mixed-effects linear meta-regression was performed using publication year, algorithm, LDD classification, use of data augmentation and developmental design or external validation as predictors.

Results
Classifications included disc degeneration, herniation, bulge, Pfirrmann and Modic change grading. Algorithms were grouped into deep learning (DL), SVM, kNN, random forest, naive bayes, and custom methodologies. Most included studies used DL, suggesting developers' preference for DL. However, meta-regression showed no superior performance of any algorithm type, DL complexity requires experience and proficiency for successful design. We found a superior performance trend when several algorithms were combined. Data pre-processing may influence algorithm performance and data augmentation improved accuracy in small studies.

Conclusions
ML applications can perform on par with human radiologists however there are currently insufficient validations to safely translate to clinical settings. The field will benefit if studies using ML for spinal MRI improve design and reporting standards. Additionally, innovation in phenotype definition and data sharing needs to be encouraged.

Paper Session 5: Spinal Rehabilitation

The effect of early compared to late mobilisation following spinal cord injury on function, complications and wellbeing - a systematic review

Natalie Gray[1], Vicky Booth[1], John Gladman[1], Alison Cowley[1], Pip Logan[1], Vicky Tolfrey[2], Nasir Quraishi[3]
[1]University of Nottingham, Nottingham, United Kingdom. [2]University of Loughborough, Loughborough, United Kingdom. [3]Nottingham University Hospitals, Nottingham, United Kingdom

Introduction
The optimum time to mobilise following spinal cord injury (SCI) is unknown but may have implications for patient outcomes. Objective: to evaluate the effect of early compared to later initiation of mobilisation on function, incidence of complications and wellbeing, in patients with SCI.

Methods
A literature search of six databases was completed 01-02/2022 (CINAHL (ESBCO), MEDLINE (Ovid), Embase (Ovid), The Cochrane Library, Web of Science, EThOS). Studies were included of any research method giving numerical results comparing one or more outcomes of interest between adult in-patients mobilised <6 weeks and >6 weeks following traumatic or acquired SCI. All forms of mobilisation were considered, including sitting, standing and walking. The certainty of findings was reported using the GRADE approach.

Results
Of 1473 identified studies, only two met the inclusion criteria, involving 492 patients. In meta-analysis, earlier mobilisation compared to later mobilisation, was associated with greater improvement in Barthel (0-100) score of 16.3 points (CI:8.9, 23.7). One study reported lower incidence of complications in the group treated <6 weeks following SCI (37% vs 61%). Measures of wellbeing were not reported. Both studies were at high risk of bias and indirectness (difficulty isolating the effect of mobilisation from rehabilitation).

Conclusion
Earlier vs later mobilisation in SCI may produce a large effect on functional gains, but this finding is of low certainty because of risk of bias and indirectness. There is insufficient evidence to examine whether earlier vs later mobilisation is associated with a difference in complications or wellbeing.

Do pain catastrophising and kinesiophobia mediate pain and physical function improvements with Pilates exercise? A mediation analysis of a randomised controlled trial

Lianne Wood ORCID iD[1], Geronimo Bejarano Cardenas[2], Ben Csiernik[3], Gisela Miyamoto[4], Gemma Mansell[5], Jill Hayden[6], Martyn Lewis[7], Aidan Cashin[8]
[1]Univeristy of Exeter, Exeter, United Kingdom. [2]University of Texas, Austin, USA. [3]Canadian Memorial Chiropractic College, Toronto, Canada. [4]Universidade Cidade de São Paulo, Sao Paulo, Brazil. [5]Aston University, Birmingham, United Kingdom. [6]Dalhousie University, Halifax, Canada. [7]Keele University, Newcastle-under-Lyme, United Kingdom. [8]Neuroscience Research Australia, Sydney, Australia

Objectives
The mechanisms for how exercise effects chronic low back pain (CLBP) are poorly understood. This study aimed to determine whether the reductions in pain intensity and improvements in physical function from Pilates exercise were mediated by changes in pain catastrophising and kinesiophobia.

Methods
This was a secondary causal mediation analysis of a four-arm randomised controlled trial testing Pilates exercise dosage (once-, twice-, three-times weekly) against a booklet control. All analyses were conducted in R software (version 4.1.2) following a preregistered analysis plan. A directed acyclic graph was constructed to identify potential pre-treatment mediator-outcome confounders. For each mediator model, we estimated the intervention-mediator effect, the mediator-outcome effect, the total natural indirect effect (TNIE), the pure natural direct effect (PNDE), and the total effect (TE).

Results
Data from 255 participants was analysed. Pain catastrophising mediated the effect of Pilates exercise compared to control on outcomes pain intensity (TNIE mean difference (MD) -0.21 (-0.47, -0.03) p=0.01) and physical function (TNIE MD -0.64 (-1.20, -0.18) p=0.002). Kinesiophobia mediated the effect of Pilates exercise compared to control on outcomes pain intensity (TNIE MD -0.31 (-0.68, -0.02), p=0.03) and physical function (TNIE MD -1.06 (-1.70, -0.49), p<0.0005). The proportion mediated by each mediator was moderate (21-55%).

Conclusions
Reductions in pain catastrophizing and kinesiophobia mediated the pathway to improved pain intensity and physical function when using Pilates exercise for CLBP. These psychological components may be important treatment targets to consider when prescribing exercise for CLBP.

Learning to swim with back pain: a qualitative study of swimmers with chronic low back pain

Helen Oakes[1], Marlize De Vivo[2], David Stephensen[1], Hayley Mills[2]
[1]East Kent Hospitals University NHS Foundation Trust, Canterbury, United Kingdom. [2]Canterbury Christ Church University, Canterbury, United Kingdom

Introduction
Swimming is often advised to people with low back pain (LBP) by health professionals as a form of exercise despite limited evidence. The aim of this study was to explore the experience of people who use swimming to manage chronic LBP.

Methods
This qualitative study recruited 14 swimmers who were using swimming to manage LBP. A semi-structured interview guide was followed; topics included the swimmers experience of swimming with LBP, adaptations to swimming, strokes they found helpful, and motivation to keep swimming. Thematic analysis was used to analyse the interview data.

Results
The interview data provided a rich multi-dimensional view of the experience of using swimming as a self-management tool for LBP. Five common themes were developed during the analysis: (1) My back pain journey; (2) Learning to swim with back pain; (3) How swimming looks for me; (4) What I gain from swimming; and (5) Keep calm and carry-on swimming. The themes outline a journey from the swimmers learning to swim with LBP, adapting their swimming stroke, developing a training regime, integrating into a community of swimmers, and incorporating swimming into their daily life. Swimming offered more than just pain relief, it also had a positive impact on mobility, weight, fitness, daily function, and mental health.

Conclusion
This study found that swimming was a valuable and effective self-management tool for LBP. Swimming could provide an alternative form of exercise for this population, helping people with LBP manage pain and improve mobility, mental health, and levels of physical activity.

Change in walking ability, and factors associated with outcome after surgery for neurogenic claudication

Suzanne McIlroy ORCID iD[1], Lindsay Bearne[2], John Weinman[3], Sam Norton[3]
[1]King's College Hospital NHS Foundation Trust, London, United Kingdom. [2]St George's University, London, United Kingdom. [3]King's College London, London, United Kingdom

Introduction
Surgery for neurogenic claudication (NC) aims to improve symptoms and walking, yet not all people increase their walking post-operatively. If the modifiable determinants are known, they could be targeted with rehabilitation and walking improved.

Methods
A prospective study recruited adults (≥50 years, listed for surgery to treat NC). Patients were assessed pre-surgery and 12 weeks postoperatively (six-minute walk distance (6MWD, m), self-rated maximum walking distance (max-walk, m) Oswestry Disability Index (ODI)). A range of measures were collected including potentially modifiable biopsychosocial variables (e.g. balance and falls, fear of movement, illness perceptions). Analysis included descriptive, correlation and regression statistics adjusted for pre-operative scores, age, and sex.

Results
134 participants were recruited and assessed pre-operatively (51% male, mean age 70-years (SD8.6)). 116 underwent surgery, 108 (93%) provided follow-up data. Mean pre and post-op scores were 6MWD 237.5-297.5, max-walk 366.3-1234, ODI 43.0-27.1 (all p<.001). Approximately 50% did not achieve minimum clinically important difference in 6MWD.

Pre-operative number of falls (b:-1.96) and living alone (b:-52.71) were associated with change in 6MWD. Concern with NC (b:-178.2) and LBP when walking (b:-106.83) were associated with change in max-walk. All other variables did not reach statistical significance (p<.05).

Conclusion
Patients demonstrated significant improvements in outcomes, however, changes were not clinically meaningful for many. Self-rated walking capability was not associated with objective walking capability. Baseline 6WMD explained a large proportion of the residualised change score in walking improvement. The results indicate that pre-operative rehabilitation targeting walking, balance and psychosocial factors may be an area for future research.

Paper Session 6: Spinal Paediatric Deformity

Surgical Complications in Neuromuscular Scoliosis Surgery: Systematic Review and Meta-Analysis in the Last Ten Years

Mostafa Meshneb, Nasir Quraishi, Mohamed Patel, Siddharth Shah
The Centre for Spinal Studies and Surgery (CSSS), Queens Medical Centre, Nottingham University Hospitals, Nottingham, United Kingdom

Introduction
Surgical correction of neuromuscular scoliosis is a complex surgical procedure,commonly associated with perioperative complications from the surgical stress as well as the physiological morbidity in these patients. The purpose of this study was to conduct a systematic review of postoperative complications in neuromuscular scoliosis patients who underwent spinal deformity corrective surgery and analyze the risk factors associated with these complications.

Methods
A literature search was performed across multiple database including PUBMED, Scopus, Cochrane Library of Review and Google Scholar limiting to the last ten years using PRISMA guidelines. Inclusion criteria were studies with at least >30 patients, minimum 2 years follow up, English language and human studies. Data extraction and meta-analysis were performed using random mode effect.

Result
Twenty-three studies including cohort and case control studies met the inclusion criteria involving a total of 2183 patients. The levels of evidence of the studies were III and IV (13 and 10 respectively). The pooled incidence rate of wound complications was the highest at 13.7% (CI 10.838 to 16.861). This was followed by respiratory complications 12.4% (CI 6.255 to 20.307), implant failure 8.7% (CI 6.418 to 11.465), pseudarthrosis 5.1% (CI 2.3 to10.6) and neurological deficit 3.7% (CI 1.989 to 6.086). The pooled rates of revision surgery was 10.9% (CI 6.584 to 16.129).

Conclusion
Wound complications remain the most common complication rates among studies after corrective surgery for neuromuscular scoliosis, most significantly associated with diagnosis of Spina Bifida. Respiratory complications are more significantly associated with patients of Duchenne Muscle Dystrophy and Spinal Muscle Atrophy.

Is it Better to Correct the Scoliosis First in Children with a Neuromuscular Syndrome and Coexisting Hip Displacement and Scoliosis?

Mostafa Meshneb, Siddharth Shah, Mohammed Patel, Nasir Quraishi
The Centre for Spinal Studies and Surgery (CSSS), Queens Medical Centre, Nottingham University Hospitals, Nottingham, United Kingdom

Introduction
Children with neuromuscular disorders have a high incidence of spine and hip deformities. There are no widely accepted clinical or radiological guidelines on which of these conditions should be addressed first.

Purpose
To evaluate the outcome of either scoliosis or hip surgery in children with neuromuscular disorders and its effect on progression of the other deformity as well as the rate of second operation.

Methods
This was a retrospective review of all children undergoing hip or scoliosis surgery in our centre between 2012 and 2022 with minimum follow up of 12 months. Demographic and operative data were collected; hip MI, Cobb angle of main curve and degree of pelvic obliquity were measured pre and postoperatively.

Results
42 neuromuscular patients with hip displacement and scoliosis presenting at the same time were analysed retrospectively. In 17 patients average age 10 years, mean follow up 52.2 months, hip surgery was performed first hip group and 25 patients average age was 12.4 years, mean follow up 31 months, primarily underwent scoliosis correction scoliosis group.In hip group,pelvic obliquity, hip MI and Cobb angle were 15.5°, 68%, and 52.5° respectively. At final follow up, the mean pelvic obliquity and Cobb angles significantly progressed postoperatively to 25.04° and 84.04° respectively P value 0.003 and 0.0016. All patients had scoliosis correction after the hip surgery. In the scoliosis group, the mean pelvic obliquity, hip MI and Cobb angle were 21°, 45 % and 67.7° respectively. At final follow-up, pelvic obliquity and Cobb angle significantly improved to 8° and 25° P value 0.003 and 0.0013. In 13/25 patients, hip MI had significantly increased following the spinal surgery to 62% P value 0.017, but only 5/25 patients underwent hip surgery after scoliosis correction.

Conclusion
In neuromuscular patients presenting with hip displacement and scoliosis deformity at the same time, it is advisable to perform corrective scoliosis surgery first due to significant correction of pelvic obliquity and low rates of secondary hip surgery.

3D Reconstructions From EOS Imaging to Assess Changes in the Lumbar Spine After Instrumented Scoliosis Correction to T12 or L1 in Adolescent Idiopathic Scoliosis (AIS)

Matthew Bellamy[1], Raveen Jayasuriya ORCID iD[2], Ashley Cole ORCID iD[2]
[1]Sheffield Medical School - The University of Sheffield, Sheffield, United Kingdom. [2]Sheffield Children's Hospital, Sheffield, United Kingdom

Background
Instrumented scoliosis correction to T12/L1 can be a full correction (FC) of single curves or a selective thoracic fusion (STF). Post-operative effects on the lumbar spine have been reported for plain radiographs. This study aims to assess the un-instrumented lumbar spine utilising EOS 3-dimensional modelling.

Methods
Retrospective review. Inclusion criteria: primary operation 2018-2021; AIS Lenke 1 or 3; lowest instrumented level T12-L1; reconstructable EOS bi-planar images pre-op, post-op and 1 year follow-up.

Results
Eighteen patients were included, 7 Lenke 1A (FC), and 11 Lenke 1B-3C (STF). Lumbar Cobb correction was 54.2%, 42.8% and 33.3% for 1A, 1B and 1C/3C respectively. Lumbar apical vertebral translation was increased by 2.7mm in 1A and decreased by 3.2mm and 8.7mm for 1B and 1C/3C respectively. Mean lumbar axial rotation (corrected for hip rotation) pre-operatively was 10.39°, 13.13° and 13.42°.

STF and FC failed to correct the axial rotation of the apical lumbar vertebrae: Lenke 1B (+0.38°, p=0.735); 1C/3C models (+4.33°, p=0.180). In fully corrected Lenke 1A, axial rotation was insignificantly reduced at 1 year (-4.29°, p=0.072).

True pelvic rotation was significantly reduced for Lenke 1A curves (-4.72°, p=0.018) but not for 1B or 1C/3C (-1.75°, p=0.062; -0.67°, p=0.785). Mean axial lumbar rotation across the un-instrumented lumbar spine had no significant decrease at 1-year post-op for any curves.

Discussion
EOS 3D modelling demonstrates that STF and FC fails to correct axial plane rotation of mobile lumbar spine. Apparent reduction of lumbar rotation on plain radiographs is more likely to be due to pelvic rotation.

A Comparison between 3D Printed Custom Navigation Jigs and Freehand Pedicle Screw Insertion for Posterior Spinal Fusion in the treatment of Scoliosis

Libby Gooda[1], Emily Tsang[1], Bisola Ajayi[2], Priyanshu Saha[1], Zion Hwang[1], Tesfaldet Kurban[2], Samuel Walters[2], Mohamed Abdalla[2], Jason Bernard[2], Timothy Bishop[2], Darren Lui[2]
[1]St. George's University of London, London, United Kingdom. [2]St. George's Hospital, London, United Kingdom

Introduction
Pedicle screw insertion during posterior spinal fusion surgery for scoliosis is traditionally done with a 'freehand' technique. Three-dimensional printed custom navigation jigs (3DPCNJ) can be created from a pre-operative Computerised Tomography (CT) scan, to allow efficient drilling and insertion of pedicle screws in a predetermined trajectory. This study sought to compare freehand pedicle screw insertion vs. 3DPCNJ.

Methods
A total of 100 patients were identified (50 freehand, 50 3DPCNJ), and these groups were matched by demographics and Lenke classification. Patients with Adolescent Idiopathic Scoliosis were included, leaving 43 patients in each group. Patient-reported outcomes (SRS-22), intra-operative parameters and radiographic measurements were collected.

Results
There were no differences in mean age (15.3 vs 15.2), gender (81% vs 77% female), or length of stay (7.2 vs 5.9 days). There were no statistically significant differences between SRS-22 scores, or the changes in radiographic parameters. Two patients in the freehand group had a complication related to incorrect screw placement (none in the 3DPCNJ group).

With 3DPCNJ, significantly more screws were placed relative to the number of levels stabilised (screw density – 82.8% vs 66.5%, p<0.01), but yet there were no statistically significant differences for duration of surgery or intra-operative blood loss.

Conclusion
The use of 3DPCNJ allowed significantly higher density of pedicle screws, without any increase in operative time or blood loss, showing it to be safe and more efficient than freehand insertion. Sharing the load between more screws should help mitigate screw pull out, although long-term follow up data is not yet available.

Paper Session 7: Intradural, Spinal Cord Injury and Spinal Oncology

Spinal Infection Causing Spinal Cord Injury: A Review of the Current Medico-Legal Position

Lisa Grandidge ORCID iD[1], Naomi Assame[2], Pradeep Thumbikat[1]
[1]Princess Royal Spinal Injuries Centre, Sheffield Teaching Hospitals, United Kingdom. [2]NHS Resolution, Leeds, United Kingdom

Introduction
This is a retrospective analysis of clinical negligence claims related to spinal infection in England. This is the first time a detailed analysis has been undertaken of spinal infection claims in the UK.

Methods
Clinical Negligence claims related to spinal infection from 01/01/2009 to 31/12/2019 were identified using the NHS Resolution Claims Management System (n=232) and the overall cost of clinical negligence claims was identified. Letters of claim for the 85 claims settled with damages paid were reviewed to identify presenting symptoms, risk factors, neurological outcomes and cause of diagnostic delays.

Results
The total predicted cost to the NHS over the period analysed was £278,763,701. This equates to 21 claims per year with a potential annual cost of £25.3 million. This is over £92.5 million more than the cost of claims relating to cauda equina syndrome (between January 2008 to December 2018).

Delayed diagnoses were caused by failure to consider spinal infection as a diagnosis (65%), failure to consider red flag symptoms (58%) and delayed imaging (58%).

27 (32%) suffered spinal cord injuries or "nerve damage".

Conclusion
Spinal infection and delays in its diagnosis have resulted in a substantial cost to the NHS through pursuit of clinical negligence claims. The majority of claims were successful. We recommend a greater index of suspicion when considering the differential diagnosis of spinal pain and better access to out-of-hours MRI. A recent invasive procedure, recent infection and up-trending C-reactive protein should be considered as additional warning signs for new onset spinal/chest pain.

Can radiological factors predict outcome in ASIA A cervical spinal cord injuries?

See Yung Phang, Margaret Purcell, Natasha Fullerton, Christopher Barrett
Queen Elizabeth University Hospital, Glasgow, United Kingdom

Introduction
ASIA A cord injury patients have the poorest functional and neurological outcome. In this retrospective cohort study, we wanted to investigate, whether there are any radiological features that can help predict ASIA grade improvements in ASIA A cervical cord injury patients.

Methods
All cervical cord ASIA A patients over a period of 11 years were analysed from the Scottish Spinal Injury database. Patients who had both, a CT and MRI scan, performed were included. Data was collected from measurements performed on images on the Scottish PACS. Measurements analysed include CT cross sectional area; T2 lesion length (T2LL); STIR lesion length (SLL); T2 signal intensity ratio (T2SIR); STIR signal intensity ratio (SSIR); maximum spinal cord compression-MRI (MSCC); maximal canal compromise-CT (MCC), axial and cross-sectional; presence of cord haemorrhage.

Results
58 patients were included in the study. 16 patients had at least one ASIA grade improvement. The average timespan from the time of injury to the MRI scan was 2.9 days. We found that MCC (p=0.046) and T2SIR (p=0.045) were statistically significant in predicting ASIA A conversion.

Conclusion
We found two independent radiological factors that can help predict likelihood of conversion in patients initially diagnosed as an ASIA A cervical cord injury. These findings can be useful not only for prognostic purposes, but also for helping clinicians select patients, who might benefit the most from early decompressive surgery.

Use of non-penetrating titanium anastomotic clips in the closure of intentional durotomies for intra-dural pathology

Edward Dyson ORCID iD[1], David Rowland[1], George Prezerakos[1], Kia Rezajooi[2], Parag Sayal[1], Adrian Casey[1]
[1]National Hospital for Neurology and Neurosurgery, London, United Kingdom. [2]Royal National Orthopaedic Hospital, London, United Kingdom

Introduction
Water-tight dural closure is an essential part of surgery to address intra-dural spinal pathology to prevent cerebrospinal fluid related complications including leakage and meningitis. This is traditionally achieved with a continuous monofilament suture. This technique has stood the test of time but can be time-consuming and requires use of a sharp instrument close to the unprotected spinal cord. The needle may also traumatise the dura leading to leakage of fluid.

Non-penetrating titanium anastomotic clips (NoPTACs) (Le Maitre™ AnastoClip®) have been in use for some years for macro- and microsurgical vascular anastomosis of vessels to grafts with a good safety record.

