14th Annual Spine Academic Day

SPINEFEST

UNIVERSITY OF TORONTO SPINE PROGRAM

Monday June 13, 2022

9:00 AM EST

Hybrid

Surgery
UNIVERSITY OF TORONTO
Spine Program

SPINEFEST

14th Annual Spine Academic Day

UNIVERSITY OF TORONTO SPINE PROGRAM

MONDAY
JUNE 13, 2022
8:30 AM - 3:15 PM (EST)

Content

About SpineFEST

SpineFEST, which was first established 14 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

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 2022

- To gain knowledge in the critical areas of spine deformity and related surgery that pose increased risks of complications

- To understand the various forms of spinal osteotomies used to treat spinal deformity and their unique attributes and risks

- To provide tips for the preoperative, intraoperative and postoperative care of spinal deformity patients to optimize their outcomes by lowering complications

Accreditation

Royal College of Physicians and Surgeons of Canada – Section 1: This event is an Accredited Group Learning Activity (Section 1) as defined by the Maintenance of Certification Program of the Royal College of Physicians and Surgeons of Canada, approved by Continuing Professional Development, Temerty Faculty of Medicine, University of Toronto up to a maximum of 4.5 credits.

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

Michael Fehlings MD PhD FRCSC FACS **(Co-Chair)**

Christopher Nielsen MD FRCSC

Stephen Lewis MD MSc FRCSC

Eric Massicotte MD MSc FRCSC

Y Raja Rampersaud MD FRCSC

Alexander Velumian PhD DSc

St Michael's Hospital @ UHT

Henry Ahn MD PhD

Howard Ginsberg MD PhD FRCSC

Jefferson Wilson MD PhD FRCSC

Christopher Witiw MD PhD FRCSC

Hospital for Sick Children

David Lebel MD PhD FRCSC

Stephen Lewis MD MSc FRCSC

James Drake BSE MB BCh MSc FRCSC

Reinhard Zeller MD FRCSC

Sunnybrook Health Sciences Centre

Leo da Costa MD

Mahmood Fazl MD FRCSC

Joel Finkelstein MD MSc FRCSC

Michael H. Ford MD FRCSC

Michael Hardisty PhD

Jeremie Larouche MD, MSc, FRCSC

Meaghan O'Reilly PhD

Farhad Pirouzmand MD MSc FRCSC

Arjun Sahgal BSc MD FRCPC

Cari Whyne PhD

Albert Yee MD MSc FRCSC **(Co-Chair)**

Mount Sinai Hospital

Carlo Ammendolia DC PhD CCRF

University of Toronto

Cindi M Morshead BSc PhD

Karl Zabjek BSc MSc PhD

Margarete Akens Dr med vet PhD

Molly S Shoichet PhD FRSC

W Mark Erwin PhD DC

[Faculty]

Remarks from the Co-Directors

Colleagues,

As we gradually emerge out of the over two year COVID 19 pandemic, we continue to conduct our academic, research and clinical activities in earnest, either online or in hybrid format. During our current academic calendar year of 2021/2022, the U of T Spine Program has been dynamic in fostering citywide collaborations within the university and the affiliated hospitals while taking the lead in several key regional, national, and international initiatives. Our Program has grown a respected academic footprint locally, nationally, and globally. Collaboration and inter-professional, and inter- disciplinary knowledge exchange remain the key element to our success.

On June 13th, The U of T Spine Program celebrates its 14th 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. As the restrictive public health measures have been lightened, SpineFEST will be held as a hybrid event this time. We are pleased to have Dr. Lawrence Lenke, Professor of Orthopaedic and Neurological Surgery at Colombia University in New York City, visit us to provide our keynote address at the Tator-Hall Lecture during SpineFEST meeting on Monday June 13th. Professor Lenke is a world leader in spinal deformity in both adult and pediatric patient populations. We look forward to sharing his remarkable lifelong knowledge in the optimization of outcomes and safety in pediatric and adult spinal deformity surgery. Please join us in welcoming Professor Lenke to SpineFEST 2022!

The New Faculty talk will be presented by Dr. Christopher Nielsen, who will discuss the training of the next generation of spine surgeons. We welcome Dr. Nielsen to our Program's faculty board and wish him a continued success. The talk will be followed by interesting and complex spine deformity cases presented by our citywide spine fellows. The meeting will continue to highlight research from faculty and trainee. Outstanding research from both clinical and basic science perspectives will be presented by our invited trainees and winners of our Best Abstract Awards. SpineFEST this year received around 30 excellent scientific abstracts (☞ abstract), most of which have been presented online on (☞ VoiceThread). All participants are welcome to interact online with the trainees until end of June 13th.

Recent activities have leveraged our education platform to help create and support a national spine surgery fellowship training curriculum for cognitive and procedural competencies. Building on this, our

program, over many years, has established and enhanced Neurosurgery and Orthopaedic Surgery spinal training opportunities between Toronto Academic Health Sciences Network (TAHSN) teaching hospitals: Toronto Western Hospital (TWH-UHN); Sunnybrook Health Sciences Centre (SHSC); Saint Michael's Hospital (SMH); and 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 the past 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 are primarily focused at one of the TAHSN hospitals, great options exist for a citywide experience. Many thanks to Drs. Albert Yee, Michael Fehlings, Stephen Lewis, Eric Massicotte, Joel Finkelstein, Howard Ginsberg, Henry Ahn, and Reinhard Zeller for their valued help in shaping our citywide fellowship training opportunities. Building on our national fellowship curriculum, our Program also continues with the surgical case-log for our citywide spine fellows with around 9000 cases and procedures recorded. We thank Drs. Jeremie Larouche and Tony Bateman, and Ms. Nadia Jaber for creating a successful case-log program for our citywide fellows.

We are excited to formally announce that our continued efforts to promote Spine Surgery as a distinct recognized discipline at the Royal College have been successful. An application to establish a RCPSC Area of Focused Competence (AFC) Diploma for Spine Surgery, which was submitted through the Canadian Spine Society (CSS) and in conjunction with five other Canadian universities including U of T, has been approved through the Royal College Committee on Specialty Education. We look forward to our continued planned work 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 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. Several members in our Program Education Subcommittee have expressed keen interest in being involved as the initiative develops; a terrific opportunity for our Program to continue developing materials that will shape the future of spine surgical education in Canada. It will provide a valued competence-based model for our international community of surgical educators as well.

This year as in the past, we launched our academic calendar of events with a welcome dinner for our incoming fellows. This past year, with public health measures being in practice we organized the dinner meeting as a hybrid event to continue providing 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 of chairing a citywide fellow surgical skills course, introducing advanced anatomy of the spine with fellows performing anterior and posterior surgical approaches as well as spinal instrumentation. Over the past several years, Dr. Lewis extended 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. Last year, the course took place in November after being rescheduled upon cancelation made due to the third wave of Covid 19 back in May. Many thanks to our industry partners: Medtronic, Stryker, De Puy Synthes, and Zimmer Biomet for their continued support of the course.

This past year we continued to complement the residents' surgical training with our Royal College Mock Oral course prepping trainees on fellowship level spine cases and treatment. The course is Co-Chaired by Drs. Fehlings and Yee and supported by a number of faculty. On March 7[h] the course was facilitated virtually via Zoom® and assisted with breakout rooms. Our citywide spine fellows took a key leadership role in teaching the senior residents and organizing a selection of representative case scenarios in Royal College examination format. The residents also benefited from valuable tips and pearls in addition to updated literature reviews on several spine disorders provided by fellows and staff. We thank our citywide fellows Drs. James Wu, Hasaan Chaudhry, Nader Hejrati, Karlo Pedro, Johann Hofereiter, and Martin Gagiliardi for taking the lead in teaching our residents. Also, many thanks to our faculty members Drs. Chris Witiw, Chris Nielsen, Joel Finkelstein, Jeremie Larouche, and our alumnus Dr. Simon Harris for their invaluable input and guidance throughout the training.

With the challenges imposed by the prolonged pandemic restrictions, our Program has been keen on bringing together citywide surgeons and trainees in multiple virtual activities. The citywide Fellow Journal Club continued to be held several times a year. We discussed multiple hot off the press spine articles and featured a number of relevant cases. Many thanks to Drs. Fehlings and TWH team for hosting journal club on the perioperative management & optimization of spine patients, and to Drs. Jeff Wilson and Albert Yee and the SMH and SHSC teams for hosting a journal club on the latest research papers on disc herniation surgery.

The Program invites several world-renowned Professors each year to a Hospital-Based Visiting Professorship. A few previously scheduled lectures have been postponed to resume when the pandemic restrictions are lifted and larger in-person meetings are permitted. Meanwhile, our Program, jointly with

the Division of Orthopaedic Surgery hosted a virtual Visiting Professorship on January 28th featuring Dr. Scott Paquette from Division of Neurosurgery and Orthopedic Surgery at the University of British Colombia who provided a lecture on the evolution of spine surgical education in Canada. Following the lecture, we enjoyed Dr. Paquette's wonderful case-based discussion with our citywide fellows who presented a number of interesting and rather complex spine cases. As the pandemic and related public health restrictions has eased up, we are delighted to resume our hospital-based visiting professorship in person this summer, on August 22nd, featuring Dr. Dror Ovadia from the Pediatric Orthopaedic Department at the Dana Dwek Children's Hospital in Tell-Aviv, Israel. His lecture will focus on treating severe scoliosis without 3 Column Osteotomy. The Tator-Turnbull Spinal Cord Injury Symposium was also held virtually last October 29th. This event is hosted jointly with the TWH Spinal Cord Injury Program and the Collaborative Program in Neuroscience. The event continues every year to pay tribute to the enormous contribution of Dr. Charles Tator and Ms. Barbara Turnbull in driving advances and advocacy in SCI research. It was delightful to have had Drs. Greqoire Courtine and Jocelyne Bloch as our keynote note speakers who provided a joint presentation about their quite impressive discoveries of spinal cord gateways in restoring neurological functions. This fall, on October 21st, we look forward to featuring Professor Michael Sofroniew whose research focuses on cell biology of the response to injury in the adult central nervous system.

We want to take this moment and celebrate the graduation of our 2021/2022 citywide spine fellows who will be completing their fellowship training in July this year. Congratulations to Drs. Johann Hofereiter, Martin Gagliardi, Nader Hejrati, Ohad Einav, Karlo Pedro, Sho Akahori, Nasser Alenezi, Hasaan Chaudhry, Doron Edelman, James Wu, Carlo Iorio (who will continue training for a second year of subspecialty), and Muhammad Jalil (who will be graduating in December). We acknowledge their relentless efforts and dedication in completing advanced fellowship training during this challenging year. We wish them all the best for a successful and rewarding professional career. We look forward to their continued future engagement in our Program's activities as valued alumni members. We also would like to extend our warmest congratulations to Dr. Joel Finkelstein on becoming a full professor; a well-deserved promotion for many years of dedication and excellent achievements in spine surgical training, education, and research.

On a final note, we want to extend our appreciation to the University of Toronto Department of Surgery Spine Program Council, administrative staff, educators, and trainees for the continued dedication and

professionalism 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. James Rutka who over the last 10 years has been steadfast in his support of multidisciplinary spine care and academia within the Department and the University.   As he completes his term as our University Departmental RS McLaughlin Professor and Chair, we welcome and look forward to working closely with the incoming Chair Dr. Carol Swallow. Alongside Drs. Peter Ferguson and Gelerah Zadeh, we are fortunate to benefit from very strong Departmental and Divisional support. We also would like to thank all our long-standing industry partners, Medtronic, Zimmer Biomet, De Puy Synthes and Stryker for their continued support over many years and particularly during the past two years. We also thank Cerapedics and Anchor Orthopedics for their support to SpineFEST and to other Program educational activities occurring this year. Many thanks to our Program members; we are privileged to benefit from their diverse and specialized knowledge. Special thanks to Ms. Nadia Jaber, our Program Manager, for her outstanding expertise and valued information and communication technology skills. She has and remains invaluable towards moving forward our collaborative agenda and virtual academic activities during this evolving time.

