

15th Annual Spine Academic Day

SPINEEFEST

UNIVERSITY OF TORONTO SPINE PROGRAM



Monday June 12, 2023
Hybrid



Surgery
UNIVERSITY OF TORONTO

Spine Program

Table of Contents

ABOUT SPINEFEST	2
PREVIOUS VISITING PROFESSORS	2
LEARNING OBJECTIVES - SPINEFEST 2023	3
TIME AND LOCATION:	3
ABOUT THE UNIVERSITY OF TORONTO SPINE PROGRAM	3
VISION	3
INTEGRATION	3
FACULTY MEMBERS	3
MESSAGE FROM THE CO-DIRECTORS	5
AGENDA	10
BIOSKETCH	13
TATOR & HALL	13
U OF T SPINE PROGRAM CO-CHAIRS	14
KEYNOTE SPEAKER -TATOR-HALL LECTURESHIP	17
INVITED SPEAKERS	17
INVITED RESEARCH TRAINEES PRESENTATIONS	19
BEST ABSTRACTS – ORAL PRESENTATIONS	20
ORGANIZING TEAM	22
SCIENTIFIC ABSTRACTS	23
ACKNOWLEDGEMENT	64

About SpineFEST

SpineFEST, which was first established 15 years ago, is our Annual Academic Spine Day and the key spine event at the University of Toronto (U of T). SpineFEST brings together the U of T spine community to disseminate knowledge of advances in spine surgery, spine care management, and spine research. The day serves as a unique educational platform for clinicians and researchers from a broad spectrum of disciplines including neurosurgery, orthopaedic surgery, chiropractic, physiatry, physical therapy, nursing, family medicine, pain medicine, biomedical engineering, and basic/clinical and translational science.

Previous Visiting Professors

2022	Professor Lawrence Lenke, Columbia University, New York
2021	Professor Richard Fessler, Rush University Medical Center, Chicago, Illinois
2020	Professor Marcus Stoodley, Macquarie University, Sydney, Australia
2019	Professor Praveen Mummaneni, The University of California, San Francisco
2018	Professor Sanford Emery, West Virginia University
2017	Professor Zoher Ghogawala, Tufts University School of Medicine
2016	Professor Daniel Riew, Columbia University Medical Center
2015	Professor Wilco Peul, Leiden University Medical Centre
2014	Professor Kenneth Cheung, University of Hong Kong
2013	Professor Alexander Richard Vaccaro, Thomas Jefferson University
2012	Professor Jean Dubousset, The University of Paris
2011	Professor Jens Chapman, University of Washington
2010	Professor Edward Benzel, Cleveland Clinic
2009	Professor Jeffrey Wang, University of California

Learning Objectives - SpineFEST 2023

- To describe the evolution of MRI as a prognosticating tool for SCI and DCM
- To describe MRI-based techniques to follow the pathophysiological basis of SCI and DCM

Time and location:

- Location: BMO Education & Conference Centre, 60 Leonard Avenue, Toronto, Ontario
- Time: 8:30 AM to 3:15 PM (EST)
- See agenda page 9

About the University of Toronto Spine Program

Vision

Innovation and excellence in the delivery of spine care with a unique collaborative program of clinical expertise, research, teaching, and education.

[Website](#)



Integration

The University of Toronto Spine Program is a multidisciplinary collaborative unit which combines neurosurgery and orthopaedic surgery and the broad spectrum of non-operative clinical and research disciplines which are engaged in spine. The U of T Spine Program is integrated across citywide clinical and research programs at the affiliated teaching hospitals; Toronto Western Hospital (TWH) at University Health Network (UHN), Sunnybrook Health Sciences Centre (SHSC), Hospital for Sick Children (HSC), St. Michael's Hospital (SMH) at Unity Health Toronto (UHT), and Mount Sinai Hospital (MSH) at Sinai Health System.

Faculty Members

Toronto Western Hospital @ UHN	St Michael's Hospital @ UHT
Michael Fehlings MD PhD FRCSC (Co-Chair)	Henry Ahn MD PhD
Christopher Nielsen MD FRCSC	Howard Ginsberg MD PhD FRCSC

Stephen Lewis MD MSc FRCSC	Jefferson Wilson MD PhD FRCSC
Eric Massicotte MD MSc FRCSC	Christopher Witiw MD PhD FRCSC
YRaja Rampersaud MD FRCSC	Hospital for Sick Children
Alexander Velumian PhD DSc	David Lebel MD PhD FRCSC
Sunnybrook Health Sciences Centre	Stephen Lewis MD MSc FRCSC
Leo da Costa MD	James Drake BSE MB BCh MSc FRCSC
Mahmood Fazl MD FRCSC	Reinhard Zeller MD FRCSC
Joel Finkelstein MD MSc FRCSC	University of Toronto
Michael H. Ford MD FRCSC	Margarete Akens Dr med vet PhD
Michael Hardisty PhD	Carlo Ammendolia DC PhD CCRF
Jeremie Larouche MD, MSc, FRCSC	Mark Erwin PhD DC
Meaghan O'Reilly PhD	Sukhvinder Kasli-Ryan
Farhad Pirouzmand MD MSc FRCSC	Cindi Morshead BSc PhD
Arjun Sahgal BSc MD FRCPC	Karl Zabjek BSc MSc PhD
Cari Whyne PhD	Molly Shoichet PhD FRSC
Albert Yee MD MSc FRCSC (Co-Chair)	

Message from the Co-Directors

Colleagues,

As we move towards the end of our academic year, we would like to celebrate our successes for 2022/2023. In our pandemic recovery, The U of T Spine Program has continued to foster city-wide collaborations within the university and its affiliated hospitals while taking the lead in several key initiatives. Our Program has continued to develop a respected academic footprint locally, nationally and globally. Collaboration and inter-professional multi-disciplinary knowledge exchange remain as key elements to our success. As most of the restrictive public health measures have been lifted, our program has continued to provide a full and rich calendar of academic activities (in hybrid format and encouraging in-person attendance). This has enabled continued remote participation from alumni and spine community colleagues throughout Canada and across the globe.

On June 12th this year, our Program marks the 15th Annual Spine Academic Day “SpineFEST.” At this time of the year, we congregate to highlight our spinal community’s accomplishments and disseminate recent clinical and scientific advances. We are pleased to host Dr. Shekar Kurpad, Professor and Chair of Neurosurgery at the Medical College of Wisconsin, as our keynote speaker for the SpineFEST Tator-Hall Lecture. Dr. Kurpad is the Co-Director of the Center for Neurotrauma Research at Medical College of Wisconsin, and the Medical Director of the Neuroscience Service Line at Froedtert Health. He is the Director of the Spinal Cord Injury Center at Froedtert and the Medical College of Wisconsin. He is also the Founding Director of the Neuroscience Institute. Dr. Kurpad is a world leader in the development of novel MRI-based imaging biomarkers for spinal cord injury (SCI) and for cervical spondylotic myelopathy, a topic on which he will provide the keynote address. Please join us in welcoming Professor Kurpad to SpineFEST 2023!

A session on imaging biomarkers will follow the keynote lecture by Professor Kurpad. A number of faculty and trainees will share their research update on imaging biomarkers related to spinal disorders. The meeting will continue with invited trainee presentations that highlight outstanding clinical and basic science research.

Many thanks to our program judges for reviewing a numerous abstract submissions. We appreciate their time and expertise. Although many excellent submissions were received, we could only designate a few as Best Abstracts which will be presented orally. The remaining abstract submitters will have the chance to present their work at the Elevator Pitch session.

The U of T Spine Program continues to leverage our foundational education platform to help create and support a national spine surgery fellowship training curriculum for cognitive and procedural competencies. Apart from tracking fellowship training experience, our efforts have enhanced cross-institutional and collaborative Neurosurgery and Orthopaedic Surgery spinal training opportunities across Toronto Academic Health Sciences Network (TAHSN) teaching hospitals including Toronto Western Hospital (TWH-UHN); Sunnybrook Health Sciences Centre (SHSC); Unity Health Toronto (UHT); and the Hospital for Sick Children (HSC). We have built a top-tier academic hub that attracts 12-15 national and international clinical fellows and many additional visiting surgeons each year. Over several years, our program continues to offer both a one-year core fellowship training experience and a two-year fellowship program with a first-year comprehensive spine training experience followed by a second year focused on advanced subspecialty exposure. While the fellowships remain primarily focused and based at one of the TAHSN hospitals, opportunities exist and have been supported for city-wide experience. Many thanks to Drs. Albert Yee, Michael Fehlings, Stephen Lewis, Eric Massicotte, Jeremie Larouche, Chris Nielsen, Joel Finkelstein, Howard Ginsberg, Henry Ahn, and Reinhard Zeller for their valued help in shaping our citywide fellowship training opportunities. Building upon our national fellowship curriculum, our Program also continues with the surgical case-log for our citywide spine fellows with around 11,000 cases and procedures recorded since 2015. We thank Drs. Jeremie Larouche, Tony Bateman, and Ms. Nadia Jaber for creating a successful case-log program for our citywide fellows, and Drs. Ahmed Cherry and Nisaharan Srikandarajah who reviewed our broader city-wide university case-log experience this year as current fellows.

In recognizing Spine Surgery as a distinct formally designated discipline at the Royal College of Physicians and Surgeons of Canada (RCPSC) level, our application to develop Area of Focused Competence (AFC) in spine surgery was approved for national development in November 2021. The proposal to establish a RCPSC (AFC) was developed through the Canadian Spine Society (CSS) in conjunction with five other Canadian universities including the U of T. The process now has evolved into a national Royal College working group which has drafted 3 key documents (a Portfolio highlighting minimal requirements in training record, a Clinical Training Requirement CTR document which is an updated national curriculum, and a Standards of Accreditation (SA) document which will form the basis for accrediting university training programs for the diploma. These documents are currently undergoing additional internal Royal College review. There will be both adult and paediatric streams and an eventual stream also for staff surgeons already in established practice. We look forward to our ongoing efforts with the CSS and the RCPSC in developing the certifying standards and in-training portfolio. Thanks to Drs. Albert Yee, Jeremie Larouche, Michael Fehlings, Scott Paquette, Hamilton Hall, CSS office, and Ms.

Nadia Jaber for taking the lead in engaging our national society, several university spine programs, and fellowship directors across Canada in this initiative. The diploma will provide a valued competence-based model for our international community of surgical educators. This also opens the door for international collaborations as several international specialty organizations have inquired about our approach and plans.

This year as in the past, we launched our academic calendar of events with a welcome dinner for our incoming fellows and provided an update on our citywide research opportunities. Thanks to Drs. Carlo Ammendolia and Karl Zabjek for keeping us updated on the progress of spine research in Toronto. We featured outstanding research projects being conducted by our graduate students, residents, fellows, and scientists. Dr. Stephen Lewis continued an annual tradition in chairing a citywide fellow surgical skills course, introducing advanced anatomy of the spine with fellows performing both anterior and posterior surgical approaches as well as spinal instrumentation. Over the past several years, Dr. Lewis has expanded this course to include advanced complex procedures including deformity osteotomy, minimally invasive surgery, and trauma techniques. The course encompasses a combination of wet lab with image guidance technology, and faculty lectures with case-based discussions throughout the day. Many thanks to our industry partners: Medtronic, Stryker, and De Puy Synthes, for their continued support of this integral training experience.

We continued to complement the residents' surgical training with our Royal College Mock Oral course prepping senior residents from both neurosurgery and orthopedic surgery through various case scenarios. We have had 8 neurosurgery residents and 11 orthopaedic surgery residents sitting the Royal College examination this year. The course is Co-Chaired by Drs. Fehlings and Yee and supported by a number of faculty and spine fellows who have taken a leadership role in teaching the residents and organizing a selection of representative case scenarios in Royal College examination format. We thank our citywide fellows Drs. Ahmed Cherry (Lead), Ragavan Manoharan, Nisaharan Srikandarajah, Rajesh Kumar, Mark Chu Xu, and Raj Sakhrekar for teaching our residents. Also, many thanks to our faculty members Drs. Chris Witiw, Joel Finkelstein, Jeremie Larouche, and our alumnus Dr. Simon Harris for their invaluable input and guidance at the course. The Traumatic Spinal Cord Injury Course on Management and Classification this year implemented a new e-learning teaching models with pre-recorded lectures and online in-steps training followed by an in-person practicum and case-based interactive discussions. A special thanks to Dr. Sukhvinder Kalsi-Ryan and Ms. Jaber for planning and organizing a successful hybrid training model, and many thanks to the course faculty; Drs. Michael Fehlings, Jeremie Larouche, Jeff Wilson, and Julio Furlan for their valued contribution. The Spine Program continues with new educational initiatives each year, including a new course on Pediatric

Deformity Surgery held on May 2nd which received very positive feedback. Thanks to Dr. David Lebel for chairing and organizing this important course. Many thanks also to SickKids faculty Drs. Stephen Lewis, Jennifer Dermott and Mark Camp for their outstanding case-based lectures and relating teaching.

Over the past several years, our Program has been keen on bringing together citywide surgeons and trainees in multiple virtual events. The citywide Fellow Journal Club continues to be held several times a year. We discussed multiple hot off the press spine articles with a focus on education in spine surgery, management of metastatic spine lesions, and controversies around spinal fusion. Thanks to our citywide fellow Drs. Ahmed Cherry, Rajesh Kumar, and Raj Shakhrekar for leading the journal club presentations.

The Program invites several world-renowned Professors each year as part of our well established Hospital-Based Visiting Professorship series. A few previously scheduled lectures resumed when pandemic restrictions were eased. On August 22nd, we were delighted to have hosted Dr. Dror Ovadia from the Pediatric Orthopaedic Department at the Dana Dwek Children's Hospital in Tell-Aviv, Israel, who shared a number of severe scoliosis cases and their related surgical management. On April 17th, it was wonderful to have learnt from Dr. Ian Vlok (Head of Division Neurosurgery & Chief Specialist, University of Stellenbosch & Tygerberg Academic Hospital, South Africa) about the challenges and opportunities related to delivering patient care and high quality education in South Africa. On October 21st, we were excited to have had Dr. Michael Sofroniew from the University of California Los Angeles visiting us as the keynote speaker for the Tator-Turnbull Spinal Cord Injury Symposium and discussing his innovative research on cell biology and mechanism-based repair after SCI.

Our Program recognizes the university-wide initiatives around wellness, equity, diversity, and inclusion (EDI) as core values that promote excellence. We appreciate Dr. Eric Crawford's (our alumnus) efforts in leading EDI and Wellness initiatives advocating for physicians' wellness to minimize mental health issues and burnout. Dr. Crawford led "vulnerability is strength", started "Wellness Rounds" for orthopaedic residence, and is currently planning to engage in the Peer-Support Champion Program at Sunnybrook and to bring this model back to the Divisions of Orthopaedic and Spine Surgery. Dr. Crawford stands as a powerful spokesperson when he openly shared his battle with depression and burnout during his training. We are proud of Dr Crawford's leadership in physician health and we look forward to future wellness initiatives within our Program.

Earlier this year, our program initiated a volunteer and internship program to offer university students a valuable exposure to our spine academic activities, research, and clinical management. We welcome Ms. Delphine Li, our undergraduate neuroscience students for joining our Program as the inaugural volunteer student and for supporting and shadowing Ms. Jaber in moving forward our Program agenda.

We want to take this moment and celebrate the graduation of our 2022/2023 citywide spine fellows who will be completing their fellowship training in July this year. Congratulations to Drs. Rajendra Sakhrekar, Shadi Hayek, Fabio von Faber-Castell, Mohammad Alshardan, Jay Toor, Ali Eren, Rajesh Kumar, Motti Zucker, Ahmed Cherry, Nisaharan Srikandarajah, Ragavan Manoharan, Aditya Raj, Mark Chu Xu, and Doron Edelman. We wish them a successful and rewarding professional career. We look forward to their continued future engagement in our Program's activities as valued alumni members.

On a final note, we want to extend our appreciation to the University of Toronto Department of Surgery Spine Program Council, educators, and trainees for their continued dedication and support in making this past academic calendar a notable success. We wish to recognize the support from the U of T Department of Surgery and Divisions of Neurosurgery and Orthopedic Surgery. Special thanks to Dr. Carol Swallow, our new Chair of the Department of Surgery, and Dr. Peter Ferguson (Chair of Orthopaedic Surgery) and Dr. Gelerah Zadeh (Chair of Neurosurgery) for their longstanding and strong Departmental and Divisional support of our university wide program. We also would like to thank all our long-standing industry partners (Medtronic, De Puy Synthes, and Stryker) for their continued support over many years and particularly during the recent challenging pandemic years. We also thank Cerapedics and Bioventus for their support to other Program educational activities occurring this year. Many thanks to our Program members, we are privileged to benefit from your diverse and specialized knowledge. Special thanks to Ms. Nadia Jaber, our Program Manager, for her outstanding expertise and valued information and communication skills. She has and remains invaluable towards moving forward our collaborative agenda. She has been instrumental in adapting innovative models for us to deliver our academic content and events during this evolving post-pandemic time.

In closing, we wish to celebrate another outstanding academic year in our U of T Spine Program and we look forward to summer break followed by an exciting 2023-2024 academic calendar.