Methods
We present a retrospective series of 100 consecutive intentional spinal durotomies closed with NoPTACs at a single unit.

Results
We report the demographics, pathology, spinal level, complication rate and follow-up. We also present an instructional microscopic video of the operative technique.

Conclusion
NoPTACs are a safe way of achieving water-tight closure of the spinal dura in a time-efficient manner. They can also be used in the closure of inadvertent durotomies. A prospective randomised study and cost-effectiveness analysis would help to establish their place in the field.

Do oncologists get it right? An assessment of accuracy of MSCC prognostication

Vinay Jasani ORCID iD, Zeiad Alshameeri, Hussein Shoukry, Sriram Srinivasan, Stephanie Peake
University Hospital of North Midlands NHS Trust, Stoke on Trent, United Kingdom

Introduction
We evaluated the accuracy of oncologists' estimate (OE) of survival and compared this to other predictors (Tokuhashi score (TS), platelet-lymphocyte ratio (PLR) and albumin levels (Alb)) in patients with MSCC.

Method
2 years of prospective data was analysed. OE and TS predictions were categorised into 3 categories (<6 months, 6-12 months and > 12 months). PLR cut off values of > 180 and Alb of <3.5g/dl were used. Percentage accuracy compared to actual survival were calculated. Survival analysis using Kaplan-Meir graphs and log rank test were used to compare to actual survival. Cohen's Kappa value was used to assess agreements compared to actual survival. Binomial logistic regression was used for modelling survival prediction based on TS, PLR and Alb combined.

Results
190 cases were included. OE for solid malignancies had a poor percentage accuracy (53.1%) but was better for haematological (65.2%). TS for solid malignancies had a better percentage accuracy (72.7%) but was poor for haematological (26%). The Kappa coefficient for all malignancies was poor for both OE (0.32; p<0.001) and TS (0.22; p<0.001). High PLR and low Alb were independently associated with survival, but only significant for Alb, p<0.001 (log rank test). Low Alb and high PLR in a multivariate analysis improved the prediction by TS for >6months and >12 months; improving odd ratio from 10.2 to 11.9 and from 2.6 to 4.2 respectively.

Conclusion
No single predictor (including OE) gave an accurate prediction of survival. Predictions can be improved by combining TS with PLR and Albumin levels.

Outcomes in spinal ependymoma: A retrospective single centre experience of 39 patients

Daniel Robinson ORCID iD[1], Muhammad Dherijha[2], John Leach[2]
[1]*The University of Manchester, Manchester, United Kingdom.*
[2]*Salford Royal NHS, Manchester, United Kingdom*

Introduction
Spinal cord ependymomas account for 3–6% of all CNS tumours and approximately 60% of all intramedullary tumours1. This study aimed to analyse neurological outcome after treatment and to determine prognostic factors for functional outcome.

Method
We retrospectively analysed data of all patients treated in our centre from 2004-2021. We analysed the clinical and histological aspects to identify predictive factors for post-operative morbidity, extent of tumour resection and recurrence/progression of tumour.

Results
39 patients were included (mean age 54.0±15.9 years). The most common tumour location was the lumbar spine (23/39) followed by thoracic (7/39) and cervical spine (5/39). 18 cases (46.1%) were histologically classified as grade 2 and 12 (30.7%) as grade 1. 32 (82%) were treated surgically, 20 (51.2%) of which had gross total resection (GTR) and 12 (30.7%) had subtotal resection (STR). 5 patients (12.8%) were treated conservatively. No recurrence/progression of tumour was noted in the GTR group, however 3 patients in the STR group had progression of tumour on latest scan. 25 patients (64.1%) had improved functional status post-operatively, whereas 3 (7.6%) had decreased

functional status. The overall 5-year progression-free survival (PFS) rate was 87%. Those in the GTR group had a 5-year PFS of 100% and those with subtotal resection had a 5-year PFS OF 75%. No significant association was noted between post-operative radiotherapy/chemotherapy and functional outcome (p=0.1519).

Conclusion
GTR is important in the treatment of spinal ependymoma due to its beneficial value for PFS and low rates of functional deficit.

Surgical Management of Giant Cervical Paraspinal Nerve Sheath Tumours

Jack Penn, Siddharth Vankipuram, Antonino Russo, Vittorio Russo
The National Hospital for Neurology and Neurosurgery, London, United Kingdom

Introduction
Nerve sheath tumours (NSTs) are common, however, giant cervical NSTs with paraspinal extension are rare. The size and location of these tumours present unique surgical challenges due to their anatomical complexity.

Methods
A retrospective, single-centre case review of consecutive patients with giant cervical NST with paraspinal extension, treated with surgical resection between 2016 and 2022. We analysed clinical and radiological outcomes, along with surgical approaches.

Results
Seventeen patients were included in the case series. In ten patients the tumour involved the C2 nerve root. In twelve patients there was spinal cord compression from intracanalicular extension of the tumour. In six cases the tumour was causing severe compression and distortion of the vertebral artery, in eight cases the tumour abutted the vertebral artery, with no significant compression. Gross total resection was achieved in all patients and histological examination revealed Schwannomas (14), neurofibromas (2) and malignant peripheral nerve sheath tumour (1). Five patients underwent concomitant fixation. The majority of patients experienced significant clinical improvement and none experienced new post-operative neurological deficits. Posterior approach with different degrees of lateral extension was the commonest technique. Anterior and antero-lateral approaches were used in three patients and combined anterior and posterior approach in one.

Conclusions
Management of giant cervical paraspinal tumours can pose significant surgical challenges. In-depth knowledge and preservation of the surrounding anatomical structure is paramount for safe and complete resection. We present the largest surgical case series of giant cervical paraspinal NSTs.

Paper Session 8: Spinal Degenerative: Cervical

Managing risk in degenerative cervical myelopathy: a service review in response to COVID-19 delays

Eleanor Dunstan[1], Matthew Dixon[1], Lianne Wood[2]
[1]Nottingham University Hospitals NHS Trust, Nottingham, United Kingdom.
[2]University of Exeter, Exeter, United Kingdom

Introduction
Degenerative cervical myelopathy (DCM) is associated with progressive neurological deterioration; timely surgical decompression can halt but may not reverse this. The Modified Japanese Orthopaedic Assessment (MJOA) categorises clinical severity. A tertiary NHS Trust identified DCM patients as high risk for permanent neurological damage due to the impact of COVID-19 on surgical waits. The Advanced Spinal Practitioner (ASP) team implemented a surveillance project to quantify the risk of surgical delay in DCM patients.

Methods
A spreadsheet of patients on a DCM surgical waiting list was compiled for contact by ASPs (October 2021). Data collected included age, gender, MJOA score, referral pathway, date of listing, date of surgery. Where deterioration was identified, urgent face-to-face review was arranged and incident forms completed. Neurological deterioration was categorised by a multi-disciplinary team of spinal surgeons and ASPs for urgent or emergency surgical decompression.

Results
46 patients were identified (46% female (n=21)). Clinical deterioration was reported in 50% (n=23), 46% (n=21) remained stable, and 4% (n=2) were recorded as unclear. The average deterioration in MJOA was 2.6 points (range 1-5). Of those with deterioration (n= 23), 18 (78%) underwent urgent surgical decompression, two (9%) await surgery, two (9%) declined surgery and one (4%) patient died. Those that deteriorated were sent a formal apology letter.

Conclusion
Post-pandemic demand on healthcare has reduced elective surgical capacity. For DCM, a baseline assessment with an MJOA should be standard practice. Safety-netting for deterioration and clear criteria for emergency presentation and surgical decompression should be standard practice.

Now or Later? Emergency vs Elective surgery for Degenerative Cervical Myelopathy – A service evaluation from practice

Matthew Dixon ORCID iD[1], Lianne Wood ORCID iD[1], Lerato Dixon ORCID iD[2], Eleanor Dunstan[1]
[1]Nottingham University Hospitals NHS Foundation Trust, Nottingham, United Kingdom. [2]Nottingham Trent University, Nottingham, United Kingdom

Background
Surgical intervention is recommended for those with Degenerative Cervical Myelopathy (DCM) classified as moderate, severe or progressive by Modified Japanese Orthopaedic Association (MJOA) score. Surgical timing is an important consideration as individuals with DCM typically deteriorate if left untreated. However, no clinical guidelines currently exist to differentiate whether emergency or elective surgery is indicated for individuals. At our tertiary spinal centre, patients with DCM are assessed by the spinal practitioner team. Those agreed for surgery are either admitted directly to our spinal ward for emergency intervention 'Priority 1 (P1)' or listed for urgent elective surgery 'Priority 2 (P2)'.

Methods
This retrospective analysis collated DCM cases listed for either P1 or P2 surgery over a 19-week period (July-November 2022). Extracted data from medical records included: demographic variables, patient history, MJOA score, physical examination findings and radiological variables. This data was analysed using multi-variate regression analysis.

Results
Overall, 49 patients were listed. 11 as P1, including 4 converted from P2 due to deterioration. There was a statistically significant difference in MJOA score between groups using binary logistic regression model with P1 having a lower MJOA (mean=9) compared with P2 (mean=12). P1 patients were statistically more likely to have had recent deterioration in symptoms (<1 month) using Mann-Whitney U-test (95% CI [2.26, 3.13]). No other factors reached statistical significance.

Conclusions
These preliminary data suggest a clinical difference between P1 and P2 cases. Further data collection and analysis with a larger cohort is needed to confirm these findings and inform practice guidance.

Can a training workshop on Degenerative Cervical Myelopathy (DCM) be used to increase awareness and triage confidence among General Practitioners? A pilot study.

Julia Tabrah[1], Salvatore Russo[2], Nicky Wilson[3], Ben Davies[4], Jamie Brannigan[4], Oliver Mowforth[4], Diana Keeling[1]
[1]Hounslow and Richmond Community Healthcare NHS Trust, London, United Kingdom. [2]Imperial College Healthcare NHS Trust, London, United Kingdom. [3]Kings College Hospital NHS Foundation Trust, London, United Kingdom. [4]University of Cambridge, Cambridge, United Kingdom

Introduction
Diagnostic delay of DCM is common, partly due to a knowledge gap among primary care clinicians. Delayed diagnosis risks devastating consequences including paralysis and bladder/bowel incontinence. This study aimed to assess the efficacy of a one-hour training workshop on increasing DCM awareness and triage confidence among GPs in West London.

Method
The workshop was designed by a team of physiotherapists and neurosurgeons and incorporated DCM symptoms, triage and interactive case studies. It was delivered virtually to GPs in Hounslow, Richmond and Kingston of any experience level. A self-assessment survey was used to determine DCM awareness and triage confidence pre and post training. Completion of the survey was optional and anonymous.

Results
23 GPs attended the workshops. 16 completed the survey. Incomplete data was removed from the analysis. Pre-training awareness was limited (6%) or average (94%), whereas post training awareness improved to very good (62%) or excellent (38%). Pre-training triage confidence was not at all confident (7%), slightly confident (40%), moderately confident (40%) or very confident (13%), whereas post-training triage confidence increased to very confident (73%) or extremely confident (27%). DCM awareness and triage confidence increased by at least one rating point for all participants.

Conclusion
This study suggests that an interactive DCM training workshop can be used to increase GP awareness and triage confidence. A larger scale study is needed to confirm this and to determine if the training translates to reduced diagnostic delay. Multiple training forums are likely to optimize engagement e.g. webinars, e-learning modules and info-graphics.

Can an informal expert consensus process be used to identify the early, middle and late stage symptoms of degenerative cervical myelopathy (DCM)?

Julia Tabrah[1], Ben Davies[2], Salvatore Russo[3], Sue Greenhalgh[4], Chris Mercer[5], Nicky Wilson[6], Alice Moore[7], Jamie Brannigan[2], Andrew McCarter[6], Oliver Mowforth[2], Sam Bhide[8], Laura Finucane[9], Diana Keeling[1]
[1]Hounslow and Richmond Community Trust, London, United Kingdom. [2]University of Cambridge, Cambridge, United Kingdom. [3]Imperial College Healthcare NHS Trust, London, United Kingdom. [4]Bolton NHS Foundation Trust, Greater Manchester, United Kingdom. [5]University Hospitals Sussex NHS Foundation Trust, Brighton, United Kingdom. [6]Kings College Hospital NHS Foundation Trust, London, United Kingdom. [7]Berkshire Healthcare NHS Foundation Trust, Reading, United Kingdom. [8]Kingston Hospital NHS Foundation Trust, London, United Kingdom. [9]Sussex MSK Partnership, Brighton, United Kingdom

Introduction
Diagnostic delay of DCM is common, partly due to a lack of knowledge on symptom chronology. Identifying early, middle and late-stage symptoms is likely to facilitate more timely diagnosis and treatment.

Method
Twelve DCM experts were identified due to their extensive DCM experience, including physiotherapists and neurosurgeons in primary, community, secondary and tertiary care. An anonymous survey was used to capture initial thoughts. A list of 55 symptoms were included (extracted directly from a symptom incidence study (Munro et al. 2023 - pending publication)). Participants were asked to specify if these symptoms most commonly occurred in the early, middle or late stages of the condition. An online consensus meeting was used to discuss any areas of disagreement and the survey was then repeated.

Results
10 participants attended the online meeting and completed the survey. Consensus was assumed if 70% or more participants agreed. Early symptoms: hand numbness, symptom variability and neck pain. Middle stage symptoms: arm numbness, clumsiness, reduced dexterity, heavy legs and arm muscle spasms. Late symptoms: reducing mobility, loss of leg control, dragging legs, paralysis, leg muscle spasms, constipation and urinary incontinence. It is assumed that other DCM symptoms are unlikely to occur at a consistent stage in the lifespan of the condition.

Conclusion
This study identifies some early, middle and late-stage DCM symptoms which could help to facilitate earlier recognition and optimal outcomes. However, a lived experience study and a larger, more formal expert consensus project are needed to confirm these findings.

Knowledge and education of cervical myelopathy within health care professionals

Holly Clarke[1], Alex Benham[2], Jayanti Rai[3], Caroline Coulthard[1]
[1]Physiotherapy research society, Nottingham, United Kingdom. [2]Physiotherapy research society, Huddersfield, United Kingdom. [3]Physiotherapy research society, York, United Kingdom

Degenerative Cervical Myelopathy (DCM) is an under diagnosed condition that can lead to major disability. Reduced knowledge of DCM presentation can cause delays in management. This review looks at knowledge and education of DCM in health care professionals. To understand reasons behind delays.

A systematic search was conducted. Terms around knowledge, education, and DCM were used. Only articles of degenerative cause of myelopathy were included. Data was extracted to capture evidence of knowledge of diagnosis and management alongside education provided on DCM.

The search found 316 articles,19 duplicates. 297 were screened at title & abstract, 79 screened via full text. 30 articles carried over to data extraction, with 3 further articles from reference searches. DCM Education in UK medical schools showed 70% of students reported not receiving DCM training and 25% of those who had, received one hour. 96% of medical students expressed interest in further DCM teaching. In medical curricula, DCM was jointly least cited, compared to four common neurological conditions. Student performance was higher than average in DCM question banks. Reported self-rating of DCM knowledge was rated average or better in 21% of students. This did not correlate with answers to questions on DCM. A study showed DCM primary care assessment only included light touch & muscle strength testing.

Limited evidence is available on current education and knowledge of DCM. Evidence focused on medics and not other medical professions. Articles found absent or low levels of references to DCM in education at UK medical schools.

Retrospective review of clinical and radiological outcomes in stand-alone cages versus cage-screw device for multi-level anterior cervical discectomy and fusion

Laasya Dwarakanath, Adnan Shaikh, Haleem Shah, Petr Rehousek, Faizul Hassan
Royal Orthopaedic Hospital, Birmoingham, United Kingdom

Objectives
Anterior plating has been the gold standard for multi-level ACDFs. However, due to the high risk of complications associated with plate and screws, spacers are considered a better option. Our study compares the clinical and radiological outcomes of stand-alone cage with no plates (Group 1) and a cage-screw device (Group 2) for multi-level anterior cervical discectomy and fusion (ACDF).

Design
We performed a retrospective review of 84 patients who underwent multilevel ACDF procedures in the last 5 years. (September 2016-September 2021) in our tertiary level spinal centre. Clinical and Radiological outcomes were assessed using pre-operative questionnaires, clinic letters and radiographs.

Results
A total of 84 patients (39:45 - cage-screw device: stand-alone PEEK cages. The mean age ranged from 33 to 83 years with equal sex distribution and mean follow-up ranged from 6 weeks to 5 years. Seven patients underwent a 3-level ACDF with the remaining being 2-level ACDFs. There was clinical and radiological improvement across all parameters in both groups. Complications were equal in both groups but swallowing issues were slightly increased in the cage-screw device group. Subsidence was noted in both groups without clinical significance.

Conclusions
Our study confirms a comparable outcome with both devices but spacer procedures are quicker and less expensive.

Collapsing Corpectomy Cages, a Cause for Concern?

Oliver Flannery, Sophie Gatfield ORCID iD, Susannah Liddiard, Ashok Subramanian
Somerset NHS Foundation Trust, Taunton, United Kingdom

Introduction
Expandable cages can be used to support the anterior column of the cervical spine following corpectomy. One expandable corpectomy cage was introduced to our unit in 2015. A cage failure with complete collapse of the expandable portion of the cage was noted post operatively on X-ray and an MRI demonstrated buckling of the ligamentum flavum with cord signal change. The patient required further surgery. Literature shows that subsidence or dislocation of the implant may occur but mechanical failure like this has not been assessed.

Methods
We searched the British Spinal Registry and local theatre system for cervical corpectomy procedures performed in our unit since 2015. Three clinicians independently compared intra operative imaging with serial post operative radiographs. We recorded change in height of the cage based on the number of exposed threads visible and took measurements to confirm any discrepancies.

Results
72 cages were implanted between 2015 and February 2022 into 71 patients (36 male and 35 female patients, mean age 62 years and mean follow up 14.2 months). Operations were performed by 5 spinal surgeons in the unit. We noted 3 complete collapses at an average time point of 3.75 months. We noted 5 further cases where partial collapse was evident.

Conclusions and Implications
Our results show an overall failure rate of 11% with complete collapse of the expandable portion of the cage in 4%. This raises serious concerns regarding the ongoing use of the device. Further work is ongoing to investigate morbidity associated with these cage failures.

Clinical and radiological outcomes following stand-alone anterior cervical discectomy and fusion for three or four level cervical degenerative disc disease

Siddharth Vankipuram, Jack Penn, Antonino Russo, Vittorio Russo
National Hospital for Neurology and Neurosurgery, London, United Kingdom

Background
Anterior cervical discectomy and fusion (ACDF) is a well-established treatment for one or two-level cervical disc disease presenting with myelo-radiculopathy. However, data following stand-alone ACDF for three or four-level disease is less reported. We report the clinical and radiological outcomes after ACDF using zero profile cages with screws and no additional plate or posterior column support in patients with symptomatic, multi-level cervical degenerative disc disease (DDD).

Materials and methods
Patients who underwent three or four-level ACDF from 2015-2022 at a single center for symptomatic DDD were included. Patient demographics, neck disability index (NDI), visual analogue scales (VAS) for neck pain and arm pain, and modified Japanese Orthopedic Association scores (mJOA) were analysed. We also studied long-term complications and radiological fusion rates.

Results
A total of 38 patients were included with a mean age of 58.4 years (27 males/11 females) and average follow-up length of 26 months. Ten (26.3%) four-level procedures were performed (all C3-7), and 28 patients (73.7%) underwent three-level surgery. NDI, VAS and mJOA scores improved significantly in all patients. Post-operative transient dysphagia was present in 26% of the patients, with complete resolution at the long-term follow-up.

Long-term fusion rate was 100%. None of the patients needed revision surgery because of persisting/recurrent symptoms, device-related complications or the need for additional posterior column support.

Conclusions
Stand-alone ACDF using zero profile cages and screws is a valid option in the surgical management of multi-level symptomatic cervical degenerative disc disease providing excellent long-term clinical and radiological outcomes.

Paper Session 9: Spinal Paediatric Deformity

Adherence and Factors Related to Completion of SRS22 PROM Scores in Patients Undergoing Surgical Correction for Adolescent Idiopathic Scoliosis

Matthew Bellamy[1], Wei Shao Tung[1], Ellie Courtney[1], Raveen Jayasuriya ORCID iD[2], Ashley Cole ORCID iD[2], Edward Bayley ORCID iD[2]
[1]University of Sheffield, Sheffield, United Kingdom.
[2]Sheffield Children's Hospital, Sheffield, United Kingdom

Background
The Scoliosis Research Society Health-Related Quality of Life Questionnaire (SRS22) allows clinicians insights into the challenges patients with scoliosis face. This study aims to assess compliance with SRS22 questionnaires, identifying key factors impacting adherence.

Methods
This retrospective cohort study of the British Spine Registry included 207 patients who underwent surgery for Adolescent Idiopathic Scoliosis between January 2018 and March 2022 at a single institution. Completed SRS22s at 5 timepoints were collected with contact and deprivation data.