Sincerely,

Michael Fehlings & Albert Yee, Co-Directors

AGENDA

8:30 AM	Breakfast	
9:00 Am	Opening Remarks	Dr. Michael Fehlings & Dr. Albert Yee
	Greetings from U of T	Dr. Peter Ferguson, Dr. Justin Nodwell, and Dr. James Rutka
Session I	**Tator-Hall lectureship**	**Chair: Dr. Michael Fehlings**
9:15 AM	Remarks	Dr. Charles Tator & Dr. Hamilton Hall
9:25 AM	Introduction to Keynote speaker Professor Lawrence G. Lenke, MD	Dr. Michael Fehlings
9:30 AM	**Keynote: *Optimizing Safety in Pediatric and Adult Spinal Deformity Surgery***	**Dr. Lawrence G. Lenke, Professor of Orthopedic Surgery (in Neurological Surgery), Chief of Spinal Surgery, Chief of Spinal Deformity Surgery, Columbia University**
10:15 AM	Discussions	
10:45 AM	Coffee Break	
Session II	**Faculty & Fellow Presentations**	**Chair: Dr. Stephen Lewis**
11:00 AM	*Training the next generation spine surgeon: where we have been, where we are, and where we are going.*	Dr. Christopher Nielsen
11:30 AM	Deformity case - Paeds	Dr. Carlo Iorio
11:45 AM	Deformity case	Dr. Nader Hejrati
12:00 PM	Deformity case	Spine Fellow
12:15 PM	Deformity case	Spine Fellow
12:30 PM	Lunch Break and **E-Poster Viewing on VoiceThread**	

e-Poster Viewing on VoiceThread HERE

Session III	Research Presentations		Chair: Dr. Albert Yee
Invited Research Trainees			
1:15 PM	The influence of timing of surgical decompression for acute spinal cord injury: a pooled analysis of individual patient data.		Dr. Jetan Badhiwala
1:30 PM	Survival following revision en-bloc resection after intralesional index procedure for primary malignant spinal tumors		Dr. Ahmed Cherry
Best Abstracts / Oral Presentations			
1:45 PM	Mature Local Control and Reirradiation Rates Comparing Spine Stereotactic Body Radiotherapy to Conventional Palliative External Beam Radiotherapy		Dr. K. Liang Zeng
2:00 PM	Earlier Tracheostomy Reduces Complications in Complete Cervical Spinal Cord Injury: Analysis of a Multi-Center Cohort of 1095 Patients		Michael Balas
2:15 PM	Cell-Cell Contact Mediates Gene Expression and Fate Choice of Human Neural Stem/Progenitor Cells		William B McIntyre
2:30 PM	Inter-Hospital Transfer for Acute Traumatic Spinal Cord Injury: A Unique Opportunity for Altering Patient Recovery		Alex B. Bak
2:45 PM	Dural closure with non-penetrating titanium clips in spine surgery: a comparative single-center study		Dr. Johann Hofereiter
3:00	**Award Presentations and Closing Remarks**		**Drs. Fehlings and Yee**

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. 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.

Co-Chairs

Co-Chair: Dr. Michael Fehlings is a Professor of Neurosurgery, Co-Director of the Spine Program and Vice Chairman (Research) in the Department of Surgery at the University of Toronto. He holds the Halbert Chair in Neural Repair and Regeneration and combines an active clinical practice in complex spinal surgery at the Toronto Western Hospital with a translationally oriented research program focused on discovering novel treatments for the injured brain and spinal cord. He has authored over 950 peer-reviewed articles (h-index 94) chiefly in the area of central nervous system injury and complex spinal surgery. His work has been featured in Nature, Nature Neuroscience, Science Translational Medicine, Nature Reviews Neurology, JAMA, Lancet Neurology, and the New England Journal of Medicine. Dr. Fehlings has held a number of prominent leadership roles, including current President of the International Neurotrauma Society, the Chair of the AO Foundation Clinical Investigation and Documentation Advisory Committee, past Chair of the AOSpine International Spinal Cord Injury Knowledge Forum, past President of the Cervical Spine Research Society, and leader of several international clinical research trials. Dr. Fehlings is a Fellow of the Royal Society (Canada) and a Fellow of the Canadian Academy of Health Sciences. He has received numerous international recognitions including the Royal College Gold Medal, Olivecrona Award, Ryman Prize, Magnus Medal in Neurosurgery and the Jonas Salk Award.

Co- Chair: 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.

Visiting Professor & Speakers

Keynote Speaker -Tator-Hall Lectureship

Dr. Lawrence Lenke is one of the world's foremost leaders in spinal deformity surgery. His world-renowned practice, now in its 30th year, is devoted exclusively to spinal deformity surgery with an emphasis on complex reconstructive surgery in both children and adults for the treatment of various spinal deformities such as scoliosis, kyphosis, flatback syndrome, and other major spinal imbalances, as well as spondylolisthesis. He is generally regarded as the premier academic spinal deformity surgeon in the world, having developed the classification system for Adolescent Idiopathic Scoliosis (AIS), to which his name is attached.

After receiving his undergraduate degree from the University of Notre Dame (Summa Cum Laude) and his MD from Northwestern University Medical School (with Honors), Dr. Lenke completed his internship and residency training in Orthopaedic Surgery at Barnes-Jewish Hospital/Washington University-St.Louis School of Medicine. While at Washington University-St.Louis, he also completed his fellowship training in pediatric and adult spine and spinal deformity surgery and stayed on staff for 24 years rising to the rank of the Jerome J. Gilden Distinguished Professor of Orthopedic Surgery and Chief of Spinal Surgery. In 2015, he joined the faculty of Columbia University Department of Orthopedic Surgery as the 1st Tenured Professor in the over 150 year History of the Department and Chief of Spinal Surgery and Chief of Spinal Deformity Surgery, along with being named Surgeon-in-Chief of the Och Spine Hospital at New York-Presbyterian/Allen Hospital.

Dr. Lenke has been listed in America's Top Doctors for the past 15 years and Best Doctors in America the past 20 years. Dr. Lenke was honored with the North American Spine Society's 2013 Leon Wiltse Award for excellence in leadership and/or clinical research in spine care. Also in 2013, Dr. Lenke was listed in Orthopedics This Week as one of "The Top 28 Spine Surgeons in North America." He served as president of the Scoliosis Research Society 2010-2011, the oldest and most prestigious spine society in the world; its single focus is the advancement of care in patients with spinal deformity. As a

reflection of his preeminent surgical skills, he has hosted over 800 spinal surgeons from around the globe to observe his surgeries in the past 20 years.

Dr. Lenke's prolific academic career includes contributing over 560 published peer-reviewed manuscripts, editing five textbooks on Spinal Surgery, writing more than 140 textbook chapters, chairing over 125 Spinal Surgery meetings and having been an invited Visiting Professor domestically and internationally more than 120 times.

New Faculty Talk

Dr. Christopher Nielsen is a Clinical Associate in Orthopeadic Surgery at Toronto Western Hospital. His elective practice is in spine surgery where he sees a wide range of patients and treats all spinal pathologies in the cervical, thoracic, lumbar and sacral regions. His areas of interest are in adult spinal deformity and oncology. Dr. Nielsen also manages traumatic orthopaedic and spinal injuries. Dr. Nielsen completed medical school and residency in Orthopaedic Surgery at the University of Calgary. He moved to Toronto after residency for a fellowship in complex spine surgery at Toronto Western Hospital where he now works. Dr. Nielsen is currently finishing his Master's in Medical Education.

Case-Based Presentation

Dr. Carlo Iorio completed his medical studies and his orthopaedic residency at Sapienza University of Rome while working as a physician for the Italian Soccer Federation and the Italian Rugby Federation. Currently, Carlo is doing his first year of paediatric spine surgery fellowship training at The Hospital for Sick Children, and will continue with a second year training in adult spine surgery this summer at Toronto Western Hospital. In parallel, Carlo is doing his PhD in Neurosciences at Università Cattolica del Sacro Cuore (Rome, Italy) with focus on peri-operative management of patients with neuromuscular scoliosis. Prior to his training in Toronto, Carlo worked as a staff at spine surgery unit at Bambino Gesù Children's Hospital (Rome, Italy) where he will resume his position upon his return.

Dr. Nader Hejrati is a Board Certified Neurosurgeon From Zurich, Switzerland. Nader completed his MD from the University of Zurich, He thereafter completed his neurosurgery residency program at the Cantonal Hospital St. Gallen, and a combined neurosurgery and spine surgery program at the University Hospital Basel, Switzerland. Nader is currently undertaking spine fellowship training at Toronto Western Hospital, and conducting research projects at Fehlings Laboratory with focus interest on defining the optimal cell therapy for neuroregeneration after spinal cord injury.

Invited Research Trainees Presentations

Dr. Jetan Badhiwala is currently a PGY6 Neurosurgery resident. He received his MD from McMaster University in 2014 and thereafter entered the Neurosurgery Residency Training Program at the University of Toronto. He will be pursuing fellowship training in Spine Surgery at the Cleveland Clinic in 2022-2023. During residency training, Jetan completed a PhD in clinical outcomes research in spinal disorders and neurotrauma through the Surgeon Scientist Training Program under the mentorship of Dr. Michael Fehlings. Specifically, Jetan's PhD thesis centered on redefining and reclassifying cervical spinal cord injury, and took a closer look at the contemporary outcomes of 'central cord syndrome' and the value of early surgical decompression in this context. Jetan has an interest in harnessing big data to address clinical knowledge gaps and the application of artificial intelligence to healthcare data for 'personalized' or 'precision' medicine. Jetan has published over 120 peer-reviewed papers, 50 conference abstracts, and 15 book chapters to date. Many of these have been published in high impact general medical journals, such as The Lancet, JAMA, BMJ, The Lancet Neurology, and Annals of Internal Medicine, as well as subspecialty journals, such as Neurosurgery, Journal of Neurosurgery, Journal of Neurotrauma, The Spine Journal, and Spine. Jetan has been the recipient of a number of honors and awards, including the CIHR Fellowship, the AANS/CNS Spine Section Research Grant, First Place Resident/Fellow Paper (CSRS), and the Stewart B. Dunsker Award (AANS/CNS).

Dr. Ahmed Cherry is a graduating fifth year Orthopaedic surgery resident at the University of Toronto. Upon arrival to Canada, Ahmed completed an undergraduate and Masters degree in Biochemistry at the University of Windsor. He subsequently attended medical school at the University of Toronto. Ahmed will be continuing his training in Toronto next year with a spine fellowship at the Toronto Western Institute. His clinical focus is degenerative spine disease and minimally invasive procedures.

Best Abstracts – Oral Presentations

Dr. K. Liang Zeng is a radiation oncology fellow at the Odette Cancer Centre with special interest in brain, spine and gastrointestinal cancers. His primary research interest is in spinal metastases and stereotactic body radiotherapy, integrating newer and novel techniques into practice and establishing data supporting its role in an ever rapidly advancing field. To date, he has authored 6 first author publications within spine SBRT alone and this fall, will start a position at Royal Victoria Hospital to continue his practice.

Michael Balas is a second year medical student with a background in Health and Computer Science. He has a diverse set of interests ranging from single cell transcriptomics to clinical epidemiology and artificial intelligence. Michael seeks to bridge the gap between various disciplines of study and pave the way for a brighter future with unshakable optimism and unrelenting determination.

Brett McIntyre is a 3rd year PhD student in the Fehlings lab studying how Neural Stem Cells can be applied as a transplantation therapy for traumatic Spinal Cord Injury. Brett is interested in expanding his knowledge of basic neuroscience towards developmental biology and aims to pursue a career as a developmental neuroscientist for his post-doctoral work.

Alex Bak is a rising 3rd year MD student at University of Toronto interested in prediction modelling of surgical outcomes. As a concurrent graduate degree student in engineering at UofT, he is pursuing additional training in statistics, engineering design, and entrepreneurship.

Dr. Johann Hofereiter is a board-certified neurosurgeon from Germany who completed his training at the University Hospital in Munich (LMU) and the Centre for Spinal Cord Injuries (Trauma Center Murnau). Johann is currently involved in his clinical fellowship training at St. Michael's Hospital focusing on complex spine procedures.

