



# 4TH SYDNEY SPINAL SYMPOSIUM

**FRIDAY 9TH SEPTEMBER 2022**

*International Convention Centre, Sydney*

*[www.sydneysspinalsymposium.org](http://www.sydneysspinalsymposium.org)*

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# WELCOME

At the outset, on behalf of the program committee and all participants, I acknowledge the Gadigal people of the Eora Nation on whose ancestral lands our 4th Annual Sydney Spinal Symposium (SSS) will be held on Friday 9th September. Welcome to the Symposium and ICC, Sydney.

When the postponed Tokyo Olympics were held in 2021; they were still called The 2020 Olympics, no such luck with the deferred Sydney Spinal Symposium of 2021. Hence the 4th SSS has significant program content from 2021 with a lot of new material but is the 2022 SSS.

The ethos of multidisciplinary interactions continues with this program, as the past meetings have yielded some excellent collaborations advancing our field. We will have surgeons, physical therapists, cell biologists and engineers interacting with molecular biologists and epidemiologists. Intermingled program that involves academics and practitioners along with Industry representatives and for the first time Government agencies; defining better for all of us how to bring innovative technologies to the market to help our patients and communities.

The program now has 7 Key notes, 13 Podium and 22 posters – a record of sorts. A combination of established researchers and young and new investigators has yielded some great discussions in the past – I am looking forward to more.

The ICC chefs were keen for us to hold the dinner at site, so let's give that a try.

Our sponsors have been very supportive with almost all of them carrying forward their support for the postponed event. Their support allows us to maintain the event at the same venue that previous participants were keen we continue to maintain.

I wish all the participants a great learning and interacting time at the symposium.

## **Ashish Diwan**

*Conference Chair*

## **Dr Ashish Diwan**

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St George Private Hospital

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# INFORMATION FOR DELEGATES AND PRESENTERS

## Venue Directory

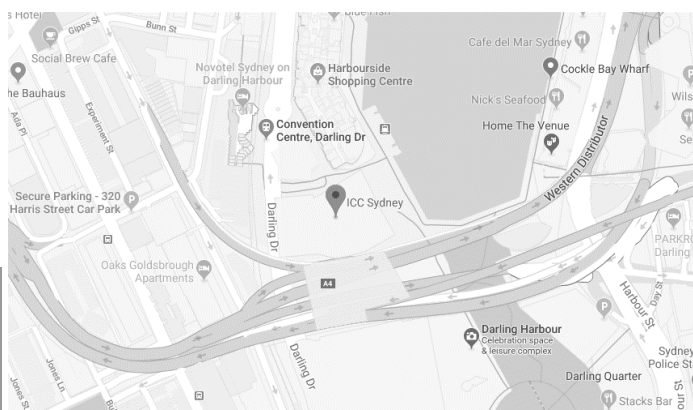
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### International Convention Centre Sydney

14 Darling Drive  
Sydney NSW 2000  
Ph: +61 2 9215 7100

Web address: [www.sydneyneuropainSYMPOSIUM.org](http://www.sydneyneuropainSYMPOSIUM.org)

Location	Item
Meeting Room C4.5	Sessions
Meeting Room C4.4	Exhibition and breaks



## Registration Desk

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The registration desk is located just outside Meeting Room C4.5. All conference related enquires should be directed to ASN Events staff at this desk.  
Operation times: Friday, 9<sup>th</sup> September 2022, 7:45 AM – 5:00 PM

### Onsite Conference Manager:

Gemma-ann Taylor, ASN Events  
Email: [gemma-ann.t@asnevents.net.au](mailto:gemma-ann.t@asnevents.net.au)  
Mobile: +61 490 514 632

### ASN Events Pty Ltd

9/397 Smith St, Fitzroy 3065  
P: +61 3 8658 9530  
Web: [www.asnevents.com.au](http://www.asnevents.com.au)

## Registration Inclusions

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Delegates will receive the following goods and services as part of their registration:

- Access to the sessions of your choice
- Conference program booklet
- Morning tea, lunch and afternoon tea
- Ticket to the Conference Mixer (booking required)
- Ticket to the Conference Dinner (booking required)
- Use of the Conference App
- Complimentary WIFI

## Drinks and Pyrmont Bridge Walk

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The Drinks and Pyrmont Bridge Walk will be held on Friday, 9<sup>th</sup> September 2022 from 5:10PM – 6:30PM at the ICC in room C4.4. Tickets are included in the registration; however, bookings are required for catering purposes. Please see the registration desk to see if there are still places available.

## Symposium Dinner

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The Conference Dinner will be held on Thursday 19<sup>th</sup> September 2019 following the Conference Mixer from 6:30PM onwards at the ICC in room C4.5. Tickets are included in the registration; however, bookings are required for catering purposes. Please see the registration desk to see if there are still places available.

## Speaker Preparation

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Presentations are to be loaded directly onto the PC in the presentation room in the break prior to your session. Presenters should bring their talk on a USB, saved in a format for display on a PC within the room (i.e. PowerPoint). An AV technician will be on hand to assist with uploading and to help you check your presentation. There is no Mac computer in the presentation room; however, you can bring your own and present from it provided you bring the appropriate conversion cables.

## Name Badges

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Delegates and registered partners are required to wear their nametags to all scientific and catered sessions.

## iPhone/Android Conference Web-App

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The App is displayed in a simple and easy to read format on your phone, iPad, or even your computer. To get the 'App', please open the below link in your internet browser on your smart phone, iPad or laptop.

<http://sss-2022.m.asnevents.com.au/>

You will be prompted to add an icon onto your device home screen. The web-based App will allow you to:

- View the full conference program
- View all abstracts for the conference
- Save your favorite sessions and plan your day
- Take notes which will then be saved and downloaded from your registration profile

To use most of these functions, you will be prompted to 'log in' each day. Simply enter the same email & password which you used to register.

## WIFI

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Complimentary WIFI is available for delegates within the conference areas for the duration of the conference. The WIFI connection is suitable for the viewing of emails and browsing. Downloading images and movies is not recommended.

How to connect:

1. Please connect to the following Network: **ICC Sydney**
2. No password required
3. Start internet

## **Special Meal Requests**

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If you have nominated for a special meal (dietary requirements, vegetarian, etc.) please identify yourself to the convention centre staff. All requests have been passed on and will be catered for accordingly.

## **Mobile Phones**

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Please ensure your mobile phone is turned to silent during any session you attend.

## **Insurance**

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The hosts and organisers are not responsible for personal accidents, any travel costs, or the loss of private property, and will not be liable for any claims. Delegates requiring insurance should make their own arrangements.

## **Disclaimer**

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The hosts, organisers and participating societies are not responsible for, or represented by, the opinions expressed by participants in either the sessions or their written abstracts.

# SPONSORS

## Silver Sponsors

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## Exhibitor



# INVITED SPEAKERS



**DR. JOHN CHOI, MBCHB FRACS**  
**Orthopaedic Spine Surgeon**  
***Spine Ortho Clinic, Melbourne, Australia***

I am an orthopaedic spine surgeon from Melbourne, currently in private practice. Currently I am the Director at Large for the SMISS - AP, AO Spine Fellowship officer and on the review panel for Asian Spine Journal, Neurospine Journal. I am involved with AIMS as the supervisor of Spine Surgery Fellowship since 2017. I have worked on several commercialised spine innovations including Crestline platform, Lateral ALIF platform and ATP prosthesis such as Acceloc XTP. I was the first user of Globus GPS Excelsius Robot in the southern hemisphere and since 2019, I have been involved in over 200 Robotic spine procedures and regularly host and teach surgeons thru VSP, Workshops, Conferences and Meetings. Recently, also started Australia's first biportal spine endoscopy surgery in 2021.



**DR MORGAN GIERS**  
**Chemical, Biological & Environmental Engineering Assistant Professor,**  
**Bioengineering**  
***Oregon State University, Oregon, United States of America***

Morgan Giers' work focuses on predicting treatment outcomes for intervertebral disc (IVD) regenerative and surgical therapies; utilizing MRI, image processing, mathematical modeling, tissue engineering, drug delivery, and surgery to study transport phenomena in vivo; studying potential molecular and biomechanical targets for IVD regeneration in the context of the nutrient-deprived human IVD.



**PROF SIOBHAN SCHABRUN**  
**William and Lynne Gray Endowed Research Chair in Mobility and Activity**  
***University of Western Ontario, London, Canada***

Dr Siobhan Schabrun is the William and Lynne Gray Endowed Research Chair in Mobility and Activity and Professor in the School of Physical Therapy at Western Ontario University, Canada. She has an undergraduate degree in Physiotherapy and a PhD in Neuroscience, specifically in the assessment and induction of neuroplasticity in humans, and has contributed more than 120 publications to the field. Dr Schabrun's work is centred on the exploration of neuroplasticity in pain using clinical populations and human transitional pain models. Her work seeks to uncover biomarkers that can identify those at risk of developing chronic pain, to understand the mechanisms that cause chronic pain and to develop brain-based treatments and preventatives.



**SIMON SINGER**  
**Principal Medical Adviser, Medical Devices Authorisation at TGA**  
***Therapeutic Goods Administration, Australian Government Department of Health, Canberra, Australia***



# PROGRAM

Friday 9<sup>th</sup> September 2022

## Registration, Coffee and Poster Mounting

7:45AM - 8:30AM

## Welcome to Country and Opening Remarks

8:30AM - 8:35AM

Meeting Room C4.5

## Session 1: The Spinal Cord

8:35AM - 9:30AM C4.5

Meeting Room C4.5

Chair: Saeed Kohan

8:35 AM

**Ashish Diwan**

Low Back Pain – From Guidelines to Precision Medicine *abs# 1*

9:00 AM

**Alisha Wafa Sial**

Diffusion Tensor Imaging of the Cervical Spinal Cord: A diagnostic tool to measure the functional state of the cervical spinal cord in Degenerative Cervical Myelopathy patients. *abs# 2*

9:10 AM

**Jo Gamble**

MIC-1/GDF15 Overexpression is associated with increased functional recovery in traumatic spinal cord injury *abs# 3*

## Session 2A: Surgery & Technology

9:30AM - 10:00AM

Meeting Room C4.5

Chair: Christopher Maher

9:30 AM

**Morgan Giers**

Machine learning model: predicting analytics for the management of lumbar degeneration disease *abs# 4*

## Coffee Break and Poster Viewing

10:00AM - 10:45AM

Meeting Room C4.4

## Session 2B: Surgery & Technology

10:45AM - 12:30PM

Meeting Room C4.5

Chair: Christopher Maher

10:45 AM

**Teng Zhang**

Towards radiation-free spine alignment synthesis with clinical validation *abs# 5*

