Surgery
UNIVERSITY OF TORONTO

Spine Program

University of Toronto Spine Program

Integration Collaboration Excellence

VIRTUAL

SPINEFEST 2020

12th ANNUAL SPINE ACADEMIC DAY

2 WEBINARs

Monday June 15 2020 @ 5:pm to 7:30pm EST

Tuesday June 16 2020 @ 5:pm to 6:15 pm EST

VIRTUAL
12TH ANNUAL SPINE ACADEMIC DAY
SPINEFEST 2020

ABOUT SPINEFEST 2020

Learning Objectives:

- The pathomechanisms and treatment options for syringomyelia
- Optimal assessment and management of cervical disorders in Ehlers Danlos syndrome
- Assessment and management of disorders of the craniovertebral junction
- Cutting edge translational research in spine

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, Faculty of Medicine, University of Toronto up to a maximum of 3.5 credit.

Previous Visiting Professors @ Tator – Hall Lecture

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

ABOUT The U OF T SPINE PROGRAM

Vision

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

Integration

The University of Toronto Spine Program is a combined neurosurgery and orthopaedic surgery program 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)

Faculty

TORONTO WESTERN HOSPITAL @ UHN

Michael G. Fehlings MD PhD FRCSC FACS
Stephen Lewis MD MSc FRCSC
Eric Massicotte MD MSc FRCSC
Y Raja Rampersaud MD FRCSC
Alexander Velumian PhD

TORONTO REHABILITATION INSTITUTE @ UHN

Karl Zabjek BSc MSc PhD
Margarete Akens Dr med vet PhD

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

ST. MICHAEL'S HOSPITAL @ UHT

Jefferson Wilson MD, PhD FRCSC
Henry Ahn MD PhD
Howard Ginsberg MD PhD FRCSC
Christopher Witiw MD PhD FRCSC

SUNNYBROOK HEALTH SCIENCES CENTRE /RESEARCH INSTITUTE

Leo da Costa MD
Mahmood Fazl MD FRCSC
Joel Finkelstein MD MSc FRCSC
Michael H. Ford MD FRCSC
Michael Hardisty PhD
Jeremie Larouche MD FRCSC

MOUNT SINAI HOSPITAL

Carlo Ammendolia DC PhD CCRF
Rita Kandel MD FRCPC

UNIVERSITY OF TORONTO

W Mark Erwin PhD DC

Barry W. Malcolm MD FRCSC MBA
Todd Mainprize MD FRCSC
Meaghan O'Reilly PhD
Farhad Pirouzmand MD MSc FRCSC
Arjun Sahgal BSc MD FRCPC
Victor Yang MD PhD PEng FRCSC
Cari Whyne PhD
Albert Yee MD MSc FRCSC
Cindi M Morshead BSc PhD
Molly S Shoichet PhD FRSC

REMARKS FROM PROGRAM CO-DIRECTORS

Colleagues,

What an unprecedented time we are currently living in! The COVID-19 has imposed challenges for our spinal community at multiple levels. This has impacted training, surgical practice, research, clinical care and certainly has adversely affected personal stress and well-being. However, given the resilience and team-work of our community we are confident that we will successfully navigate these challenges and transition to a brighter future.

Around this time of the year, we gather at SpineFEST Day to highlight the accomplishments of our spinal community, as well as to disseminate recent clinical and scientific advances. This year is no exception! We decided to hold our SpineFEST virtually using Zoom Webinar technology. In order to present the conference in a more accessible format, we decided to split the usual all-day event into two evening webinars. On Monday June 15th at 5pm Professor Marcus Stoodley, (Sydney-Australia) will present the Tator-Hall Lecture on the management of syringomyelia. This will be followed by a session on the Craniovertebral Junction with a focus on Ehlers-Danlos Syndrome. On Tuesday June 16th, the second webinar will focus on the research accomplishments of our trainees which will be presented through oral talks and an online e-poster session using VoiceThread technology.

We are very grateful to Dr. Stoodley for agreeing to presenting his lectures virtually and for graciously accommodating our SpineFEST schedule. Dr. Stoodley is the Head of Neurosciences and leads the neurosurgical research team at Macquarie University Hospital in Sydney, Australia – it is one of the largest neurosurgery research groups in Australasia with focused expertise in syringomyelia, CSF physiology, and brain AVMs. In addition to his neurovascular expertise, Professor Stoodley is recognised

internationally for the clinical management of disorders of the craniovertebral junction and syringomyelia. Please join us in welcoming Professor Stoodley to our SpineFEST 2020!

This year the University of Toronto Department of Surgery Spine Program celebrates its 12th Annual Spine Academic Day “SpineFEST”. It has been a productive academic year as our program continues to foster important city-wide collaborations within the University as well as participate and lead on several key regional and international initiatives. Our program has grown a respected academic footprint locally, nationally, and globally. Collaboration, inter-professional, inter-departmental, and inter-disciplinary knowledge exchange remains the key element to our success.

Recent activities have leveraged our education platform that has included the creation of 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 which attracts 12-15 national and international clinical fellows and many visiting surgeons each year.

Over the past years, our program continues to offer both a one-year core fellowship training experience and a two-year fellowship program with first year comprehensive spine training experience followed by second year with more focused and advanced subspecialty exposure. While the fellowships are largely focused at one of the TAHSN hospitals, great options exist for a city-wide experience. Many thanks to Drs. Stephen Lewis, Eric Massicotte, Joel Finkelstein, Howard Ginsberg, Henry Ahn, and Reinhard Zeller for their valued help in shaping our city-wide fellowship training opportunities. Building on our national fellowship curriculum our program also continues with the surgical case-log for our citywide spine fellows. We thank Dr. Jeremie Larouche, Dr. Tony Bateman, and Ms. Nadia Jaber for designing a successful case-log program for our fellows.

Each year we launch our University academic calendar of events with a welcome dinner for our incoming fellows which is combined with an update of our city-wide research opportunities. Thanks to Dr. Carlo Ammendolia and Karl Zabjek for organizing the research meeting. We also organize a mini bootcamp course for our fellows and senior residents on Traumatic Spinal Cord Injury which covers management, clinical trials, case controversies and the detailed ASIA neurological assessment. Thanks to Dr. Sukhvinder Kalsi-Ryan for coordinating the course with Drs. Fehlings, Yee, Jeremie Larouche and Jeff Wilson. Each year, Dr. Stephen Lewis (TWH-UHN & HSC) chairs a city-wide fellow surgical skills course,

introducing advanced anatomy of spine with fellows performing anterior and posterior surgical approaches as well as spinal instrumentation. This year on June 9th, Dr. Lewis extended this course to include advanced complex procedures (e.g. deformity osteotomy, minimally invasive surgery (MIS), and trauma techniques). In compliance with Covid-19 preventive measures our Program managed to facilitate and lead the way for an outstanding surgical skills course with a combination of wet lab, simulation, and virtual faculty lectures/case discussions throughout the day.

For several years now, we continue to complement the resident's surgical training with our Royal College Mock Oral on Spine course Co-Chaired by Drs. Fehlings and Yee. On Feb 12th our city-wide spine fellows took a key leadership role in teaching the residents and organizing a selection of representative case scenarios in examination format. The fellows also provided valuable tips and updated literature reviews. We also host City-Wide Fellow Journal Club several times a year to discuss recent and controversial spine articles and a collection of relevant cases. We thank Dr. Lewis and Dr. Finkelstein for hosting two of our journal clubs on deformity and trauma at their residences. Dr. Fehlings and Dr. Yee also hosted an online Journal Club webinar on COVID-19 and its impact on spine surgery. The program featured Dr. Yongchao Wu, a former U of T fellow, and his first-hand experiences from Wuhan China which included valuable strategies for us towards managing health care services during the pandemic. The webinar was timely, well attended and received quite positive responses.