Best E-Poster (Presentation on VoiceThread) Awardee

E-poster title: "Modified Frailty Index Predicts Functional and Neurological Outcome in Elderly Patients with Degenerative Cervical Myelopathy: An Analysis of a Multi Centre Prospective Dataset of 757 Patients"

Dr. Karlo M. Pedro is board-certified neurosurgeon from the Philippines. He completed his medical education and residency training from the University of the Philippines -Philippine General Hospital. During his training, Karlo served as the chief resident of the largest neurosurgical training program in the Philippines. He is currently undertaking his spine fellowship at Toronto Western Hospital.

e-Poster Session on VoiceThread HERE

Scientific Abstracts

#	Author	Title
1	**Michael Balas**, Jefferson R. Wilson, Christopher D. Witiw.	Earlier Tracheostomy Reduces Complications in Complete Cervical Spinal Cord Injury: Analysis of a Multi-Center Cohort of 1095 Patients
2	**Nayaab Punjani**, Sighild Lemarchant, Svetlana Altamentova, Jonathon Chio, Jian Wang, Yann Godfrin, Michael G. Fehlings.	Enhancing Tissue Repair, Functional and Locomotor Recovery with NX Peptide Administration in a Cervical Spinal Cord Injury Rat Model
3	**Daniel Palhares,** Kang Liang Zeng, Sten Myrehaug, Chia-Lin (Eric) Tseng, Jay Detsky, Zain Husain, Chinthaka Heyn, Pejman Maralani, Leodante da Costa, Jeremie Larouche, Arjun Sahgal, Hany Soliman.	Mature Outcomes of Stereotactic Body Radiotherapy for Spinal Metastases with 30Gy in 4 fractions
4	**Alex B. Bak**, Ali Moghaddamjou, Michael G. Fehlings	Inter-Hospital Transfer for Acute Traumatic Spinal Cord Injury: A Unique Opportunity for Altering Patient Recovery
5	K. **Liang Zeng**, Sten Myrehaug, Hany Soliman, Zain A. Husain, Chia-Lin Tseng, Jay Detsky, Mark Ruschin, Eshetu G. Atenafu PStat, Christopher D. Witiw, Jeremie Larouche, Leodante da Costa, Pejman Jabehdar Maralani, Wendy R. Parulekar, Arjun Sahgal.	Mature Local Control and Reirradiation Rates Comparing Spine Stereotactic Body Radiotherapy to Conventional Palliative External Beam Radiotherapy
6	**Sydney Brockie**, James Hong, Michael Fehlings	Examining the roles of microglia and CX3CR1 in degenerative cervical myelopathy
7	**Katarzyna Pieczonka**, Hiroaki Nakashima, Nahirito Nagoshi, Kazuya Yokota, James Hong, Anna Badner, Jonathon Chio, Shinsuke Shibata, Mohamad Khazaei, Michael Fehlings	Transplantation of Human Oligodendrogenic Neural Progenitor Cells for the Treatment of Cervical Spinal Cord Injury
8	**Carlo Iorio**, Samuel Strantzas, Michael Vandenberk, Stephen J. Lewis, Reinhard Zeller, Mark Camp, Robert Koucheki, Brett Rocos and David E. Lebel	Utility of Intraoperative Neurophysiological Monitoring in Detecting Motor and Sensory Nerve Injuries in Pediatric High-Grade Spondylolisthesis

9	**William B McIntyre**, Mehran Karimzadeh, Yasser Riazalhosseini, Mohamad Khazaei, Michael G Fehlings	Cell-Cell Contact Mediates Gene Expression and Fate Choice of Human Neural Stem/Progenitor Cells
10	**Cindy Zhou**, Sydney Brockie, Mandana Movahed, James Hong, Michael Fehlings	Examining the Role of Fractalkine on Functional Recovery after degenerative cervical myelopathy
11	**Abramian M**, Lou Z, McIntyre WB, Khazaei M, Fehlings MG.	Developing V2a and V2b Interneuron-Biased Neural Progenitor Cell Lines as a Potential Transplantation Therapy following Spinal Cord Injury
12	**Geoff Klein,** Isaac Carreno, Joel Finkelstein, Arjun Sahgal, Jay Detsky, Cari Whyne, Anne Martel, Michael Hardisty	Spinal Curvature Prediction with 3D CT Images in Coronal and Sagittal Planes
13	**Zijian Lou**, Alex Post, Narihito Nagoshi, Nader Hejrati, Jonathon Chon Teng Chio, Mohamad Khazaei, and Michael G. Fehlings	Comparing Immunosuppressed Spinal Cord Injury Rat Models for Human Neural Progenitor Cell Xenotransplant Studies
14	**Joshua Plener** DC, Mette Jensen Stochkendahl PhD, Corey Hofkirchner DC, Aksa Ahmed DC, James Young DC, MSc, Michael Schneider DC, PhD, Paul Taenzer PhD, CPsych, John Flannery MD, Carlo Ammendolia, DC, PhD	The development of the Boot Camp smartphone app to increase physical activity in older adults suffering from degenerative lumbar spinal stenosis
15	**Joshua Plener,** Sophia da Silva-Ooulop Daphne, Ben Csiernik, Jocelyn Cox, Ngai Chow, Sheilah Hogg-Johnson MMath, Carlo Ammendolia	Eligibility criteria of participants in randomized control trials assessing non-operative management of cervical radiculopathy: A systematic review
16	**Andrew Frizado**, Meaghan O'Reilly	Preliminary Investigation of Transvertebral Passive Acoustic Mapping for Treatment Monitoring of Focused Ultrasound-based Therapies of the Spinal Cord Through Numerical Methods
17	**David Martin**, and Meaghan O'Reilly	Simulation-corrected Focusing in the Vertebral Canal
18	**Nader Hejrati**, Ali Moghaddamjou, James Guest, Brian Kwon, James Harrop, Vafa Rahimi-Movaghar, Shekar Kurpad, Bizhan Aarabi, and Michael G. Fehlings	Current Practice of Acute Spinal Cord Injury Management: Results of an International Survey
19	**Karlo M. Pedro**, MD, Ali Moghaddamjou, MD, Michael G. Fehlings, MD, PhD	Modified Frailty Index Predicts Functional and Neurological Outcome in Elderly Patients with Degenerative Cervical Myelopathy: An Analysis of a MultiCentre Prospective Dataset of 757 Patients
20	**Johann Hofereiter**, Martin Gagliardi, Sho Akahori, Jefferson R. Wilson, Christopher D. Witiw, Howard J. Ginsberg	Dural closure with non-penetrating titanium clips in spine surgery: a comparative single-center study
21	**Noah D. Poulin**, Koby Baranes, Mark R. Kotter, Michael Fehlings	Regulatable Expression of GDNF and ChABC in Human iPSC-derived NPCs

22	**Oliver Zhang**, Mohamad Khazaei, Jacky Lou, Sogolie Kouhzaei, Michael Fehlings	Neural Stem Cells paired with autoregulated Chondroitinase ABC (ChABC) as a therapeutic option post spinal cord injury
23	**Laureen D. Hachem**, James Hong, Alexander Velumian, Andrea J. Mothe, Charles H. Tator, Michael G. Fehlings	Glutamate activates a proliferative and astrogliogenic program in ependymal stem cells: implications for regenerative therapeutic translation
24	**Cherry, A**., Eseonu, K., and Ahn, H.	A Canadian-based pilot study of current surgical practice and implant preferences in lumbar fusion surgery
25	**Cherry, A.,** Rampersaud, R.	The use of Minimally Invasive Navigation Guided Resection of Spinal Osteoid Osteomas and Osteoblastomas

Abstract # 1

Title: Earlier Tracheostomy Reduces Complications in Complete Cervical Spinal Cord Injury: Analysis of a Multi-Center Cohort of 1095 Patients

Authors and Affiliations: Michael Balas, B.HSc.[1], Jefferson R. Wilson, M.D., Ph.D.,[1,2,3] Christopher D. Witiw, M.D., M.S.[1,2,3.]

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

Purpose: Patients with traumatic cervical spinal cord injury (SCI) typically experience severe respiratory complications necessitating prolonged ventilatory support. Tracheostomy is frequently employed in these circumstances, although there is currently no consensus on when to perform this technique. Previous studies have used a 7-day threshold to dichotomize patients into receiving early or delayed tracheostomy. It is thought that early tracheostomy in these patients may lessen the risk of developing complications and reduce length of stay. This study assesses the clinical practices and safety of early tracheostomy across a large sample of North American trauma centers.

Methods: We conducted an observational cohort study using the American College of Surgeons Trauma Quality Improvement Program database from 2010-2016. Adult patients with a complete cervical SCI (ASIA A) who underwent surgery and tracheostomy were included. Patients were stratified into early or delayed tracheostomy groups using a threshold of 7 days. Propensity score matching was then used to assess the association between delayed tracheostomy and the risk of in-hospital adverse events including major complications, immobility-related complications, and mortality. Risk-adjusted variability in tracheostomy timing across trauma centers was investigated using mixed-effects regression.

Results: 1,095 patients from 234 North American trauma centers were included. Median time-to-tracheostomy was 9.2 days (IQR: 6.3 to 13.0 days), with 346 patients (31.6%) undergoing tracheostomy within 7 days. After propensity score matching, the odds of having a major complication (OR: 0.65; 95%CI: 0.47 to 0.90) and immobility-related complication (OR: 0.62; 95%CI: 0.45 to 0.84) were significantly lower for patients that received early tracheostomy. Patients in the early group spent 6.8 fewer days in the critical care unit on average (95%CI: -9.10 to -4.46) and 6.1 fewer days on ventilation (95%CI: -8.88 to -3.29). Furthermore, case-mix and hospital-level characteristics explained only 1.1% and 6.6% of the variability in tracheostomy timing within-centers and between-centers, respectively.

Conclusions: Physicians should strive to perform tracheostomy in this patient population within the 7-day threshold to improve outcomes and reduce length of stay. Further research is necessary to fully characterize the impact of early tracheostomy on mortality risk, in addition to its effects on patient comfort and long-term outcomes.

Abstract # 2

Title: Enhancing Tissue Repair, Functional and Locomotor Recovery with NX Peptide Administration in a Cervical Spinal Cord Injury Rat Model

Authors and Affilations: Nayaab Punjani[1,2], Sighild Lemarchant[3], Svetlana Altamentova[1], Jonathon Chio[1,2], Jian Wang[1], Yann Godfrin[3,4], Michael G. Fehlings[1,2]

[1] Genetics and Development, Krembil Research Institute, University Health Network
[2] University of Toronto
[3] Axoltis Pharma, Lyon, France
[4] Godfrin-Life Sciences, Lyon, France

Purpose: Initial physical trauma in spinal cord injury (SCI) is followed by secondary cascades which involve further cell death in the central nervous system, upregulation of inflammatory cytokines, and scar

formation. NX210c is a peptide derived from a conserved region of sub-commissural organ (SCO)-spondin, a protein proposed to be involved in spinal cord regeneration in vertebrates. The purpose of this study is to evaluate the efficacy of NX210c to promote repair and functional recovery in a traumatic cervical SCI model. It is hypothesized that NX210c will enhance neural repair and regeneration at and across the injury site, helping to improve neurobehavioural recovery.

Methods: Female adult Wistar rats will receive a clip compression-contusion SCI at the C6/C7 level of the spinal cord, which is a clinically relevant model of traumatic SCI in humans. 66 injured rats will be randomized into 4 groups, in a blinded manner, to receive one daily dose of either NX210c (8mg/kg) or sterile water intraperitonially for 8 weeks, starting 4 hours (h) or 8 h post-SCI. 12 sham rats will only receive a laminectomy with no clip-induced SCI, and water treatment beginning at 4 h post-surgery. Neurobehavioral assessments will be performed until 8 weeks post-SCI, where animals will be sacrificed for histological assessments.

Results: Early administration of NX210c (n=16-17/group) increased forelimb strength (grip strength) and improved several aspects of locomotion including interlimb coordination, (i.e., regularity index or base of support of the forelimbs; CatWalk). When delaying first administration to 8h post-injury, NX210c promoted weight gain, accelerated bladder control recovery from 14 to 9 days post-injury, and reduced sensorimotor deficits (inclined plane). Preliminary histology (n=3/group) demonstrates higher white matter preservation and reduced cavity size at the injury site with NX210c treatment beginning at 8h post-injury compared to vehicle.

Conclusions: Compared to other proposed treatments for SCI, NX provides a multi-faceted approach that mitigates various aspects of SCI. NX210c improves motor function and bladder control, while also contributing to improved white matter preservation. We anticipate that this study will provide a strong proof of concept for the use of NX210c as a treatment for acute SCI patients.

