Paediatric Spine Research has moved into new Centre for Children’s Health Research

The PSRG have moved into the recently completed Centre for Children’s Health Research (CCHR) building located just a few minutes’ walk from Mater Health Services & across the street from the Lady Cilento Children’s Hospital, Brisbane. The CCHR is Queensland’s first fully integrated research facility focused on child and adolescent health research and services. It is a historic partnership, arising from almost five years of planning between Queensland Health, through Children’s Health Queensland, and leading research organisations including Queensland University of Technology as the major partner and the University of Queensland. The CCHR is a nine-level facility with the capacity to accommodate more than 600 staff. The building consists of wet and dry laboratories, pathology services for the Children’s Hospital, corporate offices and retail space. The PSRG have office space for our researchers and students as well as a project room on Level 5. Having resided on the Mater campus since 2002, we look to continue our ongoing collaborative relationship with the Mater for many years to come, while looking toward exciting future projects at CCHR and in partnership with the new Lady Cilento Children’s Hospital.

Emeritus Professor Mark Pearcy

In July 2015, our own (newly retired) Professor Mark Pearcy was awarded the title of Professor Emeritus by QUT. This honour acknowledges Mark’s outstanding leadership and contribution to the University over almost two decades. Mark’s research career in Biomedical Engineering spans 35 years and in this time he has made seminal contributions to the understanding of spinal mechanics, fracture fixation and healing, total joint replacement tribology & design, and the development of artificial hearts. During these years Mark also taught hundreds of undergraduate and postgraduate students as well as mentoring many other Engineers and Researchers across both Industry and Academia. Mark assures us that he will continue to take an active interest in the PSRG’s research during his well-deserved retirement!

Research Masters Candidates

Dr Graham Irvin (below) joined us in 2014 and is now in the 2nd year of his Masters by Research, entitled “Multi-axial testing of multi-level spine constructs with growth modulating implants used in the management of early onset scoliosis”. Graham’s project involves using QUT’s Robotic Spine Testing Facility to measure how the spine is stiffened when a type of flexible implant known as growing rods are inserted. Growing rods are used in younger children with spinal deformities in an attempt to halt progression of the deformity whilst allowing the spine, ribcage and lungs to continue growing with the child. Modern ‘semi-constrained’ growing rod systems appear to reduce the incidence of common complications such as implant breakage and autofusion of spinal segments. Graham will study the stiffness and biomechanical behaviour of the spine instrumented with semi-constrained growing rods compared to a spine implanted with a traditional rigid growing rod. Right: Radiograph of 11 year old boy with rapidly progressing double scoliosis with semi-constrained growing rods inserted to control the deformity whilst allowing ongoing growth.

We also welcome Dr Colin Davis who is in the first year of his Masters by Research, entitled “Pedicle morphology in Adolescent Idiopathic Scoliosis”. Colin’s project will analyse the size, shape and angles of pedicles (ellipse-shaped regions of bone which connect each vertebral body with its posterior elements) in scoliosis patients to provide clinically important information to surgeons regarding the placement of pedicle screws during scoliosis correction surgery as well as to clarify the natural history of pedicle deformation during the development of scoliosis in growing children.
Congratulations - PhD awarded July 2015
Dr Bethany Keenan was awarded her doctorate at the QUT graduation ceremony in July. Beth’s PhD comprised an in-depth assessment of the progression of spinal deformity in idiopathic scoliosis, using an existing dataset of low dose CT scans as well as a prospectively collected series of 3D Magnetic Resonance Images (MRI) in growing children with scoliosis. Beth’s PhD is the first project worldwide to repeatedly image the spines of children with scoliosis at successive intervals during growth using 3D MRI. Furthermore, it has made a number of contributions to the understanding of scoliosis progression during growth that will lead to improved patient management. Beth has had two journal papers on her work already published, two currently under review and a further two papers in preparation. Her work has been presented to both Australian and International audiences on more than twelve occasions in seven different countries.

Visiting medical students from University of Linkoping, Sweden
Third year medical students Anna Sundberg (below right) & Olivia Lofgren (below left) crossed the globe to spend four months with the PSRG in sunny Brisbane between January and May 2015. They were supervised by Dr Paige Little, to fulfil the research component of their Medical degrees being undertaken at the University of Linkoping. Olivia’s project analysed the rotational correction (untwisting) of the thoracic spine that is achieved by Thoracoscopic or keyhole surgery for scoliosis correction, while Anna focussed on the asymmetry of the chest in adolescent scoliosis patients before and after surgery, and whether this correlated with the spinal column and rib cage deformity that is seen on standing x-rays.