Results
SRS22 completion averaged 45.5% across time points. Contact information was available in 84.8%. There was a significant drop in completion from 2018 (60.7%) to 2021 (26.6%) at follow-up. Binary logistic regression demonstrated preoperative and 6-week SRS22s were significant predictors of completed 6-month and 1-year questionnaires (OR: 2.42; $p = 0.042$, OR: 3.03; $p = 0.0082$). Six-month completion was a significant predictor of 1-year completion (OR: 6.06; $p < 0.001$). One year completion was the only significant predictor for 2-year completion (OR: 10.29; $p < 0.001$). Mobile or Email availability did not predict greater completion for any time-point. Index of multiple deprivation was not significant to SRS22 completion.

Discussion
With lowering rates of engagement, input at the beginning of care may provide an effective strategy to maximise long-term collection. With incomplete preliminary questionnaires, later questionnaire completion is unlikely. Long term completion does not seem to directly correspond to contact availability or area deprivation. Clinical initiative maximising completion at early time points could lead to significantly greater engagement from patients.

Efficacy and safety of the use of perioperative gabapentin in patients with adolescent idiopathic scoliosis undergoing fusion surgery: A systematic review and meta-analysis

Gonzalo Mariscal, Paloma Bas, Silvia Pérez, Jorge Morales, Pedro Rubio, Miquel Bovea, Jose Luis Bas, Teresa Bas
La Fe university and Polytechnic Hospital, Valencia, Spain

Objective
The aim of this study was to evaluate whether the perioperative use of gabapentin was associated with a decrease in the opioids consumption.

Methods
A meta-analysis of randomized clinical trials focusing on patients with adolescent idiopathic scoliosis undergoing posterior fusion surgery treated with gabapentin versus placebo were carried our. The primary outcome measures were opioid consumption. Time to introduction of oral medication, length of hospital stay and time with urinary catheterization were also recorded. Data were combined using Review Manager 5.4. Results: Four randomized clinical trials with a pool of 196 adolescent patients (mean age 14.8±2.0 years) were included. At 24 and 48 hours after surgery, opioid consumption was significantly lower in the gabapentin group: (SMD -0.50, 95% CI -0.79 to -0.22) and (SMD -0.59, 95% CI -0.88 to -0.30) respectively. At 72 and 96 hours there were no significant differences between studies, (SMD -0.19, 95% CI -0.52 to 0.13) and (SMD 0.12, 95% CI -0.25 to 0.50) respectively. Regarding the type of administration, there were significant differences in favor of the 15 mg/kg subgroup with respect to 600 mg at 48 hours (SMD -0.69; 95% CI -1.08 to -0.30). There were no significant differences with respect to time to transition to oral medication, time to hospitalization and time with bladder catheterization.

Conclusions
Gabapentin was shown to decrease opioid consumption during the first 48 hours. Doses of 15mg/kg showed superiority in reducing opioid consumption during the first 48 hours.

Diagnosed too late! - Proportion of adolescent idiopathic scoliosis curves that are added to the surgical waiting list at first presentation to a paediatric spinal clinic

Jessica Robinson, Matthew Bellamy, Raveen Jayasuriya ORCID iD, Ashley Cole
Sheffield Children's Hospital, Sheffield, United Kingdom

Background
Newly diagnosed adolescent idiopathic scoliosis patients (AIS) presenting with a Cobb angle >50 degrees are diagnosed too late for brace treatment and are often added to the waiting list for surgery.

Methods
Single centre, retrospective service evaluation of patients added to waiting list in 2019 and 2022 to evaluate: a) proportion of waiting list additions listed at first appointment; b) covid pandemic effect; c) social deprivation association with delayed diagnosis.

Results
107 and 109 patients added to the paediatric spinal waiting list in 2019 and 2022, where 42% and 47% were AIS cases respectively. Of these, 56% in 2019, and 63% in 2022 were listed at their first clinic appointment (or within 3 months with no further x-ray). Of AIS patients added to the waiting list, 73% presented with a Cobb angle >50 degrees at their first appointment.

Patients listed at first appointment pre-covid, from areas with greater health and education deprivation, presented with significantly larger curves (p=0.012, p=0.025). This was not observed post-covid.

Average wait from referral to first appointment where listed was 29 days in 2019 and 59 days in 2022.

Discussion
A large proportion of AIS patients are first presenting with curves exceeding a surgical threshold. The problem of late diagnosis was not affected by the covid pandemic, social deprivation or delays to clinic.

Late diagnosis results in patients missing the opportunity for bracing. This study supports the need for a national service evaluation to readdress a strategy for earlier diagnosis of AIS.

Reducing Blood Transfusions in Paediatric Scoliosis Surgery: The Impact of a Multidisciplinary, Evidence-Based Approach

Zacharia Silk ORCID iD[1], John Wong[2], Richard Pinder[3], Mark Harris[2], Tom Ember[2], Jonathan Lucas[2]
[1]Oxford University Hospitals NHS Foundation Trust, Oxford, United Kingdom. [2]Evelina London Children's Hospital, London, United Kingdom. [3]Imperial College London, London, United Kingdom

Introduction
The field of blood conservation has experienced huge advancements over the past 20 years, leading to a significant reduction in the use of allogenic blood transfusion (ABT) in paediatric scoliosis surgery. This study provides an insight into the impact an evidence-based, multidisciplinary pathway can have on ABT rates.

Methods
This study analysed data from 1498 patients aged 35 years or less who underwent spinal surgery between January 2001 and December 2020. Data included diagnosis, approach, perioperative haemoglobin levels, transfusion volume, and length of stay (LOS). Patients with non-scoliosis diagnoses, missing transfusion data, or who underwent non-fusion procedures were excluded.

Results
A total of 1556 surgeries were performed, with 66.6% performed on ambulant children with idiopathic scoliosis ⩾ 10 years (Type 1), and the remaining 33.4% performed on non-ambulant, or syndromic / neuromuscular / congenital / idiopathic (<10 years) patients (Type 2). Mean age was 15.1 years (SD 3.5), with a F:M ratio of 2.2:1. In the first 5 years, an overall transfusion rate of 61.8% was observed (Type 1 = 45.0%, Type 2 = 90.0%). Contemporary data shows an observed transfusion rate of 6.5% (Type 1 = 0.8%, Type 2 = 20.4%). Where ABT was used, LOS increased from 5 to 7 days (Type 1) and 6 to 8 days (Type 2).

Conclusion
This study demonstrates a significant reduction in the rate of ABT following the implementation and continual optimisation of a multidisciplinary pathway. An ABT rate of less than 1% in Type 1, and 20% in Type 2 patients is achievable.

Development of the Brace Adherence Prediction Questionnaire (BAPQ) based on Protection Motivation Theory

Raveen Jayasuriya[1], Paul Norman[2], Daniel Hind[2], Ashley Cole[1]
[1]Sheffield Children's Hospital NHS, Sheffield, United Kingdom. [2]University of Sheffield, Sheffield, United Kingdom

Background
Successful full-time bracing in adolescent idiopathic scoliosis is adherence dependent. Two previous questionnaires achieved limited success in predicting brace adherence. Factors affecting adherence behaviour in bracing have not been evaluated using a theory-based framework.

Methods
Stage 1: Semi-structured interviews explored adolescent and parent perspectives of the psychological effects of bracing. The topic guide and directed content analysis of transcripts operationalised Protection-Motivation Theory (PMT). Stage 2: Brace Adherence Prediction Questionnaire (BAPQ) development through item generation, reduction, PPI and expert panel review.

Results
Fifteen patients and nineteen parents participated in interviews. 820 coded quotations aligned to 56 themes across the 7 constructs of PMT. Content analysis and clustering identified 8 key themes which spanned the PMT constructs. These strongest themes informed the development of the BAPQ.

A long list of 90 items were generated from the content analysis, which was reduced to 38 items, which coved the 8 themes and 7 domains. BAPQ-38 was reviewed by a scoliosis PPI group, and comments actioned to produce BAPQ-32 which was subjected to expert panel (surgeons, orthotists, specialist nurses, physiotherapists) critique. The final version of BAPQ-32 has been approved by a REC for validation through the BASIS study.

Conclusion
The qualitative study demonstrates that PMT provides a coherent psychological framework to explore the factors affecting brace adherence in AIS. Dyadic interview data, PPI and expert review has informed a de novo prediction questionnaire for stratifying patient adherence, for future validation through a prospective study.

Systematic Review and Meta-analysis: Does Anterior–Posterior Spinal Fusion Still have a Role in Severe Thoracic Adolescent Idiopathic Scoliosis?

Laasya Dwarakanath ORCID iD, Mathew David Sewell, Morgan Jones, George Mckay, Matthew Newton-Ede, Jonathan Spilsbury, Enid Leung, Jwalant Mehta, Adrian Gardner
Royal Orthopaedic Hospital, Birmingham, United Kingdom

Debate exists as to whether anterior–posterior spinal fusion (APSF), rather than posterior-only spinal fusion(PSF), provides benefit for treating severe thoracic adolescent idiopathic scoliosis (AIS). This systematic review and metaanalysis compare (1) Cobb angle correction, (2) complication and reoperation rate, (3) pulmonary function, (4) number of fused segments, and 5) patient-reported outcome measures (PROMs) in both groups.

Methods
Electronic databases were searched to identify studies that met the inclusion criteria. Literature was graded for quality and bias using GRADE and MINORS criteria.

Results
Eight studies were included, defined by GRADE as low or moderate level evidence. Three studies showed superior curve correction in the APSF group; however, the meta-analysis showed no significant difference in curve correction between groups (95% CI − 3.45–12.96, P = 0.26). There were more complications in the APSF group, without statistical significance (95% CI 0.53–3.39, P = 0.54; I2 = 0%, P = 0.78). There were no re-operations in either group. Two studies reported pulmonary function; one showed better function in the APSF group, the other better function in the PSF group. One study showed fewer fused segments in the APSF group, however, no significance was observed in the meta-analysis (95%CI − 1.65–0.31, P = 0.18).

Conclusions
APSF and PSF have been found to have comparable results The present evidence cannot support recommendations for guidelines on practice, but, can be used Prima facie by the surgeon to perform the procedure of their choice, until new evidence becomes available.

Paper Sesion 10: Trauma, Infection and Miscellaneous

A systematic review and meta-analysis of vertebral artery injury after cervical spine trauma

Jesvin Tom Sunny, Kartik Goyal, Conor S Gillespie, Martin J Wilby, Simon R Clark, Nisaharan Srikandarajah
The Walton Centre NHS Foundation Trust, Liverpool, United Kingdom

Introduction
Vertebral Artery Injury (VAI) caused by cervical spine (C-spine) trauma is uncommon, with high morbidity and mortality. CT angiography (CTA) is utilised in some centres to assist in diagnosis, however, the true incidence of VAI, investigations used, and outcomes are unclear. Our objective was to identify the incidence, mechanism of injury, investigations, management, and outcomes of VAI after C-spine trauma.

Methods
A systematic review and meta-analysis were conducted in accordance with the PRISMA guidelines. Three databases were searched (PubMed, SCOPUS and CINAHL PLUS), and all articles from inception to 1st May 2022 were included. Incidence of

VAI, investigations to diagnose (CTA, Digital Subtraction Angiography (DSA) or Magnetic Resonance Angiography (MRA)), stroke incidence, and management paradigms was delineated. Incidence was calculated using pooled proportions random effects meta-analysis.

Results
44 studies were included in this review (1777 patients total). 75.5% of patients suffered blunt trauma, and 24.5% penetrating trauma. The overall incidence of VAI in C-Spine trauma patients was 0.95%. Of all studies which reported, 8.87% of patients diagnosed with a VAI had a posterior stroke. Of the 33 studies with data on investigation, 91.7% underwent CTA for diagnosis. Of the rest, 7.5% underwent MRA and 3.0% underwent DSA. Management involved 17.9% undergoing conservative therapy, anticoagulation in 14.1%, antiplatelets in 16.4%, and combined therapy in 25.5%.

Conclusion
VAI in C- spine trauma has a significant risk of posterior circulation stroke. Optimal management paradigms for the prevention and management of VAI are yet to be standardized and require further research.

Natural History of Degenerative Spinal Surgical Pathology

Joanne Chambers, Susan Morison
Neurosurgery Department, Institute Neurological Sciences, Queen Elizabeth University Hospital, Glasgow, United Kingdom

Aim
To identify why patients were removed from the elective neurosurgical spinal surgical waiting list following Extended Scope Physiotherapy (ESP) Re-Evaluation.

Method
27% of patients waiting in excess of 18months for spinal surgery were removed following ESP re-evaluation. It is known that changes may occur in pain symptoms and spinal pathology over time. Clinic correspondence was reviewed to ascertain the reason for removal from the surgical waiting list. Data was collected indicating whether no clinical indication for surgery existed (improvement in distal symptoms, resolved pathology or stable function) or patient no longer wanted surgery (other health concerns).

Results
175 surgical patients were re-evaluated June 2021 to December 2022. Of the 43 patients (27%) removed; 15 (35%) were cervical and 28 (65%) were lumbar procedures. Overall 21 patients (49%) noted improved distal symptoms, 10 patients (23%) had resolved pathology despite ongoing distal symptoms. 6 patients had stable symptoms/function, 3 patients (7%) developed other health concerns, 2 patients (5%) Did not attend or reply to any contact and 1 patient (2%) underwent surgery overseas.

Conclusions
This post COVID-19 initiative streamlined the pathway for spinal surgical patients. It also gave insight into the natural history of degenerative spinal pathology. The patients who noted improved symptoms with correlating greater functional capacity were satisfied with their non-surgical management. However patients with persistent pain and limited function despite improved pathology were not. This audit may give guidance to the appropriate timing of spinal surgical procedures to maximise symptom and functional benefit to the individual patient.

Anatomical Predictor For Safe Pedicle Screw Length In Spinal Surgery

Laura Baxter[1], Fabian Wong ORCID iD[2], Stuart James[2], Michael McCarthy[2]
[1]*University of Cardiff, Cardiff, United Kingdom.*
[2]*University Hospital of Wales, Cardiff, United Kingdom*

Introduction
Anterior cortical breach is a known complication associated with excessive pedicle screw length, whereas the pull-out strength is reduced with a shorter screw length. We hypothesise that there is an anatomical correlation between the maximum safe pedicle screw length (PL) and the Inter-Pedicular Distance (IPD), which can be used intra-operatively as a simple adjunct to assess the safe screw length.

Method
A total of 1,734 pairs of PL-IPD from the computer topography (CT) of 51 patients were assessed, including 40 consecutive adult patients with normal spinal anatomy and 11 consecutive patients with scoliosis. Maximum PLs at each vertebral level were assessed on axial imaging in the plane of optimal entry point (lateral to superior articulating facet, SAF) and insertion along the centre of the pedicle. IPDs were measured as the distance between the bilateral entry points.

Results
There is a correlation between PL and IPD at each vertebral level ($R=0.121$-0.626). In adults with normal spines, the IPD between T2 and L4 are statistically smaller than the maximum PL for each corresponding level ($p<0.001$). In patients with scoliosis, the same findings were observed between T3 and L4 vertebral levels ($p\leq0.003$). At T1 and L5, IPD is longer than PL ($p<0.001$). The intraclass co-efficient between two assessors ranged from 0.83 to 0.91, and 0.97 to 0.99 for repeated measure by same the assessor.

Conclusion
IPD is a valid and readily accessible intra-operative anatomical landmark for estimating the maximum safe pedicle screw length in both scoliosis and non-scoliosis spinal surgery.

JAK inhibitor upadacitinib conversely regulates activated innate and adaptive entheseal immune cells by interfering with innate-cell negative feedback

Sami Giryes[1], Tom Macleod[2], Chi Wong[2], Mark Harland[2], Nicole McDermott[2], Abhay Rao[3], Almas L Khan[3], Peter Loughenbury[3], Robert Dunsmuir[3], Jake Timothy[3], Vishal Borse[3], Charlie Bridgewood[2], Dennis McGonagle[4]
[1]2B. Shine Rheumatology Unit, Rambam medical center, Haifa, Haifa, Israel. [2]Leeds Institute of Rheumatic and Musculoskeletal Medicine (LIRMM), University of Leeds, Leeds, United Kingdom. [3]Orthopaedic and Spinal Surgery, Leeds Teaching Hospitals, Leeds, Leeds, United Kingdom. [4]National Institute for Health Research (NIHR) Leeds Biomedical Research Centre (BRC), Leeds Teaching Hospitals, Leeds, United Kingdom

Introduction
Enthesitis is a primary lesion in the development of spondyloarthritis that precedes the development of arthritis in ankylosing spondylitis. Innate and adaptive immune cells are largely responsible for initiating the inflammation that starts at the enthesis through the production of key disease-driving proinflammatory mediators interleukin (IL)-23, TNFα and IL-17. Recently, Janus Kinase (JAK) inhibitors, small molecule inhibitors of kinases that transduce signals from numerous inflammatory mediators, have shown great efficacy in treating spondyloarthritis. Despite this, their mechanism of action at the enthesis is largely unknown.

Method
To elucidate how JAK inhibition modulates enthesitis we utilized an ex vivo enthesitis model, stimulating entheseal innate and adaptive immune cells extracted from spinous process material removed following scoliosis correction or spinal decompression surgery.

Results
Unexpectedly, whilst upadacitinib significantly inhibited secretion of IL-17 and TNFα from activated entheseal T cells it strongly increased LPS-induced production of IL-23, TNFα and IL-1β from innate immune cells. Addition of an IL-10 receptor blocking antibody to LPS stimulated cells mimicked the upadacitinib-induced increase in IL-23 secretion, suggesting JAK inhibition may remove IL-10-mediated negative feedback exacerbating inflammatory cytokine production. Despite the increase in myeloid IL-23 production, entheseal T cell IL-17 and TNFα production remained significantly inhibited by upadacitinib.

Conclusion
These results illustrate the opposing effects JAK inhibition has on the innate vs adaptive immune system at the enthesis, highlight the pivotal role of T-cell derived cytokines in spondyloarthritis given the known efficacy of JAK inhibition, and merit consideration regarding JAK inhibition in innate immune driven conditions.

Gram positive bacteria are present within non-herniated human discs; what is their influence?

Andrea Nüesch ORCID iD[1], Exarchos Kanelis ORCID iD[2], Leonidas Alexopoulos ORCID iD[2], Francis Williams[3], Liesbet Geris ORCID iD[4], Benjamin Gantenbein ORCID iD[5], Lee Breakwell[6], Melissa Lacey ORCID iD[7], Christine Le Maitre ORCID iD[1]
[1]University of Sheffield, Sheffield, United Kingdom. [2]National Technical University of Athens, Athens, Greece. [3]King's College London, London, United Kingdom. [4]University of Liege, Liege, Belgium. [5]University of Bern, Bern, Switzerland. [6]Sheffield Children's NHS, Sheffield, United Kingdom. [7]Sheffield Hallam University, Sheffield, United Kingdom

Objectives
Vertebral bone marrow lesions visualised as Modic changes (MC) on MRI scans have been associated with disc degeneration. For MC type I two different aetiologies have been identified. One of them being infection of the intervertebral disc (IVD). Even though evidence for bacterial presence within the herniated disc increases, there are limited studies determining whether bacteria are present in the intact IVD in-vivo or whether they represent contamination. This study aimed to investigate bacterial presence in non-herniated human IVDs and the potential influence of bacterial components on disc cells.

Methods
Immunohistochemical staining for Gram positive bacteria was performed on 75 human IVD samples. Nucleus pulposus cells in monolayer were treated with Lipopolysaccharide (LPS) (5-50µg/ml) and Peptidoglycans (PGN) (5-50µg/ml) for 48 hours. Cells in alginate were treated with PGN up to 72 hours. Secretome analysis was performed using Luminex. Statistical analysis was performed using Kruskal-Wallis and Dunn's multiple comparison test.

Results
Gram-positive bacteria were internalized by at least one disc cell in 90 % of the samples analysed. The percentage of cells containing bacteria across the NP was ~3%. Treatment of NP cells with LPS and PGN resulted in an increase of several catabolic cytokines such as IL-1, TNF and IL-6 alongside an upregulation of many other factors associated with disc degeneration.

Conclusion
This demonstrate that Gram positive bacteria are present in non-herniated and cadaveric human disc samples. Furthermore, it manifests the capability of bacterial cell membrane components to trigger a catabolic response in human disc cells.

Evaluating a pathway for reducing multiple debridement for Spine Surgical Site Infections (SSI)

Vinay Jasani ORCID iD, Sriram Srinivasan, Hussein Shoukry, Ankur Kariya, Zeiad Alshameeri
University Hospital of North Midlands, Stoke on Trent, United Kingdom

Introduction
Spine SSI is a problem often needing multiple debridement (multi-debridement). We evaluate our pathway's success with single debridement in comparison with Postoperative Infection Treatment Score for the Spine (PITSS) prediction.

Method
A retrospective review of a prospective database was carried out to identify re-operated SSI cases over 2 years.

We used a pathway of an infection MDT, blood and tissue cultures, aggressive IVA until CRP<20, metalwork exchange (rods and set screws) /removal and irrigation.

PITSS was calculated. Statistical analysis used percentage success, cross- tabulation and X2 test to assess the validity of PITSS.

Results
54 cases were identified. Only 38.9% scored low risk for multi-debridement on PITSS. Actual success for single debridement was 85.2% (n=46). We found only 14.3% (n=1) of high risk had multi-debridement. 19.5% of indeterminate and 9.5% of low risk needed multi-debridement. 52.8% of patients with instrumentation had exchange / removal of metal work. For multi-debridement (n=8); 2 had Enterobacter sp., 2 Pseudomonas sp. and 1 Proteus sp. Analysis for risk of needing multi-debridement did not find instrumentation, diabetes or bone graft to be significant (p>0.5). Not exchanging metalwork was more likely to result in multi-debridement but not significantly. PITSS sensitivity was 33.1%, specificity 76%, positive predictive value 14.3% and negative predictive value 90.5% (p=0.594).