Abstract # 3

Title: Mature Outcomes of Stereotactic Body Radiotherapy for Spinal Metastases with 30Gy in 4 fractions

Authors and Affiliations: Daniel Palhares[1], Kang Liang Zeng[1], Sten Myrehaug[1], Chia-Lin (Eric) Tseng[1], Jay Detsky[1], Zain Husain[1], Chinthaka Heyn[1], Pejman Maralani[1], Leodante da Costa[3], Jeremie Larouche[4], Arjun Sahgal[4], Hany Soliman[1].

1 Department of Radiation Oncology, Odette Cancer Centre, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, ON, Canada
2 Department of Neuroradiology, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, ON, Canada.
3 Division of Neurosurgery, Sunnybrook Health Sciences Centre, Toronto, ON, Canada.
4 Division of Orthopedic Surgery, Sunnybrook Health Sciences Centre, Toronto, ON, Canada

Purpose: At our institution, 30Gy in 4 spine SBRT fractions is typically delivered for larger treatment volume and/or for the retreatment of spinal metastases. We report MRI-based local failure (LF) and vertebral compression fracture (VCF) rates for patients treated with 30Gy/4Fx of spine SBRT.

Methods: A retrospective analysis of all patients with spine metastases treated with 30Gy/4Fx from 2010 to 2021 from an institutional registry was performed. The primary endpoint was the MRI-based LF rate. Secondary endpoints included overall survival (OS) and the incidence of VCF.

Results: Were included 116 patients with 245 treated segments. The median number of consecutive segments in the treatment volume was 3 (1-7), and the median clinical target volume (CTV) was 126 cc (10-863). Kidney (25%), lung (20%), breast (19%), and prostate (19%) cancer were the most common primary histologic types. 24% of patients had spine metastases only. 15% of the patients were treated with postoperative SBRT. 54% of segments had previously been treated with radiation, while 25% had a baseline VCF, 46% epidural disease, and 53% paraspinal tumor extension. The median follow-up per patient was 18.5 mos (0.1-61). The LF rates at 12 and 24 mos were 10.7% (95% CI 7.1-15.2) and 16% (95% CI 11.5-21.2), and for VCF were 7.3% (95% CI 4.4-11.2) and 11.2% (95% CI 7.5-15.8), respectively. 60% of failures had an epidural, and 23% a paraspinal, component. Age <68y (HR=0.43, p=0.038), volume of CTV <72cc (HR=0.09, p=0.021), and prior surgical stabilization (HR=0.25, p=0.021) were protective predictors for VCF on multivariable analyses (MVA). The VCF rate at 24 mos was 1.8% for patients with CTV volume <72 vs 14.6% for ≥72cc. Median OS was 20.3 mos (95% CI 14.8-27.1). Predictors for OS on MVA included low grade/no epidural disease (HR=0.42, p=0.014) and paraspinal disease (HR=3.07, p<0.001). No radiation-induced myelopathy was observed.

Conclusions: This first report for 30Gy/4Fx as a novel fractionation for spine SBRT suggests high rates of local control and a low rate of VCF, particularly for those target volumes with a CTV<72 cc.

Abstract # 4

Title: Inter-Hospital Transfer for Acute Traumatic Spinal Cord Injury: A Unique Opportunity for Altering Patient Recovery

Authors and Affiliations: Alex B. Bak, Ali Moghaddamjou, Michael G. Fehlings

1Division of Neurosurgery, University of Toronto Faculty of Medicine

2Krembil Research Institute, University Health Network

Purpose: Interhospital transfer from community hospitals to trauma centers is a crucial means of providing critically ill patients with access to appropriate acute care. Transfers describe a sizeable portion of acute traumatic spinal cord injury (at-SCI) admission from 27% to 37.7%; however, it can strain patients, healthcare systems, and delay intervention. We aimed to investigate the impact of transfer on patient outcomes after at-SCI, wherein time to surgery is critical.

Methods: Transferred or directly admitted adult at-SCI patients were identified from a multicenter, prospective database. ASIA Impairment Scale (AIS) grade was assessed at baseline (≤72hr post-injury) with follow-up between 12 to 52 weeks. Functional independence Measure (FIM) was assessed at discharge with follow-up between 12 to 52 weeks. Primary outcomes were change in AIS grade/components and FIM scores. Secondary outcomes were length of stay and operative characteristics. Missing information was imputed with multiple imputation. 1:1 nearest-neighbour propensity-score matching between the transferred and directly admitted groups was performed using a caliper width of 0.2.

Results: A total of 1190 at-SCI patients met the inclusion criteria, with 558 transferred patients (51.2%). The transferred group were older, and had a greater proportion of women, comorbidities, and injuries that were less severe and from low energy mechanisms. After propensity-score matching, 350 pairs were matched. Transferred patients had a significantly lower rate of ≥1 AIS grade conversion (41.7% v. 50.2%, p=0.044). Upper extremity motor recovery was significantly stunted in transferred patients (10.4±11.5 v. 12.5±12.3, p=0.018), as well as diminished recovery in light touch scores (15.3±24.6 v. 21.3±30.0, p=0.007), FIM motor scores (24.1±26.5 v. 29.4±27.5, p=0.009), and FIM locomotion scores (4.1±4.2 v. 5.4±4.1, p<0.001). As expected, transferred patients received significantly lower rates of early (≤24hr) surgery (50.8% v. 63.9%, p<0.001); however, the findings were not impacted after balancing early surgery as a covariate during sensitivity analysis.

Conclusions: Patients transferred for at-SCI experience significantly compromised neurological and functional recovery, independent of early surgery status. Future prospective studies are needed to assess each part of the hospital transfer process and their impact on patient recovery trajectories.

Abstract # 5

Title: Mature Local Control and Reirradiation Rates Comparing Spine Stereotactic Body Radiotherapy to Conventional Palliative External Beam Radiotherapy

Authors and Affiliations: K. Liang Zeng MD[1], Sten Myrehaug MD[1], Hany Soliman MD[1], Zain A. Husain MD[1], Chia-Lin Tseng MDCM[1], Jay Detsky MD[1], Mark Ruschin PhD[1], Eshetu G. Atenafu PStat[2], Christopher D. Witiw MD[3], Jeremie Larouche MD[4], Leodante da Costa MD[5], Pejman Jabehdar Maralani MD6, Wendy R. Parulekar MD[7], Arjun Sahgal MD[1]

1Department of Radiation Oncology, Odette Cancer Centre, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada; 2Department of Biostatistics, University Health Network, University of Toronto, Toronto, Ontario, Canada; 3Division of Neurosurgery, St. Michael's Hospital, University of Toronto, Toronto, Ontario, Canada; 4Division of Orthopedic Surgery, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada; 5Division of Neurosurgery, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada 6Department of Medical Imaging, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada; 7Canadian Cancer Trials Group, Queens's University, Kingston, ON, Canada

Purpose: Stereotactic body radiotherapy (SBRT) improves complete pain response for painful spinal metastases compared to conventional external beam radiotherapy (cEBRT). We report mature local control and reirradiation rates in a large cohort of patients treated with SBRT vs. cEBRT enrolled previously in the Canadian Clinical Trials Group Symptom Control (SC).24 phase II/III trial.

Methods: 137/229 (60%) patients randomized to 24 Gy in 2 SBRT fractions or 20 Gy in 5 cEBRT fractions were retrospectively reviewed. By including all treated spinal segments, we report on 66 patients (119 spine segments) treated with SBRT, and 71 patients (169 segments) treated with cEBRT. The primary outcomes were MR-based local control and reirradiation rates for each treated spine segment.

Results: The median follow-up was 11.3 months (IQR:5.3-27.7 months), and median OS in the SBRT and cEBRT cohorts were 21.6 and 18.9 months (p=0.428), respectively. The cohorts were balanced with respect to radioresistant histology and presence of "Mass" (paraspinal and/or epidural disease extension). Risk of local failure after SBRT vs. cEBRT at 6, 12 and 24 months were 2.8% vs. 11.2%, 6.1% vs. 28.4% and 14.8% vs. 35.6%, respectively (p<0.001). cEBRT (HR:3.48, 95%CI:1.94-6.25, p<0.001) and presence of "Mass" (HR:2.07, 95%CI:1.29-3.31, p=0.002) independently predicted local failure on multivariable analysis. The 1-year reirradiation rates and median times to reirradiation after SBRT vs. cEBRT, were 2.2% vs 15.8% (p=0.002) and 22.9 months vs. 9.5 months respectively.

Radioresistant histology (HR:2.66, 95%CI:1.43-4.94, p=0.002) and cEBRT (HR:2.34, 95%CI:1.14-4.78, p=0.002) independently predicted for reirradiation. 8/12 iatrogenic vertebral compression fractures (VCFs) were after SBRT and 4/12 after cEBRT; Grade 3 toxicities were isolated to the SBRT cohort (5/12).

Conclusions: Risk of local failure and reirradiation is lower with SBRT compared to cEBRT for spinal metastases. Although the iatrogenic VCF rates were within expectations, Grade 3 VCF were isolated to the SBRT cohort.

Abstract # 6

Title: Examining the roles of microglia and CX3CR1 in degenerative cervical myelopathy

Authors and Affiliations: Sydney Brockie[1,2], James Hong[1], Michael Fehlings[1,2]

1 University of Toronto; 2 University Health Network

Purpose: Degenerative cervical myelopathy (DCM) is the most common form of spinal cord impairment worldwide and involves one or a combination of degenerative changes that compress the spinal cord. As the population ages, DCM is becoming increasingly prevalent, creating an urgent need for effective treatment. Currently, DCM can be treated with surgical decompression (DEC), though functional recovery is by secondary injury and chronic inflammation. In the central nervous system, the fractalkine receptor, CX3CR1, is primarily expressed by macrophages and plays a critical role in microglial-mediated neuroinflammation. We hypothesize that CX3CR1 expression is elevated by DCM and DEC and that its inhibition could attenuate inflammation and improve functional recovery.

Methods: DCM is induced in C57BL/6 wildtype (WT) and CX3CR1-knockout (KO) mice at 8 weeks of age through the insertion of an ossification-inducing polymer under C5-6 that gradually compresses the cord. After 12 weeks of DCM progression and continual neurobehavioural monitoring, animals are either sacrificed or treated with DEC and monitored until being sacrificed either 24 hours, 1 week or 5 weeks later (n=14 per endpoint).

Results: DCM is found to cause markedly more severe degeneration in WT mice, while KOs experience protective benefit over a 12-week degenerative period. Immediately following DEC, we observe acute inflammation in both WT and KO mice, but at 1- and 5-weeks post-DEC, we observe continuing

improvement in function in KO mice that is not observed in WT. Cellular and molecular markers of inflammation in the tissue of these animals will be used to further explore these findings.

Conclusions: Determining the role of CX3CR1 in DCM and DEC will provide insight into the mechanisms of secondary injury and neuroinflammation, which can be used to elucidate therapeutic targets. This study investigates a novel, clinically-relevant approach to improve functional recovery in DCM patients and paves the way for further research on inflammation-focused therapy.

Abstract # 7

Title: Transplantation of Human Oligodendrogenic Neural Progenitor Cells for the Treatment of Cervical Spinal Cord Injury

Authors and Affiliations: Katarzyna Pieczonka[1,2], Hiroaki Nakashima[1,3], Nahirito Nagoshi[1,4], Kazuya Yokota[1,5], James Hong[1,2], Anna Badner[1,2], Jonathon Chio[1,2], Shinsuke Shibata[6], Mohamad Khazaei[1], Michael Fehlings[1,2,7]

1-Division of Genetics and Development, Krembil Research Institute, University Health
Network, Toronto, Ontario, Canada
2- Institute of Medical Science, Faculty of Medicine, University of Toronto, Toronto, Ontario,
Canada
3-Department of Orthopaedic Surgery, Nagoya University Graduate School of Medicine,
Nagoya, Japan
4-Department of Orthopaedics, Keio University, Minatro City, Tokyo, JPXV+H5 Minato City, Japan
5-Department of Orthopaedic Surgery, Graduate School of Medical Sciences, Kyushu
University, Fukuoka, Japan
6-Electron Microscope Laboratory, Keio University School of Medicine, Tokyo, Japan
7-Division of Neurosurgery and Spinal Program, Department of Surgery, University of Toronto, Toronto, Ontario, Canada

Purpose: Spinal cord injury (SCI) results in the loss of myelinating oligodendrocytes, ultimately contributing to impaired neural communication. Neural progenitor cell (NPC) transplantation is an attractive approach to replace the neural cells that have been lost following SCI and to promote beneficial trophic effects. However, the injury microenvironment predominantly directs NPCs to differentiate into scar-forming astrocytes as opposed to neurons or oligodendrocytes. In order to promote oligodendrocyte differentiation, we aimed to generate human induced pluripotent stem cell (iPSC)-derived oligodendrogenically-biased NPCs (oNPCs) and to characterise the neuroregenerative role of the cells in cervical SCI.