10:55 AM

**Kyle Sheldrick**

Post Processing Of MRI scans can improve LBP diagnosis *abs# 6*

11:05 AM

**Simon L Singer**

Australia's Medical Devices Regulatory Framework *abs# 7*

11:40 AM

**Manuela Ferreira**

SUCCESS trail update *abs# 8*

11:50 AM

**Vivek Ramakrishna**

Smart orthopaedic implants: A targeted approach for continuous postoperative evaluation in the spine *abs# 9*

12:00 PM           **Ashish Diwan**  
Phase 1 AuDi trial update *abs# 10*

12:10 PM           **John Choi**  
Robotics in Spinal Surgery *abs# 11*

**Lunch and Poster Viewing**

12:30PM - 2:00PM

Meeting Room C4.4

**Session 3: Dangerous Ideas**

2:00PM - 3:00PM

Meeting Room C4.5

Chair: Ashish Diwan

2:00 PM           **Qiuzhe Chen**  
*Healthcare disparities in culturally and linguistically diverse patients with low back pain abs# 12*

2:10 PM           **Javad Tavakoli**  
How and why transition zone in the intervertebral disc matters: new findings and old assumptions *abs# 13*

2:20 PM           **Giovanni Ferreira**  
A content analysis of online information about the benefits and harms of spine surgery *abs# 14*

2:30 PM           **Gem Chew**  
Determining the applicability of research for the ageing population *abs# 15*

2:40 PM           **Siobhan Schabrun**  
Available Soon *abs# 16*

**Coffee Break**

3:00PM - 3:40PM

Meeting Room C4.4

**Session 4: PhD Presentations**

3:40PM - 5:00PM

Meeting Room C4.5

Chair: Ashish Diwan

3:40 PM           **Ben Goss**  
A narrative review of the history and evidence for restorative neurostimulation for chronic mechanical low back pain *abs# 200*

4:00 PM           **Alison M Slater**  
The thoracolumbar fascia and back pain *abs# 117*

4:20 PM           **Caitlin MP Jones**  
Systematic review and meta-analysis of the effectiveness of advice and education for the management of non-specific spinal pain *abs# 18*

4:40 PM           **Ji Tu**  
Smoking and tetramer tryptase+ Mast Cells accelerate intervertebral disc degeneration by inducing METTL14-mediated DIXDC1 m6 modification *abs# 20*

**Drinks and Pyrmont Bridge Walk**

5:00PM - 6:30PM

Meeting Room C4.4

**Symposium Dinner and Prizes**

6:30PM - 9:00PM

Meeting Room C4.5

# POSTER LISTING

**abs# 17: What proportion of patients with chronic low back pain are prescribed versus use an opioid medicine?**

**Systematic review and meta-regression of observational studies.**

Stephanie Mathieson, *The University of Sydney, Camperdown, NSW, Australia*

G. Wertheimer, C. Maher, C. Lin, A. McLachlan, R. Buchbinder, S. Pearson, M. Underwood

**abs# 101: Intrathecal morphine injection in anterior lumbar and lateral lumbar spine surgery**

Darweesh D Al Khawaja, *Brain & Spine Clinic, Penrith, NEW SOUTH WALES, Australia*

**abs# 102: Compression and fatigue behavior of laser powder bed fusion additive manufactured graded NiTi gyroid-structures for load-bearing orthopaedic applications**

Wenliang Chen, *The University of New South Wales, Kensington, NSW, Australia*

J. Kruzic, X. Li

**abs# 103: The association between pain scores and disc height change following discectomy surgery in lumbar disc herniation patients: A systematic review and meta-analysis**

Xiaolong Chen, *Spine Service, St George & Sutherland Clinical School, University of New South Wales, UNSW Medicine, Sydney, NSW, Australia*

H. Sandhu, J. Vargas Castillo, A. Diwan

**abs# 104: Spine service Clinical Trial Unit: Integrating Clinical Care and Research**

Neha Chopra, *Spine Labs, Spine Service, Kogarah, NSW, Australia*

A.D. Diwan, X. Chen, A. Sial, K. Pathinathan, F. Koremans, C. Stewart, N. Najib, S. Sima, R. De-La Lande, C. Saulys, M. Sjarief, N. Grewal, C. Tatsis, C. Burgess

**abs# 105: Role of Blood-Spinal Cord Barrier in spinal disorders & Therapeutics**

Neha Chopra, *Spine Labs, Spine Service, Kogarah, NSW, Australia*

S.S. Menounos, P.P. Choi, P.P. Hansbro, A.A. Diwan, A.A. Das

**abs# 106: Second opinions for spine surgery: a scoping review**

Giovanni Ferreira, *Institute for Musculoskeletal Health, Institute for Musculoskeletal Health, Sydney Local Health District & The University of Sydney, Sydney, NSW, Australia*

J. Zadro, C. Liu, I. Harris, C. Maher

**abs# 107: Microbiome and bone marrow metabolism dysbiosis in low back pain**

Wentian Li, *UNSW, Sydney, NSW, Australia*

J. Tu, A. Diwan

**abs# 108: Characteristics of baseline frequency data in spinal RCTs do not suggest widespread fraud**

Manon M Levayer, *School of Biomedical Engineering, The University of Sydney, Darlington, NSW, Australia*

G.R. Chew, K.A. Sheldrick, A.D. Diwan

**abs# 109: Cooled radiofrequency ablation of the sacroiliac joint a retrospective series**

Joseph Maalouly, *spine surgery, Brain and spine surgery, Bella vista, NSW, Australia*

P. Rao

**abs# 110: Endoscopic Vs microdiscectomy – a retrospective study**

Joseph Maalouly, *spine surgery, Brain and spine surgery, Bella vista, NSW, Australia*

P. Rao

**abs# 111: A clinically relevant 3D *in vitro* spinal cord injury model using biofabrication techniques**

Maryam Alsadat Rad, *School of Biomedical Engineering, University of Technology Sydney, Sydney, NSW, Australia*

J. Tavakoli, I. Kabakova, J. Tipper

**abs# 112: Fusion techniques of the Sacroiliac joint in traumatic and non-traumatic conditions**

Kalaventhnan Pathinathan, *Department of Orthopaedic Surgery, St. George Hospital Campus, Clinical Fellow, Kogarah, NSW, Australia*

*A.W. Sial, X. Chen, N. Chopra, A.D. Diwan*

**abs# 113: Radiological factors for predicting degenerative cervical myelopathy with increased intramedullary signal intensity based on x-ray and MRI**

*Christopher Saulys, UNSW, MACQUARIE PARK, NSW, Australia*

**abs# 114: Quantifying the biomechanical effects of posterior fixation in XLIF**

*Vivek A.S. Ramakrishna, School of Mechanical and Manufacturing Engineering, University of New South Wales, Sydney, NSW, Australia*

*U. Chamoli, A.G. Larosa, S.C. Mukhopadhyay, G. Prusty, A.D. Diwan*

**abs# 115: Inflammatory biomarkers in different locations in patients with low back disorder: systematic review protocol**

*Stone Sima, Spine Labs, St George and Sutherland Clinical School, Sydney, NSW, Australia*

*X. Chen, A. Diwan*

**abs# 116: Radiographic evaluation of lumbar intervertebral disc height: an intra and inter-rater agreement and reliability study**

*Stone Sima, Spine Labs, St George and Sutherland Clinical School, Sydney, NSW, Australia*

*X. Chen, J. Quan, A. Diwan*

**abs# 118: A multi-parametric MRI processing pipeline for paraspinal muscles**

*Moudrack MS Sjarief, UNSW Medicine, Sydney, NSW, Australia*

*K.K. Sheldrick, A.A. Diwan*

**abs# 119: The effectiveness of biofeedback for improving pain, disability and work ability in adults with neck pain: a systematic review and meta-analysis**

*Giovanni Ferreira, School of Health and Natural Sciences, Mercy College, Dobbs Ferry, New York, United States*

*M. Campo, J.R. Zadro, E. Pappas, M. Monticone, C. Secci, D. Scalzitti, J.L. Findley, P.L. Graham*

**abs# 120: Intervertebral disc-on-a-chip: a precision-engineered platform for low back pain studies**

*Joanne Tipper, Centre for Health Technologies, School of Biomedical Engineering, Faculty of Engineering and Information Technology, , University of Technology Sydney, Sydney, NSW, Australia*

*S.S. Bangar, D. Wen, L. Cole, A. Bottomley, J. Tavakoli*

**Abs# 121: 3D reconstruction of the lumbar spine using ultrasound images: Towards radiation-free lumbar facet joint injections**

*Haijun Zeng, The University of New South Wales, Haymarket, NSW, Australia*

*X. Chen, A. Diwan, L. Wu*

**abs# 122: Physiotherapy utilization, costs and return to work status following lumbar spine surgery: a retrospective analysis of workers compensation claims in Australia**

*Giovanni Ferreira, Institute for Musculoskeletal Health, School of Public Health, The University of Sydney, Camperdown, New South Wales, Australia*

*J.R. Zadro, A.M. Lewin, P. Kharel, J. Naylor, C.G. Maher, I.A. Harris*

**abs# 123: Obesity Back pain Evaluation Laparoscopic bariatric surgery and Imaging with X-ray and MRI study (OBELIX): A prospective observational cohort study**

*Froukje Koremans, Spine Service, St George Hospital, Kogarah, NSW, Australia*

*K. Loi, M. Madgy, J. Jorgensen, V. Kuzinkovas, D. Simar, A.D. Diwan*

**abs# 124: Establishing an Australian Degenerative Cervical Myelopathy Patient Registry**

*Nashwa Najib, St George and Sutherland Clinical School, Sydney, NSW, Australia)*

*A.D. Diwan*

# SPONSOR & EXHIBITOR LISTING

## **BAXTER HEALTHCARE PTY LTD**

**Table 1**

### *SILVER SPONSOR & SESSION SPONSOR*

Every day, millions of patients and caregivers rely on Baxter's leading portfolio of critical care, nutrition, renal, hospital and surgical products. For more than 85 years, we've been operating at the critical intersection where innovations that save and sustain lives meet the healthcare providers that make it happen. With products, technologies and therapies available in more than 100 countries, Baxter's employees worldwide are now building upon the company's rich heritage of medical breakthroughs to advance the next generation of transformative healthcare innovations.

Baxter is a registered trademark of Baxter International Inc.

## **ST GEORGE PRIVATE HOSPITAL**

**Table 2**

### *SILVER SPONSOR*

Featuring 280 rooms, more than 500 accredited surgeons and over 1,000 staff, St George Private Hospital belongs to the Ramsay Health Care Group and is one of Australia's most modern private hospitals.