Sincerely,

Michael Fehlings & Albert Yee
Co-Directors, U of T Spine Program

AGENDA

Location: BMO Education & Conference Centre, 60 Leonard Avenue

8:30 AM	Breakfast	
9:00 Am	Opening Remarks	Dr. Michael Fehlings & Dr. Albert Yee
	Greetings from U of T	Drs. Peter Ferguson, Justin Nodwell, Gelareh Zadeh, and Carol Swallow
Session I	Tator-Hall Lecture	Chair: Dr. Michael Fehlings
9:15 AM	Remarks	Dr. Charles Tator & Dr. Hamilton Hall
9:25 AM	Introduction to Keynote speaker Professor Shekar Kurpad MD PhD	Dr. Michael Fehlings
9:30 AM	Keynote: <i>Translational Perspectives of MR Imaging Biomarkers in SCI and DCM</i>	Dr. Shekar Kurpad, Sanford J Larson Professor Chairman, Department of Neurological Surgery Founding Director, Neuroscience Institute Froedtert Health, Children's Wisconsin, Zablocki VAMC and The Medical College of Wisconsin
10:15 AM	Discussions	
10:45 AM	Elevator Pitch	Research Trainees
11:15 AM	Coffee Break	
Session II	Imaging Biomarkers	Chair: Dr. Cari Whyne
11:30 AM	<i>"AI-enabled Image-based Treatment Planning and Quantitative Biomarkers for Spine Metastases and Osteosarcopenia"</i>	Dr. Michael Hardisty
11:45 AM	<i>"Clinical Utility of Multiparametric Quantitative MRI in Degenerative Cervical Myelopathy (DCM)"</i>	Dr. Muhammad Ali Akbar

12:00 PM	<i>“Advances in High Resolution Sonography of the Injured Spinal Cord”</i>	Dr. James Hong
12:15 PM	<i>“MR Imaging for Next-Generation Therapeutics”</i>	Dr. Hai-Ling Margaret Cheng
12:30 PM	Elevator Pitch	Research Trainees
1:00 PM	Lunch Break	
Session III	Research Trainee Presentations	Chair: Dr. Albert Yee

Invited Research Trainees

1:30 PM	<i>“Harnessing the Endogenous Stem Cell Response after Spinal Cord Injury”</i>	Dr. Laureen Hachem
1:45 PM	<i>“A Dive into Patient Expectations of Patients with Metastatic Spinal Disease”</i>	Dr. Annemarie Versteeg

Best Abstracts / Oral Presentations

2:00 PM	Fellow Best Abstract (1 st Place) <i>Sex, Drugs and Spine Surgery: A Nationwide Analysis of Opioid Utilization and Patient Reported Outcomes in Males and Females”</i>	Dr. Aditya Raj (Spine Fellow)
2:15 PM	Fellow Best Abstract (2 nd Place) <i>“Prevention, Diagnosis, and Management of Intraoperative Spinal Cord Injury in the Setting of Spine Surgery: Development of Guidelines and an Evidence-Based Care Pathway”</i>	Dr. Nisaharan Srikandarajah (Spine Fellow)
2:30 PM	Best Abstract (1 st Place) <i>“Safety and Efficacy of Riluzole in Acute Spinal Cord Injury (RISCIS): A Multi-Center, Randomized, Placebo-Controlled, Double-Blinded Trial”</i>	Dr. Ali Moghaddamjou (PGY4, Neurosurgery & PhD Candidate)
2:45 PM	Best Abstract (2 nd Place, Tie) <i>“The Effect of Early Surgical Decompression on Segmental Neurological Recovery in Acute</i>	Alex (Beomju) Bak (MD Student)

	<i>Traumatic Spinal Cord Injury: A pooled Analysis of Individual Participant Data from Prospective, Multicenter Trials</i>	
3:00 PM	Best Abstract (2nd Place, Tie) <i>“Generation of Synthetic μCT Images of Rat Lumbar Vertebral Fracture via Deep Convolutional Generative Adversarial Networks”</i>	Allison Tolgyes (PhD Candidate)
3:15 PM	Award Presentations and Closing Remarks	

Biosketch

Tator & Hall



Dr. Charles Tator is a Professor in the Department of Surgery, at the University of Toronto, and a neurosurgeon at the Toronto Western Hospital. He is the former Chair of Neurosurgery at the University of Toronto. He started the first Acute Spinal Cord Injury Unit in Canada in 1974, and has reported on the epidemiology, prevention and treatment of spinal cord injury. He has undertaken seminal translational and clinical research in spinal cord injury. In 1992, he founded ThinkFirst, Canada, a national brain and spinal cord injury foundation whose mission is to reduce the incidence of catastrophic injuries in Canada. In 2012, ThinkFirst merged with three other charities to form Parachute Canada, the country's foremost injury prevention agency, of which he is a founding Director. In 2008, the University of Toronto Press published his book "Catastrophic Injuries in Sports and Recreation, Causes and Prevention-a Canadian Study." He has held two research chairs at the University of Toronto, the Dan Family Chair in Neurosurgery and the Campeau Family-Charles Tator Chair in Brain and Spinal Cord Research. In 2000, he received the Order of Canada, and in 2009 he was inducted into the Canadian Medical Hall of Fame. In 2017, he was promoted to Officer within the Order of Canada, and was also inducted into Canada's Sports Hall of Fame for his work on prevention of sports injuries.



Dr. Hamilton Hall is a Professor in the Department of Surgery at the University of Toronto and on the orthopaedic staff at the Sunnybrook Health Sciences Centre. He completed his medical degree at the University of Toronto then joined CARE and was stationed at a rural hospital in Malaysia. Dr. Hall returned to Toronto for his orthopaedic residency which concluded with a fellowship in medical education at the University of Dundee, Scotland. In 1974, because of his interest in patient education and rehabilitation, Dr. Hall founded the Canadian Back Institute which expanded into the CBI Health, now the largest home care and rehabilitation company in Canada. He is co-founder and Executive Director of the Canadian Spine Society and has served on the editorial boards of Spine, The Spine Journal and The BackLetter. Dr. Hamilton Hall has worked as a team physician for the NBA Toronto Raptors and doctor for the National Ballet of Canada.

Dr. Hall has received Outstanding Paper and Poster awards from the North American Spine Society and the International Society for the Study of the Lumbar Spine. He is a recipient of the Laurie Chute Award for Best Undergraduate Clinical Lecturer Award at the University of Toronto, the NASS Henry Farfan Award for outstanding contributions to the field of spine care and two Lifetime Achievement Awards, one from Stryker Spine and the other from the Canadian Spine Society. In 2019 he was inducted into the Toronto Orthopaedic Hall of Fame.

Dr. Hall's concept of a syndrome approach to classifying mechanical back pain is an essential component of several Canadian provincial initiatives to improve spine care. In addition to over 140 published articles and book chapters and over 1200 invited presentations, many as Visiting Professor, to universities in North America, Europe and Asia, he is author of the best-selling Back Doctor series of books for the lay public.

U of T Spine Program Co-Chairs



Dr. Michael Fehlings is the Vice Chair Research for the Department of Surgery at the University of Toronto and a Neurosurgeon at Toronto Western Hospital, University Health Network. Dr. Fehlings is a Professor of Neurosurgery at the University of Toronto, holds the Robert Campeau Family Foundation / Dr. C.H. Tator Chair in Brain and Spinal Cord Research at UHN, is a Senior Scientist at the Krembil Brain Institute and a McLaughlin Scholar in Molecular

Medicine. In the fall of 2008, Dr. Fehlings was appointed the inaugural Director of the University of Toronto Neuroscience Program (which he held until June 2012) and is currently Co-Director of the University of Toronto Spine Program. Dr. Fehlings combines an active clinical practice in complex spinal surgery with a translationally oriented research program focused on discovering novel treatments to improve functional outcomes following spinal cord injury (SCI). He has published over 1000 peer-reviewed articles (h-index 112; cited over 49,000 times) chiefly in the area of central nervous system injury and complex spinal surgery. His seminal 1991 paper, cited over 2,000 times, outlined the severe and lasting consequences of SCI due to a cascade of secondary injury mechanisms following the initial trauma. His research on secondary injury mechanisms ultimately led to the commencement of the multicenter, international Surgical Timing in Acute Spinal Cord Injury Study (STASCIS), aimed at establishing the need for early surgical decompression to prevent the negative effects of the secondary injury cascade. His work examining the use of regenerative approaches including neural stem cells to

repair the injured nervous system has led to numerous international awards and has helped lead the field toward clinical translation in this area. Dr. Fehlings has published in prominent journals such as Nature, Nature Neuroscience, Lancet Neurology, and Science Translational Medicine.

Dr. Michael Fehlings has received numerous prestigious awards including the Gold Medal in Surgery from the Royal College of Physicians and Surgeons (1996), nomination to the Who's Who list of the 1000 most influential scientists of the 21st century (2001), the Lister Award in Surgical Research (2006), the Leon Wiltse Award from the North American Spine Society for excellence in leadership and/or clinical research in spine care (2009), the Olivecrona Award (2009) -- the top award internationally for neurosurgeons and neuroscientists awarded by the Nobel Institute at the Karolinska Institute in Stockholm for his important contributions in CNS injury repair and regeneration, the Reeve-Irvine Research Medal in Spinal Cord Injury (2012), the Golden Axon Leadership Award (2012), the Mac Keith Basic Science Lectureship Award for significant contributions to the basic science of cerebral palsy and childhood onset disabilities (2012), and was the Mayfield Lecturer (2012). In 2012, Dr. Fehlings served as the 40th President of the Cervical Spine Research Society (CSRS) -- the only Canadian to do so -- and was honoured with the CSRS Presidential Medallion for outstanding leadership and contributions to cervical spine research. In 2013, Dr. Fehlings was honoured with the Queen Elizabeth II Diamond Jubilee Medal presented to him by the Honourable Stephen Harper, the H. Richard Winn Prize from the Society of Neurological Surgeons, the Jonas Salk Award for Scientific Achievements from the March of Dimes Canada and the Henry Farfan Award from the North American Spine Society. In 2014, Dr. Fehlings was elected to the Fellowship of the Royal Society of Canada and to the Canadian Academy of Health Sciences, and in 2016 won the Royal College of Physicians and Surgeons Mentor of the Year Award. In 2019, the Right Honourable Jacinda Ardern, Prime Minister of New Zealand, presented him with the Ryman Prize for his work enhancing the quality of life for older people. He also received the Vilhelm Magnus Medal (2019) for his contributions to the neurosurgery field and the American Spinal Injury Association Apple Award (2016 & 2022) for excellence in spinal cord injury research publishing.



Dr. Albert Yee is the Holland Bone and Joint Program Chief and the Head of the Division of Orthopaedic Surgery at Sunnybrook Health Sciences Centre, where he holds the Marvin Tile Chair in Orthopaedic Surgery. Dr. Yee is an Orthopaedic Spine Surgeon at Sunnybrook Health Sciences Centre, an Associate Scientist (Physical Sciences Platform) at Sunnybrook Research Institute and a Consultant in Surgical Oncology, Bone Metastasis Clinic, Odette

Cancer Centre. He is a Full Professor at the University of Toronto in the Institute of Medical Sciences with a cross appointment in the Institute of Biomaterials and Biomedical Engineering. He is the Vice Chair of Research in the Division of Orthopaedic Surgery and Co-Director of the University of Toronto's Department of Surgery Spine Program. Dr. Yee is the Past President of the Canadian Orthopaedic Research Society, President of the Canadian Spine Society and Co-Chair of Bone & Joint Canada. He is the Canadian Lead for the Young Investigators Initiative (YII) of Bone & Joint Canada, and the US Bone & Joint Initiative, a grant mentorship and career development program. Dr. Yee has over 100 peer reviewed publications and has received academic honours including the American British Canadian (ABC) International Travelling Fellowship (American Orthopaedic Association / Canadian Orthopaedic Association, 2013), the Charles H. Tator Surgeon-Scientist Mentoring Award (2012), and the Canadian Orthopaedic Foundation J. Edouard Samson Award (2011). Dr. Yee's laboratory focuses on translational orthopaedic research utilizing pre-clinical surgical models to evaluate novel minimally invasive vertebral metastatic therapies (e.g., Photodynamic Therapy, Radiofrequency Ablation). His work has led to first in human clinical trials and FDA approval with commercialization of new minimally invasive spine technology. He has interest in understanding mechanisms of disease in cancer invasiveness to bone with an aim towards identifying potential new promising therapeutic targets.

Keynote Speaker -Tator-Hall Lectureship



Dr. Shekar Kurpad is the Sanford J. Larson Professor of Neurosurgery, Co-Director of the Center for Neurotrauma Research at MCW, and the Medical Director of the Neuroscience Service Line at Froedtert Health. He is the Director of the Spinal Cord Injury Center at Froedtert and the Medical College of Wisconsin, and the Founding Director of the Neuroscience Institute, a partnership between the Medical College of Wisconsin, Froedtert Hospital, Children’s Wisconsin, and the Clement J.

Zablocki VA Medical Center. Dr. Kurpad’s clinical practice focuses on the surgical treatment of patients with degenerative and traumatic conditions of the spine and spinal cord, as well as benign and malignant tumors of the spinal column and spinal cord. His laboratory focuses on the development of novel MRIbased imaging biomarkers for spinal cord injury, as well as cervical spondylotic myelopathy. He has been involved in Spinal Cord Injury (SCI) research since 2001 after being awarded the Van Wagenen Fellowship by the American Association of Neurological Surgeons. His experience in this field of research includes earlier work using stem cells for regeneration of the spinal cord begun as a postdoctoral fellow at the Karolinska Institute in Stockholm, Sweden, and the establishment of a Spinal Cord Injury research laboratory at the Medical College of Wisconsin. Dr. Kurpad’s laboratory currently focuses on delineating the pathophysiology of traumatic spinal cord injury and non-traumatic cervical spondylotic myelopathy, as well as preclinical development of therapeutic strategies from 2002 (endowed since 2010); funding to study the mechanisms of allodynia after stem cell transplantations into the injured spinal cord using VA BLR&D MERIT funding from 2006-2009; and Imaging of SCI using diffusion tensor imaging (DTI) funded by VA RR&D MERIT grants from 2009 to present. Dr. Kurpad has also served as a consultant for several imaging start-up companies based in the Milwaukee area and awarded NIH SBIR funding as Principal Investigator for these efforts. He is the clinical PI at MCW for all Phase 1-111 SCI trials in patients (10 trials since 2008 encompassing both neuroprotective and neural regeneration strategies) and has participated as a member of the National VA SCI Consortium for Translational Therapies for SCI from 2009 to present. As a surgeon actively involved in the care of SCI patients at MCW and the Zablocki VA, I am interested in translating laboratory findings rapidly to patient applications to establish new and innovative treatment options for spinal cord injury.

Invited Speakers



Michael Hardisty PhD is a Junior Scientist at the Sunnybrook Research Institute. His current research is translational and interdisciplinary with a focus on the spine, orthopaedics, cancer, and the use of artificial intelligence for medical image analysis and biomechanics. Michael Hardisty earned his PhD in Biomedical Engineering at the University of California, Davis. He has extensive experience creating and translating medical image analysis tools for clinical applications; specifically, he is focused on using imaging biomarkers and deep learning to aid in clinical decision making, predict patient outcomes and guide therapy.



Dr. James Hong did his doctoral and postdoctoral work in the lab of Dr. Michael Fehlings at the University of Toronto investigating the differences in disease progression between cervical and thoracic spinal cord trauma and disease mechanisms of degenerative cervical myelopathy. During his studies, he frequently employed the use of high resolution sonography to perform in vivo gross tissue assessments and vascular characterization of the spinal cord. Dr. Hong currently leads Verismo Health Inc, a primary care startup, and lectures in the department of human biology at the University of Toronto.



Dr. Muhammad Ali Akbar is currently one of the chief residents at the University of Toronto Neurosurgery program. He completed his graduate studies during residency, under the supervision of Dr. Michael Fehlings. His PhD was focused on characterizing quantitative MRI biomarkers to aid in diagnosis, prognostication and management of degenerative cervical myelopathy as well as spinal cord injury.



Prof. Hai-Ling Margaret Cheng is an Associate Professor at the University of Toronto in the Institute of Biomedical Engineering and the Edward S. Rogers Sr. Department of Electrical and Computer Engineering. Trained as an electrical and computer engineer, she worked in industry on synthetic aperture radar surveillance before completing her PhD in Medical Biophysics at the University of Toronto, specializing in MRI physics and developing interventional MRI guidance for focused ultrasound ablation therapy. She spent the next decade at the Hospital for Sick Children, where she developed robust quantitative MRI platforms

for clinical workflow, including liver iron quantitation, quantitative perfusion MRI, and rapid MR relaxometry, at the same time becoming one of the first Canadian scientists to introduce MRI into tissue engineering and regenerative medicine. In 2014, she joined the Faculty of Engineering at the University of Toronto, where she expanded her suite of quantitative physiological MRI capabilities to target cardiovascular disease. Her current research is focused on real-time MRI, chemistry for molecular imaging, early diagnostics for heart failure, and MRI technologies for therapy guidance. She is currently a licensed professional engineer, Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), and a long-standing member of the International Society for Magnetic Resonance in Medicine (ISMRM). She has over 80 peer-reviewed publications and holds patents on novel contrast agents and cell tracking.