Methods: oNPCs were prepared from iPSC-NPCs by mimicking oligodendroglial developmental cues in vitro. To characterise the cells in vitro, RT-qPCR and immunocytochemistry were used. For in vivo assessments, a cervical SCI was induced in RNU immunodeficient rats followed by transplantation with either oNPCs or vehicle two weeks post SCI. Behavioural recovery was monitored weekly for ten weeks post SCI. Following sacrifice, histological methods were used to determine oNPC differentiation, remyelination, astrogliosis, endogenous cell survival and tissue preservation.

Results: We found that several genes involved in oligodendroglial lineage determination were upregulated in the oNPCs compared to unbiased NPCs, including OLIG1, OLIG2 and SOX10. Immunostaining showed that the oNPCs gave rise to an increased proportion of oligodendrocytes (O1+; 47.2 ± 5.1%) than neurons (Tuj1+; 29.8 ± 3.1%) or astrocytes (GFAP+; 23 ± 3.7%) in vitro, and similar results were seen in vivo. Immunohistochemical analyses demonstrated that oNPC transplantation enhanced MBP+ remyelination, reduced GFAP+ astrogliosis and promoted the survival of endogenous NeuN+ neurons. Tissue preservation was higher in the oNPC group, as demonstrated using LFB and H&E staining. We observed no increase in the proliferation of oNPCs during the study. Importantly, oNPC transplantation correlated with significantly better grip strength and CatWalk gait scores compared to vehicle ($p < 0.05$).

Conclusions: Overall, this work suggests that oNPCs can promote remyelination and several other neuroregenerative effects which correlate with functional recovery post SCI.

Abstract # 8

Title: Utility of Intraoperative Neurophysiological Monitoring in Detecting Motor and Sensory Nerve Injuries in Pediatric High-Grade Spondylolisthesis

Authors and Affiliations: Carlo Iorio, Samuel Strantzas, Michael Vandenberk, Stephen J. Lewis, Reinhard Zeller, Mark Camp, Robert Koucheki, Brett Rocos and David E. Lebel

The Hospital for Sick Children, 555 University Ave, Toronto, ON, M5G 1X8, Canada

Purpose: Intra-operative neuromonitoring (IONM), including motor evoked potentials (MEP), somatosensory evoked potentials (SSEP), and electromyography (EMG), have been shown to be highly

sensitive and specific in detecting spinal cord injuries during adult spine surgery. However, IONM sensitivity and specificity in high-grade spondylolisthesis (HGS) remains unknown. In the present study, we aim to assess the diagnostic accuracy of IONM in the surgical management of pediatric HGS.

Methods: Data on patient demographics, radiographic parameters, and the presence of pre-and post-operative neurological deficits were collected. In addition, MEP, EMG, and SSEP alerts were extracted. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated for each modality. The 95% confidence intervals (CIs) were calculated using the exact (Clopper-Pearson) method.

Results: 54 pediatric patients with HGS undergoing PSF between 2003 – 2021 in a tertiary care centre were reviewed and included in the analysis. 72% (39/54) of patients were female and the average age was 13.7±2.3 years. In 12 patients (22.2%) post-operative neurological deficit was diagnosed; all these patients were flagged during the procedure, thus having no false negatives. Seven patients 12.9%) had an intra-operative alert which recovered following intra-operative intervention; these patients were asymptomatic post-operatively. The sensitivity of combined MEP and SSEP was 100% (95% CI [73.5 to 100]), MEP 92.3% (95% CI [64.0 to 99.8]), SSEP 77.8% (95% CI [40.0 to 97.2]) and EMG 69.2 (95% CI [38.6 to 90.9]). The specificity of combined MEP and SSEP was 80.5% (95% CI [65.1 to 91.2]), MEP 80.0% (95% CI [64.4 to 90.95]), SSEP 95.1% (95% CI [83.5 to 99.4]) and EMG 65.9 (95% CI [49.4 to 79.9]).

Conclusions: Based on our cohort, multimodal IONM, using both MEP and SSEP, were highly accurate in diagnosing motor and sensory nerve injuries in pediatric HGS. We recommend the utilization of multimodal IONM in all HGS PSF surgeries.

Abstract # 9

Title: Cell-Cell Contact Mediates Gene Expression and Fate Choice of Human Neural Stem/Progenitor Cells

Authors and Affiliations: William B McIntyre[1,2], Mehran Karimzadeh[3], Yasser Riazalhosseini[3], Mohamad Khazaei[2], Michael G Fehlings[1,2,4]

1 Institute of Medical Sciences, University of Toronto, Toronto, Ontario, Canada; 2 Krembil Research Institute, University Health Network, Toronto, Ontario, Canada; 3 Department of Human Genetics, McGill University, McGill University and Genome Quebec Innovation Centre, Montreal, Quebec, Canada; 4 Division of Neurosurgery, Department of Surgery, University of Toronto, Toronto, Ontario, Canada

Purpose: Transplantation of Neural Stem Cells (NSCs) is a promising regenerative strategy to promote neural repair following spinal cord injury (SCI) because of their ability to proliferate and integrate with injured tissue. However, large-scale manufacturing of induced pluripotent stem cell (iPSC) lines can produce variability in cultured cells, potentially altering their efficacy in recent clinical trials. Cell density is an amendable parameter during mass manufacturing of cell lines, which can regulate the survival, proliferation, differentiation, and fate choice of stem cells. To determine the extent of variability produced by inconsistent culturing densities, the present study aimed to assess transcriptomic and fate choice discrepancies observed in human induced pluripotent NSCs (hiPSC-NSCs) at a low or high plating density.

Methods: hiPSC-NSCs were expanded in culture at either a low (5×10^4 cells/ml) or high (2.5×10^5 cells/ml) plating density for 7 days. Subsequently, hiPSC-NSCs were: **(1)** characterized for their ability to differentiate into neurons, astrocytes, and oligodendrocytes *in vitro*; **(2)** transplanted into an immunodeficient (RNU Nude Rat) Cervical 6/7 contusion model of SCI, and isolated for bulk RNA-sequencing prior to and after transplantation. **(3)** Bulk RNA-sequencing data was compared to publicly available single-cell RNA sequencing (scRNA-seq) atlases to evaluate the extent of hiPSC-NSC lineage biasing to different neural cell subtypes.

Results: Compared to a lower hiPSC-NSC culturing density, **(1)** a higher density promoted differentiation towards a more neuronal fate (High: 45%; Low: 23% Neurons/total cells), and less mature astrocytes (High: 30%; Low: 47% Astrocytes/total cells). **(2)** Following transcriptomic analysis, genes involved in cell-cell contact-mediated pathways including Hippo-signaling, NOTCH, and WNT signaling were differentially expressed. Modulation of these pathways are highly associated with the regulation of pro-neuronal transcription factors, which were positively upregulated in response to higher-density hiPSC-NSC culturing. **(3)** Further comparison to scRNA-seq databases revealed a slight bias of high density hiPSC-NSCs to reflect transcriptomic signatures of excitatory and inhibitory interneuron subtypes.

Conclusions: This study highlights the importance of precise control of cell culture density in the development of hiPSC-NSC transplantation therapies. Ideally, consistent culturing techniques during the manufacturing stages of hiPSC-NSC culture can promote more robust cell therapeutics for SCI.

Abstract # 10

Title: Examining the Role of Fractalkine on Functional Recovery after degenerative cervical myelopathy

Authors and Affiliations: Cindy Zhou[1,2], Sydney Brockie[1,2], Mandana Movahed[1,2], James Hong[1,2], Michael Fehlings[1,2,3]

1 Division of Genetics and Development, Krembil Brain Institute, University Health Network, Toronto, ON M5T 2S8, Canada
2 Institute of Medical Science, Faculty of Medicine, University of Toronto, Toronto, ON M5S 1A8, Canada
3 Department of Surgery, Faculty of Medicine, University of Toronto, Toronto, ON M5T 1P5, Canada

Purpose: Degenerative cervical myelopathy (DCM) encompasses several age-related degenerative conditions that cause a compression of the cervical spinal cord. The functional deficits experienced by DCM patients may be caused by a maladaptive elimination of synapses. Recently, the fractalkine receptor (CX3CR1), which is found on microglia, has been shown to be involved in microglial-mediated synaptic elimination. Further, deletion of the receptor results in improved functional outcomes and synapse formation after traumatic spinal cord injury (SCI). The main objective of this study is to investigate the role of fractalkine (CX3CR1-CX3CL1) signaling on functional outcomes and synaptic elimination following DCM. It was hypothesized that *i)* fractalkine-mediated synaptic engulfment occurs after DCM, and that *ii) Cx3cr1* deletion will attenuate the synaptic loss whilst improving functional recovery.

Methods: DCM was induced in C57BL/6 and $Cx3cr1^{-/-}$ mice by inserting a polyether aromatic material under the C5-C6 lamina. Synaptic elimination and functional recovery were characterized at three timepoints (4, 8, and 12-weeks post-DCM) using synaptic markers and CatWalk Gait analysis.

Results: Compared to naïve animals, preliminary immunostaining revealed that after 17-weeks of DCM, the dorsal horns of C57BL/6 mice exhibit a greater synapse to neuron ratio due to less NeuN^{+} cells but no change in the number of synapses (PSD95^{+} and Homer-1^{+} cells).

Conclusions: Current preliminary data suggests that fractalkine-mediated synaptic engulfment does not occur after DCM, but further experiments using $Cx3cr1^{-/-}$ mice will provide better insight. Together, the results from this study will reveal if CX3CR1-CX3CL1 signalling can be used as a therapeutic target for DCM.

Abstract # 11

Title: Developing V2a and V2b Interneuron-Biased Neural Progenitor Cell Lines as a Potential Transplantation Therapy following Spinal Cord Injury

Authors and Affiliations: Abramian M[1,2,] Lou Z[1,2], McIntyre WB[1,2], Khazaei M[1], Fehlings MG[1,2].

1. Krembil Research Institute; 2. Institute of Medical Science

Purpose: Surviving host propriospinal interneurons play an important therapeutic role after spinal cord injury (SCI). The transplantation of post-mitotic excitatory V2a interneurons after a C3/C4 hemisection SCI model showed improved behavioural recovery in rats when compared to neural progenitor cell (NPC) transplantation. Our goal is to create an NPC line which is biased to form two populations of ventrally-derived propriospinal interneurons: V2a (excitatory) or V2b (inhibitory) interneurons. As NPCs have improved ability for integration in the injured spinal cord, the expectation is that NPCs biased to a V2a or V2b interneuron fate will better integrate than mature V2a and V2b interneurons. These biased NPCs would more readily reconnect circuits in the injury spine and may restore the excitatory/inhibitory imbalance which occurs after SCI.

Methods: Human NPCs are treated with EC23 to caudalize their regional identities to the cervical region of the spine. The NPCs are also treated with purmorphamine, a Sonic hedgehog agonist, to induce development into p2 progenitors. For V2a differentiation, the NPCs are treated with DAPT to inhibit Notch-1 signaling. For V2b differentiation, the NPCs are treated with Jagged-1, a Notch-1 agonist. qPCR is used to identify a progenitor identity (Nestin, Pax6, Sox2 upregulation), V2a identity (VSX2, Sox14 upregulation) or a V2b identity (Gata3, Foxn4 upregulation). Electrophysiology will be used to confirm the formation of mature, functional gabaergic (V2b interneurons) and glutamatergic (V2a interneurons) synapses. Confocal fluorescent imaging will be used to verify the percentage of Gata2 and VSX2 positive cells which form mature gabaergic (GAD67 positive) and glutamatergic (VGLUT2 positive) interneurons.