St George Private Hospital is committed to providing an excellent standard of patient care and prides itself on strong surgical expertise in bariatrics, cardiology, orthopaedics, oncology, spinal surgery, endoscopy, aged care, general surgery, and obstetrics.

## **LIFEHEALTHCARE**

**Table 3**

### *EXHIBITOR*

LifeHealthcare is focused on providing access to world-leading medical devices for Australian and New Zealand patients, whilst ensuring long-term economic sustainability for our healthcare system.

LifeHealthcare has a broad portfolio of products in various channels that include Spine, Orthopaedics, Robotics, Plastics & Reconstructive Surgery and Interventional Neuro-Vascular surgery.

Our passion is health

Our purpose is making life better for others

## **GLOBUS MEDICAL**

**Table 4**

### *SILVER SPONSOR*

Globus Medical, a leading musculoskeletal solutions company, is driving significant technological advancements across a complete suite of products ranging from spinal, trauma, and joint reconstruction therapies to imaging, navigation, and robotics. Globus is driven to utilize high-level engineering and technology to achieve pain-free, active lives for all patients with musculoskeletal disorders.

## **NUVASIVE**

**Table 5**

### *SILVER SPONSOR*

NuVasive is the leader in spine technology innovation, with a mission to transform surgery, advance care, and change lives. The Company's less-invasive, procedurally integrated surgical solutions are designed to deliver reproducible and clinically proven outcomes. The Company's comprehensive procedural portfolio includes surgical access instruments, spinal implants, fixation systems, biologics, software for surgical planning, navigation and imaging solutions, and intraoperative neuromonitoring technology. With more than \$1 billion in net sales, NuVasive has approximately 2,700 employees and operates in more than 50 countries serving surgeons, hospitals, and patients.

# FULL ABSTRACTS

1

## Low Back Pain – From Guidelines to Precision Medicine

**Ashish Diwan<sup>1</sup>**

1. Sydney Neurospine, St Leonards, NSW, Australia

Not available

2

## Diffusion Tensor Imaging of the Cervical Spinal Cord: A diagnostic tool to measure the functional state of the cervical spinal cord in Degenerative Cervical Myelopathy patients.

**Alisha Wafa Sial<sup>1</sup>, Ashish Diwan<sup>1</sup>, Mark Davies<sup>1</sup>, neha chopra<sup>1</sup>, Xiaolong Chen<sup>1</sup>, Kyle Sheldrick<sup>1</sup>, Ralf Loeffler<sup>2</sup>, Claudia Hillenbrand<sup>2</sup>**

1. St George and Sutherland Clinical school, Sydney, NSW, Australia

2. Prince of Wales Clinical School, UNSW, Sydney, NSW, Australia

Degenerative Cervical Myelopathy (DCM) is a cause of spinal cord dysfunction affecting 2% of population. Loss of axonal integrity has been implicated in DCM, but its role is to be determined in DCM with neck pain. Diffusion Tensor imaging (DTI) is a Magnetic Resonance (MR) technique capable of measuring magnitude and direction of diffusion of water molecules in tissues. Direction dependent diffusion is anisotropy, used by DTI to infer the orientation of surrounding axonal fibres and to delineate anatomical boundaries. Fractional anisotropy (FA) defines the degree of anisotropy. ADC (apparent diffusion coefficient) or Mean diffusivity (MD) is the average of the diffusivities in the 3 principal axes.

Purpose: To compare the FA and ADC values obtained by DTI in healthy and neck pain to assess the microstructural damage of the spinal cord in DCM.

Methods: MRI DTI images from subjects with or without neck pain will be obtained. FA and ADC will be estimated and compared. In Phase 1, one with and one without neck pain were scanned to establish methodology. First a sagittal T2W turbo spin echo (TSE) was acquired to evaluate spinal cord status. Second, axial T2-weighted (T2\*W), multi-echo fast field echo (mFFE) images with three echoes were acquired for anatomical references. Third, a multi-shot high-resolution DTI data were acquired using a two-dimensional navigated interleaved EPI sequence.

Results: Healthy individual [62M] and neck pain individual [69M] successfully underwent MRI in a Phillips 3-T Achieva TX scanner, scan time was 45 mins per patient. T2-weighted images were acquired using a 16-channel neurovascular radiofrequency (RF). Healthy FA was 0.83, neck pain FA was 0.543. Healthy ADC was 0.17 and neck pain ADC was 0.13.

Conclusion: We have successfully established a protocol for spinal cord DTI evaluation. We expect a positive correlation between worsened symptoms and a lower axonal integrity. DTI of the cervical spine may be a promising novel imaging modality for patients with DCM.

3

## MIC-1/GDF15 Overexpression is associated with increased functional recovery in traumatic spinal cord injury

**Jo Gamble<sup>1</sup>, Svetlana Pianova<sup>1</sup>, David Brown<sup>1</sup>**

1. Centre for Immunology and Allergy Research, Neuroinflammation Research Group, Westmead Institute for Medical Research, Sydney, NSW, Australia

### Introduction

Spinal cord injury (SCI) can severely impact upon a patient's quality of life and imposes a large social and economic burden on society. The total annual cost of spinal cord injury in Australia is estimated to be over \$3 billion. Despite this, there has been little improvement in therapies over the past decade. GDF15, a TGF- $\beta$  superfamily member, regulates inflammatory responses and is neurotrophic. Recently, we demonstrated that GDF15 enhanced recovery from traumatic spinal cord injury (SCI) in a mouse model of spinal cord injury. We observed an increase in the inflammatory cellular infiltrate in Tg mice in addition to increased tissue sparing.

### Methods and results

Severe contusive SCI (70 kilo dyne force) was induced in wild type (WT), GDF15 transgenic (Tg), and GDF15 knockout (KO) mice. Double-blinded locomotion assessment was performed on days 7, 14, 21 and 28 post SCI using the Basso Mouse Scale (BMS). Tissue and blood was harvested at 28 days to investigate cellular changes in the injury area. GDF15 Tg mice had superior locomotor recovery, and an increase in inflammatory cellular infiltrate, compared to their KO and WT counterparts. This inflammatory cellular infiltrate included an increased frequency of macrophages and dendritic cells (DCs).

### Conclusion

Overall, the findings suggest that the increase in the inflammatory cellular infiltrate following injury may improve the clinical outcome of SCI and macrophages and other innate immune cells are a promising target for novel therapies with GDF15.

## Machine learning model: predicting analytics for the management of lumbar degeneration disease

Morgan Giers<sup>1</sup>

1. Oregon State University, Corvallis, OREGON, United States

Not available

## Towards radiation-free spine alignment synthesis with clinical validation

Teng Zhang<sup>1,2</sup>, Nan Meng<sup>1</sup>, Jason PY Cheung<sup>1</sup>, Moxin Zhao<sup>1</sup>, Sofia Li<sup>1</sup>, Ashish Diwan<sup>3</sup>

1. Digital Health Laboratory, Li Ka Shing Faculty of Medicine, The University of Hong Kong, Pokfulam, Hong Kong, China

2. CoNova Medical Technology Limited, Hong Kong

3. Spine Labs, St George and Sutherland Clinical School, University of New South Wales, Sydney, NSW, Australia

Adolescent idiopathic scoliosis (AIS) is the most pervasive spinal disorder in the adolescence. Clinical screening and diagnosis require manual physical and radiographic examinations, which is either manual and subjective, or increases the radiation exposure to children to analyse the alignment of the spine. Thus, we developed and validated a radiation-free system and device utilising artificial intelligence (AI) and depth sensing (RGBD) technologies to analyse AIS. Our in-house developed device takes an RGBD image of the nude back as input and synthesises its spine alignment (Figure 1). The synthesised spine alignment contains sufficient anatomical information that can assist disease severity and curve type prediction. We tested the performance of our system prospectively at two local clinics on 230 patients. The synthesised spine alignment for AIS severity classification achieved a sensitivity and NPV of 0.95 and 0.97, and these performances were 0.89 and 0.86 for the curve type classification, with spine specialists' manual assessment results from real radiographies as ground truth (GT). Our portable system and device have the potential to assist fast and accurate AIS screening without radiation.

## Post Processing Of MRI scans can improve LBP diagnosis

Kyle Sheldrick<sup>1</sup>

1. Spine Service, St George and Sutherland Clinical School, University of New South Wales, Kogarah, NSW, Australia

Not available

## Australia's Medical Devices Regulatory Framework

Simon L Singer<sup>1</sup>

1. Australian Government Department of Health, Canberra, ACT, Australia

In Australia, medical devices are regulated under the Therapeutic Goods Act (1989) and the Medical Devices Regulations (2002), by the Therapeutic Goods Administration. The framework has adapted to facilitate effective, risk-based regulation of innovative medical devices, including software and "custom-made" devices. Whilst being based on principles (the Essential Principles), the Regulations have rules that determine the degree of regulatory oversight and specific points that need to be addressed for categories of devices.

## SUCCESS trail update

Manuela Ferreira<sup>1</sup>

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Not available

## Smart orthopaedic implants: A targeted approach for continuous postoperative evaluation in the spine

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**Aims**



There are several complications associated with lumbar interbody fusion (LIF) surgery however, pseudarthrosis presents a multifaceted challenge in the postoperative management of the patient. Rates of pseudarthrosis at least one year after LIF surgery range from 3-20% in patients with healthy bone and 20-30% in patients with osteoporosis. Plain radiographs and fine-cut CT have high false positive rates and poor agreement between the two modalities. The aim of this study was to develop a proof-of-concept load-sensing interbody cage to determine whether it may be used to monitor fusion progression.

#### Methods

Amphenol P122 pressure sensors were bonded to printed circuit boards (PCBs), which connected to a Raspberry Pi microcontroller to convert and transmit the sensor outputs. The sensors were individually calibrated within their overload limits. A polyether ether ketone (PEEK) interbody cage was manufactured with CNC milling to fit the PCBs within. Silicone and poly (methyl methacrylate) (PMMA) were inserted in the graft regions to simulate early and full fusion. The load-sensing cage was loaded with distributed and eccentric loads up to 900N at 0.6mm/min between two pieces of synthetic bone with dimensions of lumbar vertebral bodies. A finite element analysis model was developed with identical conditions to the experimental setup.

#### Results

Under maximum load, the anterior sensors recorded a 56-58% reduction in pressure in the full fusion state compared to early fusion. Lateral regions measured a 36-37% stress reduction while the central location reduced by 45%. The two graft states were similarly distinguishable by sensor-recorded pressure at lower loads. The experimental results generally fell within the range of the average and maximum values obtained from simulation. The sensors more effectively detected left and right eccentric loads compared to anterior and posterior. Further, the load-sensing cage was able to detect changes in endplate stiffness.