Our Program continues to invite several world-renowned visiting professors each year to our hospital–based visiting professorship series in order to provide lectures on their area of interest in spine care and research. On November 4th we held the Tator-Turnbull SCI symposium which we host jointly each year with TWH to pay tribute to the enormous contribution of Dr. Charles Tator and Barbara Turnbull in driving SCI research and related advocacy. We thank Dr. Brian Kwon from the University of British Columbia who provided an excellent keynote presentation on translational research in acute spinal cord injury. The event also featured a special talk from Dr. Hideyuki Okano from Keio University-Japan who shared perspective on the challenges of stem cells clinical trials for SCI. On February 4th we also hosted a special lecture featuring our guest speaker Dr. Simon Archibald from Dublin who presented application of regenerative medicine with focus on peripheral nerve and spinal cord injury. Given the current situation, it was unfortunate that we had to postpone a planned May 6th hospital based visiting professorship at SickKids with Professor Dror Ovadia from Israel; we look forward to his postponed visit next year on January 25th.

We would like to take this moment and welcome new faculty to our spinal community. Dr. Christopher Witiw, a spine neurosurgeon at St. Michael's Hospital and Dr. Michael Hardisty, a scientist at Sunnybrook

Research Institute joined our program this past academic year. There have also been numerous awards that we would like to recognize. We congratulate Dr. Fehlings on winning the 2019 Ryman Prize in recognition of his contributions to understanding degenerative cervical myelopathy. Also, congratulations to Drs. Yee and Cari Whyne on receiving the distinction of being named Fellows of International Orthopaedic Research (FIOR) from the International Combined Orthopaedic Research Society (ICORS). Congratulations to Dr. Lewis on his appointment as the Chairman AO Spine Knowledge Forum Deformity and to Dr. Arjun Sahgal on his appointment as the Co-Chair of AO Spine Knowledge Forum Tumor. Dr. Michael Fehlings established and is Past Chair of the AOSpine Spinal Cord injury Knowledge Forum. It is remarkable that three U of T Spine Program surgeons have been recognized by the AO Foundation in this way. We also congratulate Dr. Meaghan O'Reilly on receiving the ISTU Frederic Lizzi Early Career Award and Dr. Jeff Wilson on receiving the Government of Ontario Early Researcher Award and for receiving the Peters Prize from the Department of Surgery.

We also wish to celebrate the graduation of our 2019/2020 city-wide spine fellows (Drs. Allan Martin, Anna Reinmuller, Thorsten Jentzch, Colby Oitment, Hananel Yashuv, Brett Rocos, Kaoru Eguchi, Isaac Carreno, Kunal Bhanot, Eric Crawford, Carolyn Lai, Tan Chen, and Dora Pelletier). We congratulate all our fellows on successful completion of their fellowship and we wish them great success in their professional and personal life.

We would like to thank all our program faculty members and industry partners for their support over many years, and particularly during this unprecedented time. We also wish to recognize the support from the U of T Department of Surgery and Divisions of Neurosurgery and Orthopedic Surgery. We are privileged to benefit from the diverse and specialized expertise of our program membership. Special thanks to Ms. Nadia Jaber, our Program Coordinator, for her outstanding expertise and technological skills which have become of great value in moving forward our collaborative agenda and virtual academic activities during this evolving time.

Sincerely,

Michael & Albert

SPINEFEST 2020 AGENDA

WEBINAR # 1 . SESSION 1

June 15th @ 5:00 PM EST

SESSION 1.A: TATOR- HALL VISITING PROFESSORSHIP LECTURE
SESSION 1.B: CRANIOVERTEBRAL JUNCTION & EHLERS DANLOS SYNDROME

Chair: Michael Fehlings

SESSION 1: A TATOR- HALL VISITING PROFESSORSHIP LECTURE

TIME	LENGTH	TALK	PRESENTER & MODERATORS
5:00	5 MIN	In Memoriam - Todd Mainprize Introductory Comments	Jeff Wilson Michael Fehlings & Albert Yee
5:05	5 MIN	Greetings from the U of T	James Rutka and Richard Hegele
5:10	5 MIN	Tator-Hall Welcome remarks	Charles Tator & Hamilton Hall
5:15	5 MIN	Introduction to the Keynote Speaker	Michael Fehlings
5:55	40 MIN	MANAGEMENT OF SYRINGOMYELIA: IMPACT OF NEW UNDERSTANDING OF CSF PHYSIOLOGY	Visiting Professor: Marcus Stoodley MD PhD, Macquarie University-Sydney-Australia
6:15	20 MIN	Discussions	Moderators: Michael & Albert
6:20	5 MIN	Wrap up to resume after break to SESSION 1-B on CVJ and EDS	Michael Fehlings

5 MIN BREAK. Back at 6:25 pm

SESSION 1: B CRANIOVERTEBRAL JUNCTION & EHLERS DANLOS SYNDROME			
6:25	5 MIN	Introduction to Craniovertebral Junction speakers and panelists	Michael Fehlings
6:30	10 MIN	CRANIO-CERVICAL HYPERMOBILITY, CHIARI, EDS AND ROLE OF FUSION	Jeff Wilson
6:40	10 MIN	CRANIOVERTEBRAL JUNCTION: SYMPTOMS, IMAGING, AND SURGICAL INDICATIONS	Marcus Stoodley
6:50	25 MIN	Panel Discussions **Panelists**: Drs. Marcus Stoodley, Jeff Wilson, Hance Clarke and Mimish Mittal	Michael & Albert
7:15	5 MIN	Award Presentation to Dr. Stoodley,	Michael & Albert
7:20	5 MIN	Wrap up to resume for SESSION 2/ WEBINAR 2 next evening on June 16th at 5:00 pm	Michael & Albert

WEBINAR # 2. SESSION 2

June 16th @ 5:00 PM EST

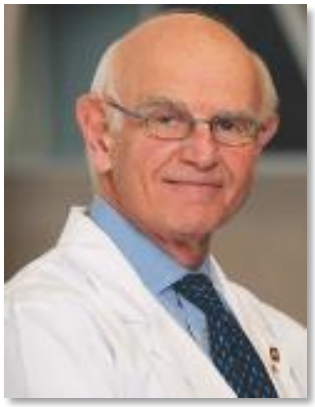
SESSION 2.A: INVITED TRAINEE PRESENTATIONS
SESSION 2.B: BEST ABSTRACTS ORAL PRESENTATIONs & AWARD PRESENTATION

Chair: Albert Yee

SESSION 2.A: INVITED TRAINEE PRESENTATION			
5:00	5 MIN	In Memoriam - Todd Mainprize Introductory Comments	Nir Lipsman Albert Yee & Michael Fehlings
5:05	7 MIN	SENSORY CORTICAL CONTROL OF MOVEMENT	Spyros Karadimas
5:12	7 MIN	LONG TERM COMPARATIVE OUTCOMES FOLLOWING LUMBAR DISK	Tan Chen