Results: Future qPCR experiments are expected to demonstrate upregulation in VSX2 and SOX14 for V2a cultures and upregulation in Foxn4 and Gata2 for V2b cultures. The expression of these markers will be used to determine when the NPCs have been biased to either a V2a or V2b fate.

Conclusions: V2a and V2b biased NPCs would be ideal transplantation candidates following cervical SCI, as they will facilitate improved functional recovery after injury over unbiased NPCs. The interneuron-biased NPCs would more effectively integrate into spinal circuits and aid in the re-establishment of the excitatory/inhibitory balance.

Abstract # 12

Title: Spinal Curvature Prediction with 3D CT Images in Coronal and Sagittal Planes

Authors and Affiliations: Geoff Klein[1,2], Isaac Carreno[5,6], Joel Finkelstein[4,5,6], Arjun Sahgal[1,3] , Jay Detsky[3], Cari Whyne[1,4], Anne Martel [1,2] , Michael Hardisty[1,4]

1Physical Sciences, 5Division of Spine Surgery, 6Orthopaedic Surgery, Sunnybrook Research Institute;
Department of 2Medical Biophysics, 3Radiation Oncology, 4Surgery, University of Toronto
Purpose:

Purpose: Vertebral metastases can lead to biomechanical instability, pain, and neurological compromise. Stereotactic body radiation therapy (SBRT) delivers high-dose focal treatment to tumours. A significant side effect of SBRT is vertebral compression fracture, occurring in 10% to 40% of patients following SBRT. Spinal malalignment (scoliotic and kyphotic deformity) has been shown to be related to vertebral fracture risk following SBRT. However, the current evaluation of spinal malalignment can be timeconsuming with substantial inter-observer variation. As such, an automated algorithm to evaluate Cobb angle in 3D CT scans was developed and applied to patients with spinal metastasis treated with SBRT.

Methods: A deep learning-based end-to-end vertebral instance segmentation model was developed using an open dataset of labelled CT images of the spine (VerSe 2019, 2020). This model can anatomically localize, segment, and classify individual vertebrae in a 3D CT scan. This enabled automated quantification of the Cobb angle in both the coronal and sagittal planes from the gradient of a spline curve through the vertebral body centroids. This model was applied to patients treated with spine SBRT for metastatic tumours in the bony spine at the Odette Cancer Centre and Sunnybrook Health Science. CT scans used for the planning of SBRT were processed by the model. Ground truth manual Cobb angle measurements (107 in the coronal and 96 in the sagittal plane) were performed by an orthopedic spine surgeon receiving fellowship training.

Results: The ground truth measured angles ranged from 0°-33.1° in the coronal plane and 0.6°-64.2° in the sagittal planes. Automated Cobb angle measurement agreed with the expert measurements with a mean P 5 University of Toronto Spine Program absolute error of 5.25±5.2° and 7.1±6.2° in the coronal and sagittal planes, respectively. The model results were equivalent or better than separate automated methods for coronal and sagittal Cobb angle measurements in isolation made on 2D X-ray images.

Conclusions: A fully automated algorithm was constructed to measure Cobb angles for both scoliotic and kyphotic deformity assessment from 3D CT scans. The performance accuracy on imaging from patients with spinal metastases suggests it may be utilized in Spinal Instability Neoplastic Scoring (SINS). Future work will focus on combining automated angle measurements with other image features related to fracture risk and clinical workflow integration.

Abstract # 13

Title: Comparing Immunosuppressed Spinal Cord Injury Rat Models for Human Neural Progenitor Cell Xenotransplant Studies

Authors and Affiliations: Zijian Lou[1, 2*], Alex Post[1,2 *,] Narihito Nagoshi[1,4], Nader Hejrati[1], Jonathon Chon Teng Chio[5], Mohamad Khazaei[1§], and Michael G. Fehlings[1, 2, 3,§]

1 Division of Genetics and Development, Krembil Brain Institute, University Health Network, Toronto, ON M5T 0S8, Canada.
2 Institute of Medical Sciences, University of Toronto, Toronto, ON M5S 1A8, Canada.
3 Department of Surgery, University of Toronto, Toronto, ON M5T 1P5, Canada.
4 Department of Orthopaedics, Keio University, Minatro City, Tokyo, JPXV+H5 Minato City, Japan
5 Tulane University School of Medicine, New Orleans, LA 70112, United States

Purpose: Current preclinical research on neural progenitor cell (NPC) transplantation to treat spinal cord injury (SCI) relies on clinically relevant animal models to test efficacy and safety of prospective treatments. Given their potential role as an autologous cell source, human-derived induced pluripotent stem cell (iPSC) NPCs are of particular relevance when designing studies with clinical applicability. However, immune system mediated rejection of grafts is one of the challenges when studying human cells in animal models. In this study, we aimed to determine the optimal immunosuppression method in terms of viability of the grafted cells and health of the animals when studying effects of grafted human NPCs in the injured spinal cord of rats.

Methods: We compared the viability of grafted human cells in rats that were either treated with an immunosuppressive agent (Tacrolimus, Cyclosporin A, or Mycophenolate Mofetil), or of an immunodeficient strain (athymic nude rats, and X-SCID rats), in the context of a clinically relevant cervical SCI model.

Results: Immune cells were shown to have infiltrated the injured spinal cord and persist for up to 2 weeks post- injury. We found that FK506, which had been reported to have a higher potency than CsA in binding calcineurin and inhibiting T cell proliferation, resulted in the highest level of cell survival among the immunosuppressants tested. NPCs transplanted into athymic nude rats displayed similar amounts of cell survival as the most effective immunosuppressant options, with better overall health for the animals. Conclusions: The athymic nude rat breed is the best balance of risk and benefits for in vivo studies involving NPC transplantation in SCI, as they require less skilled labour to maintain the immunosuppression and result in a better quality of life for the animals. Moreover, without confounding influences from immunosuppressant co-administration, it is easier to elucidate the effects of treatments.

Abstract # 14

Title: The development of the Boot Camp smartphone app to increase physical activity in older adults suffering from degenerative lumbar spinal stenosis

Authors and Affiliations: Joshua Plener DC,[1, 2] Mette Jensen Stochkendahl PhD,[3, 4] Corey Hofkirchner DC,[5] Aksa Ahmed DC,[6] James Young DC, MSc,[1,3] Michael Schneider DC, PhD,[7] Paul Taenzer PhD, CPsych,[8] John Flannery MD,[9, 10] Carlo Ammendolia, DC, PhD[2, 6, 11]

1) Division of Graduate Education, Canadian Memorial Chiropractic College, Toronto, Canada
2) Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Canada
3) Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark
4) Chiropractic Knowledge Hub, Odense, Denmark
5) Private Practice, Toronto, Ontario
6) Department of Medicine, Mount Sinai Hospital, Toronto, Canada
7) Department of Physical Therapy, University of Pittsburgh, Pittsburgh USA
8) Department of Physical Medicine and Rehabilitation, Queens University, Kingston, Canada
9) Toronto Rehabilitation Institute, University Health Network, Toronto, Ontario
10) Department of Medicine, Toronto General Research Institute, Institute of Medical Science, University Health Network, Toronto, Ontario
11) Department of Surgery, University of Toronto, Toronto, Canada

12)

Purpose: Only 4% of people with lumbar spinal stenosis (LSS) causing neurogenic claudication meet the recommended minimal daily requirement for physical activity. Limited daily physical activity and associated high sedentary time significantly increases risk for further functional decline, developing other serious co-morbid conditions and premature death in this population. The Boot Camp Program for LSS is a 6-week comprehensive self-management program, which has shown in RCTs to significantly improve pain, walking distance and functional abilities. However, it is uncertain whether this program can improve real life daily physical activity (physical performance). Smartphone physical activity apps have shown promise in their ability to increase physical performance in older adults. The objective of this study is to use intervention mapping to develop a smartphone app that is used alongside the Boot Camp program, with the goal of increasing activity in this population

Methods: Intervention mapping was used to systematically develop a smartphone app through literature searches and stakeholder (clinicians, researchers, and end-user consumers) consensus meetings. First, matrices pairing modifiable determinants and performance objectives were developed, consisting of statements of what needs to occur in order to improve patients physical activity. This was completed for the patient, health care professional, family/friends, and peers with LSS, in addition to modifiable environmental factors. Second, the required steps to achieve the performance objectives were translated into practical strategies through the linking of behavioral change techniques (BCTs), which are intervention components designed to alter behaviour and promote physical activity. Third, in consultation with the app developer, the selected BCTs and interventions were further distilled into practical components in order to create a smartphone app.

Results: A smartphone app aimed at increasing physical performance in LSS was developed. Education, goal setting, feedback/reminders, physical exercises, motivational messaging, and peer-to-peer interactions were operationalized into a smartphone app, designed to be delivered in conjunction with the comprehensive Boot Camp program.

Conclusions: This evidence-based smartphone app aims to increase physical performance in older adults suffering from LSS. Next steps include assessing the utility and feasibility of the app through pilot-testing and semi-structured interviews with patients.

Abstract # 15

P 39

Title: Eligibility criteria of participants in randomized control trials assessing non-operative management of cervical radiculopathy: A systematic review

Authors and Affiliations: Joshua Plener DC,[1,2] Sophia da Silva-Ooulop DC, FCCS (C),[1] Daphne To DC, FCCS (C),[3] Ben Csiernik BSc,[4] Jocelyn Cox DC, FCCS (C),[1] Ngai Chow DC, FCCS (C), MSc,[5] Sheilah Hogg-Johnson MMath, PhD,[6-8] Carlo Ammendolia, DC, PhD [2,9,10]

1) Division of Graduate Education, Canadian Memorial Chiropractic College, Toronto, Canada
2) Institute of Health Policy, Management and Evaluation, University of Toronto, Canada
3) Department of Clinical Education, Canadian Memorial Chiropractic College, Toronto, Canada
4) Undergraduate education, Canadian Memorial Chiropractic College
5) Private Practice, Toronto, Ontario
6) Department of Research and Innovation, Canadian Memorial Chiropractic College
7) Dalla Lana School of Public Health, University of Toronto
8) Institute for Disability and Rehabilitation Research Faculty of Health Sciences, Ontario Tech University
9) Department of Medicine, Mount Sinai Hospital, Toronto, Canada
10) Department of Surgery, University of Toronto, Toronto, Canada

Purpose: In randomized controlled trials (RCT), ensuring appropriate patients are included with the condition of interest is critical, in order to provide the best available data on treatment efficacy/effectiveness and allow for homogeneity when comparing study results. A 2012 systematic review identified a lack of uniformity for the eligibility criteria of participants in RCTs evaluating nonoperative interventions for cervical radiculopathy (CR). Since then, a large number of RCTs have been published, signalling the need for an updated evaluation of this topic. The aim of this study was to evaluate the inclusion and exclusion criteria for participants in RCTs assessing nonoperative management for CR, to determine if any consensus exists within the literature.

Methods: We electronically searched MEDLINE, CENTRAL, CINAHL, Embase, and PsychINFO from inception to April 30, 2021 to identify RCTs assessing nonoperative management of CR. Information regarding the inclusion and exclusion criteria were extracted and analyzed to determine the level of homogeneity and/or heterogeneity across studies.

Results: We retrieved 2,367 articles from the databases, with 441 records removed due to duplicates leaving 1,926 title and abstracts screened and 126 full-text articles assessed. Seventy RCTs met our inclusion criteria with 4 trials reporting results across multiple papers, resulting in 62 distinct trials analyzed. The inclusion of arm pain with or without another symptom (i.e. numbness, paraesthesia or

weakness) was required in 66.13% of trials, 50% of trials required participants to exhibit neck symptoms, and 72.6% of studies required some form of clinical examination findings, but inconsistencies existed for the number and type of tests used. Furthermore, the minority of trials included imaging, with 16.4% of trials requiring MRI. The most common exclusion criteria stated were the presence of red flags and cervical myelopathy in 64.5% and 59.7% of trials respectively.

Conclusions: Overall, there is still a lack of uniformity for the inclusion/exclusion criteria of trials assessing the nonoperative management of CR. However, compared to the 2012 review, some improvements are noted such as a greater number of trials requiring physical examination and/or diagnostic imaging tests, rather than solely relying on patient reported symptoms. Future research to develop standardized inclusion and exclusion criteria to improve consistency among studies is an important next step.