#### Conclusion

The proof-of-concept load-sensing interbody cage is able to detect differences in fusion state, endplate stiffness, and loading conditions in this in vitro experimental setup. Future research should aim to improve the implantability of the device by reducing the number of sensors, improving durability, and optimising the sensing configuration.

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### Phase 1 AuDi trial update

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Not available

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### Robotics in Spinal Surgery

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Not available

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### Healthcare disparities in culturally and linguistically diverse patients with low back pain

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#### Aims

The aims of this systematic review are (i) to identify healthcare disparities in culturally and linguistically diverse patients with low back pain, in comparison with counterparts; and (ii) to describe the existing healthcare disparities in different countries.

#### Methods

This is a systematic review conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. **Eligibility criteria** We will include observational studies that compared any type of healthcare utilisation among patients with non-serious low back pain from distinct cultural and/or linguistic backgrounds. **Database searches** We searched in MEDLINE, EMBASE and CINAHL from 1 January 2000 to 24 June 2021, using the search strategy focused on low back pain, health care, and culturally and linguistically diverse. **Study selection** Two independent reviewers conducted a pilot test and screened all retrieved studies in Covidence using the inclusion and exclusion criteria. They will independently review relevant full texts and perform forward and backward citation tracking of included studies. **Data extraction** We will develop a standardised data extraction form in Excel and calibrate with pilot testing. **Methodology quality** Included studies will be appraised risk of bias in six domains as stated in Sanderson et al. **Data analysis** Key findings will be summarised in a data description table and narratively described. Random-effects meta-analysis will be used to synthesise relevant findings, and if possible, subgroup analyses by country will also be conducted. Data will be analysed using SAS 9.4.

#### Results

We retrieved 4,660 studies from three databases and removed 1,545 duplicates. We identified 78 potentially relevant studies by title and abstract screening. The analysis will be completed by September, and we will present full results at the symposium.

#### Conclusions

Racial and ethnic disparities in pain management have been broadly reported. But there is still a dearth of reviews exploring healthcare disparities in low back pain management among culturally and linguistically diverse populations.

## How and why transition zone in the intervertebral disc matters: new findings and old assumptions

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**Aim:** The current understanding of the relationship between the structure and function of the transition zone (TZ), a region at the interface on the nucleus (NP) and annulus (AF) of the intervertebral disc (IVD), is little. The current study aims to understand the viscoelastic and failure mechanical properties of the TZ region under physiological loading and to present a structural model for the integration between the NP and AF at the fibre level.

**Method:** 36 NP-AF blocks of tissue (t = 1mm) were harvested from the anterior region of ovine IVDs. Samples from the NP, TZ and IAF (inner AF) were subjected to cyclic dynamic loading up to 70% of their initial length (n = 24) at three different strain rates (1, 3, and 5%<sup>s</sup><sup>-1</sup>) and another 8 TZ samples were subjected to tensile failure tests. Tissue blocks (n = 4) were partially digested to identify the structural organization of elastic and collagen fibres at the NP, TZ, and IAF including the integration mechanisms between the NP and AF.

**Results and conclusion:** We observed different viscoelastic behaviours for different regions of interest and various strain rates. A Friedman test revealed a significant effect of region (NP, TZ, and IAF) and strain rates on stiffness,  $\chi^2(11) = 80.694$ ,  $p < 0.001$ ,  $W = 0.917$ . The relevant mean rank was the highest for the IAF, followed by TZ and NP regions with a growing trend as strain rates increased from 1 to 5%<sup>s</sup><sup>-1</sup>. From the failure mechanical test, we found that the overall effect of strain magnitude on TZ stiffness was significant ( $p < 0.001$ ; one-way ANOVA). Our structural analysis revealed different organizations for both collagen and elastic network from the NP towards the AF and identified three mechanisms of adaptation, direct penetration and entanglement between the TZ and IAF fibres at the NP-AF interface.

## A content analysis of online information about the benefits and harms of spine surgery

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**Aims:** To describe the proportion of consumer webpages containing information about surgery for spinal pain that accurately described the evidence on the benefits of surgery, described harms and provided quantitative estimates of these harms.

**Methods:** We performed a content analysis. Webpages containing information for consumers about two common types of spine surgeries – decompression and fusion. We identified webpages through Google using search terms synonymous with 'spine fusion' and 'spine decompression surgery'. Two independent reviewers identified webpages and extracted the data. Outcomes were the proportion of webpages that had an accurate description of evidence on the benefits, described harms, and provided quantitative estimates of these harms.

**Results:** A total of 117 webpages were included. Only 29 (25%) had an accurate description of evidence on the benefits of spine surgery. A greater proportion of webpages on decompression had an accurate description of evidence on the benefits compared to webpages on fusion (31% vs 15%, difference in proportions 16%, 95% CI 2% to 31%;  $p = 0.02$ ). Harms of surgery were described in most webpages (n = 76, 65%), but only a much smaller proportion of webpages (n = 18, 15%) provided a quantitative estimate for the mentioned harms, with no difference between webpages on decompression and fusion.

**Conclusion:** Most webpages failed accurately describe the evidence on the benefits of decompression and fusion for spinal pain. Harms were described in two thirds of pages, but only a very small proportion provided a quantitative estimate of harms. Unbiased consumer resources and educating the public on how to critically evaluate health claims are important steps to improve knowledge on the benefits and harms of spine surgery.

## Determining the applicability of research for the ageing population

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### Importance:

Despite the global increase in the ageing population, increasing complications and poorer outcomes are associated with older patients undergoing spinal intervention. We believe this could be due to a lack of research targeted towards this population.

### Objective:

The primary objective of this review is to determine how applicable the current spinal research is for the ageing population. Despite several studies looking into ageism, many have only determined whether studies had an explicitly stated upper age cut-off. This, however, does not translate to the applicability of a study. Secondary objectives include looking at factors associated with ageism such as explicitly stated upper age cut-offs and type of sponsorship.

### Evidence Review:

Full-text articles from PubMed were screened with our inclusion criteria including RCTs from the top 7 spinal journals used by spinal research professionals. Data was extracted by 2 members of the research team, and discrepancies were resolved by adjudication. The number of applicable

trials were calculated for each 5-year age category from 40 to 100 years old. Trials were considered applicable for that age category if 25% or more of the patients were of that age or older.

#### Findings:

186 studies were included with a total of 26,238 participants. Decreased applicability was found with increased age. At 40-years-old, approximately 98% of studies were applicable for an individual in that age category; at 60-years-old, approximately 42% of studies were applicable; and at 80-years old, less than 2% of studies were applicable. Trials with explicitly stated upper age cut-offs had younger participants than trials that did not. Interestingly, sponsorship did not affect the participant ages.

#### Conclusions/Relevance:

The corpus of RCTs in spinal journals provide almost no information to treat patients 75-years or older. Ageism goes beyond explicitly stated cut-offs and sponsorship. It exists at three levels - systemic exclusion, explicit exclusion, implicit inclusion. Age based exclusion is not something that can be addressed by individual researchers acting independently but requires a systemic response as it largely arises at a supra-trial level.

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## Available Soon

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Not available

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## What proportion of patients with chronic low back pain are prescribed versus use an opioid medicine? Systematic review and meta-regression of observational studies.

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### Background

Clinical guidelines now discourage the prescribing of opioid analgesics for chronic low back pain because the benefits frequently do not outweigh the harms.

### Aims

To determine the extent that patients with chronic low back pain are prescribed an opioid analgesic compared to the self-reported consumption of opioid analgesics.

### Methods

Electronic databases were searched without language restrictions. We included observational studies of adults with chronic low backpain measuring opioid prescribing and use. Opioids were categorised as weak (e.g. codeine) or strong (e.g. oxycodone). Study quality was assessed using a risk of bias tool designed for observational studies measuring prevalence. Individual study results were pooled using a random-effects model. Meta-regression investigated study-level factors associated with prescribing (e.g. sampling year, the geographic region as per World Health Organization). The overall evidence quality was assessed using the Grading of Recommendations Assessment, Development and Evaluation criteria.

### Results

Twelve studies reported data on opioid analgesic prescribing between 1991 to 2015 (758,248 participants), of which seven studies were at low risk of bias. The pooled estimate of the proportion of patients with chronic low back pain prescribed opioids was 41.5% (95%CI 28.9% to 55.4%; low-quality evidence). Meta-regression determined that opioid prescribing was associated with the year of sampling (more prescribing in recent years) ( $P = 0.001$ ) but not geographic region ( $P = 0.503$ ) or setting ( $P = 0.228$ ).

Eight studies reported data on the self-reported use of opioids between 1990 to 2017 (106,191 participants), of which six studies had a moderate risk of bias. The pooled estimate of the proportion of people with chronic low back pain that used opioid analgesics was 29.8% (95%CI 20.5% to 41.2%; moderate-quality evidence). Meta-regression determined that opioid use was not associated with sampling year or geographic region.

### Conclusion

Based on available published studies, opioid prescribing for patients with chronic low pain increased over time, but opioid analgesic use in this population did not significantly increase over time.

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## Systematic review and meta-analysis of the effectiveness of advice and education for the management of non-specific spinal pain

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**Background:** Spinal pain is a leading cause of disease burden worldwide. It also is a major economic burden on society and the individual due to the costs of treatment, and work absence.

**Aim/s:** To determine the effectiveness of advice or education on pain and disability for people with non-specific spinal pain and to investigate potential treatment effect modifiers.

**Methods:** We searched multiple databases from their inception to September 2020 for randomised controlled trials comparing advice to no advice or placebo advice for adult populations with non-specific back and/or neck pain with or without radiating leg/arm pain of any duration were included. Trials recruiting pregnant women or surgical patients in the immediate post-operative phase were ineligible.

**Results:** We found 27 trials (n = 7006 participants). There was low-quality evidence that advice had a small effect on pain (MD -8.2, 95% CI: -12.5 to -3.9; n = 2241) and moderate-quality evidence that advice had a small effect on disability (MD -4.5, 95% CI -7.9 to -1.0, n = 2579) compared to no advice or placebo advice in the short-term. There were no significant modifiers of treatment effects.

**Conclusions and Clinical Implications:** Our results provide evidence that advice provides a short term benefit for non-specific spinal pain, but the effect is small and may not be sufficient as the sole treatment for patients with spinal pain.