Conclusion
Our cohort is larger than the original PITSS cohort. PITSS was a poor predictor of multi-debridement. We could not identify a specific factor associated with multi-debridement but numbers are small. Our pathway was more successful with single debridement than predicted.

Paper Sesion 11: Spinal Pathways and Commissioning

A pre-operative spinal education (POSE) intervention for spinal-fusion surgery is safe and could reduce hospital length of stay: A prospective cohort study

Jonathan Lucas, Rebecca Edwards, Jamie Gibson, Escye Mungin-Jenkins, Rashida Pickford, Gareth Jones
Guys and St Thomas' NHS Foundation Trust, London, United Kingdom

Introduction/Aims
Psychoeducative prehabilitation to optimise surgical outcomes is relatively novel in spinal-fusion surgery. The aim of this prospective cohort study was to determine if a Pre-Operative Spinal Education (POSE) programme, using the rehabilitation treatment specification system (RTSS) reduces anxieties, was safe, and reduced Length of Stay (LOS).

Methods
POSE was offered to 150 prospective patients over 10-months. Some chose to attend (Attend-POSE) and some did-not-attend (DNA-POSE). A 3rd independent retrospective group of 150 patients (mean age 57.9±14.8years, female 50.6%) received surgery Pre-POSE. POSE consisted of 60min of face to face education with accompanying literature. Across-group age, sex, median-LOS, perioperative complications, and readmission rates were assessed.

Results
Sixty-five (43%) patients (age 57.4±18.2years, female 58.8%) attended-POSE, and 85 (57%) DNA-POSE (age 54.9±15.8years, female 65.8%). There were no significant between-group differences in age, sex, surgery-type, complications, or readmission rates. Median LOS was Pre-POSE (5 range 3-7 days), Attend-POSE (3 range 2-5 days), and DNA-POSE (4 range 3-7 days). Pairwise comparisons showed statistically significant differences between Pre-POSE and Attend-POSE LOS (=0.011), but not between any other group comparison. In the Attend-POSE group, there was significant change toward greater surgical preparedness, procedural familiarity, and less anxiety.

Conclusion
POSE was associated with a significant reduction in LOS for patients undergoing spinal-fusion surgery. Patients reported being better prepared, more-familiar, and less-anxious about their surgery. POSE did not affect complication or readmission rates meaning its inclusion was safe.

Do Multidisciplinary Spine Conference alter the management plans and outcomes in Adult Spinal Deformity

Daniel Chin Shou Chien ORCID iD, Elie Najjar, Faris Karouni, Nasir Quraishi
Nottingham University Hospital - Queen's Medical Centre, Nottingham, United Kingdom

Introduction
Multidisciplinary spine conferences (MSCs) aim to improve the quality and minimise the complications of complex spine surgeries, by adopting a patient-specific approach.

Methods
A monthly MSC was established in 2019 to evaluate adult spinal deformity (ASD) patients requiring surgical correction. The meeting comprised of consultant spinal surgeons, intensivists, anaesthetists, geriatricians, radiologists, pain specialists and physiotherapists. This study compares the demographic and clinical outcomes of two cohorts of patients, pre and post-MSCs period.

Results
A total of 59 patients with an average age of 58.1 (18-84) were reviewed and discussed in the MSCs to reach consensus. Surgical plans were approved as planned in 31(52%) patients. 14 (24%) patients required pre-optimization or further investigation while 14 (24%) patients were rejected for surgeries. To date, 17 of the 31 approved patients underwent surgery. The in-hospital complications rate was 53% and one-year complications rate was 38%. The one-year revision rate was 0%.

49 patients with an average age of 65.4 (39-78) were operated in pre-MSCs period. The in-hospital complications rate was 39% and one-year complications rate was 67%. The one-year revision rate was 38%.

Statistical analysis comparing both groups showed significant reduction in one-year revision rate (38% vs 0%, p=0.03). No significant difference in age (p=0.28), BMI (p=0.48), average number of level of fusion (p=0.32), in-hospital complications (p=0.52) and one-year complications (p=0.50).

Conclusion
Implementation of MSCs was concurrent with an overall decrease in utilisation of ASD surgery in patients with multiple co-morbidities and lead to a reduction in revision rates.

Virtual Spinal Clinics versus Face to Face clinics- do patients like it? Using a Patient Reported Experience Measure (PREM) to find out

Anthony Gibson ORCID iD[1], Margaret Nugent[2], John O'Toole[1], Steve Bain[1], Odhran Murray[3]
[1]*Queen Elizabeth University Hospital, Glasgow, United Kingdom.*
[2]*Glasgow Royal Infirmary, Glasgow, United Kingdom.*
[3]*Galway Clinic, Limerick, Ireland*

A Virtual Spine Clinic (VSC) was introduced help with efficiency in 2017. Waiting times reduced but do patients like it or do they prefer a face to face (F2F) visit? We aim to measure their satisfaction using a validated patient reported experience measure (PREM).

Method
A version of the generic short patient experiences questionnaire (GS-PEQ) was sent to 140 patients reviewed through the VSC along with European quality of life, 5 dimension index (EQ5D-5L) and visual analogue scale (EQVAS). The same were collected after the clinic visit for 35 consecutive patients with direct Spine Clinic appointments.

Results
35 (25%) VSC PREMs forms were returned. The 2 groups were closely matched in deprivation and quality of life. EQ5D-5L mean index value in F2F of 0.47 and 0.41 in VSC. Mean EQVAS was 54 (SD 23) in F2F and 51 (SD 23) in the VSC group. Scottish Index Multiple Deprivation quintiles were mean 2.3 in F2F and 2.4 in VSC. Mean waiting time was 53 days in VSC and 262 days in F2F.

GS-PEQ components (scored out of 5) relating to communication in F2F were mean 4.7 v 4.3 (p=0.02) in VSC. Information in F2F was mean 4.2 v 3.6 (p=0.05). Organisation in F2F was 4.5 v 3.9 (p=0.004) and waiting time to be seen both were mean of 2.8. Perceived overall benefit was higher in F2F mean 4.8 v 2.8 (p<0.0001).

Conclusion
A recent move towards telemedicine shortens wait times. Our data suggests there may be a reduction in patient satisfaction.

The clinical utility of repeating MRI scans within 12 months in the management of lumbar disc disease

Ashhad Noor[1], Mohammed Al-Ahsqar[2], Sohail Nisar[1], James Grayston[1], Peter Loughenbury[3], Graham Radcliffe[2]
[1]*University of Leeds, Leeds, United Kingdom.*
[2]*Bradford Royal Infirmary, Bradford, United Kingdom.*
[3]*Leeds General Infirmary, Leeds, United Kingdom*

Background
MRI is the gold standard investigation for lumbosacral degenerative disc disease. However, there is controversy regarding the clinical value of repeating an MRI scan within 12 months when a patient presents with recurring or changing symptoms. This study measures rates of radiological change in a real-world cohort to guide clinicians when deciding to repeat a scan.

Methods
All patients over a ten-year window in one general hospital who underwent two lumbosacral MRI scans for degenerative disc disease within a twelve month period. MRI reports were reviewed. Time intervals between the two scans were calculated, these were collated into 30-day intervals for analysis. Repeat scans were categorized into three groups: no change, radiological improvement, and radiological deterioration. Emergency intervention due to a radiological changes were recorded.

Results
481 patients included. 390 (81%) showed no change in findings on repeat MRI scan, 18 (3.7%) were noted to have improved, and 73 (15.3%) had deteriorarated. From the 73 patients with a radiological deterioration, 3 patients (0.62% of total) required urgent surgical intervention.

Conclusion
Though there is no alternative to detailed clinical assessment in determining whether a repeat MRI scan is indicated, the findings demonstrate that repeating MRI within 12 months for patients with lumbosacral degenerative disc disease has a low chance of altering the management plan. Over the 10-year period, only three patients required an urgent change to their clinical management. We believe this data can help guide clinical decision making when considering a repeat scan.

Paper Sesion 12: Cauda Equina Syndrome and Miscellaneous

Conservative versus early surgical treatment in the management of pyogenic spondylodiscitis: a meta-analysis

Santhosh Thavarajasingam ORCID iD[1], Kalyan Vemulapalli[2], Sajeenth Vishnu K.[2], Hariharan Subbiah Ponniah[2], Alexander Sanchez-Maroto Vogel[3], Robert Vardanyan[2], Jonathan Neuhoff[4], Andreas Kramer[5], Shiban Ehab[6], Florian Ringel[5], Andreas K. Demetriades[7], Benjamin M. Davies[1]
[1]*Department of Academic Neurosurgery, Addenbroke's Hospital, Cambridge University Hospital NHS Healthcare Trust, Cambridge, United Kingdom.* [2]*Faculty of Medicine, Imperial College London, London, United Kingdom.* [3]*Faculty of Medicine, Goethe-Universität Frankfurt, Frankfurt am Main, Germany.* [4]*Center for Spinal Surgery and Neurotraumatology, Berufsgenossenschaftliche Unfallklinik Frankfurt am Main, Frankfurt am Main, Germany.* [5]*Department of Neurosurgery, Universitätsmedizin Mainz, Mainz, Germany.* [6]*Department of Neurosurgery, Universitätsklinikum Augsburg, Augsburg, Germany.* [7]*Edinburgh Spinal Surgery Outcome Studies Group, Department of Neurosurgery, Division of Clinical Neurosciences, NHS Lothian, Edinburgh University Hospitals, Edinburgh, United Kingdom*

Background
Spondylodiscitis is the most common spine infection, with a rising incidence of up to 2.4 per 100,000 per year in the Western world. Whilst antibiotics are the mainstay of treatment, some advocate that early surgery can support infection clearance, improve survival and prevent long-term consequences such as deformity. Given that the mortality rate is up to 20%, it is pivotal to identify the most effective treatment modality.

Objective
To compare mortality, relapse/failure rate and length of hospital stay of conservative versus early surgical treatment of pyogenic spondylodiscitis.

Methods
MEDLINE, Embase, Scopus, PubMed and JSTOR were searched for original studies comparing conservative versus early surgical treatment of pyogenic spondylodiscitis. Eligible studies underwent the meta-analysis.

Results
The meta-analysis, with an overall pooled sample size of 10,954 patients of 21 studies, found that the pooled proportional mortality among patients treated with early surgery was 8% and 13% for patients treated conservatively, the mean proportion of relapse/failure 15% and 21%, respectively. Further, it concluded

that early surgical treatment is associated with a 40% risk reduction in relapse/failure, 39% risk reduction in mortality when compared to conservative management, and 7.75 days per patient reduction in length of hospital stay ($p<0.01$). The most highly significant predictors of treatment outcome were found to be IVDU, diabetes, presence of epidural abscess, positive cultures, location of infection and age ($p<0.001$).

Conclusion
Overall, early surgery was always significantly more effective in terms of relapse/failure and mortality than conservative management in the treatment of pyogenic spondylodiscitis.

Elderly Spine Surgery: Is It Worth It?

Taofiq Desmond Sanusi ORCID iD, Bobby Sachdev, Sheikh Momin, Andraay Leung
Queen Elizabeth Hospital, Birmigham, United Kingdom

Introduction
An increasing ageing population is an emerging healthcare challenge. Adequate clinical evaluation and understanding outcome predicting factors are integral to delivering safe spinal surgery to the elderly.

Aim
To evaluate the outcomes of spine surgery in patients aged 80 or above.

Methods
We evaluated patients 80 years and above who underwent elective or emergency spinal surgery retrospectively between 2017 to 2022. The Eurospine Surgery Classification (ESC) was used to classify operations into Complex, Medium and Minor. We calculated Clinical Frailty Scores (CFS) pre-and post-operatively.

Results
Two hundred forty-five patients met the inclusion criteria. Most were male (n=143). The age range was 80 to 99 (mean 83.3). Most operations were elective (n=152, 62%). In our cohort, 205,19,20,2 and 1 had degenerative, trauma, tumour, infective and vascular pathologies, respectively. According to the ESC, 197 (80.4%) had Minor spine surgery (58 emergently and 139 electively), 31 had medium surgery (12.7% - 24 emergently and seven electively), and 15 had Complex surgery patients (6.1% - 7 emergently and eight electively).

184 (75%) were discharged or under follow-up. There were 11 in-patient mortalities (4.5%). Outpatient mortality was 36 (14.7%), with the average time from surgery to death being 1408 days.

CFS improved across the cohort, with an average of 6 pre-operatively to 4 post-operatively ($p <0.05$).

Conclusion
Spine surgery in those over the 80s could be performed safely and improve their quality of life, as demonstrated by improvement in CFS. Adequate pre-operative workup is essential, although it may sometimes be impossible in emergencies.

How to treat Cauda Equina Syndrome in pregnancy? A systematic review and critical appraisal of current evidence

Chinedu Egu ORCID iD, Samuel Akintunde, Motunrayo Adekoya, Elie Najjar
The Centre for Spine Studies and Surgery, Queens Medical Centre, Nottingham, United Kingdom

Introduction
Cauda equina syndrome (CES) in pregnancy is rare, accounting for 1-2% of those undergoing surgery for lumbar disc herniation in pregnancy. There is limited evidence regarding the optimal management of CES in pregnancy. We aimed to review the current evidence for the management of CES in pregnancy through critical appraisal and analysis of the available literature.

Methods
Searches were conducted in Medline, Embase, PubMed, Science-Direct, and Cochrane library from inception using predetermined search terms. All peer-reviewed studies of pregnant women with CES were included. The quality of eligible articles was assessed, and extracted data and characteristics were pooled for analysis.

Result
Twenty-six studies involving 30 patients were identified. The mean age of patients was 31.2 years (SD= 5.2), average gestational age was 26 weeks (SD=7.3). Disc herniation 73% (n=22) was the commonest aetiology. Most patients were positioned prone 70% (n=21) and had general anaesthesia 73% (n=22). Third-trimester spinal surgeries had a higher full recovery rate (41.7% vs 33% vs 0%) and reported fewer persistent symptoms (58.3% vs 66.7% vs 100%) than second and first. Minimally invasive spinal surgery had a higher full recovery rate (50% vs 23%) and lesser persistent symptoms (50% vs 77%) than the open approach.

Conclusion
There is limited evidence to guide the management of pregnant patients with CES. Despite suggestions for improved outcomes with minimally invasive spine surgery and third-trimester surgeries, selection bias and overall poor quality of current research limits reliable conclusions. Decision-making should be undertaken within an MDT setting.

Transforaminal endoscopic access to L5S1: Imaging characterization of the lower lumbar spine and pelvis for surgical planning

José Miguel Sousa ORCID iD[1], António Serrano ORCID iD[1], Afonso Nave ORCID iD[1], Vasco Mascarenhas ORCID iD[2], Paulo Nogueira ORCID iD[3], João Gamelas ORCID iD[1], José Consciência ORCID iD[4]
[1]Centro Hospitalar Lisboa Ocidental, Orthopaedics Department, Lisboa, Portugal. [2]Musculoskeletal Imaging Unit, Imaging Center, Radiology Department, Hospital da Luz, Lisboa, Portugal. [3]Instituto de Medicina Preventiva e Saúde Pública, Faculdade de Medicina, Universidade de Lisboa, Área Disciplinar Autónoma de Bioestatística (Laboratório de Biomatemática), Lisboa, Portugal. [4]Centro Hospitalar Lisboa Ocidental, Pre and Pos Graduation Department, Lisboa, Portugal

Objective
To determine and compare the pelvic and lumbosacral reference parameters with computed tomography (CT) in patients with low back pain (LBP), and a control group of asymptomatic patients, to provide quantification data and morphological correlations for L5S1 transforaminal endoscopic approach (L5S1TEA).

Methods
We prospectively evaluated 100 patients with LBP and a control group of 100 individuals, with spinopelvic CT. We measured lumbopelvic anatomic parameters and L5S1 transforaminal approach parameters: maximum and minimum approach angles (maxAA and minAA) and skin incision (maxSI and minSI), iliac crest (IC) height at intersection point (ICPi), distance between intersection of maxAA with the ilium (ICi) to the posterior limit of the IC (ΔICi-ICpost), distance between ICi to spinous process (ΔICi-SP).

Results
Mean measures: maxAA 48.38°±5.09°, minAA 32.5°±3.90°, maxSI 11.39±1.86cm, minSI 8.30±1.48cm, L5S1 facet angles 48.81°±9,60°, DICi-ICpost 0.67±0.39cm. Ilium intersection was increased in males. IC height at highest point (ICPh) was higher than ICPi. The maxAA and minAA intersected the ilium in 28% and 1.5% of cases, respectively. ICi was positively correlated with facet angle, ICPh, and ICPi, and negatively with ΔICi-SP.

Conclusion
Our results set preliminary reference values for L5S1TEA surgical planning. Traditional IC height (ICPh) does not correspond to the point of intersection of the approach and is significantly higher than ICPi. ICi correlated to higher facet angle values, ICPh and ICPi grade, and lower ΔICi-SP. Potential conflict with the ilium is increased in male population. IC is not impeditive of L5S1TEA in the majority of cases.

Spondylodiscitis: Can recent historical microbiology results help guide identification of the causative organism?

Jade Cuthbert, Benjamin Davies ORCID iD, Lennel Lutchman, Andrew Cook, Nicholas Steele, Girish Swamy, Thomas Marjoram
NNUH, Norwich, United Kingdom

Introduction
Spondylodiscitis is a potentially serious conditions with rates increasing in recent years. Early targeted antibiotic therapy improves the prognosis; however, the pathogen is unknown in up to 30% of cases. Identification of a causative organism is important for effective management, as many patients can be managed with antibiotics alone

Given that pathogenically most cases arise from haematogenous spread, we aimed to assess whether evidence of previous recent bacterial infection (as confirmed on microbiological cultures) can help guide the causative organism in patients with spondylodiscitis.

Methods
Retrospective notes review of all patients referred to our tertiary spinal unit with a first presentation of MRI confirmed spondylodiscitis between 2014-2021 were reviewed. We reviewed microbiology cultures from the 6 months preceding diagnosis, comparing positive results with the spondylodiscitis causative organism.

Results and discussion
Of the 248 patients that had an identified organism 161 had preceding urine cultures (the majority of which were negative (125/161). Of those that had an identifiable organism and a positive urine culture 35% mirrored the spondylodiscitis causative organism and sensitivities.

Conclusions
In this large series 65% of patients had been investigated for an infection within the 6 months preceding their diagnosis. 35% of those with a positive result on this investigation developed a spondylodiscitis with the same causative organism. In those patients where positive preceding microbiology results are available this study would advocate taking this into consideration when planning antibiotic therapy.

Flow Coaching Academy Cauda Equina Syndrome Big Room: System Wide Pathway Improvement

Jennifer Carroll, Manoj Khatri, Jill Billington, Poorna Veerappa
Lancashire Teaching Hospitals NHS Foundation Trust, Preston, United Kingdom

Introduction
Cauda equina syndrome (CES) is an emergency and complex spinal condition which requires time sensitive assessment and treatment. The delivery of a robust, effective Cauda Equina Pathway will negate potential catastrophic negative outcomes for both patients and clinicians, as well as supporting capacity and demand pressures across our system. Our patients' voices are central to this improvement work with patient stories informing our strategy.

Method
Utilising Flow Coaching Academy Methodology a multidisciplinary working group, CES 'Big Room' has developed a shared global aim 'to improve the pathway for patients with suspected cauda equina syndrome (CES) through standardisation of process across our system'.

Result
The process, from initial presentation, identification of symptoms, the need for timely clinical assessment, appropriate imaging, ending with confirmed diagnosis and clinical management plan has been identified. Patient outcomes are expected to be improved, improvements in patient experience have been demonstrated. Improved quality of patient care will involve standardisation of a digital electronic patient record, minimising variation, preventing duplication, enhancing communication, fewer time delays and out of hour diagnostic requests, enabling timely clinical decision making and treatment.

Utilisation of digital tools to enable system wide engagement has been embraced with outcome, process and balancing measures measured. An initial test of change within 1 of our ED departments has been undertaken with a system wide 2nd test of change across 3 Hospital Trust sites scheduled. An AHP & Nursing Development Training education event is to be delivered. This improvement work compliments the National GIRFT pathway review.

When should we use intra-operative cell salvage in Spinal Surgery?

Claire Spolton-Dean, Rajan Jandoo, Oliver Stokes
Royal Devon University Hospital, Exeter, United Kingdom

Aims
Significant blood loss is a recognised complication of spinal surgery and the use of intra-operative cell salvage (IOCS) is becoming more common.

Within our trust spinal surgery is the 2nd largest user of IOCS, after obstetrics and gynaecology, with the vascular surgeons being the 5th largest user.

Our aim was to identify any trends which would allow guidelines to be set out for routine use of IOSC.

Patients and Methods
We performed a retrospective review of all spinal patient cases where cell salvage was set up between January 2020 - September 2022, during which time 401 procedures in 396 patients were performed. Age range = 12-90. 94% of cases were planned elective.

Patients electronic records were reviewed for basic demographics including BMI and ASA grade, surgery type, CEPOD classification, number of levels, length of procedure, IOSC volume collected and reinfused, use of intraoperative TXA and pre-operative clotting.