Spine Society of Australia Annual Scientific Meeting, Canberra, April 2015
The Spine Society meeting is the largest Australian multi-disciplinary spine conference. The PSRG’s postdoctoral engineer, Caroline Grant, took the opportunity to survey the attending Spinal Surgeons on their use of 3D printing as an aid to complex spinal deformity surgery which is the basis of a paper to be submitted for a special issue on 3D printing in surgery in the journal ‘Techniques in Orthopaedics’. The PSRG work presented at the conference this year includes:
1. Sequential MRI can reveal individual level deformities in the growing scoliotic spine that are clinically masked by the Cobb angle. *Keenan, Izatt, Askin, Labrom, Bennett, Pearcy, Adam.
6. Identifying vertebral endplate lesions (Schmorl’s nodes) using a semi-automatic method. *Newell, Grant, Izatt, Little, Pearcy, Adam.

Adelaide Spine Symposium XIII, Barossa Valley, Adelaide, August 2015
This key spine research meeting brings together yearly all of the Australasian groups performing research into spine conditions and disorders to exchange ideas and build collaborations and partnerships. The PSRG’s Dr Paige Little and Dr Caroline Grant presented an aspect of their latest work. Dr Grant presented her recent MRI study on the ‘Variations in Vertebral Venous Vasculature in healthy spines versus scoliotic spines’ which mapped the venous system found in the vertebrae and Dr Little presented an update of her work ‘Predicting surgical outcomes for spinal deformity patients using subject specific FE models’.

Spine modelling from MR imaging
The PSRG has a new Masters by Research student, biomedical engineer Jessica Benitez, to take on the challenge of producing 3D spine models from MRI without the need for many hours of manual freehand selection on every MRI slice which is the only option currently. Jessica, who already has a Masters degree in Medical Physics, will use a number of algorithms for preprocessing, initialization and boundary identification and will validate her work by comparing her results to models produced using CT on the same specimens (next page). Traditionally 3D spine modelling relies on CT scans as they provide excellent bone detail which can be...
Dr Paige Little partnering with Stuttgart

April saw Dr Paige Little spend a month working at the University of Stuttgart, to advance the PSRG’s collaborative project with the Stuttgart Research Centre for Simulation Technology, at the invitation of the Executive Director, Prof. Dr-Ing Wolfgang Ehlers. Mechanical overload of the spinal tissues may cause pain or tissue degeneration and moreover, overload of spinal implants following instrumented fusion surgery may lead to complications. This collaborative project aims to amalgamate our existing spine modelling software (below left) with advanced simulation software developed by Jun-Prof Syn Schmitt and Tille Rupp (below right), enabling us to better predict the loads applied to the spinal tissues during physical activities.

Once our aim of integrating the two custom models is realised, we will have the unique ability to predict the loads in an individual patient’s spinal tissues during daily activities. With this information, we will be able to provide advice to surgeons on possible causes for adverse patient outcomes prior to the patient undergoing surgery.

Visiting Neurosurgery trainee

As part of the Australian Neurosurgery training programme, candidates are required to fulfil a twelve month research component. Dr Thorbjorn (Toby) Loch-Wilkinson applied to spend his 2014 research year with the PSRG in Brisbane. He presented his work at the Spine Society of Australia meeting in April 2015 and also at the 25th Congress of the International Society of Biomechanics in Scotland last month. Toby analysed the osseous anatomy of the thoracic intervertebral foramen in adolescent idiopathic scoliosis (AIS) sufferers. Good knowledge of the abnormal anatomy in this patient group is especially relevant when spine surgeons, whether they be orthopaedic or neurosurgical, are performing surgery on individuals with AIS.

Dr Loch-Wilkinson found that thoracic foraminal dimensions, (through which nerve roots exit the spine) were significantly affected by AIS, with all dimensions significantly larger on the convexity of the major curve and maximally affected at or close to the apex of the deformity. His paper has been accepted for publication in Spine Deformity journal.

Microstructural modelling of the intervertebral disc

The PSRG’s Research Director, Associate Professor Clayton Adam made another six month visit to Paris in 2014/15 to continue pursuing the research arising from his European Union Marie Curie Fellowship titled, “DiscSim: Multi-scale biomechanical modelling & simulation of the intervertebral disc”. Hosted by Professors Wafa Skalli and Philippe Rouch at the newly named Institut de Biomécanique Humaine Georges Charpak, Arts et Metiers ParisTech, Clayton worked with Masters students Gerry Agbobada & Alexis Peres to begin processing the first human lumbar discs which will be imaged in 3D at high resolution to better understand how disc microstructure is related to function in both the healthy and degenerate spinal joint.