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## Smoking and tetramer tryptase+ Mast Cells accelerate intervertebral disc degeneration by inducing METTL14-mediated DIXDC1 m6A modification

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### INTRODUCTION

Although smoking and low back pain (LBP) are common worldwide, their correlations and the mechanisms of action remain unclear. Mast cells (MCs) are hematopoietic cells that complete their differentiation and maturation in tissues. Excessive activation of TT+ MCs is thought to play beneficial roles in bacterial infections and preventing life-threatening internal blood clots, but adverse roles in many of inflammatory diseases. N6-methyladenosine (m6A) is mammalian cells' most prevalent internal mRNA modification. m6A participates in nearly every aspect of mRNA function and metabolism and in diverse cellular, developmental, and disease processes. In this study, we described a detailed mechanism by which MCs and their TT performed mediators play a central role in CS-induced disc degeneration.

### METHODS

The discectomy outcomes were evaluated for smokers, former smokers and never smokers with 12 months follow up. Tightly controlled amounts of cigarette smoke were delivered to the airways of mice, and the pathological features of intervertebral disc degeneration was assessed. The role and physiology of mast cell (MC)-restricted tetramer tryptases (TT) and m6A were explored in nucleus pulposus (NP) cells in vivo. and in vitro.

### RESULTS

Patients who smoke showed poor Oswestry Disability Index (ODI) benefit compared with those who never smoked when discectomy was conducted. Mechanically, we found that smoking exposure results in the release of MC-restricted TT inside the intervertebral disc (IVD)s. Furthermore, we found that hTT can regulate the expression of methyltransferase 14 (METTL14) at epigenetic level by inducing N6-methyladenosine (m6A) deposition in the 3'-untranslated region (3'-UTR) of the transcript that encodes DIX Domain Containing 1 (DIXDC1). That reaction increases the mRNA stability and expression of DIXDC1. DIXDC1 functionally interacts with 'Disrupted in Schizophrenia-1' (DISC1) to accelerate the degeneration and senescence of nucleus pulposus (NP) cells by activating a canonical Wnt pathway.

### SIGNIFICANCE

Our study demonstrates the association between CS, MC-derived TTs, and LBP. Our data raise the possibility that METTL14-mediated DIXDC1 m6A modification could serve as a potential therapeutic target to block the development of degeneration of the NP in LBP patients.

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## Intrathecal morphine injection in anterior lumbar and lateral lumbar spine surgery

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**Introduction.** Intrathecal morphine (ITM) is routinely used in many surgical specialties as an adjunct to postoperative analgesia. There have been multiple reports of the benefits of ITM in lumbar spine surgery where it has been shown to significantly reduce the need for intravenous opioid analgesia, improve time to mobilization, and shorten length of hospital stay.

Anterior lumbar spine surgery (ALSS) includes anterior lumbar interbody fusion (ALIF) and lumbar total disc replacement (TDR). Lateral lumbar spine surgery (LLSS) includes transpsoas lateral lumbar interbody fusion (LLIF), anteromedial to psoas (AMP), or anterior to the psoas oblique lumbar

interbody fusion (OLIF). ALSS and LLSS have become mainstay surgical techniques, broadly indicated for the restoration of structural and biomechanical integrity in a variety of degenerative lumbar pathologies. In recent times ALSS and LLSS have increased in popularity with potential benefits of efficient access and direct visualization of the anterior column and disc space, shorter operative times and reduced iatrogenic trauma to paraspinous neurovasculature and musculature.

The widely known method of administering ITM intraoperatively during Lumbar Spine Surgery is via a posterior approach. Although Posterior lumbar spine surgery provides an opportunity for intrathecal injection, a theoretical concern of this is the risk of an iatrogenic cerebrospinal fluid (CSF) leak with dural puncture.

Large numbers of standalone anterior spinal surgeries are performed in our institution. The patient is positioned supine with no access during surgery to the posterior spine and therefore we developed a method of administering ITM through the anterior or lateral approach.

Herein we describe a technique for injection into the dural sac via the Anterior and Lateral approaches to the Lumbar Spine. This technique can be performed easily and quickly with standard surgical equipment. Through use of this technique, patients undergoing spine surgery may benefit from ITM with no risk of iatrogenic CSF leak.

1. Al Khawaja D. Intrathecal morphine injection in anterior lumbar and lateral lumbar spine surgery: technical note. *J Spine Surg* 2021. doi: 10.21037/jss-20-610

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### Compression and fatigue behavior of laser powder bed fusion additive manufactured graded NiTi gyroid-structures for load-bearing orthopaedic applications

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Publish consent withheld

1. [1] W. Chen, Q. Yang, S. Huang, J.J. Kruzic, X. Li, Compression Behavior of Graded NiTi Gyroid-Structures Fabricated by Laser Powder Bed Fusion Additive Manufacturing Under Monotonic and Cyclic Loading, *JOM - J. Miner. Met. Mater. Soc.* (2021). <https://doi.org/10.1007/s11837-021-04938-x>.

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### The association between pain scores and disc height change following discectomy surgery in lumbar disc herniation patients: A systematic review and meta-analysis

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**Purpose:** To evaluate the impact of discectomy on disc height (DH) in lumbar disc herniation (LDH) patients following discectomy surgery and address the association of DH change with pain score change.

**Methods:** We searched three online databases for randomized controlled trials (RCTs) and observational studies. In LDH patients, eligible for discectomy surgery, the changes in pre- and post-operative back and/or leg pain score and DH and/or disc height index (DHI), were considered as primary outcomes. Standardise mean difference (SMD) and their 95% confidence intervals (CI) were evaluated. The GRADE approach was used to summarize the strength of evidence.

**Results:** Two RCTs and sixteen observational studies were included in the analysis of 893 LDH patients undergoing discectomy surgery. The mean overall follow-up was 211 weeks. There was a statistically significant reduction in DH (14.4% reduction: SMD = -0.74 (95% CI = -0.86 to -0.61)) and DHI (11.5% reduction: SMD = -0.81 (95% CI = -0.97 to -0.65)) following discectomy surgery. There was a significant relationship between the reduction in DH and decrease in back pain score ( $r = 0.68$ , (95%CI = 0.07-1.30),  $p = 0.034$ ) after discectomy surgery. No significant relationship between DHI change and decrease in clinical pain scores (back and leg pain) could be established.

**Conclusion:** Discectomy surgery produces significant and quantifiable reductions in DH and DHI. Additionally, the reduction of DH is responsible for the decrease in back pain scores post discectomy, but further studies will improve understanding and aid preoperative counselling.

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### Spine service Clinical Trial Unit: Integrating Clinical Care and Research

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Clinical care and clinical research, till date, are viewed as discrete areas, that actually have the same ultimate aim - patient benefit. With advancements in various technologies and new found awareness for the need of research, especially after the pandemic, the profound importance of research is explicit. Therefore, integration of clinical care and research appears to be the next inevitable step for healthcare delivery.

For above reasons, the Clinical Trial Unit (CTU) at Spine Service is a central facility that takes a spine-surgery-related studies through its life span from inception to publication. Conceived in 2021 (Covid wave 2), CTU is a team of experienced spine clinicians, senior researchers, statisticians, PhD

students who have extensive experience in evaluating the safety and efficacy of innovative pharmaceuticals, devices and diagnostics. The 3 phase work-flow comprises of Study design (feasibility testing), study plan (ethics approval) and study execution. Study execution entails vital processes such as recruitment, follow-up, sample logistics (from clinic to laboratory) and data analysis to fulfill the study objectives per ICH-GCP standards. CTU focuses on spinal surgical recruitment, that is usually a challenge along with maintaining longitudinal cohort which requires an approach which is care-management centric. Hence CTU is uniquely positioned for surgeon's participation.

At present, CTU is coordinating sponsored device-related (AuDi), imaging related (TAO & PSR) trials along with spine registries (DegenPro) with on-going recruitments. Apart from sponsored trials, CTU also coordinates investigator-initiated research studies encompassing diverse fields such as human microbiome-pain axis, novel decay variance & DTI imaging techniques, obesity-pain axis, outcomes of XLIF, TLIF, ACDF's and many more. CTU is also expanding to other areas such as shoulder.

Though time and again COVID interruptions impact the recruitment process for patients, CTU has come up with innovative digital ways to acquire patient e-consent and also maintain all data record electronically. We aim to make CTU an integral part of regular surgical clinical practice, where both present and future patients would immensely benefit with new knowledge generated with each study.

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## Role of Blood-Spinal Cord Barrier in spinal disorders & Therapeutics

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Though the role of Blood Brain Barrier (BBB) is well studied in brain disorders, its functional equivalent, the blood-spinal cord barrier (BSCB), lacks in-depth investigation regarding its role in spinal cord and neurological disorders as it is still considered simply an extension of the BBB. The major structural constituents of both the BBB and BSCB are similar, yet functional differences in their role in diseases of the spinal cord exist. Compared to the brain, the spinal cord is a far more agile organ that is surrounded by supporting diverse tissues and extracellular matrices. In the event of dysfunction, immune responses generated from the spinal cord clinically differ from those in the brain and require a suitable intervention. Dysfunction of the BSCB is associated with various traumatic and non-traumatic injuries, aging and cancer and should be considered as a separate entity for research and clinical purposes. Thus, it is crucial to understand the composition of BSCB and also to establish the cause-effect relationship with aberrations and spinal cord dysfunctions. We have done a descriptive analysis of the anatomy, current techniques to assess the impairment of BSCB, associated risk factors and impact of spinal disorders such as spinal cord injury (SCI), amyotrophic lateral sclerosis (ALS), peripheral nerve injury (PNI), ischemia reperfusion injury (IRI), degenerative cervical myelopathy (DCM), multiple sclerosis (MS), spinal cavernous malformations (SCM) and cancer on BSCB dysfunction. Along with diagnostic and mechanistic analyses, we also provide an up-to-date account of available therapeutic options for BSCB repair. We emphasize the need to address BSCB as an individual entity and direct future research towards it.

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## Second opinions for spine surgery: a scoping review

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**Aims:** The aims of this scoping review are to describe: (i) the characteristics of second opinion services for spinal surgery; (ii) diagnostic agreement between first and second opinions; (iii) agreement in treatment recommendations between first and second opinions; (iv) the results of second opinion services for reducing rates of surgery and improving patient-reported outcomes; and (v) the costs and healthcare use associated with second opinion services

**Methods:** Two independent researchers screened three electronic databases (Pubmed, EMBASE and Cochrane CENTRAL) from their inception to May 6th, 2021. Studies of any design were eligible provided that they described a second opinion intervention for people with spinal pain (low back or neck pain with or without radicular pain) either considering surgery or to whom surgery had been recommended. We assessed studies' methodological quality with the Downs & Black scale. Outcomes were: i) characteristics of second opinion services, ii) agreement between first and second opinions in terms of diagnoses, need for surgery and type of surgery, iii) their effectiveness in reducing surgery rates and improving patient-reported outcomes; and iv) the costs and healthcare use associated with these services. Outcomes were presented descriptively

**Results:** We included 12 studies (11 had poor methodological quality; one had fair). Studies described patient, doctor, and insurance-initiated second opinion services. Diagnostic agreement between first and second opinions varied from 53% to 96% across studies. Agreement for need for surgery between first and second opinions ranged from 0% to 83%. There is some very-low quality evidence that second opinion services may reduce surgery rates in the short-term, but it is unclear whether these reductions are sustained in the long-term or if patients only delay surgery. Second opinion services may reduce costs and some healthcare use (e.g. imaging), but might increase others (e.g. injections, prescription drugs)

**Conclusions:** There is a need for high-quality studies to determine the value of second opinion services for reducing spinal surgery.