		ARTHROPLASTY: A CANADIAN SPINE OUTCOMES RESEARCH NETWORK (CSORN) STUDY	
5:19	7 MIN	CHARLES KUNTZ AWARD WINNING RESEARCH ON THE NATURAL HISTORY OF DCM	Allan Martin
5:26	7 MIN	HOW TO BEND THE ROD FOR SPINAL DEFORMITIES	Colby Oitment
5:31	10 MIN	Panel Discussions	Albert Yee
SESSION 2.B: BEST ABSTRACTS ORAL PRESENTATIONS & AWARD PRESENTATION			
5:41	2 MIN	Introduction	
5:43	7 MIN	REMOTE ISCHEMIC PRECONDITIONING AMELIORATES ISCHEMIA REPERFUSION INJURY ASSOCIATED WITH DECOMPRESSION SURGERY FOR DEGENERATIVE CERVICAL MYELOPATHY	James Hong
5:50	7 MIN	IMAGING-BASED LOCAL CONTROL OUTCOMES SPECIFIC TO SPINE STEREOTACTIC BODY RADIOTHERAPY (SBRT) FOR PROSTATE CANCER METASTASES	Ahmed Abugharib
5:57	10 MIN	Panel Discussions	Albert Yee
6:07	5 MIN	Award presentation	Albert & Michael
6:12	3 MIN	Wrap up of SpineFEST and resume to e-poster viewing session on VoiceThread	Albert & Michael
SESSION ON E-POSTER VIEWING FROM 6:15 PM TO 7:15 PM ON VOICETHREAD CLICK HERE			

TATOR & HALL

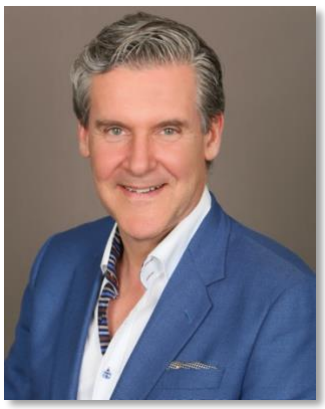


Dr. Charles Tator is a Professor in the Department of Surgery, at the University of Toronto, and a neurosurgeon at the Toronto Western Hospital. He is the former Chair of Neurosurgery at the University of Toronto. He started the first Acute Spinal Cord Injury Unit in Canada in 1974, and has reported 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.

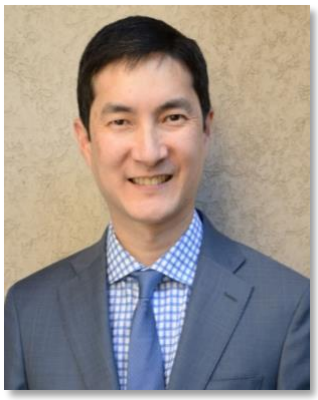
Dr. Hamilton Hall is a Professor in the Department of Surgery at the University of Toronto and on the orthopaedic staff at the Sunnybrook Health Sciences Centre. He completed his medical degree at the University of Toronto then joined CARE and was stationed at a rural hospital in Malaysia. Dr. Hall returned 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 Group, now, with over 13,000 employees, the largest rehabilitation company in Canada. Dr. Hall continues to serve as its Medical Director. 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 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 a Lifetime Achievement Award from the Canadian Spine Society. 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 130 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-DIRECTORS



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.



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.

SESSION 1 SPEAKERS AND PANELISTS

VISITING PROFESSOR & KEYNOTE SPEAKER

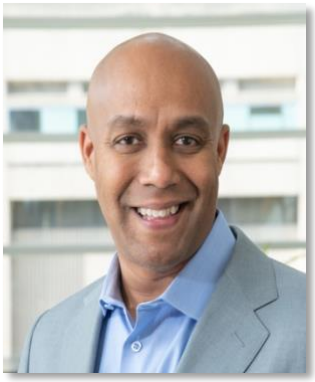
Dr. Marcus Stoodley is head of neurosciences at Macquarie University Hospital. He graduated from the University of Queensland Medical School. After completing neurosurgery training in Australia, he undertook further subspecialty training in vascular neurosurgery at Stanford University and the University of Chicago. Dr. Stoodley heads the neurosurgery research team at Macquarie University. This is one of the largest neurosurgery research groups in Australasia, with research efforts in syringomyelia and CSF physiology, and in the development of new treatments for brain AVMs. This work has attracted over $4 million in research funding. He has produced more than 150 publications and has supervised over 15 postgraduate research students. He has delivered over 80 invited lectures at national and international scientific meetings. In 2012, Professor Stoodley was awarded the John Mitchell Crouch Fellowship, the premier surgical research award of the Royal Australasian College of Surgeons. He has become an Australian leader in cerebral bypass surgery, especially in the treatment of Moyamoya disease and other occlusive disorders. In addition to his neurovascular expertise, Professor Stoodley is recognised internationally for the clinical management of Chiari malformation and syringomyelia.

SPEAKER and PANELIST

Dr. Jefferson Wilson entered the neurosurgery program at University of Toronto after completing his MD at the University of Saskatchewan in 2007. During residency he earned a PhD through IMS and the Surgeon Scientist Program under the mentorship of Michael Fehlings and Abhaya Kulkarni with his research focused on the epidemiology and clinical epidemiology of traumatic spinal cord injury. Jeff's research has been funded by multiple grants from the Christopher and Dana Reeve Foundation, Cervical Spine Research Society and the Ontario Neurotrauma Foundation; further, he has been the recipient of numerous prestigious awards including: the K.G. McKenzie Prize from the Canadian

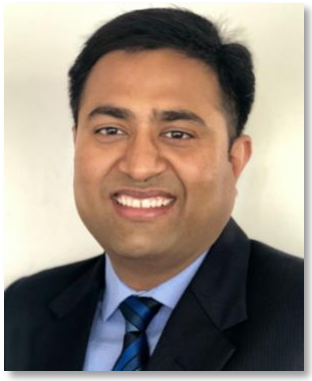
Federation of Neurological Sciences, the Synthes Spinal Cord Injury Award from the American Association of Neurological Surgeon and the Shafie S. Fazel Outstanding Resident Surgeon and Investigator Award from the U of T Department of Surgery. After obtaining his FRCSC in neurosurgery in 2015, Jeff undertook a combined neurosurgery orthopedic fellowship in complex spine surgery at Thomas Jefferson University in Philadelphia, PA under the mentorship of James Harrop and Alex Vaccaro. Jeff returns to Toronto as a Surgeon Scientist at St. Michael's Hospital with clinical focus on the full spectrum of spinal disorders. From a research perspective, he is primarily interested in topics related to the epidemiology and clinical epidemiology of spinal trauma and spinal cord injury. Currently he serves as the Deputy Editor of the journal Clinical Spine Surgery.

PANELIST



Dr. Hance Clarke is the Director of Pain Services and the Pain Research Unit at the Toronto General Hospital (TGH). He is the knowledge Translation Chair for the University of Toronto Centre For the Study of Pain and an Associate Professor in the Department of Anesthesiology and and Pain Medicine. Currently he is the Director of the GoodHope Ehlers Danlos Syndrome Clinic at the Toronto General Hospital. The GoodHope EDS Clinic offers a path-breaking interdisciplinary model to address historical gaps in the diagnosis and treatment of Ehlers Danlos Syndrome (EDS) and hypermobility spectrum disorders (HSD)). In the GoodHope EDS Clinic, experts from various medical specialties work together to provide comprehensive care that addresses the multi-systemic nature of EDS. Dr. Clarke is a champion of evidence-based solutions for the opioid crisis and a national pain and addictions strategy.