Invited Research Trainees Presentations



Dr. Laureen Hachem is currently a PGY4 neurosurgery resident at the University of Toronto. She completed her medical training at the University of Toronto, after beginning her undergraduate studies in neurosciences there, as well.

Her research focuses on regenerative strategies to enhance plasticity in the injured central nervous system and specifically examining the mechanisms of endogenous neural stem/progenitor cell activation after traumatic spinal cord

injury. She is conducting her PhD as part of the Surgeon Scientist Training Program examining glutamate-mediated signalling mechanisms in ependymal stem cells after spinal cord injury.

Her research is supported by grants from the Canadian Institutes of Health Research, American Academy of Neurological Surgeons/Neurosurgery Research & Education Foundation and Physicians Services Incorporated Foundation. Laureen has received numerous recognitions including a Vanier Scholarship (CIHR), the K.G. McKenzie Basic Research Prize (CNSF), AANS/CNS

Neurotrauma/Critical Care Section Research Award, the Starr Medal (UofT) and Kuntz Scholar Award (AANS/CNS Spine/Peripheral Nerve Section).



Dr. Anne Versteeg is currently a PGY3 Orthopaedic surgery resident at the University of Toronto. She completed her MD/PhD program at the University of Utrecht in The Netherlands. Her PhD was completed in collaboration with the Vancouver Spine Surgery institute at the University of British Columbia. Anne's PhD was focussed on optimizing outcomes for patients with spinal metastases through improvements in patient selection and treatment strategies

using a multidisciplinary approach. During the final year of her PhD she moved to Vancouver and completed the Master of Health science in epidemiology and biostatistics at the University of British Columbia. Since 2016, she is involved with the AOSpine Tumor Knowledge Forum, an international group of renowned spine oncology surgeons and (radiation) oncologist who perform international multicenter research to advance patient care. After residency she hopes to pursue further training with a spine fellowship.

Best Abstracts – Oral Presentations



Dr. Aditya Raj is an Orthopaedic spine surgeon trained in India. He is currently enrolled with the University of Toronto pursuing a spine fellowship at Toronto Western Hospital. He attended medical school with Maharashtra University of Health Sciences in India and graduated top of his class. He further completed his Orthopaedic surgery training at Seth G.S Medical College and King Edward Memorial Hospital in

Mumbai and was awarded a gold medal for finishing top of his class. He completed a spine fellowship from Stavva Spine Hospital and Research Institute, India in adult and pediatric spine surgery. He was also awarded Asia Pacific Spine Fellowship and attended a fellowship program directed at pediatric and adult spine deformities at Samsung Medical Centre in Seoul, South Korea. He was also trained in Uniportal and Biportal Endoscopic Spine Surgery in South Korea. His research interests include spinal deformities, craniovertebral junction diseases, spinal infections.



Dr. Nisaharan Srikandarajah is a FRCS trained neurosurgeon from Liverpool, UK currently undertaking a clinical spine fellowship at Toronto Western Hospital. He has done a PhD in the topic area of cauda equina syndrome and has a research interest in patient outcomes in spine surgery. He will be returning to Liverpool, UK as a staff neurosurgeon with clinical and academic complex spine practice.



Alex (Beomju) Bak is a 3rd-year medical student at University of Toronto. During medical school, he also pursued a master in biomedical engineering. His current interests lie in surgical data science, product development, and improving fracture outcomes. In his free time, Alex likes to ski/snowboard, scuba dive, and team trivia.



Dr. Ali Moghaddamjou is a neurosurgery resident at the University of Toronto who is concurrently pursuing a PhD under the guidance of Dr. Fehlings. Dr. Moghaddamjou completed his medical school and undergraduate studies at the University of British Columbia. He has a passion in combining technology with medicine to improve patient outcomes. His research is centered on the development of predictive models for spinal cord injury, with an aim to create more personalized treatment approaches by leveraging big data and machine learning techniques.



Allison Tolgyesi completed a bachelor of applied science at the University of Ottawa in biomedical mechanical engineering in 2019. She then began her PhD in biomedical engineering at the University of Toronto in 2020 in the Orthopaedic Biomechanics Laboratory led by Dr. Cari Whyne at Sunnybrook Research Institute. Her work is focused on the characterization of the mechanical impact of focal and systemic cancer treatments on healthy and metastatically involved vertebral bone. Her methods have included preclinical animal models and imaging, biomechanics testing, and most recently computational approaches to fracture modeling.

Organizing Team



Nadia Jaber is the Manger of the University of Toronto Spine Program. She manages the Program’s operations, communications, and fundraise. She plans and organizes the Program’s education and knowledge translations platforms. Nadia completed her Master of Information Studies at the University of Toronto, and obtained trainings in Entrepreneurship Essentials and in Leadership Principles from Harvard Business School – Online. She continues to integrate her education, knowledge and expertise in information, communication and technology to enhance the Program’s experience in collaboration, education, teaching, and community outreach and advocacy.



Delphine Li is a third-year HBSc candidate double-majoring in Neuroscience and English at the University of Toronto. She has received both a University of Toronto Scholar award and the Dean's List Scholar designation. As an aspiring medical student, she joined the U of T Spine Program as a Program Volunteer to gain exposure to spine disorders and spine care delivery and learn more about current city-wide spine research and education in the Program. Delphine is excited to integrate her multidisciplinary background in both the Life Sciences and the Humanities to assist in planning and organizing knowledge translation activities at in the U of T Spine Program.

Scientific Abstracts

#	Authors	Title
1	Alex Beomju Bak, Ali Moghddamjou, James S. Harrop, Bizhan Aarabi, Michael G. Fehlings	Independence of bowel and bladder function after complete ASIA A acute traumatic spinal cord injury: a longitudinal analysis of prospective, multicenter data in 319 patients
2	Alex Beomju Bak, James S. Harrop, Paul M. Arnold, Ali Moghaddamjou, Michael G. Fehlings	Relationship between pain and other functional and health-related outcome measures in degenerative cervical myelopathy: Results of a prospective, multicenter dataset of 914 patients
3	Alex Beomju Bak, James S. Harrop, Paul M. Arnold, Ali Moghaddamjou, Michael G. Fehlings; on behalf of the CSM-Protect Investigators	Predictors of Long-term Dysphagia after Anterior Decompression for Degenerative Cervical Myelopathy: Results of the CSM-Protect Multicenter, Randomized, Controlled Trial
4	Alex Beomju Bak, Ali Moghddamjou, James S. Harrop, Bizhan Aarabi, Michael G. Fehlings	The effect of early surgical decompression on segmental neurological recovery in acute traumatic spinal cord injury: a pooled analysis of individual participant data from prospective, multicenter trials
5	Alex Beomju Bak, James S. Harrop, Paul M. Arnold, Ali Moghaddamjou, Michael G. Fehlings	The Effect of Regional Procedural Preference on Outcomes after Posterior Decompression for Degenerative Cervical Myelopathy: Individual Participant Data Meta-Analysis of a Prospective, Multinational Dataset of 1047 Cases
6	Armaan K Malhotra MD, Yingshi He MSc, Erin M Harrington BMSc, Blessing Jaja MD PhD, Mary P Zhu MD, Husain Shakil MD MSc, Nicolas Dea MD MSc FRCSC, Michael H Weber MD PhD FRCSC, Najmedden Attabib MD MBBCH FRCSC, Philippe Phan MD PhD FRCSC, Yoga Raja Rampersaud MD FRCSC, Jerome Paquet PhD, W Bradley Jacobs MD FRCSC, David W Cadotte MD PhD FRCSC, Sean D Christie MD FRCSC, Andrew Nataraj MD FRCSC, Christopher S Bailey MD MSc FRCSC, Michael Johnson MD FRCSC, Charles Fisher MD MSc FRCSC, Hamilton Hall MD FRCSC, Neil Manson MD FRCSC, Kenneth Thomas MD FRCSC, Howard J Ginsberg MD PhD FRCSC, Michael G Fehlings MD PhD FRCSC,	Development of the Cervical Myelopathy Severity Index: A New Myelopathy Specific Patient Reported Outcome Measure to Facilitate Clinical Care and Research

	Christopher D Witiw MD MSc FRCSC, Aileen M Davis PhD, Jefferson R Wilson MD PhD FRCSC	
7	Ali Moghaddamjou, MD , Michael G. Fehlings, MD, James S. Harrop, MD, Ralph Stanford, MBBS, Jonathon Ball, MD, Bizhan Aarabi, MD, Brian J. C. Freeman, MB, Paul M. Arnold, MD, James D. Guest, MD, Shekar Kurpad, MD, James M. Schuster, MD, Ahmad Nassr, MD, Karl M. Schmitt, MD, Jefferson Wilson, MD, Darrel S. Brodke, MD, Faiz U. Ahmad, MD, Albert Yee, MD, Wilson Z. Ray, MD, Nathaniel P. Brooks, MD, Jason Wilson, MD, Diana S-L Chow, PhD, Elizabeth G Toups, MSc, Branko Kopjar, MD	Safety and Efficacy of Riluzole in Acute Spinal Cord Injury (RISCIS): A Multi-Center, Randomized, Placebo-Controlled, Double-Blinded Trial
8	Aditya Raj , Stephen Lewis, Christopher Nielsen	A Prospective, Observational, Multicenter Study Assessing Functional Improvements After Multilevel Fusion for Adult Spinal Deformity (ASD): 5 Year Follow Up Results
9	Aditya Raj , Jean Christophe Murray, Ahmed Cherry, Greg McIntosh, Christopher Nielsen, Nisaharan Srikandarajah, Ragavan Manoharan, Carlo Iorio, Mark Xu, Anthony Perruccio, Mayilee Canizares, Yoga Raja Rampersaud	Sex, Drugs and Spine Surgery: A Nationwide Analysis of Opioid Utilization and Patient Reported Outcomes in males and females
10	Allison Tolgyesi , Cari M. Whyne, Michael Hardisty	Generation of Synthetic μ CT Images of Rat Lumbar Vertebral Fracture via Deep Convolutional Generative Adversarial Networks
11	Bryce Thomsen , Danny Vesprini, K. Liang Zeng, Sten Myrehaug, Chia-Lin Tseng, Jay Detsky, Hanbo Chen, Beibei Zhang, Katarzyna Jerzak, Eshetu Atenafu, Jefferson Wilson, Pejman Maralani, Hany Soliman, Arjun Sahgal	Stereotactic Body Radiotherapy (SBRT) for Breast Cancer Spinal Metastases is Associated with Low Rates of Long-Term Local Failure (LF) and Vertebral Compression Fracture (VCF) Independent of Molecular Status
12	Cherry, A. , Jaber, N., Yee, A., Fehlings, M	The Use of a Standardized Surgical Case Log to Document Operative Exposure to Procedural Competencies in a Spine Surgery Fellowship Curriculum: A University Wide Initiative
13	Cherry, A. , Raj, A., Manoharan, R., Murray, JC., Xu, M., Iorio, C., Canizares, M., McIntosh., G, Nielsen, C., Rampersaud, R. On behalf of the Canadian Spine Outcomes and Research Network (CSORN)	Assessment of changes in Opioid Utilization One Year After Elective Spine Surgery - A Canadian Spine Outcomes and Research Network Study
14	Gustavo Balbinot , Shirin Tajali, Kei Masani, Michael Fehlings	Cervical transcutaneous spinal cord stimulation elicits motor evoked responses in the forelimb of rats

15	Husain Shakil , Armaan K Malhotra, Michael G. Fehlings, Jefferson R. Wilson, Christopher D Witiw	Early Surgery Compared to Non-Operative Management for Mild Degenerative Cervical Myelopathy: A Cost-Utility Analysis
16	Jane Jomy , Nisaharan Srikandaraj, Michael Fehlings	Enhanced recovery in spinal surgery protocols in degenerative cervical spine disorders
17	Joshua Plener DC, MSc , Ben Csiernik DC, Daphne To DC, FCCS (C), Sophia da Silva-Oolup DC, FCCS (C), Corey Hofkirchner DC, Jocelyn Cox DC, FCCS (C), Carol Cancelliere, DC, PhD, Ngai Chow DC, FCCS (C), MSc, Sheilah Hogg-Johnson MMath, PhD, Carlo Ammendolia, DC, PhD	Conservative management of cervical radiculopathy: A systematic review
18	Joshua Plener DC, MSc , Silvano Mior DC, PhD, Melissa Atkinson-Graham PhD, Sheilah Hogg-Johnson MMath, PhD, Pierre Côté DC, PhD, Carlo Ammendolia DC, PhD	<i>Information is power</i> : a qualitative study exploring the lived experiences of patients with degenerative cervical radiculopathy
19	Katarzyna Pieczonka , Mohamad Khazaei, Michael G. Fehlings	Promoting the Differentiation of Neural Progenitor Cells into Oligodendrocytes Through the Induction of Olig2 Expression
20	Leanna Abraham , Christine Huang, Michael Hardisty, Cari Whyne, Margarete K. Akens	Rat model of mixed osteoblastic-osteolytic bone metastasis suggests psoas muscle attenuation and volume loss
21	Nayaab Punjani , Sighild Lemarchant, Svetlana Altamentova, Jonathon Chio, Jian Wang, Yann Godfrin, Michael Fehlings	Subcommissural organ-derived peptide promotes functional recovery and enhances tissue repair in a rat cervical spinal cord injury model
22	Nisaharan Srikandarajah , Nader Hejrati, Mohammed Ali Alvi, Ayesha Quddusi, Ali Moghaddamjou, Brian Kwon, Michael G Fehlings	Prevention, Diagnosis, and Management of intraoperative spinal cord injury in the setting of spine surgery: Development of Guidelines and an Evidence-Based Care Pathway
23	R. Manoharan , A. Cherry, N. Srikandarajah, A. Raj, M. Xu, C. Iorio, C.J. Nielsen, Y.R. Rampersaud, S.J. Lewis	Distal Lordosis is Associated with Reoperation for Adjacent Segment Disease in Degenerative Lumbar Fusion Patients
24	Rajendra Sakhrekar , Nicholas Shkumat, Birgit Ertl-Wagner, Stephen Lewis, David E. Lebel, Mark Camp	Pedicle Screw Accuracy Placed with Assistance of Machine Vision Technology in Patients with Neuromuscular Scoliosis
25	Priscilla Chan , Zijian Lou, Christopher S Ahuja, Alexander Velumian, Dylan Deska-Gauthier, Mohamad Khazaei, Michael G. Fehlings	Anterograde and Retrograde Self-Tracing Neural Progenitor Cells for Mapping Transplant Integration into the Endogenous Neural Network
26	Tiffany Lung , Mayilee Canizares, Anthony Perruccio, Raja Rampersaud	Persistent poor sleep is associated with worse pain and quality of life in patients with degenerative thoracolumbar conditions undergoing surgery: A retrospective cohort study

27	S. Brockie , C. Zhou, N. Poulin, M. Movahed, J. Hong, & M.G. Fehlings	Examining the Role of CX3CR1 in Degenerative Cervical Myelopathy
28	Dr Rajesh Kumar , Dr. Albert Yee, Dr.Jeremie Larouche	Recognizing Spine Fellowship Training in Canada: An updated literature review of fellowship education and a surgical case list review referencing a national curriculum of procedural competencies
29	Daniel Palhares, MD, MSc , Kang Liang Zeng, MD, Sten Myrehaug, MD, Chia-Lin (Eric) Tseng, MDCM, Hany Soliman, MD, Hanbo Chen, MPH, MD, Pejman Maralani, MD, Jeremie Larouche, MD, Jeff Wilson, MD, PhD, Mark Ruschin, PhD, Beibei Zhang, PhD, Eshetu G. Atenafu, MSc, PStat, Arjun Sahgal, MD, Jay Detsky, PhD, MD	Stereotactic Body Radiotherapy (SBRT) for Sacral Metastases: Deviation from Recommended Target Volume Delineation Predicts Higher Risk of Local Failure
30	Rajendra Sakhrekar , Samuel Yoon, Carlo Iorio, Stephen Lewis	Ewing Sarcoma of pediatric spine operative techniques and outcomes- a case series of 7 patients

Abstract # 1

Title: Independence of bowel and bladder function after complete ASIA A acute traumatic spinal cord injury: a longitudinal analysis of prospective, multicenter data in 319 patients

Authors and Affiliations: Alex Beomju Bak¹, Ali Moghddamjou¹, James S. Harrop², Bizhan Aarabi³, Michael G. Fehlings¹

¹University of Toronto, Toronto, Canada

²Thomas Jefferson University, Philadelphia, USA

³University of Maryland, Baltimore, USA

Purpose: Neurogenic bladder and bowel management are frequently referenced as among the top long-term recovery priorities after traumatic spinal cord injury (SCI). Hence, it is important to identify the recovery trajectories and associated factors for managing patient expectations and counselling.