## Microbiome and bone marrow metabolism dysbiosis in low back pain

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Publish consent withheld

## Characteristics of baseline frequency data in spinal RCTs do not suggest widespread fraud

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### Background

Fraud in clinical research is a reality. A recent scandal of non-genuine data in numerous randomised clinical trials from one site in the field of back pain has highlighted the risk of fraud impacting the assessment of treatment effects and consequently impacting clinical guidelines.

### Aim

We investigated whether evidence of non-random baseline data in randomised studies for spine disorders was widespread or if the aforementioned case was an anomaly.

### Methods

We performed a PubMed search to identify all papers published in 4 major spine journals (Spine, The Spine Journal, the Journal of Neurosurgery Spine, and the European Spine Journal) classified by the journal as RCTs between 2016 and 2020. We extracted all baseline covariates which were reported as frequencies and calculated p values using a Pearson Chi Square test of independence. Individual variable p-values were combined into a study wise p-value using the Stouffer method. We calculated the proportion of studies with a study wise p-value of <0.01, <0.05, >0.95 and >0.99. All studies with p values >0.99 or <0.01 were examined for explanations.

### Results

Our literature search returned 228 studies, of which 169 were included. In total, we extracted 938 variables. After calculating all study wise p-values and looking at the proportions that presented a study wise p-value of <0.01, <0.05, >0.95 or >0.99, we observed only small differences between our results and the number of studies that would be expected to fall into these categories by random chance.

### Conclusion

We conclude that the overall distribution of frequency baseline similarities between study arms in RCTs published in major spine journals is not suspicious. No evidence of systemic presentation of false data was found. We will examine continuous variables in future work.

## Cooled radiofrequency ablation of the sacroiliac joint a retrospective series

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**Background:** Sacroiliac (SI) joint dysfunction is a common source of back pain. Recent evidence from different parts of the world suggest that cooled radiofrequency ablation of sacral nerves supplying the SI joints has superior pain alleviating properties than currently available treatment options for SI joint dysfunction.

**Patients and methods:** after obtaining institutional review board approval, the medical records of 81 patients who underwent cooled radiofrequency ablation in a single institution and by a single surgeon were analyzed retrospectively, recurrence of pain, progression to fusion and functional outcomes were noted. The patients operated on between June 2020 and December 2021 included 59 females, 22 males, 22 patients had previous lumbar fusions, and the average age was 55.4±17.3. They had at least 6 months follow up.

**Results:** 7 patients progressed to fusions, 6 patients had to have the procedure done again to relieve their pain. Student t-test was used to compare between preop and postop values of NPRS (numerical pain rating score) and ODI (Oswestry disability index). It showed significance with P-value <0.001 in both.

**Conclusions:** Sacroiliac joint radiofrequency ablation is a good option in the treatment of SI joint pain showing good results in the short term follow up period. It is a simple procedure that can be done under 30 minutes and is capable of providing significant pain relief for patients.

## Endoscopic Vs microdiscectomy – a retrospective study

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**Background:** Endoscopic spine surgery has been recently introduced in Australia. A comparison of endoscopic lumbar discectomy ,open or microscopic approach with learning curve is presented.

**Patients and methods:** A retrospective study of Uniportal endoscopic lumbar discectomy of a single surgeon series was conducted. All patients above 18 years of age with symptomatic disc herniation and who have failed non-surgical management were selected. This data is the initial 30 consecutive uniportal endoscopic lumbar discectomy patients (group E). These were compared to the immediately prior 30 lumbar microdiscectomy (Group M) cases of the same surgeon. Demography, operative data, complications and postoperative results were collected. Learning curve duration for endoscopic cases was also examined.

**Results:** There were 39 males and 21 females with mean age of 53.6 yrs. In group E there were 23 Transforaminal cases and 7 interlaminar cases. Mean operative time was 125.5 min. The first 10 cases took 181 mins, next 11mins and last 10, 84 mins showing a vast improvement with learning curve. A significant difference in operative time between transforaminal endoscopic and interlaminar endoscopic discectomy ( $P < 0.001$ ) was found. On comparison of endoscopic and microscopic cases a significant difference was found in blood loss ( $p < 0.001$ ) and there was an expected non-significant difference in operation time. Complication rates were comparable (dural tears – 1 E, 2 M) and recurrent discs (E=1, M=2).

**Conclusion:** We present an Australian perspective of endoscopic vs microscopic lumbar discectomy. Early results reveal comparable outcomes of endoscopic lumbar discectomy compared to microscopic surgery with respect to operative time, blood loss and complications. In endoscopic cases, interlaminar approach had longer operative time and complications compared to transforaminal approach. With the learning curve the operative times improved. Further studies are required to evaluate long term outcomes and complications

## A clinically relevant 3D *in vitro* spinal cord injury model using biofabrication techniques

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### Aims

The creation of spinal cord injury (SCI) models *in vivo* is highly invasive and time-consuming. In addition, the complexity of the central nervous system (CNS) makes it challenging to understand the impact of mechanical injuries on the response of CNS cells. On the other hand, current *in vitro* SCI models are over simple and can neither mimic the cellular and physiological characteristics of the native spinal cord tissue nor truly resemble injury conditions often observed in the accident. The current research aimed to investigate how CNS cells within a bioprinted 3D GelMA hydrogel respond to contusion injury models in a controlled environment.

### Methods

C6 astrocyte-like and NG 108-15 neuronal cells were embedded in GelMA hydrogel (5%) and bioprinted to simulate the spinal cord environment. An Electroforce machine (BioDynamic 5110) was used to model a contusion injury at high velocities (1000 and 3000 mm.s<sup>-1</sup>) with compressive displacements of 30%, 60%, and 80% of the initial height of the hydrogel sample. The cellular responses to the compressive displacements and velocities were investigated using immunocytochemistry analysis.

### Results

Astrocytic expression of glial fibrillary acidic protein (GFAP) of C6 astrocyte-like cells increased with increasing displacement and velocity over 10 days post-injury. The metabolic activity of all injured groups was significantly increased compared to the non-injured group from the third day onwards. However, NG 108-15 neuronal cells showed the opposite behaviour, where the use of  $\beta$ III-tubulin (a neuronal marker) highlighted more significant neurite outgrowth in a non-injured group than in the injured group over 10 days. A significant reduction in NG 108-15 neuronal cell viability was observed for injured groups compared with the non-injured group.

### Conclusions

The novel SCI platform developed in this study was successfully used to model a contusion injury and enabled interrogation of the response of individual cell types to injury mechanics, which is difficult to achieve using animal models. The proposed model offers a reproducible, clinically relevant and reliable universal 3D *in vitro* platform to perform different relevant mechanobiological studies.

## Fusion techniques of the Sacroiliac joint in traumatic and non-traumatic conditions

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### Introduction

Sacroiliac joint fusion strategies are successful in patients who are well selected. There are several methods described. In any arthrodesis, the principles followed are: articular surface preparation, compression of articular surfaces, augmenting with bone graft and achieving stable fixation without affecting the native joint stability. Because of the anatomical topography and complex innervation, following all these principles are difficult for sacroiliac joint surgical fusion. The purpose of this study is to compare the available techniques for the fusion of sacroiliac joint and their outcome.

### Methods

A literature review has been performed for randomized controlled trials to find out the best sacroiliac fusion strategy with good outcome measures. Closed reduction/ open reduction and percutaneous screw fixation or open fixation using plates and screws, intraarticular porous coated metal bar insertion, open debridement and percutaneous screw fixation are compared, and their outcome is discussed.

### Discussion



In studies analyzing open surgical techniques, computed tomography (CT) has been used to assess the fusion. Fusion was achieved in 20-90% of cases. Excellent satisfaction was obtained in 18-100%. Poor outcome was observed in 0-47%. The re-operation rate was 0-65%. In studies analyzing minimal invasive techniques, CT and radiographs were used to assess the fusion rate. Excellent outcome was observed in 56-100% and the reoperation rate was 0-17%.

#### Conclusion

Sacroiliac joint fusion is a viable option for a carefully selected group of patients with sacroiliac joint dysfunction. There are few quality studies available in this field. Anyway, prospective randomized controlled studies with the scope of assessing the long-term outcome are still lacking. Further, meta-analyses are necessary to understand the long-term outcome and complications of sacroiliac joint fusion.

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## Radiological factors for predicting degenerative cervical myelopathy with increased intramedullary signal intensity based on x-ray and MRI

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**Aims:** The aims of this study were (1) to determine the prevalence of the IISI in patients with DCM; (2) to investigate individually the prevalence and distribution of disc degeneration, height loss, osteophyte formation, endplate sclerosis, spondylolisthesis, segmental instability and spinal stenosis; (3) to address the association between radiological parameters and IISI.

**Methods:** A retrospective study was performed by measuring X-ray and MRI of 45 consecutive patients with DCM. The measurements on X-ray include disc height, horizontal intervertebral displacement, Torg-Pavlov ratio, rotational angle, C2-C7 Cobb angle, cervical sagittal vertical axis, segmental alignment, T1 slope and facet joint degeneration. Measurements on MRI include presence of IISI on MRI, posterior disc bulge, Pfirrmann classification, maximum spinal cord compression, maximum canal compromise, Modic changes, foraminal stenosis, cervical tilt, and cranial tilt. Methods used for the statistical analysis include independent T-test to calculate mean radiographic degeneration for each gender and point-biserial correlation coefficient to assess the correlation between patient/level-specific IISI and radiographic degeneration. Fisher's test, Phi and Cramer's V and point-biserial correlation coefficient were used to assess the independence, strength of association and strength of linear relationship respectively between presence of IISI and radiographic degeneration.

**Results:** A total of 45 patients with DCM (18 males, 27 females; age: 55.27±15.86) remained in the study with 19 (42.2%) patients having IISI in T2WI. There were 9 IISI at the level of C4-5, 7 at the level of C5-6, 6 at the level of C3-4, 5 at the level of C6-7, 3 at the level of C2-3, and 2 at level C1-2. There was no significant difference in presence of radiological DCM parameters between patients with IISI and patients without IISI.