Results
69% of cases processed sufficient IOSC to transfuse patients with autogenic blood between 88-1940ml.
8% of cases required an allogenic blood transfusion.
66% had TXA at induction.

No statistical difference has been identified between CEPOD, spinal level, surgery type or complexity for IOSC volume collected.

Conclusion
IOSC use in spinal surgery is worthwhile, with the majority of cases receiving their own blood back. This reduces the risks and costs associated with allogenic blood transfusion and protects limited resource. We suggest a national study looking at IOSC data in spinal surgery to identify statistically significant trends to further rationalise the use of IOSC. ■

BritSpine 2023 Poster Abstracts

Cauda Equina Syndrome

Suspected Cauda Equina Syndrome - Are We Getting It Right?

Benjamin Drake, Lucie Ferguson, Thompson Opara, Simon Tizzard, Zak Choudhury
James Cook University Hospitals, Middlesborough, United Kingdom

Introduction
The 2019 Get It Right First Time (GIRFT) report for Spinal Services aimed to reduce variability in spinal care and promote referral pathways. Recommendations for Cauda Equina Syndrome (CES) suggests a low threshold for emergency Magnetic Resonance Imaging (MRI), which should be available at referring hospitals 24/7.

Aim
To establish whether GIRFT guidelines are being met and demonstrate a clear case to empower referring units to run a 24/7 MRI service.

Method
A retrospective audit of all referrals through www.referapatient.org. with suspected CES to James Cook University Hospital in 2021 was conducted, with a reaudit from October-December 2022.

Results
In 2021 there were 221 referrals with suspected or MRI confirmed CES. 135/221 patients were referred from centres that do not have 24/7 MRI. 39/135 patients were transferred for an emergency MRI scan and 35/39 were transferred out of hours (OOH). 30/35 required no acute spinal input and were transferred back to the referrer. In 2022 one unit opened a 24/7 MRI scanner. When reaudited 18 patients were referred OOH with two transferred for MRI compared to 33 referrals and six transfers during the same three months in 2021.

Conclusions
GIRFT recommendations are not being fully met. However, following the introduction of a 24/7 MRI scanner at one local unit, OOH transfers significantly reduced, cutting pressure on ambulance services and tertiary centres. There is also likely a financial saving that can be made.

Rethinking community and primary care referral pathways for cauda equina syndrome: A service evaluation

Jonathon Gill ORCID iD[1], Jos M. Latour ORCID iD[2], Sue Greenhalgh ORCID iD[3], Stephen Pickup ORCID iD[1], Pradeep Madhavan[1], Paul Thorpe[1], James Gagg ORCID iD[1], Paul Burn[1], Guru Karnati[1], Gillian Yeowell ORCID iD[4]
[1]*Somerset NHS Foundation Trust, Taunton, United Kingdom.*
[2]*University of Plymouth, Plymouth, United Kingdom.*
[3]*Bolton NHS Foundation Trust, Bolton, United Kingdom.*
[4]*Manchester Metropolitan University, Manchester, United Kingdom*

Introduction
Cauda equina syndrome (CES) is a rare, but devastating, spinal emergency. Physical, psychological and emotional sequelae are commonplace. National guidance recommends emergency access to MRI scanning to expedite diagnosis.

Research shows introducing a CES pathway improves diagnosis, but also increases MRI utilisation, on-call Orthopaedic workload, and out-of-hour scanning. To address these issues, our hospital adopted a novel approach of requesting emergency MRI scans based on criteria-led community/primary care referral details; enabling MRI planning to commence whilst patients travelled to the Emergency Department (ED).

This service evaluation aims to evaluate standards of care following the implementation of the new pathway.

Method
A retrospective service evaluation was undertaken of all emergency MRI scans investigating CES, over two 3-month periods (pre-/post-implementation). Key outcomes were: time to MRI scan, duration in ED, time to surgery, on-call Orthopaedic involvement, and out-of-hours MRI utilisation.

Results
The redesigned pathway resulted in additional MRI scans: pre-implementation n=50, post-implementation n=128; which is consistent with other CES pathways. However, it also resulted in a 2-hour reduction in time to MRI; 1.5-hour reduction in duration in ED (mean/median<4hours); reduced time to surgery; and a fivefold reduction in out-of-hours scanning, from 10 to 2 patients. On-call Orthopaedic involvement reduced by 37.5%, additional advantages of MRI results being presented on initial referral were also highlighted. Increased Radiology workload was noted, with ongoing efforts to address this.

Conclusion
By employing this novel approach, improvements were made in all timed outcomes. This suggests expediting MRI scans can result in significant downstream benefits.

Exploring diagnostic uncertainty in cauda equina syndrome: presenting features and association with radiological cauda equine syndrome in a same day emergency care service evaluation

Lianne Wood ORCID iD[1], Eleanor Dunstan[1], Khalid Salem[1], Daniel D'Aquino[1], Mohammed Patel[1], Martyn Lewis[2]
[1]Nottingham University Hospitals NHS Trust, Nottingham, United Kingdom. [2]Keele University, Newcastle-under-Lyme, United Kingdom

Cauda equina syndrome (CES) may have significant individual consequences if delays to diagnosis or treatment occur. Clinicians seek reassurance regarding the variability of patient presentation due to the medico-legal implications of a missed diagnosis. The aim of this service evaluation was to evaluate the presenting subjective and objective features of patients with suspected CES.

Methods
This was a retrospective analysis of all cases presenting with suspected CES to a tertiary NHS Trust same day emergency care unit. Routine data collection was supplemented with subjective and objective assessment records and compared between radiological cauda equina compression (CEC) and non-CEC. Chi square analysis, univariate and multivariate regression analyses were conducted.

Results
790 patients presented with suspected CES between 2020-2021. 96 (12.2%) had radiological CEC. Of those with non-CEC (n=694), 476 (60.3%) had spinal pathology and 218 (27.6%) had no spinal pathology. Most were female (n=559, 70.8%), on average 45.51 years old, referred from the Emergency Department (n=352, 44.6%). Only sexual dysfunction (2.83, 95% CI 1.11 -7.21); bilateral leg pain (OR 2.38, 1.03- 5.53); absent bilateral ankle jerks (OR3.46, 1.47 -8.16) remained statistically significant for association with CEC in the final multivariate model.

Conclusions
This service evaluation of suspected CES cases presenting to a same day emergency care unit highlights the variability in presenting features of CES. This suggests that clinicians need to remain suspicious for CES irrespective of the subjective or objective presentation, however, those with bilateral leg pain, absent ankle reflexes or sexual dysfunction may need higher indices of suspicion.

Cauda equina syndrome: a retrospective service evaluation of radiological cauda equina compression cases presenting to a same-day emergency care unit

Lianne Wood ORCID iD[1], Eleanor Dunstan[1], Khalid Salem[1], Daniel D'Aquino[1], Mohammed Patel[1], Martyn Lewis[2]
[1]Nottingham University Hospitals NHS Trust, Nottingham, United Kingdom. [2]Keele University, Newcastle-under-Lyme, United Kingdom

Cauda equina syndrome (CES) may have significant individual consequences if delays to diagnosis or treatment occur. The aim of this service evaluation was to explore the outcome of those with a radiological compression of CES with symptoms presenting to a tertiary NHS Trust a same day emergency care unit.

Methods
This was a retrospective analysis of all cases presenting with radiological CES compression and CES symptoms. These were categorised using the Lavy framework: suspected CES (CESS), early CES (CESE), incomplete CES (CESI) and retention CES (CESR). Descriptive statistics (mean, %), and chi square analysis was used to compare proportions, with ANOVA regression analyses to compare means.

Results
115 patients presented with radiological compression of CES between 2020-2022. CES cases were most often referred from other sources n=48 (41.7%)(secondary care, on call service, or other), emergency department (n=44, 38.3%) and primary care (n=23, 20.0%), and were on average 43.4 years (SD 12.6) and male (n=67, 58.2%). Most CES cases were defined as CESI (39.1%), followed by CESE (32.2%), CESS (18.3%) and CESR (10.4%). 88/115 (76.5%) proceeded to have surgery and outcomes were related to categorisation (CESS 100%, CESE 69.2%, CESI 76.3%, CESR 45.5% resolution respectively).

Conclusions
This service evaluation demonstrates that most presenting cases attending a same day emergency care unit had complete symptom resolution post-operatively despite categorisation. However, those with milder symptoms (CESS, CESE, CESI) had higher proportions of full recovery. This evaluation highlights the importance of addressing suspected CES features with early imaging and appropriate counsel.

Post Void Residual Volume in the assessment of Cauda Equina Syndrome

Jocelyn Cheuk ORCID iD, Harriet Lewis, Hui-Ling Kerr
Gloucestershire Hospitals NHS Foundation Trust, Gloucester, United Kingdom

Background
Cauda equina syndrome (CES) is associated with devastating functional disabilities. There is no combination of red flag symptoms or signs that reliably predict a positive diagnosis. Studies demonstrate a post void residual (PVR) volume of greater than 200mls having a high sensitivity and specificity for MRI confirmed CES.

Aim
To assess the standard of PVR documentation before and after the introduction of electronic patient records and to determine the degree of correlation between PVR and MRI confirmed CES.

Method
A retrospective audit was conducted between November 2018 and September 2021 of all suspected CES admissions. Paper clerking records were reviewed to assess documentation of post void residual volumes. The PACS imaging system was used to identify MRI confirmed CES. Following the introduction of electronic patient records a subsequent re-audit between February and October 2022 was performed.

Results
The initial audit of 132 paper patient records identified that 19.6% (n=26) had a documented PVR. Following the introduction of electronic patient records the PVR was documented in 46.7% of 152 patients (n=71). 15.7% (n=24) had a PVR greater than 200mls and MRI confirmed CES in 20.8% (n=5) of these cases, providing a sensitivity of 22.7%, a specificity of 85.0%, and a negative predictive value (NPV) of 86.4% (p=0.23).

Conclusion
This study mirrors the literature, supporting a high NPV for CES with a PVR less than 200mls and making the PVR volume an useful adjunct to conventional clinical assessment and facilitates risk-stratification. Electronic patient records improve the documentation of this study.

Impact of a local DGH pathway on the waiting time for urgent MRI and surgery in suspected cauda equina syndrome

Harshad Dabke ORCID iD, Saad Islam, Alexander Chowdhury, Benjamin Woolner, Alexander Denning, David Gibbs, Graham Lloyd-Jones, Nick Evans, Guy Barham
Salisbury District Hospital, Salisbury, United Kingdom

Aims
The impact of a local pathway on waiting times for urgent MRI and surgery was assessed in patients presenting to a UK district hospital with suspected Cauda Equina Syndrome (sCES).

Method
The Salisbury Protocol for Assessment of Cauda Equina Syndrome (SPACES) was implemented during 2017. 524 consecutive patients who had urgent MRI scan were divided in to 2 groups- 2016 (control group) and 2018-21 (study group). Patient gender, age, MRI diagnosis, time from MRI request to imaging, time from admission to surgery and number of transfers to tertiary centre were compared.

Results
In 2016, 66 patients underwent MRI out of which 10.6% had cauda equina compression (CEC), 63.5% had other spinal pathology and 25% had a normal scan. In 2018-21, out of 458 patients, 9% had CEC, 84% had other spinal pathology and 7.7% had a normal scan. Despite increased referrals, median waiting time for MRI decreased from 9.3 hours in 2016 to 3 hours in 2018-21. Waiting time from admission to surgery in 2016 was 24 hours and in 2018-21 was 19.7 hours. Average number of transfers to the regional hub decreased from 7 in 2016 to 3 every year (2018-21).

Conclusions
Implementation of SPACES resulted in a substantial reduction in waiting times for MRI and number of transfers to the regional hub hospital. There was no difference in the waiting time for surgery. CEC requiring emergency surgery was seen in only 8-10% patients. We encourage other UK hospitals to implement such a pathway for patients with sCES.

Innovation & technology

Image-driven subject-specific spine models: developing a novel tool to measure in-vivo loading

David Williams[1], Michael Ward[2], Emily Kelly[2], Dionne Shillabeer[1], Jenny Williams[1], Akbar Javadi[2], Timothy Holsgrove[2], Judith Meakin[2], Cathy Holt[1]
[1]Cardiff University, Cardiff, United Kingdom.
[2]University of Exeter, Exeter, United Kingdom

Introduction
Determining the force that an individual spine is experiencing is essential for characterising healthy spine function and understanding the development of spinal disorders such as back pain. Multimodal imaging has the capability to provide a complete understanding of how the spine moves and responds to load in vivo, and our project aims to develop methods for using spine imaging to inform customised subject-specific computer models that can predict spine forces in vivo.

Methods
Magnetic resonance and biplane x-ray imaging are used to capture information about the anatomy, tissues, and motion

of an individual's spine as they perform a range of everyday activities. This information is then utilised in a subject-specific computational model based on the finite element method to predict the forces in their spine. The project is also utilising novel machine learning algorithms and six-axis mechanical testing on human, porcine and bovine samples to rigorously develop and test the modelling methods.

Results
Protocols have been developed for measuring spine kinematics in vitro and in vivo, and testing is in progress. Preliminary model work has evaluated potential machine learning approaches and quantified the sensitivity of our models to material properties.

Conclusion
The development and testing of our image-driven subject-specific spine models will provide a new tool for determining forces in the spine. It will also provide new tools for measuring and modelling spine movement and quantifying the properties of the spinal tissues.

Booting up and Logging on: a real turn off? A survey of 'wasted' clinician time navigating NHS Trusts' multiple non inter-compatible IT systems

Akshat Sharma, Anurag Dixit, Anthony Marino
Royal Wolverhampton Hospitals NHS Trust, Wolverhampton, United Kingdom

Introduction
NHS England aspires to carbon neutrality by 2045. Our Trust's 'Green Plan' includes becoming '100% paperless', having introduced 'PACS' digital radiology in 2008, Electronic Patient Records (EPR) in 2012, Electronic Dictation (ED) n 2017 and a Sustainability Lead ('Green Champion') in 2022. However, frustration is frequently expressed at delays in 'setting up for clinic' due to perceived excessively laborious, repetitive and time consuming 'booting up' / multiple logons before commencing actual 'clinical activity'. We present a survey of current out-patient clinic experience, quantifying these delays.

Methods
Up to 20 clinicians (Consultants/ Middle Grades) work at any one time in our out-patient department, each accessing a personal computer (PC). For each PC, the time required for booting up, then logging on to the PC,EPR, 'PACS' and the ED was recorded , inviting colleagues' comments.

Results
It took an average of 91 seconds to switch the PC's on (range 13-269 seconds), then 94 seconds(s) to log on to a PC (range 36-455) , 'PACS' 55s (range 22-138), EPR 66s (range 26-213), ED 52s (range 135-950), giving an average of 4 minutes 4s 'delay' per clinician in commencing actual clinical activity. However, taking into account colleagues' reporting of 6 re-boots and 14 'timing out' repeat logons , the actual average delay was 5 minutes 54 seconds, equating to a total of 2 hours and 4 minutes perceived loss of 'clinical activity' per OPD clinic.

Conclusion
We look forward to working with our IT Department to try and streamline the 'logon' on process.

Miscellaneous

Anticoagulation And Spinal Injections. Perioperative Safety Of Anticoagulation Use For Spinal Injections

Muzamil Baba, Ocha Onazi, Amit Amit, Hamidreza Khairandish
Kettering General Hospital NHS Foundation Trust, Kettering, United Kingdom

Background
Pre- and post-procedural management of prophylactic and therapeutic anticoagulation in spine injections from anaesthesia to steroids is important to mitigate post-procedural risks of complications. A growing field of research shows most guidelines are based on spinal surgeries and anticoagulant half-lives in therapeutic doses and we wanted to find the safety use of anticoagulation for spinal injections.

Objectives
We aim to question if current guidelines for anticoagulation in spinal surgeries can be extended to spinal injections, and if so, to what degree based on the bleeding risk categories. As well as review existing evidence for safe practice of spinal injections in patients who are on anticoagulation.

Methodology
A PubMed search from the last 5 years using multiple search words in order to find well reviewed and up to date literature on anticoagulation and spine injections.

Results
16 articles consisting of 3 Prospective Randomized studies of 1036 procedures, 5 retrospective studies of a total of 4178 procedures, 2 prospective studies of 13 214 procedures, 3 cross-sectional studies of 595 practices in the UK, US and Germany, and 1 case report were analysed. There is overwhelming evidence that continuing anticoagulation in spinal injections and procedures with low to intermediate bleeding risk is safe.

Conclusion
With a look at the ASRA grading of bleeding risks, based on increasing evidence, we can begin to consider continuing anticoagulants and/or reducing multiple anticoagulation regimens to one agent, for minimally invasive spine procedures or procedures with low to intermediate bleeding risks.

A UK survey evaluation of First Contact Practitioners' and musculoskeletal physiotherapists' confidence, recognition, and referral of suspected axial spondyloarthritis

Eliza Steen ORCID iD[1], Carol McCrum[2], Melinda Cairns[1]
[1]*University of Hertfordshire, Hatfield, United Kingdom.*
[2]*University of Brighton, Brighton, United Kingdom*

Background
An evaluation by the same authors (2021) found physiotherapists lacked adequate awareness of axial spondyloarthritis (axSpA) in back pain assessments or features that raise suspicion. Since the previous survey, axSpA professional education has occurred and First Contact Practitioners (FCPs) in General Practice are now also key in supporting earlier recognition.

Aims
To evaluate FCPs and re-evaluate musculoskeletal physiotherapists' awareness, knowledge, and confidence in recognising features of axSpA and compare to previous research.

Methods
Using the previous strategy, an online survey was undertaken combining back pain vignettes (axSpA, non-specific low back pain (NSLBP) and radicular syndrome) and questioning on features of suspected axSpA. Analysis used descriptive statistics and content analysis.

Results
Of 165 surveys analysed, only 73% (n=120/165) of respondents recognised the axSpA vignette compared to NSLBP 91% (n=80/88) and radicular syndrome 88% (n=68/77). A trend towards improvement in axSpA recognition was demonstrated compared with previous data. FCPs performed slightly better with 77% (n=67/87) recognising the axSpA vignette. Adequate awareness of national referral guidance was evident in only 55% of 'clinical reasoning' and 6% of 'further subjective screening' responses. There was still misplaced confidence in recognising clinical features of axSpA and when to refer compared to knowledge levels demonstrated.

Conclusion
Musculoskeletal physiotherapists demonstrated some improved knowledge and awareness of axSpA compared with previous findings. Consideration of axSpA is still not universal in approaches to back pain assessments by musculoskeletal physiotherapists or FCPs. There remains a need for ongoing professional education to support earlier diagnosis and better outcomes.

Intraoperative Considerations for Surgical Management of Scoliosis in GGSPS1 a Rare Genetic Muscular Dystrophy: A Case Report

Matthew Bellamy[1], Raveen Jayasuriya ORCID iD[2], Ian Scivill[2], Robert John[2], Edward Bayley ORCID iD[2]
[1]*Sheffield Medical School, Sheffield, United Kingdom.*
[2]*Sheffield Children's Hospital, Sheffield, United Kingdom*

Background
GGPS1 is a rare genetic muscular dystrophy and is associated with progressive scoliosis, commonly resulting in early wheelchair use. Of the 21 globally reported cases, 15 have undergone fusion surgery. There is no published literature on spinal management or surgical considerations to guide preoperative planning.

Methods
A rare disease case study of an 8-year-old girl with GGPS1 and rapidly progressing left thoracic scoliosis who underwent T2-L3 posterior spinal fusion. This report focuses on intra operative learning points to optimise surgical management and early post-operative results.

Results
Preoperatively the patient had normal motor function, thus full sensory-motor neuromonitoring was expected prior to proceeding with surgery. Intraoperative monitoring was adjusted from 1mS to 4mS interstimulus interval to achieve adequate morphology and amplitude of MEP waveforms.
Preoperative assessment had not identified metabolic bone abnormalities. Very poor bone quality was clinically evidence intraoperatively, prompting a change to a higher instrumentation density (1.5) construct. This achieved coronal plane correction from 65degrees to 29degrees.
Probing pedicle screw holes was highly haemorrhagic, resulting in estimated blood loss of 750mls (80% of circulating volume), with 303ml returned by cell salvage, 166mls of donor blood. Surgical progress was paused whilst fluid resuscitation with blood products reinstated haemodynamic stability.
Neurological function was normal postoperatively and no further blood products required.

Discussion
Learning points: 1) Neuromonitoring needs adapting in view of neuromuscular pathology. 2) Consider metabolic bone specialist pre operatively 3) High implant density required, 4) Prepare for high volume blood loss with pause for resuscitation and cross-matched donor blood.

A retrospective review of gram-negative spinal infections in a single tertiary spinal centre over six years

Daniel Tadross ORCID iD[1], Cieran McGrory[2], Julia Grieg[3], Robert Townsend[3], Neil Chiverton[3], Adrian Highland[3], Ashley Cole[3]
[1]*Doncaster Royal Infirmary, Doncaster, United Kingdom.*
[2]*Huddersfield Royal Infirmary, Huddersfield, United Kingdom.*
[3]*Sheffield Teaching Hospitals, Sheffield, United Kingdom*

Introduction
Gram-negative infections are associated with co-morbid patients but outcomes are less well understood. This study reviewed diagnosis, management and treatment for a cohort treated in a tertiary spinal centre.