Methods: Individual patient data from two prospective, multicenter datasets (NACTN SCI Registry and STASCIS trial) were pooled, from September 2009 to April 2017. All patients who underwent decompressive surgery for sensorimotor complete acute SCI were included. Complete SCI was assessed as an ASIA impairment scale grade of A, within 72 hours of injury. Bladder and bowel management were evaluated using Functional Independence Measure (FIM) criteria from 1 (requiring total assistance) to 7

(complete independence). Latent class trajectory modelling (LCTM) was performed on bladder and bowel management scores at acute care discharge and 3mo, 6mo, and 1yr follow up. Predictors of LCTM trajectories were estimated using multivariate logistic regression on baseline patient, injury, and neurological function variables and presented as odds ratios (OR), with corresponding 95% confidence intervals (CI) and p-values. A final prediction model was assessed using R-squared values and area under the receiver operating characteristic curve (AUROC).

Results: Of 319 patients with sensorimotor complete, predominantly cervical SCI (82.6% cervical, 53% thoracic, 0.6% lumbar), 24.8% followed a trajectory of recovery of their bowel sphincter function, while 75.2% did not recover by 1 year. With respect to bladder sphincter function, 27.9% followed a trajectory of improving to independent bladder function management, while 72.1% did not recover their bladder sphincter function. On multivariate regression, upper extremity motor score was the only significant predictor of both bowel function (OR: 1.07, 95% CI [1.02–1.13], p=0.011) and bladder function (OR: 1.07, 95% CI [1.01–1.13], p=0.015). Cervical level of injury was not a significant predictor. A single-item model with upper extremity motor score had an R-squared value of 0.1333 and 0.183 and AUROC of 0.739 and 0.783 for predicting bowel and bladder function recovery, respectively.

Conclusions: Approximately three-quarter of patients with complete acute spinal cord injuries follow a trajectory of minimal recovery of their bladder and bowel independence by 1yr follow up. In those that recover, the upper extremity motor score assessed within 72 hours of injury is strongly predictive of bladder and bowel independence.

Abstract # 2

Title: Relationship between pain and other functional and health-related outcome measures in degenerative cervical myelopathy: Results of a prospective, multicenter dataset of 914 patients

Authors and Affiliations: Alex Beomju Bak¹, James S. Harrop², Paul M. Arnold³, Ali Moghaddamjou¹, Michael G. Fehlings¹

¹University of Toronto

²Thomas Jefferson University

³Carle Illinois College of Medicine

Purpose: While pain is increasingly regarded as a top recovery priority by patients living with degenerative cervical myelopathy (DCM), this outcome has been under-recognized and understudied.

Pain can be a driver to seek surgical intervention particularly in individuals with mild DCM. To address this knowledge gap, we examined the relationship between pain and other functional and health-related outcome measures in DCM.

Methods: We identified patients who underwent surgical decompression for DCM from the prospective, multicenter AOSpine CSM-NA, CSM-I, and CSM-Protect trials with non-missing pain data. Outcomes were modified Japanese Orthopedic Association (mJOA) score, Nurick classification, Short Form 36 (SF36) Physical Component Summary (SF36-PCS), and SF36 Mental Component Summary. Pain was prospectively assessed using Neck Disability Index Pain Intensity (NDI-PI) score preoperatively, and at 6mo and 1yr follow up. Pain intensity was categorized as minimal (NDI-PI = 0 or 1), moderate (NDI-PI=2), and severe (NDI-PI>2). Correlation between pain intensity as a continuous variable and outcome measures at each timepoint, as well as their changes at 1yr from baseline was described with Spearman's ρ and P values. Correlation between change in pain and rate of minimum clinically important difference (MCID) for mJOA, SF36-PCS, and SF36-MCS was described with Pearson's correlation coefficient r and P values.

Results: Of 914 eligible DCM patients, 32.2% had severe preoperative pain, 29.1% moderate pain, and 38.7% had minimal pain. Preoperative mJOA, SF36-PCS, and SF36-MCS were higher in patients with less pain. Female patients and those with anxiety/depression was associated with reporting greater preoperative pain. Pain intensity was poorly correlated with mJOA and Nurick preoperatively and all follow-up time points. SF36-PCS and SF36-MCS was significantly and moderately correlated with pain at all time points. Changes in mJOA was poorly correlated with changes in pain ($\rho = -0.12$; $P<0.001$) as was Nurick grade ($\rho = 0.15$; $P<0.001$). Changes in patient-reported outcomes of SF36-PCS was significantly and fairly correlated with changes in pain ($\rho = -0.37$; $P<0.001$) as was SF36-MCS ($\rho = -0.26$; $P<0.001$). Changes in pain was poorly correlated with reaching MCID of mJOA ($r = -0.10$; $P=0.152$), but moderately correlated with reaching MCID for SF36-PCS ($r = -0.29$; $P<0.001$) and MCS ($r = -0.22$ $P=0.001$). In a subset of 156 mild DCM patients, 23.1% reported severe preoperative pain, 29.5% reported moderate pain, and 47.4% had minimal pain. The pain groups did not differ in demographic, medical, or procedural variables. Patients with greater pain was associated with lower self-reported preoperative mental health and physical functioning, but not preoperative Nurick or mJOA scores. Correlation trends were similar to the total DCM cohort.

Conclusions: There is a high prevalence of preoperative pain in DCM patients who undergo surgery. The mJOA and Nurick classification, both of which are clinician-administered, are poorly correlated with

pain and insensitive to changes in pain, postoperatively. Patient-reported outcomes of the Mental and Physical Component Summaries of the SF36 were moderately and significantly correlated with pain and changes in pain, postoperatively.

Abstract # 3

Title: Predictors of Long-term Dysphagia after Anterior Decompression for Degenerative Cervical Myelopathy: Results of the CSM-Protect Multicenter, Randomized, Controlled Trial

Authors and Affiliations: Alex Beomju Bak¹, James S. Harrop², Paul M. Arnold³, Ali Moghaddamjou¹, Michael G. Fehlings¹; on behalf of the CSM-Protect Investigators

¹University of Toronto

²Thomas Jefferson University

³Carle Illinois College of Medicine

Purpose: Early dysphagia is one of the most common complications after anterior cervical surgery. However, there is a gap in the literature of factors associated with the development of chronic postoperative dysphagia, in part due to the scarcity of large, granular longitudinal data.

Methods: Adult patients who received anterior decompressive surgery for DCM between 2012 to 2017 across 16 university-affiliated sites as part of the prospective, randomized CSM-Protect clinical trial. Presence and severity of dysphagia was assessed with the Bazaz scale, which grades patients' dysphagia as none, mild, moderate, or severe based on its frequency and type of food or liquid ingested. Latent class trajectory modelling (LCTM) was applied to classify patients into distinct trajectories based on their Bazaz scale score over the initial 1yr after surgery with time points at baseline, 1mo, 6mo, and 1yr. Predictors of recovery trajectories were identified using descriptive statistics and multivariate logistic regression with odds ratios (ORs) and 95% confidence intervals (CIs) on demographic and surgical variables.

Results: From a total of 290 patients, 132 subjects met the eligibility criteria. Preoperatively, 11.4% of patients had moderate dysphagia, which peaked to 19.7% at 1mo with 7.6% developing severe dysphagia. This rate decreased to 11.4% of moderate and 3.8% of severe dysphagia at 6mo and further to 10.6% and 3.0%, respectively at 1yr. From this raw data, two distinct cubic trajectories for postoperative dysphagia were identified. Their polynomial course was classified as: 1) resolved early dysphagia (n=112,

84.9%), described by an early development of mild dysphagia by 1 month and rapid, complete resolution of symptoms by 6mo; and 2) chronic dysphagia (n=20, 15.1%), described by a development of mild to moderate dysphagia by 1mo and continued or worsening symptoms at 1yr. Demographically, older patients and male sex were associated with the resolved early dysphagia trajectory. Conversely, pertaining to comorbidities, patients with a history of psychiatric disorders such as anxiety, depression, and suicidal ideation was associated with chronic dysphagia trajectory. Additionally, presenting with gait impairment and having a stenotic cause due to hypertrophied ligamentum flavum was associated with unresolved dysphagia at 1yr.

Conclusions: Greater than an eighth of DCM patients that underwent anterior cervical surgery reported unresolved dysphagia of moderate or greater severity at one year. Patients with psychiatric comorbidities were more likely to report subjective long-term symptoms of dysphagia. Our findings lend support to the existence of a heterogeneous group of patients wherein the customarily reported pattern of resolved early postoperative dysphagia does not apply.

Abstract # 4

Title: The effect of early surgical decompression on segmental neurological recovery in acute traumatic spinal cord injury: a pooled analysis of individual participant data from prospective, multicenter trials

Authors and Affiliations: Alex Beomju Bak¹, Ali Moghddamjou¹, James S. Harrop², Bizhan Aarabi³, Michael G. Fehlings¹

¹University of Toronto, Toronto, Canada

²Thomas Jefferson University, Philadelphia, USA

³University of Maryland, Baltimore, USA

Purpose: Burgeoning evidence shows the association of early (<24 hours after spinal injury) surgical decompression after acute traumatic spinal cord injury (SCI) and improved neurological outcomes. However, the impact of early surgery on recovery of injured spinal cord levels is unclear. In the current absence of established minimum clinically important differences of sensorimotor scores, recovery of even one sensorimotor-intact neurological level may mean the difference of regaining ability to perform activities of daily living.

Methods: Individual participant data from three independent, prospective, multicenter trials (NACTN, STASCIS, NASCIS III) from December 1991 to March 2017 were analyzed. All participants that

underwent decompressive surgery for SCI were included. Participants were stratified into early (<24 hr after spinal injury) and late (≥ 24 hr after spinal injury) decompression cohorts. Neurological outcomes were assessed using the ASIA or ISNCSCI examination. The primary endpoint was change in neurological level of injury from baseline to 1 yr after spinal trauma. Two-stage meta-analysis was performed using hierarchical mixed-effects regression adjusting for age, sex, mechanism of injury, baseline ASIA grade, total motor score, pin prick score, light touch score, baseline neurological level of injury, Glasgow Coma Scale, and administration of methylprednisolone. Effect size was estimated with adjusted mean difference (MD), with corresponding 95% confidence intervals (CI) and *P* values. Subgroup analysis was conducted in cervical SCI with the same methodology as primary analysis.

Results: A total of 1328 eligible subjects were identified from the datasets (77.3% cervical, 14.9% thoracic, 7.8% lumbar). Patients who underwent early surgical decompression (n=439, 40.3%) experienced greater recovery of injured spinal levels than those who underwent delayed surgical decompression (MD: 1.08 levels, 95% CI [0.06 to 2.10], p=0.037). In patients with cervical SCI (n=1026, 77.3%), the effect size was greater in patients that underwent early surgical decompression with a greater recovery of 1.25 levels than those with delayed decompression (95% CI [0.04 to 2.46], p=0.043).

Conclusions: Surgical decompression within 24 hours of acute spinal cord injury is associated with improved recovery of neurological spinal levels. These data add further to the growing evidence in support of early surgical intervention in acute spinal cord injury, including ASIA A patients.

Abstract # 5

Title: The Effect of Regional Procedural Preference on Outcomes after Posterior Decompression for Degenerative Cervical Myelopathy: Individual Participant Data Meta-Analysis of a Prospective, Multinational Dataset of 1047 Cases

Authors and Affiliations: Alex Beomju Bak¹, James S. Harrop², Paul M. Arnold³, Ali Moghaddamjou¹, Michael G. Fehlings¹

¹University of Toronto

²Thomas Jefferson University

³Carle Illinois College of Medicine

Purpose: There is considerable debate regarding the relative effectiveness of laminoplasty vs. laminectomy and fusion for posterior surgical decompression of degenerative cervical myelopathy

(DCM). Some of the variability in surgical approach is driven by regional variations in care. We sought to explore the impact of regional differences in surgical outcomes of posterior cervical surgery for DCM using a large, prospective international dataset.

Methods: Individual participant data of adult subjects with DCM was derived from three independent, prospective, multicentre clinical trials (CSM-NA, CSM-I, CSM-Protect), between 2005 to 2018. All patients who underwent posterior surgical decompression were included. Primary endpoint was change in 36-Item Short Form Physical Component Summary score (SF36-PCS; minimum clinically important difference [MCID] 4) at 1yr compared to pre-operative assessment. Secondary endpoints were change in modified Japanese Orthopedic Association (mJOA; MCID 2) score, Neck Disability Index (NDI; MCID 15) score, NDI Pain Intensity score, and SF36 Mental Component Summary (SF36-MCS; MCID 4) score. Two comparison cohorts were created: i) laminoplasty (LP) and ii) laminectomy and fusion (LF). One-stage hierarchical mixed-effects meta-analyses with study and treatment exposure as random effects were performed, adjusting for differences in baseline covariates. Effect sizes were reported as adjusted mean differences (aMD) with corresponding 95% confidence intervals (CI). As subgroup analysis, the influence of procedural volume between LP-predominant sites, LF-predominant sites, and volume-equivalent sites was investigated.

Results: From a total of 1047 patients with DCM, 369 patients met eligibility criteria. There was geographic variability in surgical choice with higher rates of laminectomy and fusion in Brazil and Canada and higher laminoplasty rates in Japan and India. USA had similar rates of LF and LP. Patients who underwent laminoplasty did not experience greater improvements at 1yr of follow-up than those who underwent laminectomy and fusion in SF36-PCS score (aMD 0.02 [95% CI -2.24 to 2.29], p=0.985); mJOA score (aMD 0.32 [95% CI -0.36 to 1.01], p=0.360); NDI score (aMD -2.55 [95% CI -7.07 to 1.97], p=0.272); SF36-MCS score (aMD 0.36 [95% CI -2.95 to 3.66], p=0.844); or pain intensity (aMD -0.06 [95% CI -0.36 to 0.25], p=0.727). When compared to LF-predominant sites, LP-predominant sites achieved greater rates of MCID for mJOA at 1yr (85.4% v. 68.7%, p=0.036) with their predominant technique. There were no significant differences in MCID rates of NDI, SF36-PCS, or SF36-MCS. When comparing LF-predominant and LP-predominant sites with USA, a volume equivalent site, there were no significant differences in MCID rates of all outcomes.

Conclusions: Laminoplasty and laminectomy with fusion achieve similar improvements in function in DCM, in support of previous literature. However, there may be an effect of procedural volume because of region-specific procedural preference. Sites that primarily used LP achieved greater rate of MCID in

mJOA with laminoplasty than laminectomy with fusion from primarily LF sites. These data suggest that experience with either LP or LF can drive outcomes which has interesting implications from a health care delivery perspective.

Abstract # 6

Title: Development of the Cervical Myelopathy Severity Index: A New Myelopathy Specific Patient Reported Outcome Measure to Facilitate Clinical Care and Research

Authors and Affiliations: Armaan K Malhotra MD^{1,2}, Yingshi He MSc¹, Erin M Harrington BMSc¹, Blessing Jaja MD PhD¹, Mary P Zhu MD¹, Husain Shakil MD MSc^{1,2}, Nicolas Dea MD MSc FRCSC³, Michael H Weber MD PhD FRCSC⁴, Najmedden Attabib MD MBBCH FRCSC⁷, Philippe Phan MD PhD FRCSC⁸, Yoga Raja Rampersaud MD FRCSC⁹, Jerome Paquet PhD¹⁰, W Bradley Jacobs MD FRCSC¹¹, David W Cadotte MD PhD FRCSC¹¹, Sean D Christie MD FRCSC¹², Andrew Nataraj MD FRCSC¹³, Christopher S Bailey MD MSc FRCSC¹⁶, Michael Johnson MD FRCSC¹⁴, Charles Fisher MD MSc FRCSC³, Hamilton Hall MD FRCSC¹⁵, Neil Manson MD FRCSC⁷, Kenneth Thomas MD FRCSC¹¹, Howard J Ginsberg MD PhD FRCSC^{1,6}, Michael G Fehlings MD PhD FRCSC⁵, Christopher D Witiw MD MSc FRCSC^{1,2,6}, Aileen M Davis PhD², Jefferson R Wilson MD PhD FRCSC^{1,2,6}

¹Division of Neurosurgery, Department of Surgery, St. Michael's Hospital, University of Toronto, Toronto, Ontario, Canada

²Institute of Health Policy Management and Evaluation, University of Toronto, Toronto, Ontario, Canada

³Combined Neurosurgical and Orthopaedic Spine Program, Department of Orthopaedic Surgery, University of British Columbia, Vancouver, British Columbia, Canada

⁴Division of Orthopedic Surgery, McGill University, Montreal, QC, Canada

⁵Division of Neurosurgery, Department of Surgery, Toronto Western Hospital, Toronto, Ontario, Canada

⁶Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario, Canada

⁷Canada East Spine Centre, Saint John, New Brunswick, Canada

⁸The Ottawa Hospital - Civic Campus, Ottawa, Ontario, Canada

⁹ Division of Orthopedic Surgery, Department of Surgery, Toronto Western Hospital, Toronto, Ontario, Canada

¹⁰Department of Surgery, Faculty of Medicine, Université Laval, Quebec City, Canada

¹¹Division of Spine Surgery, Foothills Medical Centre, University of Calgary, Calgary, Alberta, Canada

¹²Department of Surgery, Dalhousie University, Halifax, Nova Scotia, Canada

¹³ Division of Neurosurgery, Department of Surgery, University of Alberta Hospital, Edmonton, Alberta, Canada

¹⁴Department of Orthopaedics, University of Manitoba, Winnipeg, Manitoba, Canada

¹⁵Department of Surgery, University of Toronto, Ontario, Canada

¹⁶Department of Orthopaedic Surgery, London Health Science Centre, Western University, London, Ontario, Canada

Purpose: Existing degenerative cervical myelopathy (DCM) severity scales have significant shortcomings, including poor sensitivity to clinical change in patients with mild symptoms, modest

reliability and lack of items pertaining to neck and upper-extremity pain. There is a need to develop an improved DCM-specific outcome measurement tool to facilitate clinical care and research. We therefore sought to create the Cervical Myelopathy Severity Index (CMSI), a new DCM patient-reported outcome measure of symptoms and functional limitations.