**Conclusions:** The prevalence of IISI constituted 19 of 45 DCM patients studied and was most prevalent at the C4-C5 level. The presence of radiographic DCM parameters was not associated with IISI in the cervical spine with no significant difference found between IISI patients and non-IISI patients.

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## Quantifying the biomechanical effects of posterior fixation in XLIF

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#### Aims

Extreme Lateral Interbody Fusion (XLIF) may be performed with a standalone interbody cage, or with the addition of unilateral or bilateral pedicle screws. Whilst decisions regarding supplemental fixation are predominantly based on clinical indicators, the aim of this study was to quantify the biomechanical impacts of posterior supplemental fixation by examining its effect on facet micromotions, cage loads, and load-patterns at adjacent levels in a L4-L5 XLIF. Further, these were to be evaluated at partial and full fusion stages.

#### Methods

Computed tomography data from an asymptomatic subject were anatomically segmented and digitally stitched into a surface mesh of the lumbosacral spine (L1-S1). The interbody cage and posterior instrumentation were inserted at L4-L5. The volumetric mesh was imported into finite element software for pre-processing, running nonlinear static solves, and post-processing. XLIF with no fixation (NF), unilateral fixation (UL), and bilateral fixation (BL) were studied.

#### Results

Loads and micromotions at index-level facets reduced commensurately with extent of posterior fixation. Load-pattern changes observed at adjacent facets, however, were potentially anatomically dependent. In flexion at partial fusion, compressive strain on the cage-graft construct reduced by 48% and 64% in UL and BL models respectively; in extension the reductions were 51% and 69%. A similar pattern was observed at full fusion. There was a notable reduction in cage stress-risers with BL compared to UL and NF. No changes were found at adjacent discs. Posterior ligaments were more strained in flexion in adjacent regions (12-21%) with posterior fixation compared to NF. No biomechanical differences were found between UL and BL models at adjacent facets, discs, or ligaments.

#### Conclusion

Posterior supplemental fixation with XLIF alters biomechanics at index and adjacent levels. Results suggest that single-sided fixation provides sufficient biomechanical stability to the joint, which warrants consideration alongside clinical information (such as subsidence risk) during pre-surgical planning.

## Inflammatory biomarkers in different locations in patients with low back disorder: systematic review protocol

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**Background:** Low back pain (LBP) is one of the greatest contributors to disability adjusted life years (DALYs) in the world. Inflammation results in proliferation of cytokines that activate inflammatory pathways which can result in non-specific LBP. The purpose of this systematic review was to analyze current literature on the association between inflammatory biomarkers, location, clinical presentation and outcome of treatment in patients with non-specific LBP.

**Methods:** A search was conducted in PubMed, Embase and Cochrane databases. MeSH terms and keywords were used to identify studies that measured the association between inflammatory biomarkers and non-specific LBP. Two reviewers independently screened titles, abstracts and full text, and extracted data. Methodological risk of bias assessment was conducted via the Newcastle Ottawa quality assessment scale for cohort studies and Cochrane collaboration risk of bias tool for randomised controlled trials. Mean and standard errors were calculated to compensate for the great number of prospective studies. For this meta-analysis STATA software (Release 16, StataCorp LLC, TX) was used for the analysis. The GRADE approach was used to assess the quality of the evidence

**Results:** The literature search is illustrated in the PRISMA flow diagram. Twenty-two studies met the selection criteria for the purposes of the present review, which included xxx RCT and xxx observational studies. Different inflammatory biomarkers in different locations will be analysed. To calculate the association of mean pain/disability score with the measurements of biomarkers, we include the measurements of inflammatory biomarker as a predictor in a meta-regression. This meta-regression proportion of between-study variance will be explained with Knapp-Hartung modification.

**Conclusions:** We conducted this review as an inflammatory substrate in patients with LBP could be a potential target for anti-inflammatory therapy, specifically non-steroidal anti-inflammatory drugs (NSAIDs) or transforaminal epidural corticosteroids. We address many questions in particular: (1) the inflammatory biomarkers in patients with LBP; (2) the difference of inflammatory biomarkers in different locations; (3) the association between the level of inflammatory activity and clinical symptoms.

## Radiographic evaluation of lumbar intervertebral disc height: an intra and inter-rater agreement and reliability study

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**Purpose:** Disc height has been found to be related to disc degeneration and LBP. However, choosing an accurate and efficient measurement for disc height remains controversial. The aim of this study was to evaluate intra- and inter-rater agreement and reliability of seven reported DHI measurement methods on X-ray.

**Methods:** The adult patients who had standing lateral X-ray of lumbar spine were consecutively recruited (30 for intra- and 288 for inter-rater assessment) in this retrospective study. Seven methods were used to measure the DHI of each lumbar intervertebral disc level. Bland and Altman's Limits of Agreement (LOA), standard difference, and intra-class correlations (ICC) with 95% confidence intervals were estimated.

**Results:** The intra-rater reliability in DHI measurements using different methods were ICCs from 0.807 (0.794, 0.812) to 0.922 (0.913, 0.946) by rater 1 (SS) and from 0.827 (0.802, 0.841) to 0.918 (0.806, 0.823) by rater 2 (XC). Method 2, 3, and 5 on all segmental levels had bias (95% CI does not include zero) or/and out of the acceptable cut-off proportion (>50%). A total of 609 outliers in 9174 segmental levels' LOA range. The inter-rater reliability was good-to-excellent in all but method 2 (0.736 (0.712, 0.759)) and method 5 (0.634 (0.598, 0.667)). ICCs of related lines to good-to-excellent reliability methods was excellent in all but only indirect line in method 1 and 4 (ICCs lie in the range from 0.8 to 0.9). Agreement and inter-rater reliability were compromised by difficulties in accurately identifying the indirect lines and reducing the vertebral rotation.

**Conclusions:** Following a structured protocol, intra- and inter-rater reliability was good-to-excellent for most DHI measurement methods on X-ray. However, caution should be taken when measuring used complicated method and defining anatomical landmarks during vertebral rotation. A standardized protocol to assess DHI was required in future study.

## The thoracolumbar fascia and back pain

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*The Thoracolumbar Fascia and Back Pain*

*Once regarded mere "packing material", fascia has emerged from anatomical obscurity to being the subject of diligent research, gaining prominence as we strive to understand human movement, pain, and dysfunction. The implication of its role in proprioception, nociception, the immune response, inflammation, lymphatic efficacy, thermoregulation, force transmission and elastic recoil validates this more exhaustive scrutiny. Fascia is ubiquitous throughout the body, forming an "endless web" profoundly and inextricably affiliated with muscle, as well as encompassing a variety of structural components from thick aponeuroses to tendon, to ligament, and to the loose and compliant tissue immediately beneath the skin. Derived from the mesodermal layer during embryologic development, fascial form follows function as it adapts structurally and morphologically to the load demands in any given somatic locale, in health and disease.*

*The thoracolumbar fascia and its connection to multiple muscle components in the trunk has been the focus of considerable attention elevating our speculative appreciation of spinal pain and pathology. Consideration of its anatomical associations, thickness, and its capacity to glide relative to adjacent tissue and bone are hallmarks in the determination of its viability and functionality. Previous studies in the observed differences between healthy versus chronic low back pain patient cohorts has served to inform clinical practice. The potential impact on bony spinal components, discs and associated neural tissue secondary to chronic dyskinesia, adaptive postures, fear avoidance behaviours, compensatory movement patterns, scar tissue and fascia's response to resultant relative inactivity cannot be overlooked. This will provide the basis of my studies going forward, as I strive to pursue a PhD with fascia as my focus.*

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## A multi-parametric MRI processing pipeline for paraspinal muscles

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Traditionally paraspinal muscle quality has been assessed using morphological characteristics and measures of macroscopic composition such as muscle fat infiltration on computer tomography (CT) and magnetic resonance imaging (MRI). The evidence for associations between these characteristics and low back pain (LBP) is conflicting. We sought to investigate the role of non-morphological quantitative parameters of muscle quality (primarily those derived from multi-echo acquisitions) in low back pain.

We present here a pipeline for automatic quantification of morphological characteristics, segmentation of intra- and extra-muscular fat, and the calculation of quantitative T2 and T2\* relaxation times and Decay Variance. We have applied this processing pipeline to a prospective cohort study of 20 patients aged 29-74 who experienced cryptogenic LBP, with no previous spinal surgery and meeting the NIH definition for chronicity. Patients had lumbar MRI with standardised acquisition parameters at a single centre. Data was collected prospectively. Due to the semi-automated nature of the processing pipeline intra- and inter-rater reliability was high for all measures. Future work will focus on the integration of DTI parameters into the pipeline, and correlation with patient clinical features.

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## The effectiveness of biofeedback for improving pain, disability and work ability in adults with neck pain: a systematic review and meta-analysis

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**Background:** Neck pain is a leading cause of disability worldwide. Biofeedback can be used to optimise muscle activation patterns in people with neck pain and may be a promising non-pharmacological treatment strategy.

**Aims:** To evaluate the safety and efficacy of electromyographic and pressure biofeedback on pain (primary outcome), disability and work ability in adults with neck pain.

**Design:** Systematic review and meta-analysis.

**Methods:** We searched key databases and trial registries to September 2020, using terms synonymous with 'neck pain' and 'biofeedback'. We included randomized controlled trials (RCTs) evaluating biofeedback (against any comparison) for adults with neck pain. Outcomes included pain (primary outcome), disability, work ability and adverse events. Two authors independently selected the studies, extracted data, and evaluated risk of bias. GRADE was applied to each meta-analysis. Data were pooled using random-effects models to determine the standardised mean change (SMC).

**Results:** We included 15 RCTs (n=990). Moderate-quality evidence suggests biofeedback has a moderate effect on reducing short-term disability (SMC=-0.42, 95%CI:-0.59 to -0.26, nine trials, n=627), and a small effect on reducing intermediate-term disability (SMC=-0.30, 95%CI:-0.53 to -0.06, five trials, n=458). Biofeedback had no effect on pain or work ability in the short- and intermediate-term (low- to moderate-quality evidence). One study reported headaches in 6.7% of participants, but headache frequency was not reported by group.

**Limitations:** There were a variety of control interventions across studies. Few studies compared biofeedback with no treatment or placebo.

**Conclusion:** Biofeedback appears to have a small-to-moderate effect on reducing neck pain disability in the short- and intermediate-term, but no effect on pain (our primary outcome) or work ability. More trials reporting adverse events and comparing biofeedback to placebo are needed. Clinicians should communicate these findings to patients with neck pain so patients can better understand the value of biofeedback and make an informed treatment choice.