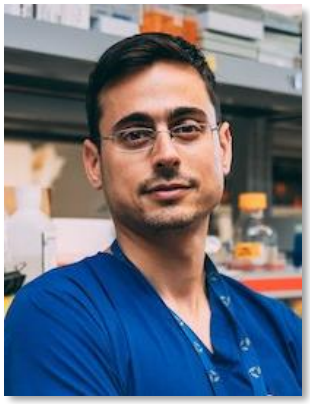
PANELIST



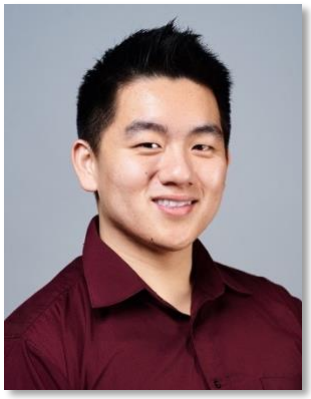
Dr. Nimish Mittal is an Assistant Professor at the University of Toronto, Division of Physical Medicine and Rehabilitation. He holds a full-time Clinical Investigator appointment at the Comprehensive Pain and Musculoskeletal Program at Toronto Rehabilitation Institute. Dr. Mittal is the Medical Lead of Good Hope Ehlers Danlos Syndrome Rare Disease Program, Toronto General Hospital. Dr. Mittal is an active member of the Hypermobile EDS and Hypermobility Spectrum Disorders committee and The Pain working group of the international consortium of Ehlers Danlos Syndrome. He also serves as newsletter liaison of the Regenerative Pain Medicine SIG of the American Society of Regional anesthesia and Pain Medicine

He completed three different fellowships in chromic and interventional pain management and has completed a Master's in Health Research Methodology from McMaster University. Dr. Mittal has a special interest in the development of treatment pathways and models of care for multisystemic issues in hypermobility related complex connective tissue disorders. His other clinical and research interests include comprehensive multimodal pain management, including image-guided injections. He has published several articles in national and international peer-reviewed journals.

SESSION 2 SPEAKERS



Dr. Spyros Spyridon is a third-year neurosurgery resident at the University of Toronto. He completed his medical degree at the University of Athens, Greece and his Ph.D. in Neuroscience at the University of Toronto under the supervision of Dr. Michael Fehlings. Spyros' research is dedicated to investigating the neural networks and motor control in health and disease. Spyros has received numerous international awards for his research including the American Spinal Injury Association Apple Award for the best research in the spinal cord injury worldwide. His research has been published in prestigious journals such as Nature, Nature Neuroscience, Science Translational Medicine and highlighted in Nature Reviews Neuroscience. Spyros intends to pursue his clinical interest in skull base and cerebrovascular surgery and continue to investigate brain circuitries.

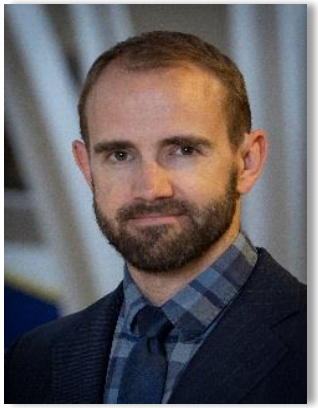


Dr. Tan Chen is a recent graduate from the University of Toronto's orthopaedic surgery residency, and is currently undertaking the combined orthopaedic and neurosurgical spine fellowship based at Sunnybrook and St. Michael's Hospital.

Originally raised in Vancouver BC, Tan moved to New Hampshire to complete his undergraduate degree in neuroscience, before moving again to Michigan for medical school. As an avid competitive fencer, Tan developed his skills while abroad and eventually switched one blade for another when he began his surgical training in Toronto.

Tan is very grateful for the support of his wife, family, friends, and mentors, and lucky to be part of the Toronto spine family. Following fellowship, he will begin practice as a spine surgeon specializing in minimally invasive techniques. Tan would like to thank U of T Spine for the opportunity to speak at this year's SpineFEST.

Dr. Colby Oitment completed his undergraduate training at the University of Toronto in neurosciences, medical training at the University of Queensland, and orthopedic surgical training at McMaster University. He is currently completing a fellowship in complex adult spine surgery at the University of Toronto. Clinically, he is interested in academic adult spinal deformity surgery, the management of traumatic spinal injuries and neoplasms involving the spine. His research interests involves these topics as well as trainee education and teaching. He will be working as a staff spine surgeon at McMaster in July with a clinical scholar position while completing a part time Master's degree in epidemiology and biostatistics.



Dr. Allan Martin is a Spine Neurosurgery Fellow at Toronto Western Hospital. Allan's undergraduate education was in Engineering Science at University of Toronto and he subsequently had a 10-year career in software engineering with IBM prior to medical school, which included obtaining 9 patents for technical innovations. He also completed his medical training at University of Toronto, and completed his PhD research in microstructural spinal cord MRI. He will begin his career as an Academic Spinal Neurosurgeon at University of California, Davis with a clinical specialization in complex spine surgery and deformity, and a research focus in imaging and technology innovation.

Dr. James Hong is a post-doctoral fellow at the Fehlings laboratory at the Krembil Research Institute, Toronto Western Hospital. His doctoral thesis focused on the temporal profiling of local and peripheral changes after traumatic cervical and thoracic injury. He is the author of 11 articles in the field, and currently works on the development of therapies and next-generation sequencing analysis of degenerative cervical myelopathy and traumatic cervical spinal cord injury. He will present the unpublished results of his most recent collaborative work with Dr. Hiroyuki Katoh investigating the efficacy of a non-invasive strategy for enhancing functional recovery following surgical decompression of degenerative cervical myelopathy.

Dr. Ahmed Abugharib graduated from medical school in Sohag University, Egypt, 2006 followed by rotation internship in Sohag University hospital. He completed his residency program in Clinical Oncology Department at Sohag University Hospital in 2011, and his master degree in 2012 followed by his PhD degree in 2019. Ahmed completed two year-fellowship training in Radiation Oncology Department of Michigan University Hospital with research focus on prostate cancer. Anmed is a Clinical Oncologist & Lecturer of Clinical Oncology, Sohag University, Sohag, Egypt, and he is currently enrolled in a

clinical fellowship in CNS unit, radiation Oncology Department at Sunnybrook hospital and University of Toronto.

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ABSTRACT # 1

TITLE: THE CERVICAL SPINE IN ADOLESCENT IDIOPATHIC SCOLIOSIS- THE PREOPERATIVE AND SURGICAL CONSIDERATIONS

AUTHORS AND AFFILIATIONS: Brett Rocos MD FRCS (Tr & Orth) 1; John Hutchinson BAO FFRCS (Tr & Orth) 2;1 Department of Orthopaedic Surgery, Hospital for Sick Children, 555 University Avenue, Toronto, ON, Canada M5G 1XB. 2 Department of Trauma & Orthopaedic Surgery, Southmead Hospital, Bristol, UK BS10 5NB

PURPOSE: The purpose of the cervical spine is to preserve a gaze that is parallel to the ground and maintain sagittal balance whilst allowing a physiological range of movement in the thoraco-lumbar spine. In this study, we have investigated the cervical sagittal profile of a cohort of patients with adolescent idiopathic scoliosis (AIS) and compared them with normal values for the same age group. We hypothesise that patients with AIS show a different cervical sagittal profile to normal both before and after corrective surgery.

METHOD: The local paediatric and adult spinal deformity database was scrutinized for details of patients who underwent corrective surgery for AIS between 2007 and 2011 and had pre- and post- operative radiographs showing the C2 vertebral body and L5-S1 junction on a single image. Each radiograph was examined to identify the Cobb angle between the inferior borders of C2 and C7. The pre and post operative cervical sagittal alignment was compared to normal values found in the literature using a 2 tailed unpaired Students t- test.

RESULTS: This series shows that female patients with AIS who warrant surgical treatment have a hyperkyphosed cervical profile. Male patients do not have a significantly abnormal cervical profile preoperatively. Both genders are more kyphosed than normal patients after corrective surgery.

CONCLUSIONS: We showed that females with AIS have abnormal preoperative cervical kyphosis. Both males and females have exaggerated hyperkyphosis following corrective surgery. Increasing cervical kyphosis could lead to pain and disability and so should be carefully considered in planning corrective procedures.