Abstract # 16

Title: Preliminary Investigation of Transvertebral Passive Acoustic Mapping for Treatment Monitoring of Focused Ultrasound-based Therapies of the Spinal Cord Through Numerical Methods

Authors and Affiliations: Andrew Frizado[1,2], Meaghan O'Reilly[1,2]
1 University of Toronto, Department of Medical Biophysics
2 Sunnybrook Research Institute

Purpose: Drug delivery the spinal cord is incredibly limited due to the presence of the blood-spinal cord barrier (BSCB). Focused ultrasound (FUS) can be used, in combination with ultrasound (US) contrast agents (microbubbles; MBs), to non-invasively open the BSCB at safe US exposure levels. These microbubbles are mechanically driven by FUS, aiding in barrier opening and providing feedback/contrast through pressure-dependant acoustic emissions, known as acoustic signatures. Passive acquisitions of these microbubble emissions can be beamformed to provide a spatiotemporal measure of bubble activity, and in turn, the mechanisms that induce the bioeffect. This is known as Passive Acoustic Mapping (PAM), and is complicated in the context of the spine, due to the highly heterogeneous acoustic paths that sound must traverse from skin to spinal cord and vise-versa.

Methods: Using CT-derived acoustic property maps of ex-vivo stacked human vertebra, time-domain FUS (forward) and microbubble (inverse) emission acoustic simulations were performed using the kWave

US modelling toolbox in MATLAB. A simulated spine-specific phased array was used in receive mode for trans-vertebral signal detection. Signals were then beamformed using the passive Time Exposure Acoustics (TEA) algorithm and its 'short-time' forms. Considerations for unwanted, pre-focal emission interference (vertebral laminae + spinalis muscles) were also interrogated.

Results: To investigate the transvertebral detection of intra-canal MBs, acoustic emissions from short burst sonications were simulated as single point source locations along the axial, lateral and vertical directions, then sampled across over these 150 locations in 10 vertebrae. Using TEA beamforming, source localization error was 1.3 +/- 1.1 mm, with peak side-lobe ratio of 0.43 +/- 0.14, both of which were improved via phase-correction methods to 0.4 +/- 0.5 mm and 0.36 +/- 0.7, respectively. In the presence of pre-focal sources, localization of intra-canal sources was disrupted when using TEA and its 'short-time' form algorithms, due to suspected pre-focal interference.

Conclusions: With the spine-optimized aperture, beamforming through the vertebra appears to be feasible when isolating single MBs. Further work regarding pre-focal and canal source interactions, and their suppression, will be required to mitigate their disruption on localization abilities and the resulting ability to robustly monitor FUS+BSCB opening.

Abstract # 17

Title: Simulation-corrected Focusing in the Vertebral Canal:

Authors and Affiliations: David Martin, and Meaghan O'Reilly
University of Toronto, Sunnybrook Research Institute

Purpose: Ultrasound-mediated drug delivery to the spinal cord has great potential to improve treatment of CNS pathologies. The irregular geometry and variable density of the spinal column necessitates treatment planning for controlled focusing to the human vertebral canal. This study evaluates the fidelity of two simulation-based phase correction methods for transvertebral focusing applications ex vivo benchtop experiments.

Methods: Benchtop experiments were conducted in degassed, deionized water using a prototype spine-specific phased array and segment of ex vivo thoracic human vertebrae. Individual vertebrae were mounted in the tank and phase corrections were calculated with 4 methods: geometric (water-case) time-of-flight measurements, a steady-state ray acoustics simulation (in-house), a time-dependent pseudospectral model (k-Wave), and benchtop hydrophone measurements (gold standard). Phase-

corrected transvertebral sonications were performed with a 400 kHz Gaussian-windowed pulse. Focal plane measurements were recorded by scanning a needle hydrophone across the vertebral canal.

Results: Preliminary results were recorded for 4 vertical positions in a single vertebra (T9). Geometric orrection resulted in mean XZ targeting error of 1.5±0.4 mm and mean YZ targeting error of 0.9±0.2 mm. Gold-standard hydrophone correction reduced mean XZ error to 0.8±0.6 mm and mean YZ error to 0.6±0.1 mm, while increasing mean pressure by 9±3% relative to the geometric case. Ray acoustics produced a mean XZ error of 1.2±0.6 mm and a YZ error of 0.5±0.3 mm and a mean change in target pressure of 0±2% relative to the geometric case. The k-Wave corrected focus had mean XZ error of 1.2±0.6 mm, mean YZ error of 0.7±0.2 mm, and a mean decrease in target pressure of 2±5% relative to the geometric case.

Conclusions: Simulation-corrected focusing decreases targeting error relative to the geometric case when focusing a phased array into the vertebral canal. However, simulation-based methods do not improve target pressure relative to the geometric case. Further experiments will determine the limits of simulation-corrected FUS in the spinal canal.

Abstract # 18

Title: Current Practice of Acute Spinal Cord Injury Management: Results of an International Survey

Authors and Affiliations: Nader Hejrati[1,2], Ali Moghaddamjou[1,2,3], James Guest[4], Brian Kwon[5], James Harrop[6], Vafa Rahimi-Movaghar[7], Shekar Kurpad[8], Bizhan Aarabi[9], and Michael G. Fehlings[1,2,3]

1 Toronto Western Hospital, University Health Network, Krembil Neuroscience Centre, Toronto Western Hospital, Toronto, ON, Canada
2 University of Toronto, Division of Neurosurgery and Spine Program, Department of Surgery, Toronto, ON, Canada
3 University of Toronto, Institute of Medical Science, Toronto, ON, Canada
4 University of Miami, Miller School of Medicine, Department of Neurological Surgery, Miami, FL, United States
5 University of British Columbia, Department of Orthopaedics, Vancouver, BC, Canada
6 Thomas Jefferson University Hospital, Department of Neurological and Orthopaedic Surgery, Philadelphia, PA, United States
7 Tehran University of Medical Sciences, Sina Trauma and Surgery Research Center, Tehran, Iran
8 Medical College of Wisconsin, Neurosurgery, Wauwatosa, WI, United States
9 University of Maryland, School of Medicine, Neurosurgery, Baltimore, MD, United States

Purpose: Translational research on the importance of secondary injury mechanisms has promoted development of management strategies for patients with acute spinal cord injuries (SCIs). These findings have been adopted in guidelines such as the 2013 AANS/CNS and the 2017 AOSpine guidelines on SCI management. The goal of this study was to examine current international practices as well as knowledge,

adoption, and barriers to guideline implementation around three key areas of acute SCI management: administration of steroids, hemodynamic management, and timing of surgical decompression

Methods: A survey was distributed to members of AOSpine International on October 1st, 2021. The questionnaire was structured into 1) demographic data and preferred practices surrounding 2) steroid use, 3) hemodynamic management and 4) timing of surgical decompression. Data were analyzed in Stata version 16.1.

Results: 593 members completed the survey including orthopaedic surgeons (54,3%, n=319), neurosurgeons (35.6%; n=209), and traumatologists (8.4%; n=49). Most [61.2% (n=352)] respondents were from low and middle-income countries (LMICs) with 38.8% (n=223) from high income countries (HICs). 53.6% used steroids as a neuroprotective option (n=256). Respondents from LMICs were more likely to administer steroids than HICs (178 vs. 78, p <.001). Interestingly, AIS A patients were less likely to receive steroids (72.6%; n=185), than AIS B (82.8%; n=211) and AIS C patients (76.5%; n=195).

331 respondents (81.5%) answered that patients would receive mean arterial pressure (MAP) targeted treatment. In LMICs, SCI patients were less likely to be provided with MAP-targeted treatment (76.9%, n=193) as compared to HICs, (89%, n=138; $p < .05$).

The majority of respondents (87.8%) reported that patients would benefit from early decompression. Despite overwhelming evidence and surgeons' responses that would offer early surgery, 231 (62.4%) stated they encounter logistical barriers in their institutions. This was particularly evident in LICs and MICs, where 129 respondents (57.9%) indicated that early intervention would be rather unlikely to accomplish ($p < .001$).

Conclusions: This survey highlights challenges in the implementation of standardized practice in the management of acute SCI. Future research efforts will need to refine SCI guidelines and address barriers of guideline implementation, such as logistic hurdles in the implementation of early decompressive surgery.

Abstract # 19

Title: Modified Frailty Index Predicts Functional and Neurological Outcome in Elderly Patients with Degenerative Cervical Myelopathy: An Analysis of a MultiCentre Prospective Dataset of 757 Patients

Authors and Affilations: Karlo M. Pedro, MD, Ali Moghaddamjou, MD, Michael G. Fehlings, MD, PhD

Toronto Western Hospital

Purpose: The objective of this study is to evaluate the association between modified frailty index and mJOA at 24 months after surgery among elderly with DCM

Methods: The outcomes of patients older than 70 years of age with a diagnosis of DCM undergoing surgery was analyzed using the multicentre, prospectively acquired AO Spine-CSM-North America and International study data set which enrolled a total of 757 patients. Clinical information, comorbidities, mJOA score and surgical variables were compared between frail and non-frail elderly patients. Frailty was assessed using the mFI-5, and patients were categorized as non-frail (0/5), pre-frail (1/5), frail (2/5) and severely frail ($\geq$3/5). Functional (mJOA) and disability outcome (NDI) were compared at baseline and at two-years postoperatively. A multivariate logistic regression analysis was used to identify significant factors associated with change in mJOA (ΔmJOA).

Results: The mean age of the cohort, which included 100 patients, was 75.6 years with no significant difference in sex, smoking status, baseline mJOA and NDI scores and race between the frail and non-frail groups. At two years, both cohorts showed functional improvement from baseline but the difference was not statistically significant (ΔmJOA 2.77 vs 2.08, p = 0.901). A similar pattern was observed when patients were stratified into different mFI groups (p value = 0.069). There is a significant correlation, however, between mJOA change at 24 months and mFI-5 score as demonstrated in a linear regression model (R = -0.67, p = 0.046). Using multivariate analysis, a higher mFI score (mFI$\geq$3) is associated with lesser magnitude of mJOA change from baseline with results reaching statistical significance in severely frail elderly patients (p = 0.05).

Conclusions: mFI score of $\geq$3/5 variables were associated with higher risk of poor functional outcome following surgery for DCM. The mF1-5 can be used to stratify elderly patients with DCM and could be a valuable tool to counsel patients and families around anticipated outcomes and to target patients with modifiable medical comorbidities for an Enhanced Recovery after Surgery (ERAS) protocol.

Abstract # 20

Title: Dural closure with non-penetrating titanium clips in spine surgery: a comparative single-center study

Authors and Affiliations: Johann Hofereiter, Martin Gagliardi, Sho Akahori, Jefferson R. Wilson, Christopher D. Witiw, Howard J. Ginsberg

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

Purpose: Postoperative cerebral spinal fluid (CSF) leakage constitutes a troublesome complication in spine surgery and could lead to severe consequences. Intradural lesions are particularly susceptible to this occurrence hence a watertight dural closure is required. The standard technique comprises suturing the dura mater. More recently, dural closure using nonpenetrating titanium clips (hemoclips) has been proposed as an effective technique. Accordingly, we aimed to compare the effectiveness of these techniques in preventing postoperative CSF leaks in patients undergoing intradural spinal surgery.

Methods: We analyzed a cohort of adult patients diagnosed with intradural spinal lesions (e.g. tumour, vascular) treated with surgery between 2014 and 2021. Dural closure was performed either with hemoclips or sutures. We reviewed the medical reports, the preoperative and postoperative MRI imaging. The primary outcomes were the occurrence of pseudomeningocele, clinical evidence of CSF leak, and the rate of revision surgery due to CSF leak. In addition, we assessed for interference in the radiological follow-up due to the closure material. The independent t-test and Mann-Whitney test were used to determine differences in parametric and non-parametric continuous variables. Fisher's exact test was used to determine differences in categorical variables between the two cohorts. Statistical significance was set at $P < 0.05$.

Results: A total of 112 patients diagnosed with intradural spinal lesions operated on from 2014 to 2021 were analyzed. After thorough assessment for inclusion and exclusion criteria, 24 were excluded; thus, 88 participants were enrolled in the study. Age, sex, and the interval between the surgery and the MRI assessed for pseudomeningocele were similar in both groups. About the primary outcomes, there was no significant difference in the rate of pseudomeningocele (n=6 suture group vs. n=4 hemoclip group, p=0,92). No patient had clinical evidence of CSF leak or required revision surgery due to CSF fistula. In addition, no significant artefacts were noticed on postoperative MRI imaging.