Methods: This prospective observational study included adult DCM patients belonging to 1) observation, 2) preoperative surgical and 3) postoperative treatment groups. Item generation was performed using semi-structured patient focus groups emphasizing symptoms and functional limitations. Readability was assessed through think aloud patient interviews. Item reduction involved surveys of DCM patients across a spectrum of disease severity groups in addition to spine surgeons experienced in DCM treatment. *A priori* criteria for item reduction included a combination of several factors including median patient-reported importance and severity thresholds across items, between-item correlation (Spearman rank), temporal reliability (weighted Kappa) and clinician importance ratings for candidate items.

Results: There were 42 items generated; items captured sensorimotor symptoms and limitations related to upper and lower extremities as well as sphincter dysfunction. Ninety-eight patients and 51 surgeons completed the assessment. Twenty-three items remained after application of median importance and severity thresholds and weighted kappa cut-offs. After elimination of highly correlated items, the final CMSI questionnaire list included 14 items detailing the following domains of functional limitation and symptoms: upper extremity sensory (2 items), upper extremity motor (5 items), upper extremity sensorimotor (1 item), lower extremity sensory (1 item), lower extremity motor (1 item), lower extremity sensorimotor/ balance (3 items) and sphincter function (1 item). A summative score can be determined (out of 42), with higher values reflecting greater DCM severity.

Conclusions: We have developed a new patient-completed 14-item measure for patients with DCM to evaluate symptom severity and functional limitations. Future work will aim to evaluate validity, reliability, and responsiveness of this measure. Subsequent incorporation of the validated CMSI could help to improve clinical care, communication, and research in this field.

Abstract # 7

Title: Safety and Efficacy of Riluzole in Acute Spinal Cord Injury (RISCIS): A Multi-Center, Randomized, Placebo-Controlled, Double-Blinded Trial

Authors and Affiliations: Michael G. Fehlings, MD^{1,2}, Ali Moghaddamjou, MD¹, James S. Harrop, MD³, Ralph Stanford, MBBS⁴, Jonathon Ball, MD⁵, Bizhan Aarabi, MD⁶, Brian J. C. Freeman, MB⁷, Paul M. Arnold, MD⁸, James D. Guest, MD⁹, Shekar Kurpad, MD¹⁰, James M. Schuster, MD¹¹, Ahmad Nassr, MD¹², Karl M. Schmitt, MD¹³, Jefferson Wilson, MD¹, Darrel S. Brodke, MD¹⁴, Faiz U. Ahmad, MD¹⁵, Albert Yee, MD¹⁶, Wilson Z. Ray, MD¹⁷, Nathaniel P. Brooks, MD¹⁸, Jason Wilson, MD¹⁹, Diana S-L Chow, PhD²⁰, Elizabeth G Toups, MSc²¹, Branko Kopjar, MD²²

¹Division of Neurosurgery, Department of Surgery, University of Toronto, Toronto, ON, Canada

²Division of Neurosurgery, Krembil Neuroscience Centre, Toronto Western Hospital, University Health Network, Toronto, ON, Canada

³Department of Neurological Surgery, Thomas Jefferson University, Philadelphia, PA, USA

⁴Neuroscience Research Australia and Prince of Wales Hospital, Sydney, Australia

⁵Royal North Shore Hospital, St. Leonards, New South Wales, Australia

⁶Department of Neurosurgery, University of Maryland School of Medicine, Baltimore, MD, USA

⁷Centre for Orthopaedic & Trauma Research, Adelaide Medical School, The University of Adelaide, Adelaide, Australia

⁸Carle Illinois College of Medicine, University of Illinois Urbana-Champaign, Champaign, IL, USA

⁹Department of Neurosurgery and The Miami Project to Cure Paralysis, The Miller School of Medicine, University of Miami, Miami, FL, USA

¹⁰Department of Neurosurgery, Medical College of Wisconsin, Wauwatosa, WI, USA

¹¹Department of Neurosurgery, Pennsylvania Hospital, University of Pennsylvania Health System, Philadelphia, Pennsylvania, USA

¹²Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN, USA

¹³Department of Neurosurgery, Health Science Center, University of Texas, Houston, TX, USA

¹⁴Department of Orthopaedics, University of Utah, Salt Lake City, UT, USA

¹⁵Department of Neurological Surgery, Emory University School of Medicine, Atlanta, GA, USA

¹⁶Department of Surgery, University of Toronto, Toronto, ON, Canada

¹⁷Department of Neurosurgery, Washington University, St. Louis, MO, USA

¹⁸Department of Neurological Surgery, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA

¹⁹Department of Neurosurgery and School of Medicine, Louisiana State University Health Sciences Center, New Orleans, LA, USA

²⁰Department of Pharmacological and Pharmaceutical Sciences, College of Pharmacy, University of Houston, Houston, TX, USA

²¹Department of Neurosurgery, Houston Methodist Hospital, Houston, TX, USA

²²Department of Health Services, University of Washington, Seattle, WA, USA

Purpose: Riluzole is sodium-glutamate antagonist used to attenuate neurodegeneration in amyotrophic lateral sclerosis (ALS). It has shown favourable results in promoting neural recovery in preclinical models of traumatic spinal cord injury (tSCI) with early phase clinical results suggesting enhanced neurological

outcomes. This study aimed to evaluate the efficacy and safety of Riluzole in patients with acute cervical tSCI.

Methods: An international, multi-center, prospective, randomized, double-blinded, placebo-controlled, adaptive, Phase III trial (NCT01597518) was undertaken. Patients with ASIA Impairment Scale (AIS) A-C, cervical (C4-C8) tSCI, and <12 hours from injury were randomized to receive either Riluzole or placebo. The primary efficacy endpoint was change in Upper Extremity Motor (UEM) scores at 180 days from baseline. The primary efficacy analyses were conducted on an intention to treat (ITT) and completed cases (CC) basis. The study was powered at a planned enrolment of 351 patients.

Results: The trial began enrollment in October 2013 and was halted by the sponsor on May 2020 in the face of the global COVID-19 pandemic. One hundred ninety-three patients (54.9% of the preplanned enrolment) were randomized with a follow-up rate of 82.7% at 180 days. At 180 days, in the CC population the Riluzole treated patients compared to placebo had a mean gain of 1.76 UEM scores (95% confidence interval: -2.54-6.06) and 2.86 total motor (TOTM) scores (CI:-6.79-12.52). No drug related serious adverse events were associated with the use of Riluzole. Additional pre-planned sensitivity analyses revealed that in the AIS B patients had higher reported independence, measured by the SCIM score (45.3 vs. 27.3; d: 18.0 CI: -1.7-38.0) at 180 days. AIS A patients who received Riluzole had a higher average gain in neurological levels at 6-months compared to placebo (mean 0.50 levels gained vs 0.12 in placebo; d: 0.38, CI: -0.2-0.9).

Conclusions: The primary analyses failed to achieve the predetermined endpoint of efficacy for riluzole, likely related to insufficient power. However, on pre-planned secondary analysis, all subgroups of cervical SCI subjects (AIS grades A, B and C) treated with Riluzole showed significant gains in functional recovery. The results of this trial may warrant further investigation to confirm/extend these findings and potentially from guideline development groups to assess the possible clinical relevance of the secondary outcome analyses.

Title: A Prospective, Observational, Multicenter Study Assessing Functional Improvements After Multilevel Fusion for Adult Spinal Deformity (ASD): 5 Year Follow Up Results

Authors and Affiliations: Aditya Raj, Stephen Lewis, Christopher Nielsen
University Health Network

Purpose: Increasing number of patients are undergoing surgical treatment for ASD. The main indications are pain, disability and loss of function. Multiple patient reported Health Related Quality of Life (HRQOL) measures are utilized to assess functional status and disability before and after the surgery. Some components of these questionnaires may be more pertinent in the elderly population. Primary aim was to assess which key functional outcomes were most impacted by multilevel fusion surgery for ASD. Secondary aim was to assess if these functional improvements were maintained over the follow up period.

Methods: Patients ≥ 60 years of age from 12 international centres undergoing spinal fusion of at least 5 levels were included. Follow up visits were performed at 10 weeks, 12 months, 24 months and 60 months. Function was assessed using the Scoliosis Research Society 22r (SRS22r) function domain, and with the personal care, walking, sitting and standing sections from the Oswestry Disability Index (ODI) and EQ-5D-3L scores.

Results: A total of 219 patients (80.4% females) were included with a mean age of 67.5 years. The mean SRS-22r function scores preoperative were 2.7 (0.7) which improved to 3.5 (0.8) by 2 years post-surgery and were sustained at 5 years (3.4). 44.9% patients were either bedbound or had primarily no activity before the surgery which reduced to 18.3 % at 2 years and 17.1% at 5 years follow up. Patients that could stand >30 minutes improved from 24.4% to 68.6% at 2 years and 60% at 5 years. 26% of the patients could walk for a mile or more before surgery which improved to 63.1% at 2 years and sustained in 57.3% patients at 5 years. 42.6% had unlimited sitting pre-operatively, that improved to 65.0% at 2 years and 64.2% at 5 years. Normal social life was seen in 18.8% of patients at baseline compared to 56.0% at 2 years and 50.4% at 5 years.

Conclusions: Patients undergoing multilevel spinal fusions for ASD experienced significant functional improvements in sitting, standing, walking and their social life. This improvement is sustained at 5 years postoperatively and can be utilised during patient counselling pre-operatively.

Abstract # 9

Title: Sex, Drugs and Spine Surgery: A Nationwide Analysis of Opioid Utilization and Patient Reported Outcomes in males and females

Authors and Affiliations: Aditya Raj¹, Jean Christophe Murray¹, Ahmed Cherry¹, Greg McIntosh², Christopher Nielsen¹, Nisaharan Srikandarajah¹, Ragavan Manoharan¹, Carlo Iorio¹, Mark Xu¹, Anthony Perruccio¹, Mayilee Canizares¹, Yoga Raja Rampersaud¹

¹University Health Network

²Canadian Spine Outcomes and Research Network

Purpose: There is increasing evidence of biological sex differences in pain experience and opioid utilization. Our primary objective was to identify any preoperative differences in opioid use between males and females. Our secondary objectives were to identify 1) factors associated with baseline opioid use and 2) the impact of baseline use on 12-month Patient Reported Outcome Measures (PROMs).

Methods: Retrospective review of CSORN data. Surgical patients (n=6691) with degenerative spinal disorders and available data on baseline opioid use, were included. Univariate and multivariable analyses were stratified by sex. Logistic regression was performed to identify independent factors associated with baseline opioid use.

Results: Overall, 48.4% of all patients used opioids at baseline. Among males, 44.8% were opioid users and 52.7% among females. ($p < 0.001$). There were no sex differences in most baseline factors between opioid-users and non-users. Univariate analysis by user status revealed that age, BMI, number of comorbidities, thoracolumbar location, smoking status, compensation claims, work status, routine exercise, PHQ9 score, disc herniation, and stenosis were differentially significant in both sexes; for females there was also a difference in spondylolisthesis diagnosis, while education status also differed in males. Multivariable analysis demonstrated more comorbidities, thoracolumbar location of pain, not working, not exercising, and worse PHQ9 score were independently associated with opioid-use in females. More comorbidities, thoracolumbar location of pain, smoking, not working, worse PHQ9 score, and disc herniation were independently associated in males. Regardless of sex, in males and females, opioid users and non-users showed significant and similar degrees of improvements ($p < 0.001$) in all PROMs at 12 months, compared to baseline. However, opioid-users had worse scores for all PROMs at both baseline and 12 months.

Conclusions: Pre-operative opioid use was significantly higher in females as compared to males. Our study demonstrates sex differences in independent baseline factors associated with opioid use. Further investigation to determine interaction by sex and subsequent development of sex specific mitigation strategies in the perioperative period is required.

Abstract # 10

Title: Generation of Synthetic μ CT Images of Rat Lumbar Vertebral Fracture via Deep Convolutional Generative Adversarial Networks

Authors and Affiliations: Allison Tolgyesi^{1,2}, Cari M. Whyne^{1,2,3}, Michael Hardisty^{1,3}

¹Orthopaedic Biomechanics Laboratory, Sunnybrook Research Institute, Toronto, ON, Canada

²Institute of Biomedical Engineering, Faculty of Engineering, University of Toronto, Toronto, ON, Canada

³Division of Orthopaedics, Department of Surgery, University of Toronto, Toronto, ON, Canada

Purpose: The complex ultra-structure, heterogeneous material properties, and ubiquity and stochasticity of flaws in bone matrix present challenges in modeling bone fracture. Bone damage has been successfully modeled with micro finite element models; however, these require extensive setup and are computationally expensive limiting their use for large scale bone quality simulations. Deep learning (DL) presents useful tools for modeling using a data-driven approach. Generative DL models can represent stochastic processes and allow for multi-scale modeling. The present study aimed to develop a generative DL model to create synthetic 3D μ CT images of fractured rat lumbar vertebrae.

Methods: A 3D conditional generative adversarial network learned the mapping between unloaded μ CT images of rat lumbar vertebrae and their fracture patterns after load-to-failure testing. Sixty-five cropped and resampled (70 μ m) real 3D μ CT image pairs of unloaded and fractured rat vertebrae were used for training. Random image augmentations increased the training dataset to 1365 pairs. Ten real pairs were held out for validation. Training used a learning rate of 0.0002, batch size of four, Adam optimization, and ran for 1000 epochs. The generator was a 3D U-Net, and the discriminator was a four-layer 3D deep convolutional neural network for conditional-image classification. Training was run in parallel on four NVIDIA V100-SMX2-32GB GPUs.

Results: After 1000 epochs (~283s/epoch), generated training and validation images appeared realistic, with correct anatomical features (pedicles, spinous process), trabeculae and intervertebral discs. Generated images consistently captured deformations in matching structures to real images. Fractures were occasionally modeled but with less severity (i.e., smaller fractures) than real images. Fractures through pedicles were more often generated than those in the vertebral body. Future work will consider pre-conditioning and incorporating sequential μ CT images acquired during loading before fracture.

Conclusions: This generative DL model shows promise in creating realistic images of fractured rat vertebrae. Success of this approach may enable vertebral fracture predictions, which could improve detection of unstable vertebrae in pathologic bone. Understanding fracture mechanics of pathologic bones and the effects of treatments (chemotherapy, radiotherapy, bisphosphonates) could be facilitated without the need for destructive testing. The DL approach allows for thorough (and feasible) computational study of vertebral fracture phenomena.

Abstract # 11

Title: Stereotactic Body Radiotherapy (SBRT) for Breast Cancer Spinal Metastases is Associated with Low Rates of Long-Term Local Failure (LF) and Vertebral Compression Fracture (VCF) Independent of Molecular Status

Authors and Affiliations: Bryce Thomsen, Danny Vesprini, K. Liang Zeng, Sten Myrehaug, Chia-Lin Tseng, Jay Detsky, Hanbo Chen, Beibei Zhang, Katarzyna Jerzak, Eshetu Atenafu, Jefferson Wilson, Pejman Maralani, Hany Soliman, Arjun Sahgal

¹Department of Radiation Oncology, Odette Cancer Centre, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, ON, Canada

²Royal Victoria Regional Health Centre, Barrie, ON, Canada

³Department of Medical Oncology, Odette Cancer Centre, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, ON, Canada

⁴Department of Biostatistics, University Health Network, University of Toronto, Toronto, ON, Canada

⁵Department of Medical Imaging, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, ON, Canada

Purpose: There is limited outcome data specific to breast cancer spinal metastases following spine SBRT. This study aims to report outcomes specific to breast cancer spinal metastases receiving spine SBRT and determine the implication of biomarker status.

Methods: We have been maintaining a prospective database since the inception of the spine SBRT program. A retrospective review identified 168 breast cancer patients with 409 spinal segments treated with spine SBRT between January 2008 and January 2023. Molecular subtypes were grouped based on luminal A, luminal B, basal, and HER2 enriched. Patients were followed with q3-monthly full-spine MRI and a clinical assessment. The primary endpoint was MRI-based local failure (LF), and secondary endpoints were overall survival (OS) and vertebral compression fracture (VCF).