Methods
Retrospective review was performed of gram-negative only spinal infections (n=40, median age 68) at a single centre between 2015-2020 (2-6yr follow-up). Information was gathered from clinical/MDT notes. Organism identification method, antibiotic regime and treatment outcomes (including clinical, radiological and biochemical) were collected.

Results
All patients had co-morbidities and/or interventional procedures in the previous year. Most infections affected lumbar segments (28/40) with E.Coli the commonest organism (19/40). Causative organisms were identified by blood culture (24/40); biopsy (10/40); or intra-operative samples (6/40). There were 75 different antibiotic regimes, PO ciprofloxacin was most prevalent (16/75, 21.33%). Multi-level, contiguous infections were common (9/40, 23%) usually resulting in bone destruction and collapse. Epidural collections were seen in 14/40 (35%) but only 3 patients required surgery for neurological symptoms. Overall, 9 patients required surgery, 5 for neurological deterioration. 32 patients improved or fully recovered, with average halving of CRP at 8.3 days. At time of review (maximum 5-6 years post diagnosis) 16 patients were deceased.

Conclusions
This is the largest cohort of gram-negative spinal infections. In older patients with co-morbidities +/- previous interventions in the last year, a high level of suspicion must be given to gram-negative infection with blood cultures and biopsy essential. Early organism identification permits targeted treatment and good initial clinical outcomes, however, mortality is 40% at 2-6 years after diagnosis.

Back to Driving (A questionnaire gauging the recommendations of UK spinal surgeons on returning to driving postoperatively)

James Beavis ORCID iD[1], Dominique da Luz[2], Duncan Whittaker[1], Santosh Baliga[1]
[1]*NHS Grampian, Aberdeen, United Kingdom.*
[2]*Aberdeen Medical School, Aberdeen, United Kingdom*

Introduction
United Kingdom guidelines state patients must consult their doctor concerning returning to driving (RTD) post-spinal surgery. However, little consensus or national guidance exists on how to give advice. This study aims to examine RTD advice from UK spinal surgeons.

Methods
A voluntary questionnaire was distributed to members of the British Association of Spinal Surgeons examining the RTD advice for four spinal operations. Qualitative data was gathered regarding opinions on leaflets, liability and national guidelines. Numerical responses were analysed using SPSS.

Results
115 surgeons responded: 69% (79) orthopaedic surgeons, 30% (35) neurosurgeons, and 1% (1) dual-trained. 70% (80) practised within England, 22% (25) Scotland, 4% (5) Northern Ireland, 3% (4) Wales and 1% (1) Ireland. The mean recommendations for weeks until RTD were: 4.03 (SD=1.88) for lumbar spine decompression and/or fusion, 4.91 (SD=1.95) for lumbar spine discectomy, 4.56 (SD=2.19) for anterior cervical discectomy, and 6.50 (SD=2.61) for thoracolumbar fixation for fracture. Considering all operations, the mean weeks until RTD recommendation was: 4.96 in England, 3.84 in Scotland, 4.60 in Northern Ireland, 5.27 in Wales and 6.00 in Ireland ($p=0.007$). Neurosurgeons recommended RTD 1.06 weeks before orthopaedic surgeons ($p=<0.001$). 83% (96) of respondents thought the patient is liable in a postoperative driving accident and 30% (35) give a leaflet concerning RTD. 45% (52) feel national guidance concerning RTD is necessitated.

Conclusions
Post-spinal surgery RTD advice differs based on location and operating surgeon, which can have economic, personal and health consequences to patients. Further deliberation and research are needed on RTD.

One to be aware of – Facet Joint Septic Arthritis!

Sheweidin Aziz, Ananth Srinivasan, Beibit Bahabayev, Partha Basu
University Hospitals of Leicester, Leicester, United Kingdom

Aims
Facet joint Septic Arthritis (FJSA) is a lesser-known and less-reported spinal infection variant. The role of modern spine surgical practice is scarcely reported. We aim to raise awareness and share our experience.

Methods
A prospective observational study of 25 patients presenting with FJSA to a spinal unit with close collaboration with Infectious Diseases (ID) from 2016 - 2022. Data included demographics, presentation, clinical course and outcomes.

Results
There were 12 women and 13 men. Median age was 66 (9-84, IQR 55-71). Twenty-two (88%) presented with axial spinal pain, six (24%) had fever and two (8%) were septic. Seven (28%) had neuro-deficit on admission, six reported neuropathic pain, one had complete Cauda Equina syndrome, twelve (48%) had epidural collection, eight had (32%) paraspinal abscesses and six (24%) concomitant spondylodiscitis. Four (16%) had concurrent extra-spinal septic foci. One case was following acupuncture for back pain, the remaining were haematogenous.

MRI whole spine confirmed all FJSA cases. Raised C-Reactive Protein (CRP) and Neutrophilic leucocytosis in 22 cases (88%). Staph Aureus was the commonest identified organism (11/14).

Three patients had image-guided abscess drainage, and two had decompressive surgery. One patient died from super-added Covid pneumonia. Fourteen patients returned to baseline function by discharge, and 10 had some limitations with partial improvement.

Conclusion
Multi-disciplinary approach and close collaboration with ID and Radiology are critical to successful treatment with selective use of surgical intervention. FJSA is a lesser-known variant of spinal infection with a high incidence of epidural/paravertebral abscesses, most commonly caused by Staph Aureus.

The Role for Intra-operative Neurophysiology Monitoring in Cranio-Cervical Junction Surgery in Children

Khaled Badran[1], Mohamed Abdelsadg[2], Roddy O'Kane[1], Anthony Amato-Watkins[1]
[1]Royal Hospital for Children, Glasgow, United Kingdom.
[2]Queen Elizabeth University Hospital, Glasgow, United Kingdom

Badran[1], Abdelsadg[2], Malik[3], Siti[3], O'Kane[1], Amato-Watkins[1]
Department of Paediatric Neurosurgery, Royal Hospital for Children[1], Department of Neurosurgery[2], Department of Neurophysiology, Queen Elizabeth University Hospital, Glasgow[3]

Introduction
Compression at the cranio-cervical junction (CCJ) is challenging in children. Positioning, especially younger children, with larger heads and the desire to flex patients for access, leaves patients vulnerable to exacerbating brainstem and spinal cord compression. There is anecdotal evidence of catastrophic outcomes even during positioning this cohort. Our series of patients includes achondroplasia and complex Chiari malformation. The Intra-operative neurophysiology monitoring (IOM) was able to elicit neural compression during positioning and surgery, helping optimise positioning, minimising cord compression and potentially detrimental outcomes. Additionally, amplitude improvement in IOM maybe a useful marker of sufficient surgical decompression of neural structures.

Method
Case series of CCJ surgeries in young children performed in our institution including data from IOM recordings.

Results
IOM showed amplitude changes during positioning and surgery. Early recognition led to optimised positioning without neural compromise. Additional improvements in amplitude waveform post decompression of neural structures was noted.

Conclusion
Intra-operative neurophysiology is useful and reliable adjunct, even young children with neural compression at the CCJ. Younger children, IOM is often thought less reliable due to more immature pathways. However this study shows changes in IOM that benefit the operation, providing a safety role also. Amplitude waveform improvements post decompression could be a potential marker for adequacy of surgery. This would benefit from further studies evaluating the role of IOM as predicting decompression surgery success.

Spinal Adult Deformity

The effects of Physiotherapy Scoliosis Specific Exercise on truncal shift in idiopathic scoliosis: a 12-month follow-up

Georgina Frere[1], Charles Impey ORCID iD[1], Zion Hwang[2], Darren Lui[3], Jason Bernard[3], Bisola Ajayi[3], Tim Bishop[3]
[1]*Scoliosis SOS Clinic, London, United Kingdom.*
[2]*St George's University of London, London, United Kingdom.*
[3]*St George's Hospital, London, United Kingdom*

Introduction
Truncal shift can be measured with a Formetric Scanner using the Maximal Thoracic Apical Deviation (MTAD) measurement. It is a well-documented complaint in patients with idiopathic scoliosis (IS), and is an important measure in pre-operative assessment and post-operative outcomes.

Objective
The aim of this retrospective cohort study was to determine the long-term effects of an intensive course of Physiotherapy Scoliosis Specific Exercise (PSSE) on MTAD in patients with IS.

Methods
Consecutive IS patients with a single right-sided thoracic curvature who completed an intensive 4-week course of PSSE between April 2019 and December 2021 were recruited. All patients were scanned pre-, immediately post-, and at 12 months post-treatment. MTAD, measured in millimetres, was documented. Adults (>17 years old) (group 1) and children (group 2) were analysed separately.

Results
In group 1 (n=29, age =18-81, female = 90%) there was a 21.5% improvement in MTAD from 33.2mm pre-treatment to 26.1mm post-treatment ($p<0.05$). At 12 months follow-up, the MTAD was maintained at 26.1mm. This difference was significant compared to pre-treatment ($p<0.05$), but not compared to post-treatment ($p>0.05$). In group 2 (n=24, age = 10-17, female = 92%) there was a 28.6% improvement in MTAD from 26.4mm pre-treatment to 18.8mm post-treatment ($p<0.05$). MTAD at 12 months follow up was maintained at 18.0mm. This difference was significant compared to pre-treatment ($p<0.05$), but not compared to post-treatment ($p>0.05$).

Conclusion
An intensive course of PSSE significantly improved MTAD in both adults and children with IS and the results were maintained at 12 months follow-up.

Quantitative changes in the lumbar discs and facet joints in Adult Spinal Deformities: A CT / MIMICS based assessment

Jwalant Mehta ORCID iD[1], Amey Kelkar[2], Adrian Gardner[1], Rajpal Nandra[1], Vijay Goel[2]
[1]*Royal Orthopaedic Hospital, Birmingham, United Kingdom.*
[2]*Engineering Centre for Orthopaedics Research Excellence, The University of Toledo, OH, Toledo, OH, USA*

Introduction
De novo adult spinal deformity is a consequence of asymmetric degeneration of the facet joints. This should imply that there would be a quantitative variability between the sizes of the facet joints between the convex and the concave sides. This study explores the quantitative differences between the lumbar facets and the discs compared to normal controls.

Methods
We compared 30 patients with ASD with 10 non-deformity controls. The ASD cohort included 22 females with a mean age of 73 y. The deformity characteristics included SVA 73.6 cm, coronal shift 23.4mm and a mean of Cobb 270. We excluded patients with any previous spinal surgery. CT scan were reformatted with the MIMICS software to generate a 3D scalar reconstruction of the facet joints and the disc spaces, allowing measurements of lumbar spine area and volume, based on a previous pilot study.

Results
A statistical difference was noted between the control and deformity groups for facet surface contact area left L12 ($p < 0.01$) and right L12 ($p = 0.01$) and right L34 ($p < 0.01$) and disc volume at L34 ($p= 0.03$), L45 ($p = 0.02$) and L5S1 ($p = 0.04$). Additionally, correlation for disc area and axial rotation was not significant.

Conclusions
Lumbar facets hypertrophy asymmetrically in the upper lumbar spine while the disc volume reduces in lower lumbar spine in patients with sagittal plane deformities. This work leads to a hypothesis that the main block to correction of the deformity is posterior rather than anterior.

Spinal Conservative Care

Development of a physiotherapist competency package to deliver spinal nerve root block injections

Alistair Christmas[1], Eleanor Dunstan[1], Kate Wiltshire[1], Lianne Wood[2]
[1]Nottingham University Hospitals NHS Trust, Nottingham, United Kingdom. [2]University of Exeter, Exeter, United Kingdom

Introduction
Empirical evidence and the NHS Longterm strategy supports the use of advanced practice physiotherapists (APPs) in pathways for orthopaedic patients. Spinal nerve root block injections (SNRBI) are recommended as diagnostic or treatment interventions for those with radicular pain. A competency framework was standardised for the spinal APP under a robust framework with clear clinical justification and authorisation from the head of the spinal surgical services. The primary aim of this service evaluation is to report the development of a pathway to standardise the delivery of SNRBI by APPs.

Methods
A data competency package was developed using available local and national guidance, and input from consultant APP, -spinal surgeons, -radiologist and -anaesthetist. APP's recorded 10 jointly-performed injections, and 10 independently performed SNRBIs with consultant spinal surgeons or anaesthetists. APP injection delivery was subject to ongoing evaluation through reflection, case-based study and review of rootograms. A prospective audit of 100 patients with radicular leg pain and concordant spinal imaging will be performed.

Results
The SNRBI competency framework was developed by utilising 1) the Chartered Society of Physiotherapists expectations of educational programmes in Injection Therapy 2011; and 2) Working in New Ways' Expanding the Scope of Professional Practice Policy 2011. Clear pre-requisites to perform SNRBI were outlined. The APP assumed accountability. There are currently 2 APP's practicing SNRBI independently. Audit data is ongoing.

Conclusion
A spinal APP competency package to deliver SNRBI has successfully been developed and implemented. Further evaluation of the outcomes of the pathway will be evaluated.

A Systematic Review and Meta-Analysis of Manual Therapy and Exercise for Cervicogenic Headaches

Pietro Bini[1], David Hohenschurz-Schmidt ORCID iD[2], Vincenzo Masullo[1], Diana Pitt[3], Jerry Draper-Rodi ORCID iD[1]
[1]University College of Osteopathy, London, United Kingdom.
[2]Imperial College London, London, United Kingdom.
[3]Ara Institute of Canterbury, Christchurch, New Zealand

Manual therapy is one of the most common treatment choices for ervicogenic headaches. Nonetheless, recent guidelines on the management of cervicogenic headache underlined the lack of trials comparing manual and exercise therapy to sham or no-treatment controls. This systematic review and meta-analysis assessed the effectiveness of different forms of manual and exercise therapy in people living with cervicogenic headache, when compared to other treatments, sham, or no treatment controls.

MEDLINE, CENTRAL, DOAJ, and PEDro were searched until January 2022. We included randomized controlled trials assessing the effects of manual or exercise therapy on patients with cervicogenic headache using headache intensity or frequency as primary outcome measures. Study selection, data extraction, and Risk of Bias (RoB) assessments were done in duplicate. GRADE was used to assess quality of the evidence.

Twenty studies were included. Meta-analysis was possible for six manual therapy trials with sham comparators. Manual therapy effects were moderate-to-large for headache frequency and intensity at short-term, small-to-moderate for disability at short-term, small-to-moderate for headache intensity and small for headache frequency at long-term. A sensitivity meta-analysis of two low-RoB spinal manipulation trials showed small effects over sham on headache intensity, frequency, and disability at short and long-term. Evidence quality was moderate.

The evidence suggests that manual and exercise therapy may reduce headache intensity, frequency and disability at short and long-term in people with cervicogenic headache. More high-quality trials are necessary to make stronger recommendations.

The protocol for this meta-analysis was pre-registered (PROSPERO ID: CRD42021249277).

Spinal Cord Injury

Neurological Improvement & Functional outcomes in Spinal Cord Injured Patients: Analysis from a Tertiary Acute Spine Centre

Balakumaran Thangarajah ORCID iD, Saloni Singh, Saajid Kaleel, David Cumming, Maitravaarun Burgula, Sriram harish Srinivasan ORCID iD
East Suffolk and North Essex NHS Foundation Trust, Ipswich, United Kingdom

Introduction
Clinical management following spinal cord injury is to aid recovery and achieve functional independence. We present the use of ASIA (ISNCSCI) charts and the recently validated Spinal cord Independence Measure (SCIM III) to demonstrate neurological and functional improvement over the follow-up period.

Method
We analysed the prospectively collected data from 84 SCI patients (M/F - 58:26) who were admitted to the Ipswich Spine Centre between 2017 and 2020.

Result
Of the various aetiologies, 44 were traumatic injuries. Mean Length of stay was 39.4 days. ASIA score improvement allowed 30 (40%) to be discharged home, 26 (34%) transferred to the spinal rehabilitation, 19 (25%) went into community rehabilitation and nine died in hospital. Mobility, Self-care and Respiration-Sphincter management SCIM scores (Mean) on admission were 8.7, 10.4 & 15.2. Functions improved to 22.5, 15.8 & 26.9 at discharge and 29.2, 17.6 & 32.7 at one year (ANOVA test p value<0.001). Under subgroup analysis, 9 were paraplegic ASIA A & B, 17 were paraparesis ASIA C & D, 8 were quadriplegic ASIA A & B and 28 were quadriparesis ASIA C & D. Mobility in all groups showed substantial improvement except in the paraplegic ASIA A & B group.

Conclusion
Depending on the severity of the initial neurological injury, Patients were noted to achieve functional improvement significantly in all areas including mobility, bladder and bowel status in the first few months and continued to improve slowly during the following period.

Spinal Degenerative: Cervical/Thoracic

A Simple Method For Identifying Surgical Level For Thoracic Disc Surgery

Andrew Blythe, Rakesh Dhokia, Jennifer Salmon, Jim Sales
Royal Victoria Hospital, Belfast, United Kingdom

Introduction
Identifying the level of thoracic disc surgery with intra-operative fluoroscopy can pose a significant challenge, increasing risk of radiation exposure and surgical time. Counting levels from the sacrum or C2 level relies on stitching fluoroscopic imaging. This can introduce error relating to wrong-level surgery.

Method
We describe a simple method of identifying correct thoracic pre-operatively to reduce the risk of wrong-level surgery in our institution. Prior to surgery all thoracic discs are required to have CT imaging to identify the disc, assess amount of calcification, and aid with surgical planning for thoracotomy. We utilised the use of a radio-opaque marker prior to CT. This was inserted awake using a posterior-based stab incision under local anaesthetic, simply counting spinous processes to approximate the spinal level. A Twin-Fix 3.5mm bone-anchor was inserted to centre of the spinous process. This is a readily-available anchor in all surgical units of low cost. Following this, CT acquisition to accurately identify the level of the marker was performed. The patient proceeded to surgery and intra-operative imaging safely identified the marker and corresponding level.

Results
We understand multiple methods describe to identify correct level for anterior thoracic disc surgery have been described. For institutions without intra-operative CT imaging this is a simple, effective, and reproducible method to aid safe provision of thoracic disc surgery.

Conclusion
A radio-opaque bone-anchor inserted pre-operatively in combination with cross-sectional imaging can be an effective method of identifying the correct level to avoid wrong-level thoracic disc surgery.

Spinous Process Osteotomy for Exposure of the Posterior Cervical Spine : A Novel Surgical Approach

Harshad Dabke ORCID iD, Oliver Townsend
Salisbury District Hospital, Salisbury, United Kingdom

Introduction
Posterior cervical spine exposure usually involves bilateral muscle dissection and removal of midline structures which may lead to chronic neck pain, dropped head syndrome and ugly scarring. We present our experience of a novel surgical technique using spinous process osteotomy with preservation of posterior midline structures.

Method
10 degenerative cervical myelopathic patients underwent 2-4 level posterior decompression with or without fusion, were prospectively reviewed. Left sided exposure was done through a midline skin incision; bilateral spinal exposure was achieved through spinous process osteotomies using a small McCulloch osteotome. Rest of the operation was done as required and the wound was closed over a drain. All patients were mobilised without orthosis.

Results
There were 7 males and 3 females with mean age of 72 years; mean blood loss was 150 mls; mean operating time was 115 mins; mean follow-up was 12 months. The mean improvement in NDI at final follow-up was 39% mean VAS improved by 3-points. JOA score improved from a mean of 2 to 6 and using Odom's criteria, final outcome was good in 6 and excellent in 4 patients. Nurick grade improved from 3 to 1 and all patients reported significant relief of myelopathic symptoms without chronic neck pain. No post-operative wound infection was seen but 1 patient underwent reoperation for haematoma.

Conclusion
Our novel technique showed good results, most likely related to minimal tissue trauma and preservation of the posterior tension band. However bigger and comparative studies are required before recommending its routine use.

Medium term results of cervical laminoplasty for cervical myelopathy

Angus Kaye, Omar Naji, Babak Shariati, Stuart Blagg, Edward Seel
Buckinghamshire Health Trust, Aylesbury, United Kingdom

Introduction
There is a paucity of literature available looking at the outcomes of cervical laminoplasty for cervical myelopathy, few over 2 years. We present medium term outcomes.

Method
PROMS were prospectively collected as part of our national registry between 2014 and 2020 collecting EQ-5D, Visual analogue score neck / arm, Neck disability index and Myelopathy Disability Index. 19 patients were identified as having scores with a minimum of 2 years follow up, average 48 months (range 24 – 84 months). 12 of these patients had pre-op scores available.

Results
EQ-5d scores improved by 0.169 (on average from 0.376 to 0.545). Visual analogue health scores improved by 13.6 (from 48.75 to 62.5). NDI scores improved by 13 (from 37 to 24). MDI score improved by 12.2 (from 34.8 to 22.61). VAS neck scores improved by 0.08 (from 0 to 9.1), VAS arm pain scores improved by 0.18 (from 0 to 7.5)

Discussion
These results show that cervical laminoplasty improves the outcome in patients with cervical past 2 years. Minimal improvement in VAS pain scores for neck and arm are in line with similar studies and highlights the indication of this operation for myelopathy symptoms.