ABSTRACT # 2

TITLE: THE 3 ROD TECHNIQUE: A SAFE AND EFFICIENT ALTERNATIVE TO 3 COLUMN SPINAL OSTEOTOMIES IN PREVIOUSLY UNFUSED SEVERE SCOLIOSIS

AUTHORS AND AFFILIATIONS: Brett Rocos MD FRCS (Tr & Orth) 1, Eliane Rioux- Trottier MD 1, Masayoshi Machida MD 1, Amit Sigal MD 1, Jim Kennedy MD , David Lebel MD PhD 1, Reinhard Zeller MD FRCSC 1

1 Department of Orthopaedic Surgery, Hospital for Sick Children, 555 University Avenue, Toronto, ON, Canada M5G 1XB

PURPOSE: Severe scoliosis is a challenge to manage with options being posterior instrumentation with either three column osteotomies or skeletal traction. The three rod technique, utilising a short apical concavity rod is an option to achieve controlled correction. We describe this technique, the complications encountered, and the long term outcomes.

METHOD: All paediatric patients who underwent corrective surgery for scoliosis ≥ 100° using 3 parallel rods were included. Radiographs were assessed to evaluate the correction and clinical records examined for any loss of correction, complications, revision procedures or neuromonitoring events.

RESULTS: 27 patients met the inclusion criteria. All underwent posterior fusion, 5 circumferential fusion and 3 halogravity traction. The main thoracic curve (MT) measured 112° (100- 145°), the proximal thoracic (PT) 48° (20- 75°) and thoracolumbar (TL) 22° (2- 97°). 1 patient sustained a durotomy and 11 showed transient changes in MEPs. All patients had normal postoperative neurology. One patient underwent removal of hardware for late infection. The cohort showed a 49% correction of MT, 29% of PT and 33% of TL. There was no loss of correction at a mean follow up of 3.7 years (95% CI 2.75- 4.6 years).

CONCLUSIONS: Our series suggests that three rod constructs lead to a 50% correction of severe curves, that three column osteotomies may not be necessary, and that the technique is safe and effective for the correction of severe scoliosis. Further work evaluating the role of HGT and the influence of curve aetiology would be useful in refining the technique.

ABSTRACT # 3

TITLE: WHAT IS THE OPTIMAL SURGICAL METHOD FOR ACHIEVING SUCCESSFUL SYMPTOM RELIEF IN PAEDIATRIC HIGH GRADE SPONDYLOLISTHESIS?

AUTHORS AND AFFILIATIONS: Brett Rocos MD FRCS (Tr & Orth) 1; Reinhard Zeller MD FRCSC 1; Stephen Lewis MD FRCSC 1; Tony Tan MSc CCRP 1, David Lebel MD PhD 1

1 Department of Orthopaedic Surgery, Hospital for Sick Children, 555 University Avenue, Toronto, ON, Canada M5G 1XB

PURPOSE: Options for the surgical management of paediatric high grade spondylolisthesis include partial reduction and fusion (PRF) or reduction and interbody fusion (RIF). It is not clear which strategy leads to the optimal radiological outcome or lowest rates of complication and revision surgery.

METHOD: We conducted a retrospective consecutive case-series investigation of high-grade spondylolisthesis treated between 2006 and 2017. Children with an L5-S1 slip ≥ 50% treated with either PRF or RIF were included. Post-operative complications, revisions and radiological parameters to a minimum of 2 years were assessed.

RESULTS: 31 eligible patients were identified with a mean follow up of 41 months. The groups showed no difference in age (mean 13.6 years), Meyerding grade, Labelle classification, L5/S1 angle (p=0.29)

slip angle (p=0.27) or pelvic tilt (p=0.07). Symptoms were similar between the groups. Of 11 treated with PRF, 2 had post-operative weakness with all resolving by 2 years. None underwent further surgery. Slip angle reduced by 9°, pelvic tilt (PT) and sacral slope (SS) were unchanged and C7-SVL reduced by 42mm (p=0.17). In the RIF group, 4 sustained dural tears, 1 a laminar fracture and 7 had post-operative weakness or dysaesthesia, 4 of which resolved by 2 years. 8 underwent unplanned further surgery, 3 for pseudarthrosis. Slip angle reduced by 15°, C7-SVL by 27mm and PT and SS were unchanged.

CONCLUSIONS: Treating paediatric high grade spondylolisthesis carries a risk of complications regardless of strategy. At 2 years, RIF shows a higher rate of unplanned return to surgery and neurological changes.

ABSTRACT # 4

TITLE: IMAGING-BASED LOCAL CONTROL OUTCOMES SPECIFIC TO SPINE STEREOTACTIC BODY RADIOTHERAPY (SBRT) FOR PROSTATE CANCER METASTASES

AUTHORS AND AFFILIATIONS:

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Jay Detsky MD, Department of Radiation Oncology, Odette Cancer Centre, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, ON, Canada

PURPOSE: We report the first dedicated series of spine SBRT specific to prostate cancer metastases.

METHOD: A prospective database was retrospectively reviewed identifying 183 spinal segments in 93 prostate cancer patients treated with SBRT. The primary endpoint was imaging-based local control rates and secondary outcomes included overall survival and vertebral compression fracture.

RESULTS: Of the 183 spine segments, 130 had no prior radiation, 18 were post-operative, and 35 were re-irradiated. Median follow-up was 16 months (range 2-70 months). 67 patients were oligometasatic (<5 metastases) of which 36 had a solitary spinal metastases. 44 patients (47%) had castrate resistant disease at the time of SBRT, while 10 of the 49 patients with hormone sensitive disease at the time of SBRT developed castrate resistance during follow up at a median time of 15 months after SBRT(range 7 – 37 months). The median spinal instability neoplastic score (SINS) was 5 (range 0-13). The majority of spinal segments (75%) were treated with 24-28 Gy/2 fractions. Actuarial local control rates at 1 and 2 years were 97% and 92%, respectively. The median OS was 61 months (range 43-77 months). The cumulative risk of VCF was 5% at 1-year and 13% at 2 years.

CONCLUSIONS: Excellent local control rates were observed in this cohort of patients with spinal metastases from prostate cancer with an acceptable risk of VCF. Whether similar rates could be observed with conventional palliative radiation remains to be proven.

ABSTRACT # 5

TITLE: UTILITY AND ROLE OF VIRTUAL REALITY-BASED SIMULATION MODELS IN SPINAL DECOMPRESSION TRAINING

AUTHORS: T Chen, MD FRCSC1; S Yoon, MD1; E Crawford, MD MSc1; Y Zhang2; M Hardisty, PhD2; J Finkelstein, MD MSc FRCSC1

1 Division of Spine Surgery, Sunnybrook Health Sciences Center, Toronto, Ontario, Canada
2 Sunnybrook Research Institute, Sunnybrook Health Sciences Center, Toronto, Ontario, Canada

PURPOSE: Surgical simulation is a valuable educational tool for trainees to practice in a safe, standardized, and controlled environment. Interactive feedback-based virtual reality (VR) has only recently moved to the forefront of spine surgery training, with the majority of commercial products focused on pedicle screw placement. A paucity exists of learning tools to understand anatomy, pathology, and principles of treatment in spinal stenosis. The purpose of this study was to evaluate the efficacy of VR simulation models and its educational role in decompression surgery.

METHOD: A VR simulation module was designed using the Microsoft Oculus Rift user interface and incorporated patient-specific 3D-interactive models of lumbar spinal stenosis. A surgical toolkit allowed users to perform decompression procedures. Orthopaedic and neurosurgical trainees were prospectively enrolled. Each subject was categorized by post-graduate year. Subjects underwent a pre-test on anatomical knowledge and critical information on spinal stenosis, followed by performing VR spinal decompression. A post-test and exit questionnaire was administered to assess module utility as a learning device.