Results: The median follow-up was 33 months (range, 3.3-123 months). Amongst the 168 patients, the majority were ECOG 0 or 1 (95%), neurologically intact (94%), polymetastatic (74%), and either luminal A (71%) or luminal B (8%). A total of 17% of patients were HER2+ve versus 83% HER2-ve. Of 409 treated segments the majority (76%) had no prior radiation or surgery (denovo), were SINS stable (60%), had either no or low-grade epidural disease (86%) and treated with 24-28 Gy in 2 fractions (73%). The LF and OS rates at 1, 3, and 5 years were 5%, 11%, and 14%, respectively, and 91%, 65%, and 45%, respectively, independent of molecular subtype on univariate analyses. The cumulative risk of VCF at 2 and 5 years was 7% and 10%, respectively.

Conclusions: We observe, in the largest breast cancer spine cohort to date, excellent long-term local control rates independent of molecular sub-group, and acceptable VCF rates.

Abstract # 12

Title: The Use of a Standardized Surgical Case Log to Document Operative Exposure to Procedural Competencies in a Spine Surgery Fellowship Curriculum: A University Wide Initiative

Authors and Affiliations: Cherry, A.¹, Jaber, N.¹, Yee, A.², Fehlings, M¹

¹ Toronto Western Hospital

² Sunnybrook Health Sciences Center

Purpose: Spine surgery fellowship includes trainees from both neurosurgical and orthopaedic backgrounds and is increasingly undertaken in preparation for a career in spine surgery. Currently, there is a paucity of Canadian literature assessing the competencies required and exposure of trainees completing a spine fellowship in Canada.

Methods: Data from 2015-2022 was obtained via case-logs entered into the T-res logbook software by fellows in the University of Toronto Spine fellowship program. This includes the Hospital for Sick Children (HSC), Sunnybrook Health Sciences Centre (SHSC), Toronto Western Hospital (TWH) and St. Michael's Hospital (SMH).

Results: A total of 9275 cases were logged, with an average of 1325 cases per year. Fifty-one percent of cases were performed at TWH, 29% at SHSC, 20.5% at SMH and 5.9% at HSC, respectively. Diagnoses at the time of surgery were determined to be degenerative or inflammatory in 5403 cases (58.3%) and 1047 cases of deformity (11.2%). Of the remaining primary diagnosis identified, there were 338 cases of infection (3.6%), 946 cases of tumour/malignancy (10.2%) and 868 cases for traumatic spine injuries (9.3%). Seventy-seven cases involved the occiput (0.83%), 2455 cases the cervical spine (26.4%), 2076 the thoracic spine (22.4%), 4265 the lumbar spine (46.0%) and 68 the sacral region (0.73%). The highest number of cases logged by a single trainee was 235 procedures in an academic year, with a mean of 77 cases logged by each fellow annually over the seven year collection period.

Conclusions: The use of a standardized case-log for procedure tracking can be an effective way to document trainee exposure to procedural competencies during fellowship. Documented exposure is increasingly being requested by hospitals during the credentialing process for surgical privileges. Case-logs are one of several accepted methods for capturing training exposure as part of the Royal College of Physicians and Surgeon's accredited Area of Focused Competence (AFC) diploma pathway. Fellowship educators can also leverage case-log data to advance curriculum opportunities that further develops training experience.

Abstract # 13

Title: Assessment of changes in Opioid Utilization One Year After Elective Spine Surgery - A Canadian Spine Outcomes and Research Network Study

Authors and Affiliations: Cherry, A.,¹ Raj, A.,¹ Manoharan, R.,¹ Murray, J.C.,² Xu, M.,¹ Iorio, C.,¹ Canizares, M.,¹ McIntosh, G.,³ Nielsen, C.,¹ Rampersaud, R.¹ On behalf of the Canadian Spine Outcomes and Research Network (CSORN)

¹Toronto Western Hospital, Ontario, Canada

²CHU de Quebec, QC, Canada

³Canadian Spine Outcomes and Research Network

Purpose: Chronic opioid use has been associated with negative individual and societal consequences with current literature identifying pre-operative opiate use as a negative prognosticator for patient outcomes. Our primary objective was to identify perioperative changes in opioid use amongst patients undergoing elective spinal surgery. Our secondary objective was to assess baseline and perioperative factors associated with positive or negative change in opioid use at one-year post surgery.

Methods: A retrospective review of CSORN data (patient reported measures, socio-demographic factors, lifestyle factors and perioperative procedural information) was collected from 2015 to 2019. Multivariable logistic regression models were used to examine the associations between these factors and change in opioid use. Oncologic and revision procedures were excluded in the study.

Results: Our data included 5059 patients (2628 (51.9%)-non-users/2431(48.1%)-users) with opioid change data, of which 52.7% were male. At one-year postoperative, 77.5% of patients were not using opioids. Patients were stratified into the following subgroups based on change in baseline opioid use status: (a) non-users-no-change (47.4%), (b) users-no-change (17.9%), (c) non-user-changed to users (4.5%), and (d) user-changed to non-user (30.1%). In other words, 62.7% of baseline users became non-users and 8.7% of non-users became users at one-year. The following baseline factors were independently associated with 1) opioid users who became non-users: lower BMI, fewer comorbidities, non-smoker, not living alone, no insurance claims, routinely exercising, shorter operations, spondylolisthesis diagnosis; 2) opioid users who remained users: higher BMI, more comorbidities, cervical spine location, smoking, married, living alone, compensation claims, not working, no routine exercise, higher PHQ9 score, longer operating time, no spondylolisthesis; and 3) non-users who became users: more comorbidities, longer symptom duration, higher PHQ9 score, and longer LOS, no spondylolisthesis diagnosis.

Conclusions: The majority of spine surgery patients are not taking opioids at one-year postoperatively. This includes two-thirds of those that were taking opioids prior to surgery. Further study of the 1-in-5 patients who are persistent or new users at follow-up is required in order to identify possible modifiable baseline risk factors and develop targeted mitigation strategies in the perioperative period.

Abstract # 14

Title: Cervical transcutaneous spinal cord stimulation elicits motor evoked responses in the forelimb of rats

Authors and Affiliations: Gustavo Balbinot^{1,2}, Shirin Tajali², Kei Masani², Michael Fehlings^{1,3}

¹Krembil Research Institute – University Health Network, Toronto, ON, Canada

²KITE – Toronto Rehabilitation Institute – University Health Network, Toronto, ON, Canada

³Division of Neurosurgery, Department of Surgery, University of Toronto, Toronto, ON, Canada

Purpose: The dorsal roots are considered the gateway to the spinal cord, with its stimulation enabling clinically relevant improvement in motor function after spinal cord injury (SCI). Here we aim to develop a new method for the electrophysiological assessment of the intrinsic cervical spinal cord circuitries in rodents using transcutaneous cervical spinal cord stimulation (TSCS).

Methods: TSCS was applied over the cervical enlargement using electrical stimulation in 2 rats and 2 humans. The evoked responses were measured using electromyography (EMG) in 4 and 6 upper limb muscles in rats and humans, respectively. A double-pulse protocol with different inter-stimulus intervals (10 ms – 50 ms) afforded the assessment of complex polysynaptic responses indicating the activation of inhibitory (postactivation depression; PAD) and excitatory (postactivation potentiation; PAP) spinal cord circuits.

Results: We observed PAD and PAP both in humans and rats, indicating the feasibility of adapting the clinical TSCS protocol for preclinical research. In rats, PAD was observed in 52%, 44%, 27% and 39% of the evoked responses above the threshold in rats for Triceps Brachii, Biceps Brachii, Extensor Digitorum and Flexor Digitorum muscles, respectively. In humans, PAD was observed in 56%, 68%, 67%, 47%, 73%, and 41% of the evoked responses above the threshold for Triceps Brachii, Biceps Brachii, Extensor Digitorum Communis, Flexor Digitorum Superficialis, First Dorsal Interosseous, and the Opponens Pollicis muscles, respectively. The reliability of the between days assessment was fair/poor for 1 rat and 1 human and good for the remainder. The motor threshold to obtain a first response was around 3.75 mA in rats and 33.75 mA in humans.

Conclusions: This study highlights the possibility of reverse translation of a minimally invasive electrophysiological assessment of the cervical cord. This may lead to a deeper understanding of the

mechanisms related to the primary afferent depolarization in the spinal cord, the consequences of SCI, and advance the assessment and development of novel treatments such as stem cell-based therapies and cervical spinal cord stimulation.

Abstract # 15

Title: Early Surgery Compared to Non-Operative Management for Mild Degenerative Cervical Myelopathy: A Cost-Utility Analysis

Authors and Affiliations: Husain Shakil^{*1-3}, Armaan K Malhotra^{*1-3}, Michael G. Fehlings^{1,4}, Jefferson R. Wilson¹⁻³, Christopher D Witiw¹⁻³

¹Division of Neurosurgery, Department of Surgery, University of Toronto, Toronto, Ontario, Canada

²Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario, Canada

³Institute of Health Policy Management and Evaluation, University of Toronto, Toronto, Ontario, Canada

⁴Krembil Research Institute, Toronto Western Hospital, Toronto, Ontario, Canada

*Equal Contribution

Purpose: Degenerative cervical myelopathy (DCM) is the most common cause of acquired non-traumatic spinal cord dysfunction in adults. There remains uncertainty regarding optimal management for individuals with mild myelopathy. We sought to perform a cost-utility analysis to compare early surgery and observation for mild DCM from the healthcare payer perspective.

Methods: We utilized data from the prospective Cervical Spondylotic Myelopathy AO Spine International and North America trials to determine health related quality of life estimates and clinical myelopathy outcomes. Clinical assessment measures were obtained using the Modified Japanese Orthopedic Association scale and health-related quality of life measures were obtained using the Short Form-6D utility score at pre-operative baseline, and 12 months post-surgery. Cost measures were derived from micro-costing estimates for a subset of AO-Spine North America patients undergoing DCM surgery at a participating Canadian study center. We employed a Markov state transition model with Monte Carlo microsimulation using a lifetime horizon to obtain an incremental cost utility ratio associated with early surgery for mild DCM.

Results: Initial surgery for mild DCM was associated with an incremental lifetime increase of 1.26 quality-adjusted life years (QALY) compared to observation. The associated cost incurred to the healthcare

payer over a patient's lifetime was estimated to be \$12,894.56 CAD, resulting in a lifetime incremental cost-utility ratio of \$10,250.71/QALY. Utilizing a willingness to pay threshold in keeping with the World Health Organization definition of "very cost-effective" (\$54,000 CAD), the probabilistic sensitivity analysis demonstrated that 100% of cases were cost-effective.

Conclusions: Surgery compared to initial observation for mild DCM was cost-effective from the Canadian healthcare payer perspective and was associated with lifetime gains in health-related quality of life.

Abstract # 16

Title: Enhanced recovery in spinal surgery protocols in degenerative cervical spine disorders

Authors and Affiliations: Jane Jomy¹⁻², Nisaharan Srikantharaj², Michael Fehlings²

¹Temerty Faculty of Medicine, University of Toronto, Toronto, ON

²Division of Neurosurgery, Toronto Western Hospital, University Health Network, Toronto, ON

Purpose: Enhanced recovery after surgery (ERAS) is a patient-centred, evidence-based, multidisciplinary team developed pathway for surgical teams to reduce patient's surgical stress response, optimize their physiologic function, and facilitate recovery. The literature demonstrates that spine surgery is associated with long and painful recovery due to pre-morbid conditions such as narcotic dependence, anxiety and the nature of spinal procedures. Previous systematic reviews focused on spine surgery have been identified, but interestingly report inconsistent findings. This mixed methods review has two main objectives. Firstly, considering the heterogeneity and dated searches (prior to January 2020), there is a substantial need to conduct a mixed-method systematic review with a meta-analysis and thematic analysis. Secondly, the seemingly lack of literature regarding ERAS for degenerative cervical spine disorder warrants a scoping search of the literature to identify and narratively synthesize any new studies.

Methods: We conducted systematic searches of MEDLINE, EMBASE, and CENTRAL on March 27, 2023 for observational studies, randomized controlled trials, and systematic reviews investigating the role of ERAS in the perioperative period for adult patients undergoing spinal surgery, including those with degenerative cervical spine disorders. Literature screening using Covidence, data extraction, quality assessment, and certainty of evidence (GRADE) will be carried out by two researchers, and any disagreements were resolved through consultation. All meta-analyses and subgroup analyses will be

DerSimonian-Laird random-effects models. Among cervical spine disorders, we will use thematic analysis to highlight themes across eligible studies and will use narrative synthesis to describe how our outcomes of interest are impacted by ERAS protocols.

Results: Of the 325 studies were identified across databases, 55 duplicates were removed, and researchers are currently screening 270 articles for eligibility. All analyses will be complete for the 2023 University of Toronto SpineFEST.

Conclusions: This review will address the critical knowledge gap in ERAS recommendations for spinal surgery, especially in degenerative cervical spine disorders, and may contribute to improved neurosurgical patient outcomes.

Abstract # 17

Title: Conservative management of cervical radiculopathy: A systematic review

Authors and Affiliations: Joshua Plener DC, MSc ^{1,2} Ben Csiernik DC,³ Daphne To DC, FCCS (C),⁴ Sophia da Silva-Oolup DC, FCCS (C),¹ Corey Hofkirchner DC,^{3,4} Jocelyn Cox DC, FCCS (C),⁵ Carol Cancelliere, DC, PhD,^{6,7} Ngai Chow DC, FCCS (C), MSc,³ Sheilah Hogg-Johnson MMath, PhD,^{2,6-9} Carlo Ammendolia, DC, PhD ^{2,10,11}

¹Division of Graduate Education, Canadian Memorial Chiropractic College, Toronto, Canada

²Department of Medicine, Mount Sinai Hospital, Toronto, Canada

³Private Practice, Toronto, Ontario

⁴Department of Clinical Education, Canadian Memorial Chiropractic College, Toronto, Canada

⁵Department of Undergraduate education, Canadian Memorial Chiropractic College, Toronto, Canada

⁶Institute for Disability and Rehabilitation Research, Oshawa, Canada

⁷Faculty of Health Sciences, Ontario Tech University, Oshawa, Canada

⁸Department of Research and Innovation, Canadian Memorial Chiropractic College, Toronto, Canada

⁹Dalla Lana School of Public Health, University of Toronto, Toronto, Canada

¹⁰Department of Surgery, University of Toronto, Toronto, Canada

¹¹Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Canada

Purpose: Cervical radiculopathy (CR) results in pain, sensory loss, and/or muscle weakness, resulting in significant impact to individuals' daily activities. Conservative interventions are typically first-line treatment, with the majority of patients reporting symptomatic improvement. The purpose of this systematic review is to assess the effectiveness and safety of conservative interventions compared to other interventions, placebo/sham interventions, or no intervention on disability, pain, function, quality of life, and psychological impact in adults with CR.

Methods: We searched MEDLINE, CENTRAL, CINAHL, Embase, and PsycINFO from inception to June 15, 2022 to identify studies that were RCTs, had at least one conservative treatment arm, and diagnosed participants with CR through confirmatory clinical examination and/or diagnostic tests. Studies were appraised using the Cochrane Risk of Bias 2 tool and the quality of the evidence was rated using the GRADE approach.

Results: We retrieved 2,561 articles from the databases, with 481 records removed due to duplicates leaving 2,080 title and abstracts screened and 138 full-text articles assessed. Fifty-nine RCTs met our inclusion criteria consisting of 4108 participants. Due to clinical and statistical heterogeneity, the findings were synthesized narratively. There is very-low certainty evidence supporting the use of acupuncture, prednisolone, cervical manipulation, and low-level laser therapy for pain and disability in the immediate to short-term, and thoracic manipulation and low-level laser therapy for improvements in cervical range of motion (ROM) in the immediate term. There is low to very-low certainty evidence for multimodal interventions, providing inconclusive evidence for pain, disability, and ROM. There is inconclusive evidence for pain reduction following conservative management compared to surgery, rated as very-low certainty.

Conclusions: There is a lack of high-quality evidence, limiting our ability to make any meaningful conclusions. This review highlighted methodological deficiencies within the literature such as lack of intention to treat analysis, lack of pre-trial registry or protocol published, lack of clear randomization and concealment description and lack of reporting of co-interventions and adverse events. As the number of people with CR is expected to increase, there is an urgent need for the conduction of higher quality studies to help provide recommendations to better guide clinical practice.

Abstract # 18

Title: *Information is power:* a qualitative study exploring the lived experiences of patients with degenerative cervical radiculopathy

Authors and Affiliations: Joshua Plener DC, MSc,^{1,2} Silvano Mior DC, PhD,³⁻⁵ Melissa Atkinson-Graham PhD,³ Sheilah Hogg-Johnson MMath, PhD,³⁻⁷ Pierre Côté DC, PhD,⁴⁻⁷ Carlo Ammendolia DC, PhD^{2,8}

¹Division of Graduate Education, Canadian Memorial Chiropractic College, Toronto, Canada

²Department of Medicine, Mount Sinai Hospital, Toronto, Canada

³Department of Research and Innovation, Canadian Memorial Chiropractic College, Toronto, Canada

⁴Institute for Disability and Rehabilitation Research, Oshawa, Canada

⁵Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Canada

⁶Faculty of Health Sciences, Ontario Tech University, Oshawa, Canada

⁷Division of Epidemiology, Dalla Lana School of Public Health, University of Toronto, Toronto, Canada

⁸Department of Surgery, University of Toronto, Toronto, Canada

Purpose: Degenerative cervical radiculopathy (DCR) can lead to severe pain, paraesthesia, and/or motor weakness, resulting in significant morbidity, disability and reduced quality of life. Typically, individuals suffer from prolonged symptoms, with time to complete recovery spanning months to years. Little is known about the impact DCR has on peoples' lives. Therefore, this study aimed to explore the everyday experiences of individuals living with DCR.