Spinal Degenerative: Lumbar

SPECT CT guided lumbar fusion surgery improves functional outcomes in patients with axial backpain

Priyanka Jani[1], Aman Sharma[1], Gregory Cunningham[2], Roozbeh Shafafy[1], Sean Molloy[1]
[1]Royal National Orthopaedic Hospital, London, United Kingdom.
[2]St John of God Murdoch Hospital, Murdoch, Australia

Introduction
Surgical decision making for axial back-pain remains challenging. Evidence is limited to support advanced diagnostic tools including MRI, CT and diagnostic injections. Whilst it is identified in prior studies that fusion for axial back pain is not reliable treatment, these studies are limited by broad patient inclusion criteria for surgery and varied surgical planning methods and operative techniques.

Method
A retrospective review of prospectively collected patient reported outcome measures (PROMS) data with average 5.4years follow-up. Oswestry Disability Index(ODI) and Back Pain VAS were the primary outcomes assessed. We outlined strict patient selection criteria and employed pre-op SPECT-CT to identify pain generators and support surgical-planning.

Results
25 patients who underwent primary and revision fusion procedures across 68 Levels (total) with average 5.4 year follow-up (range 3years - 9years) were included. Analysis revealed statistically significant improvements across all PROMS. A mean improvement in ODI of 48.64 ($p<0.001$) and Back Pain VAS of 6.60 ($p<0.001$) was observed. These patients benefitted from higher QALY gains (0.61) comparable to those in joint arthroplasty.

Conclusion
Consistent improvement in all PROMs is demonstrated following spinal fusion in this study. We believe a combination of strict patient selection criteria, pre-op identification of 'pain generator' using SPECT-CT and pre-determined surgical goals resulted in statistically significant improvement in post-op ODI and axial back pain. In patients that have completely exhausted non-surgical management of their axial back pain and meet our described "Patient criteria for surgery", this data supports the use of spinal-fusion surgery for treatment of axial back pain.

Spinal Fundamental Science

Comparative phenotyping of axial and peripheral joint enthesis sites examining IL-23-responsive tissue resident immune cells

Mark Harland[1], Chi Wong[1], Paula David[1], Tom Macleod[1], Abhay Rao[2], Almas L Khan[2], Peter Loughenbury[2], Robert Dunsmuir[2], Dennis McGonagle[3]
[1]Leeds Institute of Rheumatic and Muculoskeletal Medicine, University of Leeds, Leeds, United Kingdom. [2]Orthopaedic and Spinal Surgery, Leeds Centre for neurosciences, Leeds Teaching Hospitals NHS Trust, Leeds, United Kingdom. [3]National Institute for Health Research (NIFR) Leeds Biomedical Research Centre (BRC), Leeds Teaching Hospitals, Leeds, United Kingdom

Introduction
The spondyloarthropathies are a host of diseases significantly driven by the interleukin (IL)-23/IL-17 axis cytokines. Indeed, therapies that target these cytokines have shown enormous success in treating spondyloarthritis (SpA) and psoriatic arthritis. However, despite success in peripheral psoriatic arthritis, therapies targeting IL-23 failed in axial ankylosing spondylitis suggesting differences exist in IL-23 biology between peripheral and axial sites. In both peripheral and axial SpA, enthesitis is considered the cardinal lesion.

Methods
In order to examine whether fundamental differences exist between peripheral and axial entheseal sites, entheseal cells were isolated from peripheral tissue taken from knee and hip replacements and axial tissue from spinal decompression or scoliosis corrective surgery. Extracted cells were phenotyped by flow cytometry and functionally assessed by stimulation with inflammation-driving cytokines. The capacity of entheseal cells to respond to IL-23 was determined by the addition of recombinant IL-23, and their ability to generate IL-17 independent of IL-23 was determined through the addition of an IL-23-blocking antibody to stimulation assays.

Results
Analysis of the results showed immune cells from axial and peripheral entheseal sites are phenotypically similar, and that modulation of inflammatory cytokines is evident between axial and peripheral sites.

Conclusion
These results contribute to our understanding of how inflammation differs at axial and peripheral entheseal sites and may help direct future usage of IL-23 targeted therapeutics in SpA.

IL-17F is the dominant IL-17 isoform expressed by spinal enthesis resident innate and adaptive T cells

Nicole McDermott[1], Tom Macleod[1], Charlie Bridgewood[1], Almas L Khan[2], Peter Loughenbury[2], Abhay Rao[2], Robert Dunsmuir[2], Dennis McGonagle[3]
[1]Leeds Institute of Rheumatic and Musculoskeletal Medicine, University of Leeds, Leeds, United Kingdom. [2]Orthopaedic and Spinal Surgery, Leeds Teaching Hospitals NHS Trust, Leeds, United Kingdom. [3]National Institute for Health Research (NIHR) Leeds Biomedical Research Centre (BRC), Leeds Teaching Hospitals, Leeds, United Kingdom

The spondyloarthropathies are a group of inflammatory diseases affecting the spine that are heavily driven by the interleukin (IL)-23/IL-17 cytokine axis. Enthesitis, inflammation of the connective tissue where tendon or ligament attaches to bone, is the cardinal lesion in the development of spondyloarthritis (SpA). The T cell-derived cytokines IL-17A, IL-17F and TNFα significantly contribute to SpA pathology, as illustrated by the success of biologics targeting these cytokines. Recently, dual targeting of both IL-17A and IL-17F has shown advantages over IL-17A targeting, yet the role of IL-17F at the human enthesis is not clear. In order to investigate the role IL-17A and IL-17F play at the enthesis and identify the cells responsible for their production, entheseal cells were extracted from spinous process material removed following scoliosis correction or spinal decompression surgery. Entheseal T cells were activated by anti-CD3 and -CD28 antibodies and intracellular levels of IL-17A and IL-17F were assessed by flow cytometry. In addition, untreated and activated entheseal cells were analyzed by CyTOF to phenotype and identify IL-17A and IL-17F producing cells. Results of the simulations showed that IL-17F is preferentially produced over IL-17A by CD4+T cells at the enthesis after 72hr activation. CyTOF analysis revealed the immune landscape at the enthesis and demonstrate rare γδ T cells are present at the enthesis and produce both IL-17A and IL-17F following activation. These results show a preference for IL-17F production by entheseal T cells, thus providing a rationale for employing dual IL-17A/IL-17F targeting biologics in SpA therapy.

Spinal Infection

PICO (negative pressure wound therapy) dressing use as post-op prophylaxis for preventing Surgical Site Infections in Spinal Surgery; A retrospective single center study

Hassan Imtiaz[1], Chadi Ali[2], Hilali Noordeen[1]
[1]*Royal National Orthopaedic Hospital, London, United Kingdom.*
[2]*Kettering General Hosptial, Kettering, United Kingdom*

Introduction
Surgical site infections (SSI) are among one of the dreaded complications of spinal surgery. These typically develop within the first 30 days following surgery. The overall pooled incidence of SSIs is reported at 3.1% (13% for neuromuscular scoliosis).

Negative pressure wound therapy (NPWT) has been employed for the management of open wounds and soft tissue injury. This involves the use of VAC pumps and portable devices such as PICO. There are only few studies evaluating prophylactic use of NPWT in Spinal Surgery.

The aim of this study was to evaluate if prophylactic use of PICO dressings can reduce SSI incidence in complex Spinal Surgery.

Methods
Data was collected retrospectively for patients undergoing spinal surgery, with a PICO dressing used for closed surgical incisions, from February 2021 to October 2022. Each patient was followed up for 30 days. The results were compared with local hospital infection control statistics for previous years.

Results
A total of 50 patients underwent complex spinal surgery and had PICO dressings post-operatively. 2 (4.0%) patients developed SSI who were managed conservatively, with use of antibiotics and prolonged NPWT. None of the patients returned to theatre for washout. The overall incidence of SSI at our center during the first quarter of 2022 was 3.3% (only few cases of PICO use), which drastically reduced to 0.1% by the end of the year.

Conclusion
PICO dressing use shows tremendous potential, by providing a cost-effective measure for the prevention of Surgical Site infections in complex Spinal Surgery cases.

The value of echocardiogram (echo) in non-iatrogenic spinal infections (NISI)

Vinay Jasani ORCID iD, Hussein Shoukry, Sriram Srinivas
University Hospital of North Midlands, Stoke on Trent, United Kingdom

Introduction
We evaluate the use of echo to screen for infective endocarditis (IE) in non-iatrogenic spinal infections (NISI).

Method
Our policy is for echo assessment in NISI.

We retrospectively reviewed a prospective database over 1 year.

Cases were analysed for echo, type of echo, comorbidities, bacteraemia, organism, IE. Only percentages were suitable for statistical analysis.

Results
61 cases had NISI. 52% had MSSA, 8.2% Strep. sp, 6.6% other Staph. sp, 3.3% E.Coli, 3.3% Enterococcus sp. 18% had no positive cultures.

70.4% had bacteraemia.

80.3% (n=49) had echo of which 89.8% had transthoracic echo (TTE) and 10.2% had transoesophageal echo (TOE).

3.3% (n=2) were positive for IE. Neither had clinical features of IE. Both had extraspinal sites for infection (28.8% of non IE cases). Both survived.

Case 1 had lumbar epidural abscess with MSSA bacteraemia. TTE was low suspicion of IE, TOE was positive.

Case 2 had cervical and thoracic discitis with Streptococcus gallolyticus bacteraemia. The patient had a TAVI. Echo was inconclusive with IE diagnosed on positron-emission-tomography (PET).

No TTE cases negative for IE re-presented with cardiac issues within the follow-up period. 14.7% of the cohort died (various causes).

Conclusion
Compared to a previous report, our rate of IE was low (3.3% compared to 33%); although we used predominantly TTE not TOE. We did not see any re-presentation as IE for those negative for IE on initial TTE. A larger study is recommended to determine the value of echo in all NISI cases and the benefit of TOE over TTE.

Spinal Oncology

Predicting the post-operative survival of patients with metastatic bone disease in the spine – a evaluation of models

Sam Hodgson[1], Paul Pynsent[1], Simon Hughes[2], Petr Rehousek[2], Adrian Gardner ORCID iD[2]
1University of Birmingham, Birmingham, United Kingdom. [2]The Royal Orthopaedic Hospital NHS Foundation Trust, Birmingham, United Kingdom

Background
Spinal metastases are a risk to the length and quality of life of up to 10% of all patients with cancer.

The benefit of palliative spinal surgery is well documented. Prognosis is a primary indicator of eligibility for surgery. Previous tools, including the Tokuhashi and Tomita can perform poorly.

Baumber recently published a prognosis score for surgical patients with long-bone disease. We aim to assess the Baumber score in predicting survival for metastatic spinal disease when compared to actual survival and other prognostic tools.

Methods
For each participant, prognostic scores were calculated and compared against actual survival. The survival predicted using the Baumber score was analysed at 6 and 12 months.

Results
We identified 64 eligible participants. Survival curve analysis showed that 50% were alive at 900 days post intervention (32 surviving more than 6 months and 19 more than a year). The Baumber score predicted 6 and 12 month risk of death as means of 10% and 16%. Actual risk of death was 57% at 6 months and 73% at 12 months. The Tokuhashi score indicated a prognosis of <6 months for n=32, >6 months for n=22 and >12months for n=10. The Tomita score indicated a prognosis of < 3months for n=8, 6-12 months for n=13, 1-2 years for n=7 and >2 years for n=36.

Conclusion
The Baumber score under predicted the risk of death at 6 and 12 months for spinal metastatic disease. The Tokuhashi score was closer to the observed truth than the Tomita score.

Spinal cord Compression Outcomes Of Treatment (SCOOT): A case-matched study

Sheweidin Aziz, Beibit Bashabayev, Omar A. Gabbar, Grahame JS Taylor
University Hospitals of Leicester, Leicester, United Kingdom

Background
Patients with MSCC present with pain and/or neurological loss. NICE guidance recommends surgery to prevent paralysis or manage pain in paralysed patients. There is a paucity of literature comparing surgery with no surgery.

Aims
To compare surgery with no surgery for neurological change, analgesic requirements, survival, length of stay and re-admissions.

Methods
A case-matched cohort study comparing patients managed surgically with those who declined surgery when offered. Patients were matched by the primary tumour, presentation ambulatory status, co-morbidities, age and gender. Prospective dart collection from 2014-2020. Statistical analysis was performed using GraphPad prism 8.2.

Results
Twenty-seven patients declining surgery were matched to 54 receiving surgery. In both groups, there were neurologic deteriorations and improvements (p=0.07). Patients in the surgery group required more simple analgesics (p=0.0002), but fewer strong opioids (p=0.004) compared to the no-surgery group. At 3 months, survival rates were 83% in the surgery group and 61% in the no-surgery group (p=0.05). The average initial length of stay in the surgery group was 21 vs. 10 days in the no-surgery group (p<0.001). There were more readmissions in the surgery group than in the no-surgery group, 45% vs. 36% (p=0.05).

Conclusion
In this study, albeit underpowered, surgery resulted in no statistically significant difference in neurological outcomes. Significantly lower opioid requirements and lived longer. Surgical patients did, however, have longer initial hospital stays, and higher re-admission rates.

Spinal Paediatric Deformity

Vertebral Rotation Ratio: A simplified novel technique for estimation of apical vertebral rotation in adolescent idiopathic scoliosis

Christopher McKee[1], Nagy Darwish[2]
[1]Queen's University Belfast, Belfast, United Kingdom.
[2]Royal Victoria Hospital, Belfast, United Kingdom

Introduction
Historically, severity of Adolescent idiopathic scoliosis (AIS) has been determined by Cobb angle, and less so by vertebral rotation. Multiple rotation measurement methods have been

formulated with varying inter-observer reliability and accuracy, in addition to non-routine additional scans performed, increasing radiation exposure.The aim of this report is to outline a simplified yet accurate estimation of vertebral rotation through use of parameters that can be obtained from routine coronal and sagittal plane radiographs.

Methods
Pedicle distance (PD) is measured relative to vertebral width to find the translation of the pedicle due to axial rotation (PDx100/VW). This creates a scalar measure of degree of axial rotation from 0-100. Ten patients with AIS awaiting surgical correction were prospectively imaged using routine radiography. The measurements as outlined above were performed with other parameters obtained including age, gender, Cobb angle, Lenke and Risser classification. Measurements were obtained by two observers to evaluate interobserver reliability through intraclass correlation coefficient (ICC).

Results
Mean patient age was 14 (range 12-17) with 9 being female and 1 male. Lenke classification ranged from 1A N to 4C +, with Risser stage ranging 1-4. Mean rotation was 28.2 (range 17.1-45.6). The ICC for vertebral width, pedicle distance, rotation ratio and Cobb angle was > 0.9 indicating excellent reliability.

Conclusions
The degree of vertebral rotation can be accurately assessed by use of the vertebral rotation ratio. Measurements can be obtained easily from standard radiographic images without requirement of additional imaging. Furthermore, use of the ratio calculation reduces error and variation in measurement.

Factors affecting brace adherence in adolescent idiopathic scoliosis - a qualitative application of Protection-Motivation Theory

Raveen Jayasuriya ORCID iD[1], Paul Norman[2], Daniel Hind[2], Ashley Cole[1]
[1]*Sheffield Children's Hospital, Sheffield, United Kingdom.*
[2]*University of Sheffield, Sheffield, United Kingdom*

Background
Successful full-time bracing in AIS is adherence dependent, and variable between individuals. The factors affecting health related behaviour in bracing have not been evaluated in a theory-based framework.

Methods
This study explores patient and parent perspectives of the psychological effects of bracing through semi-structured interview dyads. The topic guide and directed content analysis of transcripts operationalised protection-motivation theory (PMT) as the underpinning psychological framework.

Results
Fifteen patients and nineteen parents participated. Appraising the threat of the diagnosis was difficult as scoliosis was an unknown for half. With information from surgeons and independent research, consistent themes of severity of their scoliosis and vulnerability for future prognosis emerged. The response cost of treatment adherence was dominant and consistent between participants, despite good belief in response efficacy of bracing. The self-efficacy strategies that patients employed to increase adherence, and the maladaptive response rewards of non-adherence was variable.

Discussion
This qualitative study demonstrates that PMT provides a coherent psychological framework to explore the factors affecting brace adherence in AIS. Wearing the brace at school poses a great challenge; worrying about how peers will perceive them, to the limitations of how to make the brace less visible with clothing choices and coordinating extra-curricular activities. This study highlights circumstances where patients would choose not to wear the brace, and self-efficacy strategies to maintain adherence. This data will inform a de novo adherence prediction tool for stratifying and offers clinicians a framework to augment information provided to patients to maximise protection-motivation behaviour and brace adherence.

Clinical and radiological outcomes of serial elongation de-rotation flexion (EDF) casting for early onset scoliosis

Peter Loughenbury, Callum Eve, Luc Nyunt, Almas Khan, Vishal Borse, Nigel Gummerson
Leeds General Infirmary, Leeds, United Kingdom

Introduction
Early onset scoliosis is a significant challenge for paediatric spinal surgeons. Serial elongation, derotation, flexion (EDF) casting is one method controlling and possibly correcting deformity in younger patients. This study reports the clinical and radiological outcomes using this technique in a tertiary referral centre for paediatric spinal deformity.

Methods
Consecutive series of patients with early onset scoliosis treated with serial EDF casting in a single Institution from January 2011 to January 2021. Retrospective analysis of clinical and radiological outcomes.

Results
44 patients completed casting treatment during the study period. Median time in cast was 19.5 months. Considering all cases there was a slight improvement in thoracic curve magnitude during serial casting (40.8 degrees before casting compared with 39.1 degrees after casting). There was no difference in lumbar curve magnitude in the same period.

25/44 (57%) showed an improvement in curve magnitude following casting while 19/44 (43%) were either static or progressed slowly. Overall rate of complications was 1.94 complications per patient. 42/44 (95%) experienced minor issues with cast discomfort and 22/44 (50%) returned to hospital due to soiling of the cast or for advice due to difficulty sleeping/ feeding. 7/44 (16%) noted medical complications including chest infections (5) and superior mesenteric artery syndrome (2).

Conclusion

Serial EDF casting is a safe and effective method of controlling growth in younger patients with early onset scoliosis. The majority of patients show some improvement in curve magnitude. Minor complications with cast management are common but medical complications during casting are rare.

A comparative study reviewing post-operative bracing and functional outcomes after scoliosis correction surgery

Sachi Shah ORCID iD, Aman Sharma, Matthieu Durand-Hill, Helen Hartshorn, Julian Leong, Hilali Noordeen, Jan Lehovsky, Alexander Gibson

Royal National Orthopaedic Hospital, London, United Kingdom

Introduction

Thoracolumbar sacral orthosis and soft braces are used routinely after spinal deformity correction surgery. Incremental surgical advances with robust stabilisation has changed the post-operative paradigm and allowed for early mobilisation. This challenges the need for routine post-operative bracing given the complications associated with wound healing and mental health.

Method

This comparative study evaluates the effect of post-operative bracing on patient reported outcomes (PROMS), clinical and radiological outcomes and cost of patient care. The demographic data (age, sex, comorbidities, cobb angle) and PROMS were analysed.

Results

117 patients were included from a single tertiary centre (24 male, 93 female, mean age 17.83). In the braced group (N=58), mean Cobb angle at 6 weeks was 17.91 and 17.44 at 6 months (-0.47 loss of correction). In the unbraced group, mean Cobb angle was 24.10 at 6 weeks and 24.03 at 6 months (-0.07 loss of correction). The difference in loss of correction between both groups was not statistically significant (two-tailed p value = 0.285). The unbraced cohort had better mental health scores which was statistically significant at 6 months and 1 year (p= 0.036 and p=0.039 respectively). There was no statistically significant difference in both groups when comparing function, pain, self-image and satisfaction scores. Brace use has significant cost implications (£360/brace) as well as increasing length of stay (£368/day).

Conclusion

This is the first patient reported outcome study evaluating post-operative brace versus no brace in spinal deformity correction surgery with no statistical difference in clinical and functional outcomes.

3D Printed Custom Navigation Jigs in Posterior Spinal Fusion: A Retrospective Case Series

Libby Gooda[1], Emily Tsang[1], Bisola Ajayi[2], Priyanshu Saha[1], Zion Hwang[1], Tesfaldet Kurban[2], Sam Walters[2], Mohamed Abdalla[2], Timothy Bishop[2], Jason Bernard[2], Darren Lui[2]

[1]St. George's University of London, London, United Kingdom.

[2]St. George's Hospital, London, United Kingdom

Introduction

The use of 3D printing in spinal surgery is a recognised technique. A whole spine, low dose, 1mm axial cut CT scan is used to create a life-size model of the spine, to which 3D Printed custom navigation jigs (3DPCNJ) are created unique to each vertebra.

Methods

50 scoliosis patients with posterior spinal fusion using 3DPCNJ at a tertiary medical centre had data collected prospectively for screw insertion and facet osteotomies regarding time and blood loss. Our standard free hand technique is to perform a facet osteotomy prior to screw insertion and thus was studied in this manner.

Results

The mean age was 15.1 and female patient 77.8%. The mean Screw density 81.9%.

Mean time for screw insertion was 79.9 minutes (average 3.9 minutes per screw/osteotomy).

Total blood loss during screw insertion and all facet osteotomies was 180.6mls (average 8.6ml per screw/osteotomy).

There were no spinal cord monitoring events during screw insertion.

Average hospital length of stay was 5.87 days with a return to surgery rate 4.65%

SRS-22 preoperatively was 3.46 vs. 4.38 postoperatively (12 months).