RESULTS: A total of 15 trainees were enrolled (12-orthopaedic, 3-neurosurgery). Pre-test scores on spine anatomic knowledge progressively improved and showed strong positive correlation with year in training (Pearson's r = 0.78). Following simulation, the average improvement in post-test scores was 11.7% in junior trainees (PGYI-II), and 2.9% in senior trainees (PGYIII-Fellows). 93% of participants found the VR module useful in understanding and learning the pathology of spinal stenosis. 80% found it useful in learning to perform a decompression. 100% believed it had utility in preoperative planning with patient-specific models.

CONCLUSIONS: Simulations play a vital role in medical training and can be influential as surgical curriculums become more competency-based. Our original VR spinal decompression module has shown to be overwhelmingly positively received amongst trainees as both a learning module of patho-anatomy and patient-specific preoperative planning, with particular benefit for junior trainees. With further integration of haptic and acoustic feedback, VR-based training modules will be instrumental in the future of surgical education in a way that is interactive, safe, and immersive.

ABSTRACT # 6

TITLE: UTILITY AND ROLE OF VIRTUAL REALITY-BASED SIMULATION MODELS IN SPINAL DECOMPRESSION TRAINING

AUTHORS: T Chen, MD FRCSC[1]; S Yoon, MD[1]; E Crawford, MD MSc[1]; Y Zhang[2]; M Hardisty, PhD[2]; J Finkelstein, MD MSc FRCSC[1]

1 Division of Spine Surgery, Sunnybrook Health Sciences Center, Toronto, Ontario, Canada
2 Sunnybrook Research Institute, Sunnybrook Health Sciences Center, Toronto, Ontario, Canada

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ABSTRACT # 7

TITLE: DRUG REPURPOSING: DELAYED ADMINISTRATION OF HIGH DOSE HUMAN IMMUNOGLOBULIN G FOR TREATMENT OF TRAUMATIC CERVICAL SPINAL CORD INJURY

AUTHORS AND AFFILIATIONS: Jonathon Chon Teng Chio1,2,3, Jian Wang1, Vithushan Surendran1, Lijun Li1, Michael G. Fehlings1,2,3

Department of Genetics and Development, Krembil Research Institute, University Health Network, Toronto, Ontario, Canada Institute of Medical Science, University of Toronto, Toronto, Ontario, Canada
University of Toronto, Toronto, Ontario, Canada

PURPOSE: Neuroinflammation exacerbates damage caused by initial trauma from spinal cord injury (SCI). Severity of neuroinflammation depends on integrity of the blood-spinal cord-barrier (BSCB), as a compromised BSCB enhances neuroinflammation by facilitating immune cell infiltration. By targeting neuroinflammation, immunosuppressants are used to treat SCI patients. However, as patients experience immune suppression, immunomodulation is more effective than immunosuppression. Human Immunoglobulin G (hIgG) is used in clinic as an immunomodulatory treatment for inflammation. Although we have shown that administration of hIgG (2g/kg) is beneficial after SCI, the optimal time window of administration and mechanism of hIgG are unknown. We hypothesize that hIgG is beneficial when administered at extended time points post-SCI by stabilizing the BSCB.

METHOD: With a clinically relevant rat model of SCI, a single bolus of hIgG (2g/kg) or control buffer was administered intravenously at 15 minutes, 1 hours or 4 hours post-SCI. Spinal cord, serum and spleens were collected to evaluate hIgG's effects.

RESULTS: hIgG co-localized with BSCB. At 24 hours post-SCI, relative to control buffer, hIgG (2g/kg) significantly enhanced BSCB integrity when administered at delayed time points. This was associated with reduced spinal cord neuroinflammation. hIgG (2g/kg) increased serum levels of inflammatory cytokines, reduced neutrophil counts in blood and resulted in spleens with greater amounts of neutrophils. Short term benefits of delayed hIgG (2g/kg) administration correlate with enhanced tissue preservation and functional recovery at eight weeks post-injury.

CONCLUSIONS: As a clinically relevant immunomodulatory treatment, hIgG (2g/kg) can improve health of patients. hIgG alleviates neuroinflammation without increasing immune suppression.

ABSTRACT # 8

TITLE: REGIONAL SPECIFICATION OF NEURAL PROGENITOR CELLS IN THE BRAIN AND SPINAL CORD

AUTHORS AND AFFILIATIONS: William Brett McIntyre (B.HSc.)1,2, Mohammad Khazaei (PhD.)2, Michael G. Fehlings (MD, PhD, FRCSC, FACS)1,2,3.

1 - Division of Genetics and Development, Krembil Research 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.

PURPOSE: Neural stem cell (NSC) transplantation is a promising therapeutic strategy to replace lost neuronal circuitry following Central Nervous System (CNS) degeneration. However, transplanted NSCs in the CNS often do not sufficiently integrate with endogenous tissue, resulting in suboptimal regeneration. Recently, researchers observed that more successful transplant attempts were observed in NSC grafts that were derived from the same region they were transplanted into. Despite this, the majority of cell transplant studies do not consider the regional identity of cells, nor how this contributes to their integration in a transplant environment. Thus, the purpose of this study is to characterize regional identity of spinal and brain-derived NSCs.

METHODS: Murine embryos were isolated, where brain and spinal cord regions were dissected. NSCs were then characterized and expanded into neurospheres, further differentiated into mature cells, and eventually will be transplanted in vivo, into either matching or discordant environments. RT-qPCR of regional identity homeobox (Hox) gene markers will be used to confirm NSC identity.
RESULTS: After expansion, RT-qPCR confirmed that spinal-derived NSCs exhibited Hox paralog expression HoxA4 through HoxD10. Brain-derived NSCs do not express paralog groups 4-12, but rather exhibit enhanced expression of brain Hox markers, such as Otx2 and Foxg1.

CONCLUSIONS: These results show preliminary evidence that NSCs derived from the CNS retain their identity following proliferation and maturation in vitro. Future co-culturing experiments and in vivo transplants may confer that regional identity of NSCs are maintained, and that matching cell identity to a transplant environment can facilitate optimal NSC transplantation in any CNS-degenerative context.

ABSTRACT # 9

TITLE: BIASING MURINE NEURAL PROGENITOR CELLS TOWARD AN OLIGODENDROGENIC FATE

AUTHORS AND AFFILIATIONS: K Pieczonka, M Khazaei and MG Fehlings

Krembil Research Institute, University Health Network; Department of Surgery, University of Toronto; Institute of Medical Science, University of Toronto

PURPOSE: Myelin structure is particularly susceptible to dysregulation after spinal cord injury (SCI), ultimately contributing to impaired signal conductivity in the central nervous system (CNS). Neural progenitor cell (NPC) transplantation represents a potential regenerative approach for promoting remyelination, however the injury microenvironment predominantly directs NPC differentiation into astrocytes as opposed to oligodendrocytes. Our lab has successfully developed a protocol for priming human neural progenitor cells (NPCs) toward an oligodendrogenic (oNPC) fate. Transplanted human oNPCs effectively differentiate into a greater ratio of oligodendrocytes and promote myelination and functional recovery in the immunocompromised RNU rat. Moving forward, we aim to bias murine NPCs toward oNPCs for transplantation into the mouse and we hypothesize that this will allow us to provide a significant source of oligodendrocytes while avoiding the need for immunosuppression.

METHOD: Murine induced pluripotent stem cells will be differentiated into NPCs and exposed to culture conditions adapted from our human oNPC protocol that mimick oligodendrogenic developmental cues. Briefly, the cells will be caudalized using B27 and N2 supplements, retinoic acid and EGF, followed by ventralization using the sonic hedgehog agonist, Purmophamine. The cell differentiation will then be characterized using immunohistochemistry and RT-qPCR.

RESULTS: It is expected that this protocol will bias murine NPCs toward a pro-oligodendrogenic fate.