Methods: A qualitative study was conducted through an interpretivist lens exploring the experiences of participants. Participants were purposefully recruited and interviewed with two research team members. Eligible participants were 45 years of age and older and diagnosed by the referring clinician via signs/symptoms of radiculopathy, positive clinical examination findings, and/or diagnostic tests. Transcripts were independently analyzed by two reviewers, and coding finalized by consensus. Analysis was performed using a descriptive phenomenological approach, with emergent themes mapped onto the five domains of the International Classification of Functioning, Disability and Health framework.

Results: Eleven participants were interviewed between December 2021 and April 2022. Three themes emerged: the biopsychosocial impact of DCR, role of the healthcare provider, and uncertainty surrounding DCR. Pain and paraesthesia were the most common symptoms experienced by participants, leading to significant psychological distress and impact to daily activities, most notably driving, housecleaning, sleep, and ability to work. Participants described the uncertainty they experienced as a result of the unpredictable nature of DCR and the important role that healthcare providers play in their journey with DCR. Healthcare providers were seen as either acting as a facilitator or a barrier to their recovery.

Conclusions: The findings of our study provide the first account of the lived experiences of people with DCR and factors that may facilitate recovery. These findings can be used by clinicians providing patient-centered care to better understand the experiences of people with DCR. Participants conveyed the significant physical, psychological, and social impact that DCR has on their life. Overall, participants described similar experiences but the degree of impact differed based on their level of disability. Future studies to explore the provider-patient relationship and identify ways it can be enhanced may provide further insight into peoples' experiences with DCR.

Abstract # 19

Title: Promoting the Differentiation of Neural Progenitor Cells into Oligodendrocytes Through the Induction of Olig2 Expression

Authors and Affiliations: Katarzyna Pieczonka^{1,2}, Mohamad Khazaei¹, Michael G. Fehlings^{1,2,3}

¹Division of Genetics and Development, Krembil Research Institute, University Health Network, Toronto, ON, Canada

²Institute of Medical Science, Faculty of Medicine, University of Toronto, Toronto, ON, Canada

³Department of Surgery, Faculty of Medicine, University of Toronto, Toronto, ON, Canada

Purpose: Spinal cord injury (SCI) is associated with the loss of oligodendrocytes, which play key roles in myelination and in modulating interactions between glia and neurons. Neural progenitor cells (NPCs) are a promising source of cells for SCI treatment, due to their ability to replace the lost oligodendrocytes, neurons and astrocytes. However, the differentiation of NPCs into oligodendrocytes is often inefficient, whereby the majority of the cells tend to differentiate into astrocytes within the injury microenvironment. In order to enhance oligodendrocyte differentiation, we aimed to generate an adjustable source of inducible oligodendrogenic NPCs (ioNPCs) in which the extent of oligodendrocyte differentiation could be carefully regulated.

Methods: Human ioNPCs were prepared by engineering NPCs to express Olig2 under the control of the conditional doxycycline-inducible tet-ON promoter, in which doxycycline administration regulates Olig2 expression. The cells were then treated with doxycycline for 3, 7 or 10 days in order to adjust the extent of biasing. Next, the cells were characterized using a combination of (1) qRT-PCR analysis, (2) immunostaining, and (3) bulk RNA sequencing.

Results: (1) qRT-PCR analysis revealed that the expression of several genes involved in oligodendroglial lineage determination, including OLIG1, OLIG2 and PDGFRA, progressively increased with longer doxycycline treatment timelines. (2) Immunostaining showed the ratio of O1+ oligodendrocytes was significantly higher in the ioNPCs ($39.44 \pm 16.5\%$) compared to NPCs ($24.73 \pm 6.5\%$). (3) Bulk RNA sequencing revealed that a total of 521 genes were differentially expressed between ioNPCs and NPCs. These included oligodendroglial genes such as OLIG1, PDGFA, and MYRF which were upregulated in the ioNPCs, as well as neuronal and astrocyte genes such as TUBB3, MAP2 and S100B, which were downregulated in this group. Furthermore, gene ontology analysis identified pathways corresponding to

oligodendrocyte cell fate commitment and spinal cord oligodendrocyte fate specification amongst the differentially expressed genes.

Conclusions: In conclusion, our study suggests that ioNPCs are a promising source of adjustable cells in which the extent of oligodendroglial biasing can be regulated, thus making them an optimal cell therapy for SCI.

Abstract # 20

Title: Rat model of mixed osteoblastic-osteolytic bone metastasis suggests psoas muscle attenuation and volume loss

Authors and Affiliations: Leanna Abraham^{1,5}, Christine Huang^{2,4}, Michael Hardisty^{3,4}, Cari Whyne^{2,3,4}, Margarete K. Akens^{1,3,5}

¹ Department of Medical Biophysics

²The Institute of Biomedical Engineering (BME)

³Department of Surgery, University of Toronto

⁴Sunnybrook Research Institute

⁵Techna Institute, University Health Network, Toronto, ON, Canada

Purpose: Prostate cancer has a high susceptibility to form mixed osteoblastic-osteolytic spinal metastases. Advanced metastatic prostate cancer often presents with sarcopenia (the loss of skeletal mass and function). This study aims to quantify changes in the psoas muscle secondary to metastatic prostate cancer. Muscle volume and attenuation are hypothesized to be correlated with tumour burden.

Methods: Athymic, 6-week-old male rats received an intra-cardiac injection of with luciferase-transfected Ace-1 prostate cancer cells (control N=5; injected N=4) resulting in the formation of bone metastases. The rats were scanned with in vivo μ MR (NanoScan, Mediso, with Gadolinium contrast) and μ CT (NanoScan, Mediso) at days -1, 13, and 20 post-tumour-injection to monitor changes to the psoas muscle and vertebrae. Tumour formation and progression were monitored with bioluminescence imaging (IVIS Spectrum) upon luciferin injection on days 14 and 21 post-tumour-injection. Psoas muscles were manually segmented from fused MR/CT images to obtain muscle volume and attenuation and normalized to the L2 vertebrae volume. After sacrifice the vertebrae were imaged ex vivo using high resolution μ CT (μ CT100, Scanco, 34.4 μ m isotropic voxels) to confirm mixed bone metastases.

Results: Bioluminescence and ex vivo μ CT images confirmed mixed osteoblastic-osteolytic bone metastases in the vertebrae of 4 rats. Normalized psoas muscle volumes for rats with bone metastases had no increase in volume from days -1 to 13 post-injection as compared to healthy controls, where an increase in volume was observed at day 20. Animals with metastases had significantly smaller increases in normalized muscle volume from days -1 to 20 post-injection (ANOVA single factor, $p=0.02$), indicating muscle loss. μ CT analysis suggests that animals with bone metastases had higher fatty infiltration during disease progression, indicated by a greater negative change in muscle attenuation from days -1 to 13 post injection (ANOVA single factor, $p=0.02$); however, these findings need to be confirmed following histological analysis.

Conclusions: Sarcopenia is observed with imaging biomarkers in this preclinical model of spinal metastases secondary to prostate cancer. The biomarkers evaluated in this study may be used to facilitate the earlier diagnosis of sarcopenia in prostate cancer patients, leading to earlier intervention.

Abstract # 21

Title: Subcommissural organ-derived peptide promotes functional recovery and enhances tissue repair in a rat cervical spinal cord injury model

Authors and Affiliations: Nayaab Punjani^{1,2}, Sighild Lemarchant³, Svetlana Altamentova², Jonathon Chio⁴, Jian Wang², Yann Godfrin^{3,5}, Michael Fehlings^{2,6}

¹Institute of Medical Science, University of Toronto, Toronto, Canada;

²Genetics and Development, Krembil Research Institute, University Health Network, Toronto, Canada;

³Axoltis Pharma, Lyon, France;

⁴Tulane University School of Medicine, New Orleans, Louisiana, United States of America

⁵Godfrin Life-Sciences, Caluire-et-Cuire, France;

⁶Division of Neurosurgery and Department of Surgery, University of Toronto, Toronto, Canada

Purpose: Initial physical trauma in spinal cord injury (SCI) is followed by secondary cascades which involve further neural cell death and scar formation. Clinically, the highest incidence of traumatic SCI occurs at the cervical level, often with more severe sensorimotor deficits. NX210c is a 12 amino acid peptide derived from the sub-commissural organ (SCO)-spondin, a protein proposed to be involved in vertebrate spinal cord regeneration. The purpose of this study is to evaluate the efficacy of NX210c to promote repair and functional recovery in a traumatic cervical SCI model.

Methods: Female adult Wistar rats (250-300g) will receive a clip compression-contusion SCI at the C6/C7 level of the spinal cord to model traumatic SCI in humans. 66 injured rats will be randomized into 4 groups, to receive one daily dose of either NX210c (8mg/kg) or vehicle intraperitoneally for 8 weeks, starting 4 hours (h) or 8 h post-SCI. 12 sham rats will receive a laminectomy and vehicle treatment beginning at 4 h post-surgery. Neurobehavioral tests were performed for up to 8 weeks post-injury, and rats were then sacrificed for histological assessments.

Results: Early administration of NX210c increased forelimb strength (grip strength) and improved several aspects of locomotion including regularity index and base of support of the forelimbs (CatWalk) [$p < 0.05$]. When delaying first administration to 8h post-injury, NX210c promoted weight gain [$p < 0.05$], accelerated bladder control recovery from 14 to 9 days post-injury, and improved trunk balance (inclined plane) [$p < 0.05$]. Using histology (n=6/group) we demonstrate greater white matter preservation and reduced cavity size at the injury epicenter, along with higher neuronal soma counts caudally, when NX210c treatment is started 8h post-injury compared to vehicle [$p < 0.05$].

Conclusions: NX210c improves motor function and bladder control, while also contributing to improved white matter preservation and neuronal counts. We anticipate that this study will provide a strong proof of concept for its use as a treatment for acute SCI patients.

Abstract # 22

Title: Prevention, Diagnosis, and Management of intraoperative spinal cord injury in the setting of spine surgery: Development of Guidelines and an Evidence-Based Care Pathway

Authors and Affiliations: Nisaharan Srikandarajah, Nader Hejrati, Mohammed Ali Alvi, Ayesha Quddusi, Ali Moghaddamjou, Brian Kwon, Michael G Fehlings

Division of Neurosurgery and Spine, Department of Surgery, University of Toronto, Toronto, Ontario

Purpose: Intraoperative spinal cord injury (ISCI) is a challenging complication in spine surgery. Intraoperative neuro monitoring (IONM) has been developed to detect changes in neural function. We report on the first multidisciplinary, international effort through AOSpine and the Praxis Spinal Cord Institute to develop comprehensive guideline and care pathway for the prevention, diagnosis, and management of ISCI.

Methods: This study is a mixed methods approach. Three literature reviews were registered on PROSPERO (CRD 4202229884) and performed according to PRISMA guidelines: (1) Definitions, frequency, and risk factors for ISCI. 226 articles were identified, and 7 included studies analysed. (2) Meta-analysis of the use and accuracy of IONM for diagnosis of ISCI. 2270 articles were identified and 164 studies consisting of 99937 patients were analysed. (3) Reported management approaches for ISCI and related events. 17 checklists/algorithms were identified for analysis. The results were presented in a consensus session using the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach with an 80% threshold for inclusion to decide the definition of IONM and recommendation of its use in high-risk cases.

Results: An operational definition and high-risk patient categories cases for ISCI were established. The reported incidence of deficits was documented higher in intramedullary tumour spine surgery (0-61%) with more persistent deficits (26.9%). A random effects model of multimodality IONM has a sensitivity of 0.908 (0.855; 0.943) and specificity of 0.938 (0.906; 0.960). A guideline recommendation of IONM to be employed for high-risk spine cases was made using the GRADE approach. Based on a literature review of management strategies for ISCI a checklist and overall care pathway was developed. The different sections of the intraoperative checklist include surgery, anaesthetic and neurophysiology. The care pathway includes steps 1) initial clinical assessment, 2) pre-operative planning, 3) surgical/anaesthetic planning, 4) intra-operative management and 5) post-operative management.

Conclusions: This is the first evidence based comprehensive guideline and care pathway for ISCI using the GRADE methodology. This will facilitate a reduction in the incidence of ISCI and improved outcomes from this complication. We welcome the wide implementation and validation of these guidelines and care pathways in prospective, multicentre studies.

Abstract # 23

Title: Distal Lordosis is Associated with Reoperation for Adjacent Segment Disease in Degenerative Lumbar Fusion Patients

Authors and Affiliations: R. Manoharan¹, A. Cherry¹, N. Srikandarajah¹, A. Raj¹, M. Xu¹, C. Iorio¹, C.J. Nielsen², Y.R. Rampersaud², S.J. Lewis²

¹University of Toronto Spine Program, Toronto Western Hospital

²Department of Orthopaedics, Toronto Western Hospital

Purpose: Recent studies have suggested that distal lordosis (L4-S1, DL) remains constant across all pelvic incidence (PI) subgroups, whilst proximal lordosis (L1-L4, PL) varies. We sought to investigate the impact of post-operative DL on adjacent segment disease (ASD) requiring reoperation in patients undergoing lumbar fusion for degenerative conditions.

Methods: A retrospective review of patients undergoing lumbar fusion for degenerative conditions with the two senior authors from 2007-16 was performed. Demographic and radiographic information was recorded. Univariate analysis was performed using Pearson Chi square for categorical variables and univariate binary logistic regression analysis for continuous variables. Multivariate binary logistic regression analyses were performed to control for confounders. Model selection was optimised using Bayesian and Akaike Information Criterion as well as through assessment of Receiver Operating Characteristic curves. Finally, a Kaplan Meier analysis was performed to assess reoperation free survival.

Results: 335 patients were identified and included in the final analysis. Most patients had single (67%) or two (31%) level fusion. The mean follow-up was 64 months. Fifty-seven patients (17%) underwent reoperation for ASD at an average of 78 months post-operatively (rASD group). There was no significant difference between the rASD and no reoperation for ASD (nrASD) groups in terms of age, sex, number of levels fused, MIS/open surgery, baseline DL, or adjacent disc lordosis. The rASD group had a significantly lower mean post-operative DL (27 vs 31 deg, $p < 0.001$) and mean PI (56 vs 59 deg, $p < 0.05$) than the nrASD group. On univariate analysis, patients with a post-operative DL of < 35 deg had higher odds of reoperation for ASD than those with a post-operative DL of ≥ 35 deg (OR 2.7, $p = 0.016$). In the multivariate model, post-operative DL, low/average PI, and spondylolisthesis were all significantly associated with reoperation for ASD.

Conclusions: This study provides preliminary support to an association between post-operative DL and risk of reoperation for ASD. This risk may be amplified in patients with a low/average PI and degenerative spondylolisthesis. Further multicentre prospective study is needed to independently confirm this association and identify the impact of restoration of physiological distal lumbar lordosis on long term patient outcomes.

Abstract # 24

Title: Pedicle Screw Accuracy Placed with Assistance of Machine Vision Technology in Patients with Neuromuscular Scoliosis

Authors and Affiliations: Rajendra Sakhrekar^{1,2}, Nicholas Shkumat^{1,2}, Birgit Ertl-Wagner^{1,2}, Stephen Lewis^{1,2}, David E. Lebel^{1,2}, Mark Camp^{1,2}

¹Division of Orthopaedic Surgery, The Hospital for Sick Children.

²Division of Orthopaedic Surgery, University of Toronto

³The Hospital for Sick Children, University of Toronto, 555 University Avenue, Toronto, ON, Canada M5G 1X8

Purpose: Pedicle screws are the primary method of vertebral fixation in scoliosis surgery but there are lingering concerns over potential malposition. The rates of pedicle screw malposition in paediatric spine surgery vary from 10% to 21%. Malpositioned screws can lead to potentially catastrophic neurological, vascular and visceral complications. Pedicle screw positioning in patients with neuromuscular scoliosis is challenging due to a combination of large curves, complex pelvic anatomy, and osteopenia. This study aimed to determine the rate of pedicle screw malposition, associated complications, and subsequent revision from screws placed with the assistance of machine vision navigation technology in patients with neuromuscular scoliosis undergoing posterior instrumentation and fusion.

Methods: A retrospective analysis of the records of patients with neuromuscular scoliosis who underwent thoracolumbar pedicle screw insertion with the assistance of machine-vision image guidance navigation was performed. Screws were inserted by either a staff surgeon, orthopaedic fellow, or orthopaedic resident. Post-operative ultra-low dose CT scans were used to assess pedicle screw accuracy. The Gertzbein classification was used to grade any pedicle breaches (grade 0, no breach; grade 1, <2 mm; grade 2, 2–4 mm; grade 3, >4 mm). A screw was deemed accurate if no breach was identified (grade 0).