Conclusions: This study showed that the occurrence of radiological or clinical CSF leakage after an intradural spine procedure was similar in patients who underwent dural closure with hemoclips or sutures. Furthermore, hemoclips did not interfere with the evaluation of postoperative imaging.

Abstract # 21

Title: Regulatable Expression of GDNF and ChABC in Human iPSC-derived NPCs

Authors and Affiliations: Noah D. Poulin[1,2], Koby Baranes[1], Mark R. Kotter[1], Michael Fehlings[2]
[1]Department of Clinical Neurosciences, University of Cambridge, Cambridge, UK
[2]Krembil Research Institute, Toronto Western Hospital, Toronto, CA

Purpose: Chondroitinase ABC (ChABC) and glial-derived neurotrophic factor (GDNF) infusion combined with neural precursor cell (NPC) transplantation have been explored in the context of acute spinal cord injury (SCI). However, the efficacy of these approaches in chronic SCI is limited by poor graft survival, aberrant differentiation, and the need for invasive repeated delivery. The inducible expression of GDNF and ChABC from transplanted NPCs has the potential to overcome these limitations while combining two strategies of promoting neuroprotection and regeneration. Grafted NPCs contribute to host cell survival through innate paracrine signalling, help restore synaptic connectivity, and myelinate host axons. Second, the *ex-vivo* genetic engineering of graft cells allows for regulatable local delivery of growth and plasticity-promoting factors while bypassing the blood-spinal-cord barrier: GDNF-secreting NPCs and combined delivery of NPCs with ChABC significantly increases therapeutic efficacy. While *ex-vivo* gene therapy strategies using neurotrophic factors have shown promise in pre-clinical studies, these have been mostly limited to non-inducible systems. Here, we used a dual safe harbour-targeting tetracycline-inducible control system, OPTi-OX, that provides superior control of gene expression by overcoming silencing.

Methods: Human induced pluripotent stem cells (iPSCs) were targeted at the ROSA26 and AAVS1 safe harbour sites with rtTA and GDNF/ChABC, respectively. Genotyping confirmed homozygous site-specific transgene integration without off-target integration. These iPSC lines were differentiated to neural progenitor cells using dual SMAD inhibition and NPC identity was verified using qPCR and immunohistochemistry. Immunoblotting and qPCR were used to measure GDNF and ChABC expression *in-vitro*. ChABC function was measured using the Morgan-Elson assay and neurite outgrowth assays.

Results: Western blotting and qPCR confirmed doxycycline-inducible expression and secretion of GDNF and ChABC. Withdrawal of doxycycline resulted in rapid downregulation of GDNF/ChABC expression. Functional assays confirmed ChABC activity *in-vitro*.

Conclusions: Dual safe harbour targeting of a tetracycline-inducible system enables robust regulatable expression of GDNF and ChABC in human iPSC-derived NPCs, which should be further evaluated in pre-clinical models of spinal cord injury.

Abstract # 22

Title: Neural Stem Cells paired with autoregulated Chondroitinase ABC (ChABC) as a therapeutic option post spinal cord injury

Authors and Affiliations: Oliver Zhang, Mohamad Khazaei, Jacky Lou, Sogolie Kouhzaei, Michael Fehlings

Purpose: Post-traumatic inflammation and ischemia leading to the formation of a microcavity and a glial scar in the chronic phase of spinal cord injury (SCI). A glial scar forms around the site, partially composed of CSPG which *in vitro* are inhibitory to axon growth. Bradbury et al. (2002) found that using intrathecal ChABC promoted regeneration of ascending sensory projections and descending corticospinal tract neurons. Previous work from Fehlings lab (Karemi-Abdolrezaee, S. et al, 2010) found that intrathecal administration of ChABC optimizes neural progenitor cell (NPC) transplantation in chronic SCI, resulting in extensive migration, promoted axonal integrity and plasticity of corticospinal tract, improved neurobehavioural recovery. This project focuses on the comparison between two promoters for ChABC – a more traditional tet-on promoter in comparison with an autoregulated promoter which is activated in the presence of CSPG.

Methods: Rats will receive a spinal cord injury though a clip-contusion protocol. Various behaviour tests will be used to gage recovery and effectiveness of both promoters, including catwalk, inclined plane, grip strength and Montoya reaching test. Twelve weeks after transplantation, the animals will be sacrificed and immunohistochemistry will be performed.

Results: We have yet to have experimental results, however we are in the midst of processing our data.

Abstract # 23

Title: Glutamate activates a proliferative and astrogliogenic program in ependymal stem cells: implications for regenerative therapeutic translation

Authors and Affiliations: Laureen D. Hachem[1,2], James Hong[2], Alexander Velumian[2], Andrea J. Mothe[2], Charles H. Tator[1,2], Michael G. Fehlings[1,2]

1 Krembil Research Institute, University Health Network, Toronto, ON M5T 2S8, Canada
2 Division of Neurosurgery, Department of Surgery, University of Toronto, Toronto, ON M5T 2S8, Canada

Purpose: The adult spinal cord contains a population of multi-potent ependymal-derived neural stem/progenitor cells (epNSPCs) which are normally quiescent but are acutely activated to proliferate, differentiate, and migrate after spinal cord injury (SCI). Once activated, epNSPCs serve as critical players in promoting endogenous regeneration and functional recovery. Activation of epNSPCs remains limited to the acute injury period and thus, strategies that harness their regenerative potential after subacute or chronic injury hold great promise in enhancing endogenous repair and regeneration. A major barrier to unlocking the therapeutic benefits of epNSPCs has been a limited understanding of the mechanisms that regulate their activation in response to SCI. Recently, we discovered that excitotoxic levels of glutamate, a hallmark in the pathophysiology of acute SCI, promote epNSPC proliferation and survival *in vitro*. In this study, we characterize the downstream mechanisms involved in this response and examine a therapeutic strategy targeting this mechanism to enhance endogenous regeneration after SCI.

Methods: epNSPCs were isolated from the central canal region of the adult spinal cord, cultured, and treated with glutamate in the presence and absence of pharmacological inhibitors of glutamate receptors *in vitro*. Cell survival, differentiation and pathway analysis were conducted using a combination of immunohistochemistry, RNA sequencing and Western Blot. *In vivo*, SCI was induced in adult rats and the positive AMPA receptor modulator, CX546, was administered starting 1-week post-SCI. Animals underwent behavioural and histological analysis.

Results: Glutamate leads to calcium influx in spinal cord epNSPCs via AMPA receptors and this change in calcium in concert with Notch signaling serve to increase the proliferation of epNSPCs via phosphorylated CREB, and induce astrocytic cell fate specification through Hes1 upregulation *in vitro*. Furthermore, positive allosteric modulation of AMPA receptors subacutely after SCI *in vivo* enhances epNSPC proliferation, astrogliogenesis, increases neurotrophic factor production and promotes neuronal survival and early functional recovery.

Conclusions: Our study uncovers an important mechanism by which glutamatergic signaling via AMPA receptors alters the proliferation and phenotype of spinal cord epNSPCs. Pharmacological modulation of AMPA receptor signaling offers an important therapeutic strategy to regulate the fate of epNSPCs and better harness their regenerative potential after SCI.

Abstract # 24

Title: A Canadian-based pilot study of current surgical practice and implant preferences in lumbar fusion surgery

Authors and Affiliations: Cherry, A.[1], Eseonu, K.[2], Ahn, H.[2]

[1] University of Toronto, Toronto, Ontario, Canada

[2] St. Michaels' Hospital, Toronto, Ontario, Canada

Purpose: Lumbar fusion surgery is an established procedure for the treatment of several spinal pathologies. Despite numerous techniques and existing devices, common surgical trends in lumbar fusion surgery are scarcely investigated. The purpose of this Canada-based study was to provide a descriptive portrait of current surgeons' practice and implant preferences in lumbar fusion surgery.

Methods: Canadian Spine Society (CSS) members were sampled using an online questionnaire which was based on previous investigations performed in the United Kingdom. Fifteen questions addressed the various aspects of surgeons' practice: fusion techniques, implant preferences, and bone grafting procedures. Responses were analyzed by means of descriptive statistics.

Results: Of 139 eligible CSS members, 41 spinal surgeons completed the survey (29.5%). The most common fusion approach was via transforaminal lumber interbody fusion (TLIF) with 87.8% performing at least one procedure in the previous year. In keeping with this, 24 surgeons (58.5%) had performed 11 to 50 cases in that time frame. Eighty-six percent had performed no lumbar artificial disc replacements over their last year of practice. There was clear consistency on the relevance of a patient specific management (73.2%) on the preferred fusion approach. The most preferred method was pedicle screw fixation (78%). The use of stand-alone cages was not supported by any respondents. With regards to the cage material, titanium cages were the most used (41.5%). Published clinical outcomes data was the most important variable in dictating implant choice (87.8%). Cage thickness was considered the most important aspect of cage geometry and hyperlordotic cages were preferred at the lower lumbar levels.

Autograft bone graft was most commonly preferred (61.0%). Amongst the synthetic options, DBX/DBM graft (64.1%) in injectable paste form (47.5%) was preferred.

Conclusions: In conclusion, findings from this study are in partial agreement with previous work from the United Kingdom, but highlight the variance of practice within Canada and the need for large-scale clinical studies aimed to set specific guidelines for certain pathologies or patient categories

Abstract # 25

Title: The use of Minimally Invasive Navigation Guided Resection of Spinal Osteoid Osteomas and Osteoblastomas

Authors and Affiliations: Cherry, A.[1], Rampersaud, R.[2]

1 University of Toronto, Toronto, Ontario, Canada
2 Toronto Western Hospital, Toronto, Ontario, Canada

Purpose: Osteoid osteomas (OO) and osteoblastomas (OB) are benign bone lesions which present in adolescents and young adults with non-mechanical pain, worse in the evening. Spinal lesions tend to involve the posterior elements and are often not amenable to radiofrequency ablation (RFA). Complete intralesional resection of the nidus has been shown to be curative, however, often requires instrumented spinal fusion. In this study, we sought to demonstrate the feasibility and efficacy of minimally invasive, navigation assisted, anatomy preserving resection for treatment of refractory pain secondary to spinal OOs/OBs as an outpatient procedure.

Methods: Retrospective chart review of six patients treated by a single surgeon between 2018 and 2020. Chart review included patient demographics, clinical assessments, complications, and follow-up clinical outcomes. Indication for operative intervention was a confirmed lesion on pre-operative computed tomography (CT) with clinical symptoms in keeping with OO or OB. Minimum follow up was six weeks post-operatively.

Results: The patient cohort comprised of three males and three females with an average age of 25.4 years at the time of surgery. Reported symptoms were primarily nighttime axial spine pain in all six, and stiffness and radiculopathy in two patients. Symptom duration at time of first consultation ranged from nine to 72 months. Lesions were identified on pre-operative CT and were localized to the articular facet

(n=3), vertebral body (n=2) and sacral body (n=1). Two patients had previous RFA with no resolution of symptoms. Average skin-to-skin operative time was 99.2 minutes (range of 65-154 minutes) with no patients requiring instrumentation or admission. There were no reported peri-operative complications and all patients had resolution of their primary back-focused pain at the first six-week post-operative follow up. Three patients reported subjective lumbar stiffness. One patient was noted to have S1/S2 paresthesias immediate post-operatively with almost complete resolution at six weeks. One patient had questionable recurrence of nidus on CT seven months post-operatively but reported only mild back stiffness with resolution of his pre-operative symptoms. No patients had significant changes to alignment or stability identified on post-operative x-rays.

Conclusions: Outpatient navigation guided minimally invasive targeted resection, without fusion is a feasible and effective treatment in the short-term for symptomatic spinal OO and OB.

Acknowledgement

https://surgery.utoronto.ca/spine-program

UCFcOQ5s7ksDD73lJPnsD4kA

@UofTSpine

/UofTSpine

uoft.spine@utoronto.ca

(416) 978 8468

Make a Gift!

To make a gift in support of UofT Spine Program

Click HERE

Thank you!

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

Surgery
UNIVERSITY OF TORONTO

Spine Program