CONCLUSIONS: Murine oNPCs will be a safer alternative than human oNPCs and will allow us to study demyelination and remyelination in mice without immunorejection.

ABSTRACT # 10

TITLE: OSTEOBLASTIC VERTEBRAL METASTASIS FRACTURE PREDICTIONS USING COHESIVE MICRO-FINITE ELEMENT MODELING IN A PRECLINICAL MODEL

AUTHORS AND AFFILIATIONS: Allison Clement[1], Michael Hardisty[1], Cari Whyne[1-3]
[1] Sunnybrook Research Institute, Toronto, Canada [2] Institute of Biomedical and Biomaterials Engineering, University of Toronto, Canada [3] Department of Surgery, University of Toronto, Canada

PURPOSE: The prevalence and complications of fracture in the metastatic spine motivates improved understanding of bone quality and fracture risk. Computational models can evaluate effects of changes

in mechanical properties due to the presence of pathology. This work aimed to validate voxel-based micro-finite element models (μFEM) of vertebrae with osteoblastic involvement for the prediction of fracture initiation and propagation.

METHOD: A preclinical rodent model of osteoblastic lesions in the spine was created with intracardiac injection of ZR-75-1 breast cancer cells. Motion segments (L1-L3) were excised and displacement-controlled axial and bending loads were applied with sequential imaging to capture progression of failure. Specimen specific μFEM (n=2) were created using a custom preprocessing pipeline (meshing, registration-based displacement boundary conditions, tissue specific material property assignment for healthy and metastatic tissue).'

RESULTS: Failed elements were seen at anatomical sites consistent with experimental observation, with models predicting failure in the pedicle and at the endplate accurately. However, μFEM predictions of fracture progression magnitude and direction were not consistent with experiment. Ongoing work will improve fracture progression predictions by better estimating tissue damage properties through experiment and inverse modelling.

CONCLUSIONS: Specimen specific voxel-based μFEM including cohesive zone-based damage mechanics were able to accurately predict the location of damage in preclinical vertebrae with osteoblastic lesions. Improved understanding of fracture initiation and progression in the metaststically involved spine is important for guiding clinical assessment and new therapies.

ABSTRACT # 11

TITLE: OPTICAL TOPOGRAPHICAL NAVIGATION AND DIRECT REGISTRATION TO PREVIOUS HARDWARE AS AN ADJUNCT TO REVISION SPINE SURGERY

AUTHORS AND AFFILIATIONS: Carolyn Lai[1], Victor Yang[1]

1. Division of Neurosurgery, Department of Surgery, Sunnybrook Health Sciences Centre, University of Toronto

PURPOSE: Revision spine surgery poses increased challenges to the surgeon due to distorted anatomy and increased risk of perioperative complication. Prevalence of revision spine surgery is also increasing. Conventional navigation systems often require laborious registration, and accuracy can be affected by the presence of metal hardware. Unlike conventional navigation systems, optical topographical

navigation, through selective thresholding, has the ability to register directly to previous instrumentation, avoiding artifact from distorted anatomy such as bone or scar covering neural elements. We propose that direct registration to previous hardware using optical topographical navigation improves accuracy, registration time; and is a safe, radiation-free adjunct to guide revision spine surgery.

METHOD: From August 2019-June 2020, we analyzed consecutive revision spine cases from an academic tertiary care centre. Four cases on a background of over fifty cases worldwide were identified where registration to previous hardware was performed. Accuracy and registration time was studied.

RESULTS: Average matched colocalized points between pre-operative CT and intraoperative imaging was 2307.8 points. Average registration error was 0.29 mm. The mean registration time was 95.4 seconds. There were no intraoperative complications in any of the cases. Navigation was used for a variety of revision purposes including extension of instrumentation, reinsertion of misguided screws from prior surgery and guiding revision decompression depth over prior fusion mass.

CONCLUSIONS: Based on our preliminary study, optical topographical navigation is a highly accurate, time-efficient and safe method to guide revision spine surgery. Its use is multifaceted and radiation free. Further study with a larger sample size would help understand the strengths and weaknesses of the system; and help determine its application for procedures in patients with varying indications.

ABSTRACT # 12

TITLE: CHARACTERIZING L4 AND L5 LUMBAR SPINE FRACTURES FOR OPERATIVE VS NON-OPERATIVE MANAGEMENT

AUTHORS AND AFFILIATIONS: DM Pelletier 1, JA. Finkelstein 1.

1. University of Toronto Spine Program, Sunnybrook Health Sciences Centre, 2075 Bayview Ave, Toronto, Ontario, Canada, M4N 3M5

PURPOSE: The L4 and L5 vertebrae are infrequently fractured in trauma. As a result, the literature provides inadequate evidence on how these fractures should be managed. As such, the patient may unnecessarily undergo invasive spine surgery or even costly bracing when no treatment may in fact be warranted. What is classically considered unstable in the upper lumbar spine, may not correlate with L4

and L5 given their theoretically inherent stability within the pelvis. Therefore, L4 and L5 fractures require further study to assess fracture patterns, their stability and their natural history.

METHOD: This is a retrospective chart review of patients identified in the Sunnybrook trauma database with L4 and/or L5 lumbar spine fractures over the last 20 years. A preliminary screening identified ~300 potential cases with inclusion criteria: fracture of the L4 and/or L5 vertebrae and exclusion criteria: isolated transverse process fractures. Data will be extracted from the trauma database and Sunnybrook health records. This will include age, gender, mechanism of injury, lumbar level fractured, fracture characteristics and location, associated traumatic injury/ISS, neurological deficits, imaging findings (deformity, neurological impingement etc), treatment (no bracing, bracing, surgery, complications), functional outcome.

RESULTS: Pending

CONCLUSIONS: Pending

ABSTRACT # 13

TITLE: DEVELOPING COMBINATORIAL TREATMENTS FOR CERVICAL SPINAL CORD INJURY: COMBINING FORELIMB REHABILITATION WITH NEURAL STEM CELL TRANSPLANTATION

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PURPOSE: The overall goal of this study is to develop a combinatorial treatment for cervical spinal cord injury (SCI) involving neural stem cell (NSC) transplantation and intense motor rehabilitation. A promising strategy to treat SCIs and restore function is to transplant stem cells into the injured cord to replace lost cells and promote regeneration. The objective of this study is to investigate whether skilled motor training of the affected neural networks will enhance the integration of NSCs transplanted into the damaged cord and influence their fate and function.

METHODS & RESULTS: Experiments were carried out in a clinically relevant clip-compression model of cervical SCI (C6-7) in Rowett Nude rats. NSCs used in this study were human induced pluripotent NSCs

that were genetically modified to express pro-survival and pro-neuronal glial derived neurotrophic factor (GDNF). Prior to injury, animals were trained for 10 minutes daily for 14 weeks to acquire the motor skill needed for precise reaching and grasping of sugar pellets (i.e. single pellet reaching task). This motor skill is the basis of the study's intense rehabilitative training protocol for the affected forelimbs. Prior to injury, animals were trained to reach for an average of 139.8 pellets in each 10-minute training session with an average of 50% success rate in their retrieval. This level of reaching performance is categorized as high intensity training for rats (Torres et al, 2019). To investigate the effect of this combinatorial treatment, animals were divided into 5 groups: Sham, SCI+Vehicle, SCI+NSC, SCI+Vehicle+Rehab, and SCI+NSC+Rehab. NSCs were transplanted in the subacute phase (14-days post-SCI) at the lesion and perilesional sites (5 sites). This work is currently ongoing and will continue for 15 weeks to investigate treatment effects.

CONCLUSIONS: Results of this study will have implications for clinical translation of NSC treatments for SCI and provide further insights into the functional contribution of grafted cells.