On May 12 this year, Clayton’s work was featured as part of a documentary on French television (France 5) entitled ‘Vaincre Le Mal de Dos’ (Defeating Back Pain), viewable via this link https://www.youtube.com/watch?v=ylMevkkXOQ.

The disc imaging work featured in this documentary (bovine tail) has been combined with an image-based micro-scale finite element model of the disc (see images below) which shows that the connections between lamellar layers in the outer annulus of the disc are very important in providing the disc with its high resistance to compressive forces.

Above: high resolution image of the bovine tail disc showing lamellar layers in the outer annulus of the disc (inset box at left)

Above: Micro-scale computer simulation of the same disc as shown above, (left) in its unloaded state, and (right) under 400N compressive force. Magnified inset shows separation of lamellae under load. This work has been accepted for publication in an upcoming edition of Journal of Biomechanics – see publication list over.
Biomechanics of Instrumented Fusion

Another new PSRG Masters by Research student, Mr Beau Brooker has joined us in 2015 after spending some of 2014 working as a PSRG Research Assistant after completion of his undergraduate engineering degree. His project is entitled, ‘Developing validated biomechanical models to replace large animal studies in spine research: how do motion stabilizing implants affect the biomechanics of the lumbar spine?’ Beau’s project involves biomechanical testing of human lumbar spine specimens instrumented with simulated fusions (pedicle screws and titanium rods), across single and dual levels, with GEORGE the six axis robot at QUT (below). This project will investigate the biomechanical efficacy of instrumented spinal fusion surgery and the effect this has on the biomechanics of adjacent segments. This project will also provide essential biomechanical and imaging data necessary for the validation of a virtual spine model, which will offer orthopaedic surgeons a powerful tool for pre-operative planning of spinal surgery. Furthermore, this project is significant in that it has the potential to replace the need for large animal models to investigate the biomechanics of the lumbar spine.

Dr Geoff Askin Global Speaker in 2015!

The PSRG’s founding Spinal Orthopaedic Surgeon, Adjunct Professor Geoffrey Askin has been in demand as an invited Keynote Speaker this year. Speaking invitations have taken him to Kuala Lumpur, Fiji and Edinburgh as well as local and national Australian meetings. His expertise with the management of severe spine trauma and complex spinal deformity in young children and adolescents resulted in Dr Askin presenting on ten occasions on the varied topics of; paediatric spinal trauma, metastatic spinal tumours, the role of anterior spinal surgery, thoracoscopic scoliosis correction surgery, the management of spondylolisthesis and the management of early onset progressive scoliosis. His skills were put to the test and resulted in much national and international attention last month when a sixteen month old boy presented with dislocated and unstable C1-C2 vertebrae (see left) after a motor vehicle accident. The child was surgically stabilized by Dr Askin at the Lady Cilento Children’s Hospital, Brisbane and put into a Halo Brace postop by GB Orthopaedics, Brisbane. Against all fears and expectations, he has avoided any permanent nerve or spinal cord damage. The news story can be viewed at the following link: https://au.news.yahoo.com/qld/a/29759836/world-applauds-jaxons-miracle-recovery/

Thank you to our Supporters

The PSRG would like to acknowledge those who have generously supported us in many ways in 2014 and 2015. We look forward to working with our partners and research collaborators into 2016 and beyond. Our sincere thanks to: Queensland University of Technology, Mater Health Services Pty Ltd, Children’s Health Queensland, Mater Foundation, Queensland X-Ray, Medtronic Australasia Pty Ltd, DePuy Synthes Spine, Dr Robert Labrom, Dr Geoff Askin, Mr Damon Bennett, Professor Mark Pearcy, Ms Shuang Hu and the Scoliosis Support Group of Queensland.

PSRG Publications in 2014-15

The PSRG is pleased to announce that we have had eleven scientific journal papers published, with a further eight papers currently under review.

1. Izatt MT, Carstens A, Adam CJ, Labrom RD, Askin GN. Partial intervertebral fusion secures successful outcomes after thoracoscopic anterior scoliosis correction; a low dose computed tomography study. Accepted Spine Deformity April 2015

Any questions or want to know more?
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