## Intervertebral disc-on-a-chip: a precision-engineered platform for low back pain studies

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**Aim:** Intervertebral disc (IVD) degeneration is associated with chronic low back pain, a leading cause of disability worldwide. IVD regeneration strategies have shown promise in preclinical studies; however, despite such potential, no such therapies have been broadly adopted clinically. One drawback here is lack of a physiologically relevant IVD in vitro model. The IVD models available at present are standard in vitro cultures in 2D and 3D, ex vivo systems employing human or animal IVDs and bioreactors. Unfortunately, none of the current models can truly represent the IVD structure and function or resemble the microenvironment of the degenerated IVD.

**Method:** We have pioneered and developed a unique technique (simultaneous sonication and alkali digestion) to selectively eliminate IVD extracellular matrix components and reveal the organization of collagen and elastic fibres in IVD. Building on these, we successfully employed two-photon polymerization and 3D printing to develop the first reproducible and adaptable 3D IVD-on-a-chip organ model that recapitulates the relevant IVD function and its structural complexity. The model that we developed mimics the structural organization of collagen and elastic fibres that are often observed in different regions of IVD (lamellae [in-plane and cross-section], interlamellar matrix, partition boundaries, transition zone and nucleus).

**Results and conclusions:** Our organ model allows real-time monitoring in a controlled microenvironment, precise tuning of material, mechanical and biological properties, and IVD research that targets precise questions. We have so far successfully employed our organ model to evaluate cell viability and to understand the impact of IVD microstructure on cell behaviour. In addition, we found that increasing the stiffness of the microstructure in our organ model (two-fold) did not affect the biocompatibility (L929 mice fibroblast); however, significantly altered the cell response to the structure. Cells in the stiffer platform were more elongated in the annulus region, while more round cells were observed in the nucleus region of the organ model.

## 3D reconstruction of the lumbar spine using ultrasound images: Towards radiation-free lumbar facet joint injections

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**Aims** Lumbar facet joint injections (LFJIs) are the standard of care in diagnosing the sources of and treating low back pain. The current gold standard for LFJIs is manually performed under fluoroscopic guidance. However, this approach has certain disadvantages. It is only accessible in large hospital settings, relatively expensive to take, and exposes clinicians and patients to radiation hazards. Ultrasound guidance is a potential alternative as it is accessible to non-hospital settings, relatively cheap, and poses no known risk to humans. However, LFJIs performed under ultrasound guidance have not yet been established in clinical routine due to the difficulty of interpreting ultrasound images. We propose a novel algorithm and framework to reconstruct the patient's lumbar spine with only ultrasound images that combine, for the first time, a statistical shape model with Neural Networks, aiming to pave the way toward LFJIs under pure ultrasound guidance.

**Methods** We propose to create a statistical shape model of the lumbar spine from 12 patients' CT scans and train a neural network system capable of segmenting bone features from the noisy Ultrasound images. We then register the 3D statistical shape model to the segmented 2D images from the neural network system to get the desired patient-specific lumbar spine, which can be seen as a model fitting problem. Experiments are conducted to measure the variation of the statistical shape model and the accuracy of the neural network system.

**Results** Experiment results show that the statistical shape model created has suitable shape variation that could be used for 3D shape analysis. More CT scans could be added to increase the variation further. The neural network system successfully segments the ultrasound images. The output images could be used as the registration target for the statistical shape model. The further step is to perform non-rigid registration to fit the statistical shape model to the target images.

**Conclusion** The proposed approach could be the first step in replacing fluoroscopic imaging with ultrasound guidance in LFJIs.

## Physiotherapy utilization, costs and return to work status following lumbar spine surgery: a retrospective analysis of workers compensation claims in Australia

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**Background:** No study has explored physiotherapy utilization following lumbar spine surgery in a workers' compensation setting, or in Australia.

**Aims:** Describe physiotherapy utilization and costs, and return to work status in patients following lumbar spine surgery under a NSW workers' compensation claim in Australia.

**Design:** Retrospective cohort study.

**Methods:** Using data from the New South Wales (NSW) State Insurance Regulatory Authority (Australia), we audited physiotherapy billing codes for patients who received lumbar spine surgery from 2010-2017. We summarised, by fusion vs. decompression, the number of physiotherapy sessions patients received to 12 months post-operatively, total cost of physiotherapy and time to initiation of physiotherapy. We assessed the association

between number of physiotherapy sessions or physiotherapy utilization at 12 months and return to work at 12 months. All data were analysed descriptively.

**Results:** We included 3,524 patients (1,220 had fusion, 2,304 decompression). On average, patients received 22 (standard deviation (SD)=22, range=0 to 160) physiotherapy sessions in the 12 months post-operatively (mean cost=\$1,768, interquartile range (IQR)=\$405 to \$2,557); 24% were receiving physiotherapy at 12 months. Most patients had 9-24 (31%) or 25-50 sessions (25%); 11% had >50 sessions, whereas 11% had no physiotherapy. Patients who had fusion (vs. decompression) had more physiotherapy (25 vs. 20 sessions) and incurred higher means physiotherapy costs (\$2,016 vs. \$1,637). Median time to initiate physiotherapy increased from 2010-2017. Mean number of physiotherapy sessions was not associated with return to work status.

**Limitations:** We did not have data on the type of physiotherapy treatment patients received.

**Conclusions:** There is variation in physiotherapy utilization and costs following lumbar spine surgery for patients funded by NSW Workers' Compensation. Since effective rehabilitation programs following lumbar spine surgery typically involve 8-24 physiotherapy sessions, overtreatment may be an issue for some patients in our sample. Future research is needed to understand the drivers of physiotherapy practice patterns in this setting.

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## Obesity Back pain Evaluation Laparoscopic bariatric surgery and Imaging with X-ray and MRI study (OBELIX): A prospective observational cohort study

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**Background** Obesity is a growing problem worldwide and is associated with an increased risk for multiple diseases, including musculoskeletal diseases and back pain. Several systematic reviews reported encouraging data and quantifiable reductions in back pain score outcomes after bariatric surgery produces. However, a lack of information on the association in back pain outcomes, mechanical properties and weight loss remains. We aim to explore the effect obesity and rapid weight loss by bariatric surgery has on the spine and back pain in obese patients and address the association between changes in body mass index (BMI), pain score, spinal imaging and biospecimen.

**Method** An international prospective controlled cohort using (1) obese patients undergoing bariatric surgery at different clinics located at Sydney and the Netherlands (=Group O) and (2) non-surgical obese patients (=Group N), with a follow up for 2 years. During follow-up we aim to collect Back pain questionnaires; at enrolment, after 3 months, 6 months, 1 year and 2 years.

1. Blood; at enrolment and 6 months.
2. Imaging (standing X-ray and MRI); at enrolment and 1 year.
3. Waist circumference measurements (as reference to BMI); at enrolment and 6 months.
4. Activity tracker; at enrolment and a week before the second waist circumference measurement.

**Research participants** We intent to include morbid obese adults, age between 18 and 60 years, with a BMI  $\geq 40$  or  $\geq 35$  with comorbidities, eligible for bariatric surgery. Excluded are participants who are not eligible for bariatric surgery, had prior spinal surgery, had antibiotics within one month and pregnant or breastfeeding females.

**Conclusion** The relationship between weight loss and reduction in back pain is complex but remains scientifically unclear. To further understand how and why bariatric surgery could reduce the back pain problems of obese patients, we aim to evaluate the potential changes in biospecimens/imaging/activity after surgery and if these are related to backpain.

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## Establishing an Australian Degenerative Cervical Myelopathy Patient Registry

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### Background

Degenerative Cervical Myelopathy (DCM) is the leading cause of non-traumatic spinal cord injury. Neck pain, Hoffman sign, gait instability and bladder dysfunction are common features. Although, surgical decompression remains the mainstay treatment, very few patients achieve complete recovery and end up facing life-long disability. This results in psychological distress and poorer quality of life. DCM is not very well understood and to our knowledge no DCM Registry exists.

### Aims

1. To determine the natural history of DCM.
2. To determine the M:F ratio of DCM.
3. To study the age distribution of DCM.
4. To compare the outcomes between the operative and non-operative cases of DCM.

### Methods

A prospective registry of DCM patients. For the pilot cohort, 50 patients will be recruited from various participating hospitals across Sydney over a

span of 3 years. Follow-up will be at 6 months and MRI scan of cervical spine every year. Minimum data set is as defined by the AO Spine RE-CODE DCM (Research Objectives and Common Data Elements for Degenerative Cervical Myelopathy), which will include Common Data Elements (CDE) of demographics, comorbidities, disease, imaging, examination and intervention, Outcomes under domains of economic, neuromuscular, pain, radiology, life impact and adverse events and Measurements including NDI, mJOA and EQ-5D-5L. Inclusion criteria are all DCM cases with a confirmed diagnosis by a spine surgeon or neurosurgeon, patient age  $\geq 18$  years, English speaking and willing to give informed written consent. The exclusion criteria are patient age  $< 18$  years, non-English speaking, unwilling to give consent and patients with an intellectual disability or cognitive decline.

#### **Conclusion**

The gap in knowledge and the incomplete understanding of DCM hinders the ability of clinicians to offer adequate counselling and treatment options to DCM patients. Hence, this unique data from Australian DCM Registry will help understand DCM better and establish improved clinical approaches.

## **A narrative review of the history and evidence for restorative neurostimulation for chronic mechanical low back pain**

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**Introduction:** Mechanical chronic low back pain (CLBP) can be caused by impaired neuromuscular control of the lumbar spine stability. An implantable Restorative Neurostimulation system (ReActiv8<sup>®</sup> by Mainstay Medical) bilaterally stimulates the medial branches of the L2 dorsal rami for up to 30 minutes twice daily to override underlying inhibition of the multifidus muscles to facilitate motor control restoration. The evidence to support both efficacy and understanding of the mechanism is extensive.

### **Methods**

A narrative review of the scientific basis and published and presented data supporting restorative neurostimulation from the ReActiv8 A, B, C and PMCF studies was conducted.

### **Results**

While each trial has subtle variations in selection and outcome measures when viewed as a collective body of evidence, compelling long-term durability and efficacy has been demonstrated. The progressive improvement in outcome over time are consistent with a mechanism of action that is restorative in nature which. ReActiv8-A led to improvements in surgical technique and has subsequently demonstrated long term efficacy. ReActiv8-B has three year outcome data showing profound improvements over baseline. ReActiv8-C and ReActiv8-PMCF document long term real world follow up with 2 and 3 year prospective data.

### **Conclusion**

The current evidence consists multiple studies with compelling improvements and durable outcomes. The phenotype of back pain and the proposed mechanism of action are consistent with decades of basic science and clinical research.

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# NOTES



# NOTES