Results: 25 patients were included in the analysis (mean age 13.63 years (range 11 to 18 years; 13/25 (52%) female). The average pre-operative supine Cobb angle was 89.96 degrees (range 48-120 degrees). A total of 687 screws from 25 patients were analysed (402 thoracic, 241 lumbosacral, 44 S2 alar-iliac (S2AI) screws). The overall accuracy of pedicle screw insertion was 97.98% (Grade 0, no breach). All 13 breaches that occurred in the thoracic and lumbar screws were Grade 1. Of the 44 S2AI screws placed, one screw had a Grade 3 breach (2.27%) which was noted on intra-operative radiographs

following rod placement and correction. This screw was subsequently revised. None of the breaches resulted in neuromonitoring changes, vessel, or visceral injuries.

Conclusions: When combined with careful free-hand pedicle screw insertion techniques, machine vision navigation technology helps with pedicle screw insertion accuracy, even in patients with challenging anatomy.

Abstract # 25

Title: Anterograde and Retrograde Self-Tracing Neural Progenitor Cells for Mapping Transplant Integration into the Endogenous Neural Network

Authors and Affiliations: Priscilla Chan^{1,2}, Zijian Lou^{1,2}, Christopher S Ahuja^{1,2}, Alexander Velumian^{1,3,4}, Dylan Deska-Gauthier^{1,2}, Mohamad Khazaei^{1,2}, Michael G. Fehlings^{1,2,3}

¹Division of Genetics and Development, Krembil Brain Institute, University Health Network, Toronto, ON, Canada.

²Institute of Medical Sciences, University of Toronto, Toronto, ON, Canada.

³Division of Neurosurgery, Department of Surgery, University of Toronto, Toronto, ON, Canada.

⁴Department of Physiology, University of Toronto, ON, Canada.

Purpose: Spinal cord injury (SCI) is a devastating condition that leaves patients with lifelong sensory, motor, and autonomic deficits. Stem cell therapies offer an attractive approach to repairing and regenerating the injured spinal cord. While previous studies have shown that human neural progenitor cells (NPCs) can improve neural function, assessing their integration with endogenous networks is challenging due to the insensitive nature of viral and non-viral tracing methods.

Methods: To overcome this challenge, we developed a novel approach to engineer NPCs to express both antero- and retrograde trans-synaptic tracers to map transplant integration. Wheat germ agglutinin (WGA) was used for anterograde synaptic tracing and tetanus toxin fragment C (TTC) was used for retrograde synaptic tracing. Self-tracing NPCs were validated both *in vitro* primary cultures and *in vivo* post-SCI rats.

Results: The resultant self-tracing NPCs retained typical stem cell properties and differentiated into functional neurons as confirmed by neurosphere assay and patch clamp experiments, respectively. Furthermore, the cells successfully traced primary rat cortical neurons *in vitro*. The *in vivo* data suggest self-tracing NPCs also trace host neurons in a rodent model of chronic SCI.

Conclusions: Our self-tracing NPCs can be used as a tool to delineate synaptically integrated sensorimotor pathways involved in stem cell-mediated recovery. Moving forward, these cells provide a promising experimental tool for investigating therapeutic interventions for enhancing neuronal derived stem cell transplantations.

Abstract # 26

Title: Persistent poor sleep is associated with worse pain and quality of life in patients with degenerative thoracolumbar conditions undergoing surgery: A retrospective cohort study

Authors and Affiliations: Tiffany Lung¹, Mayilee Canizares², Anthony Perruccio², Raja Rampersaud^{1,2}

¹Division of Orthopaedic Surgery, Department of Surgery, Faculty of Medicine, University of Toronto, Toronto, ON, Canada.

²Schroeder Arthritis Institute, Krembil Research Institute, University Health Network, Toronto, ON, Canada

Purpose: Limited studies have demonstrated the relationship between sleep disturbance in surgical patients and worse patient reported outcomes. The purpose of this study was to evaluate the relationship between pain-related sleep disturbance and postoperative outcomes in patients undergoing surgery for degenerative thoracolumbar conditions.

Methods: This was a retrospective cohort study using the CSORN database. There were 4145 included patients. We divided patients based on their change in sleep disturbance as reported on the Oswestry Disability Index (ODI) sleep question, from baseline to their first postoperative follow-up. The primary outcomes were the odds of attaining clinically important improvements (CII) in the Numeric Pain Rating scale (NRS) for back pain, leg pain, EuroQoL-5 Dimension Questionnaire (EQ-5D), and 12-item Short Form Survey (SF-12). Multivariable logistic regression (adjusting for age, sex, education, comorbidities, opioid use, symptoms, and relevant baseline PROM score) was used.

Results: There was a higher proportion of patients with no sleep disturbance among those with a baseline chief complaint of claudication compared to back or leg dominant pain (26% vs. 14% and 15%). Patients with ongoing severe and/or worsening sleep disturbance had statistically significant reduced odds of achieving postoperative CII in the physical (PCS) and mental component summary (MCS) scores of SF-12 (OR=0.51-0.62, 95%CI 0.32-0.95), back and/or leg pain (OR=0.44-0.54, 95%CI 0.28-0.84), and EQ-5D (OR=0.42-0.46, 95%CI 0.26-0.73). Patients with improvements in sleep were more likely to achieve

CII in MCS scores (OR=1.54, 95%CI 1.06-2.23). Severe baseline sleep disturbance alone was not associated with postoperative outcomes.

Conclusions: To our knowledge, this is the first study using the ODI sleep subsection, to demonstrate that persistent severe or worsening sleep disturbance at the first postoperative visit is independently associated with a reduced odds of achieving CII for quality of life and pain outcomes at one-year in patients who have undergone thoracolumbar surgery. Improving perioperative sleep could be a targeted intervention to optimize surgical outcomes.

Abstract # 27

Title: Examining the Role of CX3CR1 in Degenerative Cervical Myelopathy

Authors and Affiliations: S. Brockie^{1,3}, C. Zhou^{1,3}, N. Poulin^{1,3}, M. Movahed^{1,2}, J. Hong³, & M.G. Fehlings^{1,2,3}

¹Krembil Research Institute, Toronto, ON, CA

²Toronto Western Hospital, Toronto, ON, CA

³University of Toronto, Toronto, ON, CA

Purpose: The purpose of this study is to determine the role of fractalkine in degeneration and secondary injury. We hypothesize that CX3CR1 expression is elevated in DCM and post-DEC and that inhibiting it may attenuate inflammation and improve functional outcomes.

Methods: To determine this, I am inducing C5-6 myelopathy in Cx3cr1^{EGFP/EGFP} and wildtype mice, which degenerate across a 12-week period, followed by surgical decompression.

Results: Immunostaining of spinal tissue from myelopathic wildtype mice indicates upregulation of CX3CR1 by microglia throughout DCM. In the absence of fractalkine signalling, Cx3cr1^{EGFP/EGFP} knockout mice experience modestly reduced pain across DCM progression. These benefits are reversed following DEC, where knockouts exhibit significant hyperalgesia up to 5 weeks post-DEC, while wildtype mice return to their initial thresholds. In wildtype mice, we observe significant upregulation of CX3CR1 by microglia in DCM and following DEC. Further, while the number of neurons is similar between Cx3cr1^{EGFP/EGFP} knockout and wildtype mice at 12 weeks DCM, neuron loss is significantly increased in knockouts at both 24 hours and 5 weeks post-DEC relative to wildtype.

Conclusions: My findings thus far indicate a significant role played by fractalkine signaling in DCM and DEC recovery and posit microglia as a target for therapeutic intervention.

Abstract # 28

Title: Recognizing Spine Fellowship Training in Canada: An updated literature review of fellowship education and a surgical case list review referencing a national curriculum of procedural competencies

Authors and Affiliations: Dr Rajesh Kumar^{1,2}, Dr. Albert Yee^{1,2}, Dr. Jeremie Larouche^{1,2}

¹Sunnybrook Health Sciences Centre, Toronto, ON, CA

²University of Toronto, Toronto, ON, CA

Purpose: The Canadian Spine Society established a national curriculum of training competencies. The Royal College has approved developing an Area of Focused Competence (AFC) Diploma in Spine Surgery, recognizing fellowship training at accredited centres. The study purpose was to review recent international literature and compare academic year-to-date training exposure to the established national curriculum.

Methods: A PubMed review of spine surgery fellowship education was performed. The Principal Author's surgical case log (Aug2022–April 2023, T-res) was reviewed and compared to the national curriculum of procedural objectives.

Results: Of 178 surgical cases, most related to degenerative spine (n=91), followed by spine trauma (54), metastatic spine (24), infections (6) and implant removal (3). Compared to the curriculum, remaining year training should ideally focus on thoracic discectomy, multilevel anterior, and oblique/lateral lumbar procedures. Our literature review highlights a desire for accreditation and regulation (Abul 2022), that there is a substantive increase in surgical cases performed during fellowship compared to residency (average 314 annually across U.S. ACGME affiliated orthopaedic spine fellowship programs, Silvestre 2023), with a trend towards increasing annual case exposure during fellowships pre-pandemic (2010-2015 ACGME data, Malik 2021). The early impact of the COVID-19 pandemic resulted in >56% reduction in mean hours worked/week, with anticipated 11-25% decrease in mean annual case volumes (baseline=188, Swiatek 2021). Literature noted variability and gaps in program website descriptor information and a need to incorporate additional important educational content in curricula (ie.

wrong site surgery, Mesfin 2015). When measured objectively, greater adult spinal deformity knowledge was observed in individuals receiving fellowship training within the last 10 years (Grabel 2018). Further diversity efforts are required in orthopaedic spine fellowship representation from both from a trainee (Trenchfield 2023) and Fellowship Director perspective (Kamalpathy 2023).

Conclusions: Literature motivates the ongoing development, implementation and evaluation of a Royal College AFC Diploma in Spine Surgery Establishing minimal case volumes and uniformity of training spectrums nationally is desirable (Malik 2021). Regular review of case logs can help guide both trainee and supervisors where to focus remaining clinical exposure during training.

Abstract # 29

Title: Stereotactic Body Radiotherapy (SBRT) for Sacral Metastases: Deviation from Recommended Target Volume Delineation Predicts Higher Risk of Local Failure

Authors and Affiliations: Daniel Palhares, MD, MSc¹, Kang Liang Zeng, MD¹, Sten Myrehaug, MD¹, Chia-Lin (Eric) Tseng, MDCM¹, Hany Soliman, MD¹, Hanbo Chen, MPH, MD¹, Pejman Maralani, MD², Jeremie Larouche, MD³, Jeff Wilson, MD, PhD⁴, Mark Ruschin, PhD¹, Beibei Zhang, PhD¹, Eshetu G. Atenafu, MSc, PStat⁵, Arjun Sahgal, MD¹, Jay Detsky, PhD, MD¹.

¹Department of Radiation Oncology, Odette Cancer Centre, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada

²Department of Medical Imaging, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada

³Division of Orthopedic Surgery, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada

⁴Division of Neurosurgery, St. Michael's Hospital, University of Toronto, Toronto, Ontario, Canada

⁵Department of Biostatistics, University Health Network, University of Toronto, Toronto, Ontario, Canada

Purpose: An international consensus recommendation was published to guide target volume delineation specific to sacral stereotactic body radiotherapy (SBRT). We report outcomes after sacrum SBRT, focusing on the impact of contouring deviation on local failure (LF) risk, with an aim to validate this guideline.

Methods: All patients who underwent sacral SBRT from 2010 to 2021 were identified from a prospectively maintained institutional database. The primary endpoint was magnetic resonance-based LF. The secondary endpoint was vertebral compression fracture (VCF). The cumulative LF and VCF

rates were calculated per segment using the competing risk analysis method. Cox proportional hazards model was used to assess predictive factors of LF and VCF.

Results: A total of 215 treated sacral segments in 112 patients were retrospectively reviewed. The median follow-up was 13 months (range, 0.4-116.9). Most patients (52%) had treatment to a single segment. The median clinical target volume (CTV) was 129.2 cc (range, 5.8-753.5). Most segments were treated with 30 Gy/4 fractions (51%), 24 Gy/2 fractions (31%), or 30 Gy/5 fractions (10%). Thirty-one percent of segments were of radioresistant histology (gastrointestinal, kidney, melanoma, sarcoma, or thyroid primary), and 51% had extraosseous disease. Sixteen percent of segments were under-contoured per consensus guidelines, with incomplete coverage of the involved sector (71%), omission of the adjacent uninvolved sector (17%), or both (11%) as the causes for deviation. The cumulative incidence of LF was 18.4% (95% CI 13.5-24.0) at 12-months and 23.1% (95% CI 17.6-29.0) at 24-months. On multivariate analysis (MVA), under-contouring (HR=2.4, 95% CI 1.3-4.7, p=0.008), radioresistant histology (HR=2.4, 95% CI 1.4-4.1, p=0.001), and extraosseous extension (HR=2.5, 95% CI 1.3-4.7, p=0.005) were predictors of increased risk of LF. The LF rates at 12/24-months were 15.1%/18.8% for segments contoured per guideline versus 31.4%/40.0% for those under-contoured. The cumulative incidence of VCF was 7.1% (95% CI 4.1-11.1) at 12-months and 12.3% (95% CI 8.2-17.2) at 24-months. On MVA, female gender was the only risk factor for VCF (HR=2.3, 95% CI 1.1-5.2, p=0.04).

Conclusions: Sacral SBRT is associated with high rates of efficacy and an acceptable VCF risk. Adherence to target volume delineation consensus guidelines reduces the risk of LF.

Abstract # 30

Title: Ewing Sarcoma of pediatric spine operative techniques and outcomes- a case series of 7 patients

Authors and Affiliations: Rajendra Sakhrekar^{1,2}, Samuel Yoon^{1,2}, Carlo Iorio^{1,2}, Stephen Lewis^{1,2}

¹Division of Orthopaedic Surgery, The Hospital for Sick Children.

²Division of Orthopaedic Surgery, University of Toronto

³The Hospital for Sick Children, University of Toronto, 555 University Avenue, Toronto, ON, Canada M5G 1X8

Purpose: Primary Ewing sarcoma of spine is a rare condition accounting for only 3.5 to 10% of all primary sites. The management of Ewing's sarcoma of the spine usually involves three main modalities: combination chemotherapy, surgery and/or radiotherapy. The aim of this study is to evaluate surgical

strategies, techniques, minimizing the morbidities and outcomes in paediatric population (<18 years) who underwent surgical management for Ewing sarcoma.

Methods: In this study we retrospectively reviewed the management of 7 patients with primary Ewing's sarcoma from 2012–2023. This series included 3 male and 4 female patients with an average age at the time of surgery of 11.42 years (range 6-16). All patients were reasonably neurologically stable. Follow-up details were available ranging 13 months -121 months. Oncologic, clinical, radiological and functional results, including all complications, were recorded. 3 Tumors were in the lumbar spine (42.85%), the thoracic spine in 3 (42.85%), and 1 in thoracolumbar spine (12.28%). En bloc resection was performed in 4 cases, 3 cases had intralesional excision considering possible significant morbidity associated with en bloc resection. Anterior plus posterior approach used in 2 cases while rest 5 cases operated with posterior only approach. Reconstruction of resected lumbar nerves with sural nerve graft was done in 3 cases. All the 7 cases received chemotherapy while 5 patients alongside received radiotherapy. 1 patient died of their disease. 1 patient had local recurrence treated subsequently with chemotherapy and radiotherapy.

Results: There were no major intraoperative complications in terms of any major vascular or spinal cord injury. Although minor complications, in terms of dural leak were noticed in two separate patients which were immediately repaired and had no consequences. 1 patient died of their disease. Rest 6 patients are still alive and are in perfect health. 1 patient had local recurrence after 4 months of disease-free interval and treated subsequently with chemotherapy and radiotherapy. Overall, among the 7 patients with follow up over 2-10 years in this series, there was disease free survival in 87.72% of patients. This study demonstrated significant improvement in clinical, radiological, functional and oncological outcomes with good prognosis and survival rate in patients with Ewing sarcoma.

Conclusions: Ewing's sarcoma presents with variable features in pediatric population and will require specific surgical strategy and decision making with tailored options of surgical techniques combined with chemotherapy and/or radiotherapy to achieve good clinical, radiological, oncological and patient functional outcomes.

Acknowledgement

Thank you!



Surgery
UNIVERSITY OF TORONTO



Toronto Orthopaedics
Leadership. Innovation. Impact.

Medtronic



DePuy Synthes

COMPANIES OF Johnson & Johnson

stryker



CERAPEDICS
Enhancing the Science of Bone Repair



bioventus
Innovations For Active Healing

Make a Gift!

Contact:

Nadia Jaber, Program Manager

uoft.spine@utoronto.ca

Tel: (416)978 8468

Room #: 503, 5th Floor Stewart Building
149 College St Toronto, ON, M5T 1P5