ABSTRACT # 14

TITLE: SEMI-AUTOMATED CT SEGMENTATION OF PSOAS MUSCLE APPLIED TO PROSTATE CANCER PATIENTS FOR THE PURPOSE OF ASSESSING SARCOPENIA

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PURPOSE: Sarcopenia is a progressive and generalized loss of skeletal muscle mass and strength. This project aims to use 3D Computed Tomography (CT) based assessments of psoas muscle mass and composition to quantify sarcopenia in a prostate cancer patient with the longer-term goal of understanding how sarcopenia interacts with patient outcomes. This investigation examined a semi-automatic method for 3D poas muscle segmentation.

METHOD: Spine CT imaging of prostate cancer patients undergoing treatment at the Odette Cancer Center (Toronto, ON) were analysed. Psoas muscle was segmented from the L2/L3 intervertebral disc

to the L4/L5 intervertebral disc using an atlas-based approach, including initial alignment, rigid and diffeomorphic deformable registration.

RESULTS: Performance of the semi-automatic algorithm for psoas muscle segmentation was good (Dice Similarity Coeffecient=0.80, N=3) in the initial pilot data set used in this investigation.

CONCLUSIONS: This semi automated approach could help create a robust and extensive data set of labelled patient images which could be used to further develop a clinically relevant fully automated method for quantitative assessment of sarcopenia and sarcopenia progression using a deep learning model. The identification of sarcopenia as a predictor of cancer-related morbidity or mortality, and factors associated with the progresssion of sarcopenia may help to direct research into methods needed.

ABSTRACT # 15

TITLE: EVALUATION OF POSTOPERATIVE CHANGE OF SHOULDER BALANCE OVER TIME IN ADOLESCENT IDIOPATHIC SCOLIOSIS

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PURPOSE: Among patients with adolescent idiopathic scoliosis (AIS), significant residual shoulder unbalance is associated with suboptimal outcomes including a higher risk of decompensation and poor cosmetic satisfaction. There is limited information about the long-term dynamics of shoulder balance following posterior spine fusion (PSF). The purpose of this study was: (1) to clarify when shoulder balance would be stable following surgery, (2) to evaluate the correlation between proximal Cobb angle and shoulder balance.

METHOD: A retrospective radiographic analysis was performed on patients with AIS, treated with PSF between 2009 and 2017. Follow-up postoperative radiographs reviewed were at 1 week, 6 weeks, 6 months, 1 year, 2 years, and more than 2 years post-surgery. Radiographic evaluation included measurement of the proximal thoracic (PT) , main thoracic (MT), thoracolumbar (TL) Cobb angle and radiographic shoulder height difference (RSHD).

RESULTS: 124 AIS patients were included (114 females). RSHD averaged 14 mm±23 at preoperative, -13 mm±13 at 1 week, -8.2 mm±11 at 6 weeks, -6.6 mm±11 at 6 months, -5.8 mm±9.3 at 1 years, -5.3 mm±11 at 2 years, -7.4 mm±8.6 at final follow-up respectively. RSDH significantly changed over time (ANOVA, $P<0.05$). The median of stable RSDH after surgery was on average at 183 days. In addition, the evaluation of correlation analysis results revealed a weak correlation between PT Cobb angle at 2 years after surgery and RSDH ($r = -0.268$)

CONCLUSIONS: While small changes were observed during the whole course of postoperative follow-up, RSDH seems to stabilize at 6 months following surgical intervention. There was only a limited correlation between RSDH and the residual PT Cobb angle, which indicates that shoulder imbalance after scoliosis surgery remains a multifactorial event.

ABSTRACT # 16

TITLE: THE NATURAL HISTORY OF DEGENERATIVE CERVICAL MYELOPATHY:
AN AMBISPECTIVE LONGITUDINAL COHORT STUDY

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PURPOSE: Degenerative cervical myelopathy (DCM) is the most common pathology affecting the spinal cord, but its natural history is poorly characterized. Mild DCM is often managed non-operatively, but surgery is recommended if neurological deterioration occurs. This study investigates the natural history of DCM patients managed non-operatively and the utility of quantitative clinical measures to detect myelopathic progression.

METHOD: Patients with 1) a new diagnosis of DCM or 2) recurrent myelopathy after previous surgery were enrolled prospectively. Natural history data were obtained via retrospective chart reviews, . Patients that did not undergo surgery or had multiple clinic visits prior to surgery were included, using standard clinical assessments as the clinical case definition of neurological deterioration. A battery of quantitative neurological assessments were performed at one or more visits, including mJOA, QuickDASH, GRASSP-

myelopathy (motor, sensory, and dexterity), grip dynamometer, Berg Balance, gait stability ratio, and gait variability index; a deterioration of 10% in any of these measures was considered significant (e.g. a 2-point decrease in mJOA). Anatomical MRI scans were assessed for evidence of worsening compression or spinal cord signal change.

RESULTS: 116 DCM patients were included (94 newly diagnosed, 22 recurrent myelopathy). Over a mean follow-up of 2.2 years, 57% (95% CI = 47-67%) of newly diagnosed and 73% (95% CI = 52-87%) of recurrent DCM patients deteriorated neurologically. The most sensitive quantitative measures to detect deterioration were grip strength (60%), GRASSP dexterity (60%), and gait stability ratio (50%). mJOA and anatomical MRI had relatively low sensitivity (33%, 28%, respectively). A composite score of clinical measures had sensitivity=81% and specificity=82%.

CONCLUSIONS: DCM appears to have a poor natural history with a high rate of neurological deterioration. Longitudinal monitoring of patients should include grip strength, dexterity, and gait analysis. A lack of worsening on anatomical MRI or mJOA should not be considered evidence of clinical stability.

ABSTRACT # 17

TITLE: INTER-OBSERVER RELIABILITY OF THE MODIFIED JAPANESE ORTHOPEDIC ASSOCIATION SCORE IN DEGENERATIVE CERVICAL MYELOPATHY

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PURPOSE: The modified Japanese Orthopedic Association (mJOA) score is widely accepted as the most important assessment in degenerative cervical myelopathy (DCM); this score has been utilized in clinical practice guidelines and directly influences treatment recommendations, but its reliability has not been established. This study aims to determine the inter-observer reliability of the mJOA in a large cohort of DCM patients.

METHOD: This prospective cross-sectional study involved blinded administration of a refined version of mJOA to DCM patients by 2 or more experienced clinicians. The reliabilities of subscores and total score were analyzed using intra-class correlation (ICC) and concordance. Subgroup analyses were performed by mJOA severity (mild: 15-17, moderate: 12-14, severe: <12). Data were also analyzed using ANOVA for differences by assessor, assessment order, previous surgery, age, and sex.

RESULTS: 115 DCM patients underwent 245 assessments. ICC was 0.66 for upper extremity motor, 0.70 for lower extremity motor, 0.57 for upper extremity sensation, 0.65 for sphincter function, and 0.71 for total mJOA. The average difference in mJOA was 0.90 points between assessors. Identical scores (across all 4 subscores) were observed in 21%, differences of >= 2 points occurred in 19%, and disagreement between mild and moderate severity occurred in 14% of patients. Lower extremity motor score was lower during 2nd assessments, p=0.02). Other variables that were analyzed did not demonstrate significant relationships with mJOA scores.

CONCLUSIONS: The inter-observer reliability of the mJOA is moderate, and disagreement occurs in the vast majority of patients. These findings suggest that the mJOA should be interpreted with caution and considered in conjunction with additional measures; when the score falls near the threshold between severity categories, or when a patient is monitored longitudinally for deterioration, small differences can alter management. Further efforts to standardize the mJOA are needed to improve its reliability and help deliver optimal management of DCM.

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