The preoperative Cobb angle was 63.9 vs. 28.8 postoperatively.

Conclusion

The time taken for segmental facet osteotomies and pedicle screw insertion using 3DPCNJ has been shown to be efficient, rapid, effective and safe with minimal blood loss.
Radiographic parameters and PROMS improve in line with other gold standards but 3DPCNJ has an advantage over other navigation techniques due to uninterrupted workflow with no intraoperative CT scanning or accidental loss of accuracy.

Atlanto-Axial Posterior Instrumented Distraction for Reduction of Basilar Impression and Neural Compression in a Paediatric Series

Khaled Badran[1], Mohamed Abdelsadg[2], Likhith Alakandy[2], Anthony Amato-Watkins[1]
[1]*Royal Hospital for Children, Glasgow, United Kingdom.*
[2]*Queen Elizabeth University Hospital, Glasgow, United Kingdom*

Introduction

Complex cranio-cervical junction (CCJ) anomalies include basilar impression (BI) and platybasia, causing ventral compression of the brainstem and spinal cord. Symptoms cause progressive bulbar signs, central apnoea and other phenomenon such as syringomyelia. BI and brainstem symptoms are a challenge, and involve multiple aetiologies. Patients often undergo trans-oral resection odontoidectomy to directly relieve ventral compression, followed by occipito-cervical fixation for stabilisation. We present a small series of children that underwent posterior C1/2 fixation with in-situ facet joint distraction to reduce ventral cervico-medullary compression. This single manoeuvre led to resolution of brainstem symptoms and reduction of BI, without requiring additional anterior decompression surgery.

Method

A case series of patients presenting to the Royal Hospital for Children, Glasgow. Minimum follow up of one year, and patients last reviewed in 2022. Fixation involved either occipito-cervical fixation or only C1/2 fixation. Disruption of C1/2 joint using a diamond drill, followed by distraction. Fusion was achieved by autograft (calvarium) wedged between the facet joints of C1/2.

Results

All patients had progressive cervico-medullary neural compression and bulbar signs. Post operatively symptoms improved, no patients to date have required additional anterior odontoid resection. Adequate bony fusion demonstrated at C1/2 joint with autograft (calvarium).

Conclusion

This small series is based on the modified Goel facetal arthrodesis technique and has meant a single surgical intervention, with posterior only distraction and fixation, is feasible and also a more familiar technique for spinal surgeons. This also mitigates potential complications from trans-oral surgery.

Use of bending films in adolescent idiopathic scoliosis may not affect level selection in surgical planning

Daniel Onate, Neil Upadhyay, Priyan Landham, Ian Harding, Stephen Morris ORCID iD
North Bristol NHS Trust, Bristol, United Kingdom

Introduction

Adolescent idiopathic scoliosis (AIS) surgical planning typically includes posteroanterior, lateral and bending radiographs. These bending radiographs provide information about the flexibility of the curves, theoretically helping to determine the extent of spinal arthrodesis. We sought to confirm if the fusion level selection is affected by this bending test.

Methods

Radiographs of 50 patients with different patterns of AIS were categorized using the Lenke classification. Four fellowship-trained paediatric spine deformity surgeons reviewed these images in four separate surveys and documented proposed upper and lower instrumented vertebrae (LIV); two surveys included PA and lateral images only whilst the other two surveys also included bending films. LIV selection was compared using inter- and intra-observer variability and absolute agreement.

Results

From a total of 200 data sets, 106 sets had the same LIV selected. Of 94 data sets where the levels varied, more levels would be fused following bending film review in 44 patients and less levels in 50 patients. Of these patients, one level difference in LIV was seen in 63 patients and two levels in four patients. In 27 patients, a different curve was fused after bending film review, with 16 patients changing from double curve to thoracic only, and 11 patients changing from thoracic only to double curve. Analysis of agreement did not demonstrate a clear overall benefit of bending films.

Conclusions

These findings suggest the use of bending films may not result in a significant difference in level selection of LIV in patients undergoing surgery for AIS.

Spinal Pathways and Commissioning

Extended Scope Physiotherapy Service Re-evaluation of elective spinal surgery long waiters within Neurosurgery

Joanne Chambers, Susan Morison
Neurosurgical Department, Institute of Neurosciences, Queen Elizabeth University Hospital, Glasgow, United Kingdom

Aim
To identify patients on the existing neurosurgical surgical waiting list who still require spinal surgical intervention. Method: It was agreed with management and consultant body that the Extended Scope Physiotherapy (ESP) Service re-evaluate patients waiting in excess of 18months on the spinal surgical waiting list. It is known that changes may occur in both pain symptoms and spinal pathology in some patients over time. The current process of ward-based medical team review on admission was deemed inefficient and costly. ESP re-evaluation was undertaken within an outpatient/virtual setting by the existing ESP service. Data was collected indicating patients still requiring surgery, any changes required and whether surgery was no longer indicated

Results
175 patients were re-evaluated June 2021 to December 2022. 102 patients (58%) required updated imaging. 16 patients have incomplete data. From the completed data 100 patients (63%) remain on waiting list as planned (WLP), 13 patients (8%) remain on waiting list with changes (WLC). Change related to clinical priority or procedure offered. 43 patients (27%) no clinical indication for/patient no longer wanted surgery (D/C).

Conclusions
This initiative reduced the long waiter neurosurgical spinal waiting list by 27% streamlining the process for existing surgical patients who can confidently be issued a surgical date. Outpatient ESP re-evaluation prior to admission reduced bed usage and ward based medical time. This process has ensured patients receive appropriate care while increasing service efficiency. It is a positive adjunct to neurosurgical spinal services in this post-COVID period of excessive wait times.

Evaluation of specialist spinal physiotherapist-led surgical review for patients following lumbar discectomy and decompression

Lucy Clackett, Alison Heap, Navin Furtado, Marcin Czyz, Louise White
Queen Elizabeth Hospital Birmingham, Birmingham, United Kingdom

Introduction
GIRFT recommend review 6-8 weeks post-discectomy/ decompression. High patient numbers make this challenging.

In 2019, the Specialist Physiotherapy Post-Op Clinic (SPPOC) was piloted providing out-patient follow-up, instead of surgeon review, for lumbar discectomy/ decompression patients.

Methods
Phase 1: Virtual triage for all lumbar discectomy/ decompression patients for SPPOC suitability. Exclusion included greater than 3-level decompression, fracture, cancer, infection, early post-op complications.

Phase 2: Face-to-face SPPOC (Feb 2019-March 2020). Patients completed surveys (incorporating NICE Patient Experience Quality Standards) to evaluate consultation acceptability.

Phase 3: Telephone SPPOC -transformation to virtual (March 2020). Telephone surveys (n=50) evaluating consultation acceptability sampled from 2 periods (SPPOC Oct -Dec 2020 n=26, and Oct –Dec 2022 n=24) completed within 3 months of appointment.

Results
Phase 1: 83% of discectomy/ decompression surgeries triaged suitable for SPPOC.

Phase 2: 100% respondents (n=78) rated SPPOC consultation positively. 99% had “definite confidence and trust in the physiotherapist”

6% would have preferred to see a doctor.

Phase 3: 98% (n=49) respondents reported positive /neutral telephone SPPOC experience.

Mean of 97% positive/ neutral rating for being listened to, assessment, explanation, addressing concerns, being involved in decisions.

In 2020 69% would have preferred in-person attendance versus 33% in 2022.

Conclusions
Our evaluation indicates that specialist physiotherapists' post-surgery review is acceptable and results in a positive patient experience. Telephone consultations are acceptable however patients should be offered choice.

SPPOC could be developed to support post-op review for other high volume procedures.

Spinal Rehabilitation

Beyond pain: prevalence and discrepancy of subjective and objective weakness in people with sciatica

Lucy Dove ORCID iD[1], Georgios Baskazos ORCID iD[1], Thomas Kelly ORCID iD[2], Elaine Buchanan ORCID iD[3], Annina Schmid ORCID iD[1]
[1]*Nuffield Department of Clinical Neurosciences, Oxford University, Oxford, United Kingdom.*
[2]*Berkshire Healthcare NHS Foundation Trust, Reading, United Kingdom.*
[3]*Oxford University Hospitals NHS Trust, Oxford, United Kingdom*

Aim
To establish the prevalence and agreement between subjective and objective weakness in people with sciatica. If a difference exists, to establish which factors mediate this difference.

Method
Cross-sectional retrospective study carried out in the spinal service of a secondary care NHS Hospital, UK. Included 68 patients with a clinical diagnosis of sciatica. Primary outcome measures were the Sciatica Bothersome Index for subjective weakness and the Medical Research Council (MRC) scale for objective weakness. Potential factors that may mediate a difference between subjective and objective weakness included leg pain severity, Sciatica Bothersome Index sensory subscale, age, Hospital Anxiety and Depression subscale for Anxiety.

Results
85% of patients reported subjective and 35% objective weakness. Cohen's Kappa (0.066, 95% CI -1.89, 2.03; p = 0.317)] and ICC (-0.540, 95%CI -1.497, 0.50; p = 0.960) showed no agreement between objective and subjective weakness. The identified difference between subjective and objective measures of weakness was mediated only by the Sciatica Bothersome Index sensory subscale (multiple linear regression, b=0.45, p = <0.001).

Conclusions
There is a high prevalence of subjective weakness in people with sciatica, which is not reflected in objective measures of weakness. Differences between subjective and objective weakness may be driven by sensory symptoms or associated with undetected neurological deficits. Further work needs to establish if other factors mediate this discrepancy and whether patient reported weakness can be more meaningfully assessed by other means.

Swimming versus routine physiotherapy care as a rehabilitation modality for chronic low back pain: A feasibility study

Helen Oakes[1], Marlize De Vivo[2], David Stephensen[1], Hayley Mills[2]
[1]*East Kent Hospitals University NHS Foundation Trust, Canterbury, United Kingdom.*
[2]*Canterbury Christ Church University, Canterbury, United Kingdom*

Introduction
Swimming is often advised to people with low back pain (LBP), swimming ability, however, can be a barrier for many adults. The aim of this study was to test the feasibility of a swimming programme as a rehabilitation modality for LBP.

Methods
A double-arm comparative study was undertaken comparing a swimming programme (n=22) to routine physiotherapy care (n=10). The participants in the swimming arm were taught core aquatic skills and swimming stroke drills by a swimming teacher and physiotherapist in a community pool twice a week for three weeks.

Results
Swimming ability and water confidence improved; at the end of the programme 75% were able to swim a length of the pool. The outcome data was underpowered due to the nature of the study; however, it showed small improvements in pain self-efficacy, disability, and quality of life scores. There were no serious adverse events or safety issues identified during the study. At the 6-month follow-up, 60% had continued to swim on a regular basis.

Conclusions
The swimming programme enabled people with LBP to improve their swimming ability and water confidence and upon completion, many were able to incorporate swimming into their week. A swimming programme adapted for people with LBP delivered by swimming professionals and physiotherapists in a community setting, could provide an alternative form of exercise for this population, increasing levels of physical activity. Further research is required, and it is hoped that this feasibility study will support funding applications and the development of a large RCT.

Can a Lumbar Spinal Stenosis (LSS) rehabilitation group reduce the need for lumbar decompressive surgery for patients currently on surgical waiting lists? A pilot study

Lee Cameron, Dan Harding, Ashish Khurana, James Cordell-Smith, Sanjit Singh, Abraham Manoj-Thomas
Aneurin Bevan University Hospital Board, Newport, United Kingdom

Background
Degenerative lumbar spinal stenosis (LSS) is a common disorder affecting the older population and can be associated with neurogenic claudication (NC). Pain and paraesthesia into the legs, which can increase when walking/standing and relieved by sitting, are symptoms related to NC. This can have an impact on mobility, function, and quality of life (QoL) and may lead to surgical intervention.

Methods
This study (n=10) evaluated the effectiveness of a LSS rehabilitation group on walking distance, pain, function, and QoL. Patients selected from the trial were on a surgical waiting list. The LSS rehabilitation group consisted of 6, 1hr 30min sessions over 6 weeks, including education sessions, flexion-based exercises, static bike/rowing machine, strengthening/stretching exercises. Primary outcome was the 6 minute walk test (6MWT), secondary outcome measures were the Oswestry Disability Index (ODI), Swiss Spinal Stenosis Questionnaire (SSS), Euroqol - 5 dimension (EQ5D).

Results
The average age was 76 years (65-84), with an even gender distribution. A repeated measures ANOVA revealed significant improvement between pre and post 6MWT distances (MD=31.4, p=.01), indicating that LSS rehabilitation intervention may be an effective form of treatment to aid improvement in physical function. No significant differences were found in secondary outcome measures. One of 10 patients were removed from the waiting list.

Conclusion
The LSS rehabilitation group was shown to have a significant improvement in a patient's walking distances, however, this was a pilot study and we are continuing the study to increase sample size and provide reliable and valid results.

Spinal Trauma

A systematic review identifying outcome measures used in evaluating adults sustaining cervical spine fractures

Phillip Copley ORCID iD[1], Daniel Tadross[2], Nadia Salloum[1], Julie Woodfield[1], Ellie Edlmann[3], Michael Poon[1], Sadaquate Khan[1], Paul Brennan[1]
[1]Department of Clinical Neurosciences, Royal Infirmary of Edinburgh, Edinburgh, United Kingdom. [2]Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, United Kingdom. [3]Southwest Neurosurgical Centre, Derriford Hospital, Plymouth, United Kingdom

To assess outcome measures used in studies investigating adult cervical spine fractures, with/without spinal cord injury.

A literature search was performed, without historic limit on study date. Study characteristics, population characteristics and outcomes reported were extracted and analysed.

We identified 536 studies meeting inclusion criteria, involving 393,266 patients. Most studies were single centre (87.3%), retrospective (88.9%) and involved a median of 40 patients (range 6-167,278). Treatments assessed included: surgery(55.2%), conservative(6.2%), halo immobilization(4.9%), or a mixture(33.2%). Median study duration was 84 months (range 3-564 months). Timing of clinical/radiological assessment after injury was reported in 56.7%. There was significant heterogeneity in outcomes used, with 79 different reported outcome measures. Differences in use were identified between smaller/larger, retro-/prospective and single/multicentre cohorts. Over time, the use of radiological outcomes has declined with greater emphasis on patient-reported outcome measures (PROMs). Studies of conservative management were more likely to detail PROMs and mortality, whereas surgical studies reported Frankel/ASIA grade, radiological fusion, complication rates, duration of hospital stay and re-operation rates more frequently. Studies assessing patients > 65 years old used PROMs, mortality, hospital stay and discharge destination more often, whereas fusion was reported less often. Response rates for outcome assessments were lower in studies assessing elderly patients, and studies using PROMs.

We classified outcome measures used for patients with cervical spine fractures based on the COMET outcome taxonomy. We describe contexts in which outcomes are more commonly employed to help guide decision-making when designing future research endeavours.

Removal versus Retention of Metalwork following Posterior Stabilisation of Thoracolumbar Fractures: A retrospective analysis at a Major Trauma Centre

Jack Kingdon ORCID iD, Jandira Trindade, Hasan Mohammad, John Afolayan, Daniel Ochieng, Brett Rocos, Alexander Montgomery
Royal London Hospital, London, United Kingdom

Background
There is no consensus on the routine removal of posterior metalwork following thoracolumbar spine fracture fixation. Removal of metalwork in asymptomatic patients may expose them to unnecessary risks associated with the procedure and has a financial cost. However, potential implant-related complications may be avoided should routine removal be carried out.

This study aims to retrospectively analyse the removal versus retention of metalwork in patients that underwent stabilisation of traumatic thoracolumbar fractures. The relative complication rates (including revision of metalwork) were also analysed.

Methods
The Electronic Health Records (SNOMED-CT), the daily Emergency Neurosurgery admission list and Specialist Nurse database were retrospectively reviewed for all adults with traumatic thoracolumbar fractures, at a Major Trauma Centre in U.K., between January 2020 and July 2021 (n=1053) and filtered for all those that underwent posterior fixation +/- subsequent removal of metalwork (n=107).

Results
In 2020 67 patients (Female=12; Male= 55), with mean age of 45.5 (SD 18.72) had spinal fracture stabilisation. In 2021 40 patients (Female=15; Male=25), with a mean age of 43.45 (SD 19.15) had a spinal fracture stabilisation. The overall metalwork revision rate was 3.7% and < 5% of all patients underwent removal of metalwork.

Conclusion
Routine removal of metalwork following posterior stabilisation of thoracolumbar fractures is not indicated and retention is the current practice at our centre. There is a need for a consensus on the best practice for the management of this population of patients and further work to identify potential sub-sets of patients that might benefit from elective metalwork removal.

Does Balloon Kyphoplasty alter the natural history of osteoporotic vertebral fractures? A Systematic Review

Lydia Jenkins[1], Alex Torrie[2]
[1]*University of Bristol, Bristol, United Kingdom.*
[2]*Gloucester Royal hospital, Gloucester, United Kingdom*

Introduction
Osteoporotic vertebral fractures (OVF) affect approximately 1.4 million patients globally a year. Balloon Kyphoplasty (BK) is a minimally invasive procedure aiming to correct vertebral body deformity, and is a treatment option for patients with severe associated pain and disability. This study aims to investigate if BK changes the natural history of an OVF, by comparing BK with non-surgical management (NSM), using pain scores/disability indexes as outcomes.

Methods
A systematic review of Medline, Embase, Cochrane, from inception to December 2022 was undertaken. Only RCTs were included. A hand search of paper references and Google Scholar was done to ensure all relevant papers were included. 184 papers were identified and reviewed, and 2 papers were included in the final analysis.

Results
416 patients are included across the 2 studies, 209 in the NSM v 207 in the BK group. The results of this systematic review show that there is a statistically significant improvement in VAS scores (1.49 p<0.00 and 2.29 p<0.05) and SF-36(3.24 points, 95% CI 1.47–5.01, p0.0004)/Barthel Index (7.23 point reduction, p<0.005)across the 2 studies, but these improvements failed to reach the MCID for clinically significant differences. When the results are analyzed at different time points post intervention, only the results at 6 months post operatively were statistically significant(3.39 points, 95% CI 1.13–5.64, p0.003).

Conclusion
The greatest improvement in symptoms was observed in the first 6 months, indicating that BK is able to alter the natural history of OVFs in the acute phase. ■

Relax. It's sealed with Xact.

DuraSeal® Xact

CSF LEAK PREVENTION

Proven more watertight in a peer-reviewed clinical study[1]

DuraSeal® Xact is engineered for minimal swelling* and appropriate strength for the tighter confines and higher pressures of the spine

1. Wright NM, Park J, Tew JM, et al. Spinal sealant system provides better intraoperative watertight closure than standard of care during spinal surgery: a prospective, multicenter, randomized controlled study. **Spine (Phila Pa 1976)**. 2015;40(8):505-513.
*DuraSeal® Xact may swell up to 12% in any one dimension.

Availability of these products might vary from a given country or region to another, as a result of specific local regulatory approval or clearance requirements for sale in such country or region.

- Please read carefully the instructions for use.
- Non contractual document. Integra reserves the right, without prior notice, to modify the products in order to improve their quality.
- Warning: Applicable laws restrict these products to sale by or on the order of a physician.

Products mentioned in this document are CE class IIa (applicators) and III devices. Please contact Integra customer service should you need any additional information on devices classification.
All the medical devices mentioned on this document are CE marked in accordance with the applicable European laws, unless specifically identified as "NOT CE MARKED".
DuraSeal and the Integra logo are registered trademarks of Integra LifeSciences Corporation or its subsidiaries in the United States and/or other countries.
 Last revision date: 09/2022. 2964264-1-EN

Integra Contact - Sales & Marketing
EUROPE, MIDDLE-EAST and AFRICA
Integra LifeSciences Services (France) SAS
Immeuble Séquoia 2 ▪ 97 allée Alexandre Borodine
Parc technologique de la Porte des Alpes
69800 Saint Priest ▪ FRANCE
Phone +33 (0)4 37 47 59 00
Fax +33 (0)4 37 47 59 99
integralife.eu

Integra Contact - Questions & Information
Europe, Middle East and Africa: +33 (0)4 37 47 59 50 ▪ +33 (0)4 37 47 59 25 (fax) ▪ csemea@integralife.com
France: +33 (0)4 37 47 59 10 ▪ +33 (0)4 37 47 59 29 (Fax) ▪ custservfrance@integralife.com
Benelux: +32 (0)2 257 4130 ▪ +32 (0)2 253 2466 (fax) ▪ custsvcbenelux@integralife.com
Germany: +49 (0)2102 5535 6200 ▪ +49 (0)2 102 5536 636 (fax) ▪ custsvcgermany@integralife.com
Italy: +39 (0)2 577 89 21 ▪ +39 (0)2 575 113 71 ▪ custsvcitaly@integralife.com
Switzerland: +41 (0)2 27 21 23 30 ▪ +41 (0)2 27 21 23 99 (fax) ▪ custsvcsuisse@integralife.com
United Kingdom: +44 (0)1 264 345 780 ▪ +44 (0)1 264 363 782 (fax) ▪ custsvcs.uk@integralife.com

Integra LifeSciences Corporation
1100 Campus Road ▪ Princeton,
NJ 08540 ▪ USA

Integra LifeSciences Services (France)
Immeuble Séquoia 2
97 allée Alexandre Borodine
Parc technologique de la Porte des Alpes
69800 Saint Priest ▪ FRANCE