2017-2018

Trauma and Orthopaedic Research Unit
Mission Statement

The Trauma and Orthopaedic Research Unit (TORU) has capacity to undertake clinical and laboratory studies in the field of musculoskeletal disease.

This includes clinical aspects of arthroplasty, tissue reconstruction and trauma, fracture surveillance and management, medical imaging and joint kinematics.

TORU has established a laboratory facility at both Canberra Hospital and at the John Curtin School of Medical Research at the ANU. This enables us to conduct translational research within our own unit.

TORU’s mission is to conduct excellent research which meaningfully impacts on the clinical practice of orthopaedics and the well-being of patients.
TORU is a research unit embedded within a health service but also within a university. TORU also has strong links with the private sector through me and my colleagues and of course with both the University of Canberra and UNSW. As an entity we are well embedded into the fabric of research in Canberra but we are also increasing our influence on a national level.

Jennie Scarvell has been part of TORU since its inception. She completed her PhD with me in 2003 and it was clear that she was destined for greatness. After moving to UC in 2011 as head of physiotherapy she has become increasingly known for her intellect and drive and sheer ability to get things done. Last year she was promoted to full professor and this year she was made Associate Dean of research at UC. We are very fortunate to have such a talented and committed colleague and collaborator.

Mark Pickering is director of undergraduate studies at the school of engineering and information technology at UNSW (Canberra campus). Mark joined us in 2009 on the PICKLeS knee project which is supported by Zimmer Biomet. In the past year he was made a full professor which has made him even busier but he has still found time to work on the many projects we throw at him. We are delighted to be hosting Mark for part of his sabbatical next year.

Rachel Li works harder than anyone I know; I sometimes wonder if she ever leaves the laboratory. But her achievements are commensurate with her remarkable effort. Her laboratory report is enclosed in these pages but it is important to point out that her efforts at ANU have won her the respect and admiration of all she works with and she is part of the group who won 7 million dollars for the ARC training centre for multiscale imaging, modelling and manufacturing at ANU. Her huge output and her scholarly inventiveness marks Rachel as an extraordinary scientist.

Diana Perriman continues to keep the clinical arm of our business running smoothly as higher degree scholars, medical staff and medical students move through the unit with access to excellent support and supervision. The role of research for young medical candidates seeking to make orthopaedics their specialty is increasing and TORU is playing a role in this. It is becoming clear that a higher degree will soon be mandatory. Diana has just been appointed as HDR convenor for the ANU medical school. In this role she is hoping to drive a program of strategic change which will enable candidates to achieve an MPhil or PhD during their training.

Our team includes all these people above but importantly, also our scholars and students who have achieved a huge amount this year and their stories are contained within these pages. My thanks to them all and also to all of the colleagues in health and industry for your support this year. Without you we couldn’t be this successful.

I hope you all enjoy this 2018 edition of the newly named TORU Annual Report.

Paul Smith, BMBS FRACS (Ortho)
Director, Trauma and Orthopaedic Research Unit
Prof Paul Smith BMBS, FRACS, FAOrthA
Director

Professor Paul Smith is an orthopaedic surgeon at the Canberra Hospital and at Calvary John James Hospital in Canberra. He is also Co-Director of the Trauma and Orthopaedic Research Unit at the Canberra Hospital. Prof Smith is also Chairman of the John James Foundation, and Clinical Director of Orthopaedic surgery at the Canberra Hospital.

Prof Smith received his medical and surgical training in Adelaide before specialising in hip and knee joint reconstructive and replacement surgery. He was a Royal Australasian College of Surgeons Travelling Fellow in 1996 and 1997 with Fellowships in joint replacement surgery at the University of Western Ontario in Canada and at The Princess Elizabeth Orthopaedic Hospital in England. He has been honoured by The Knee Society, receiving the inaugural John N Insall Travelling Fellowship in knee surgery and has been appointed as Professor of Orthopaedic Surgery at the ANU Medical School. Prof Smith’s particular clinical interests are in reconstruction and replacement surgery of the hip and knee, complex revision joint replacement surgery and management of pelvic and acetabular injuries.

Professor Smith is passionate about research and teaching and was involved in the establishment and ongoing management of the Trauma and Orthopaedic Research Unit at The Canberra Hospital; the ACT Bone Bank; and the Canberra Orthopaedic Research and Education Foundation (CORE); His teaching affiliations include the ANU Medical School.

Contact:
psmith.admin@orthoact.com.au
Dr Diana Perriman BAppSc (Physio), MSc., PhD
Clinical Research Lead

Dr Diana Perriman, BAppSc (USyd), MSc. (University of East London), PhD (ANU). Dr Perriman is currently the clinical research coordinator of TORU.

Dr Perriman is a physiotherapist who has completed her PhD at the ANU in 2011. Prior to research, Diana had an extensive clinical career in which she worked in acute hospitals, the community and private practice both in Australia and the UK. She has worked at the Trauma and Orthopaedic Research Unit both as a research officer, PhD candidate and as the coordinator since returning from the UK in 2003.

Her PhD research investigated the thoracic spine and kyphotic thoracic posture in aging, a suite of thoracic spine biomechanical and imaging studies culminating in a randomized controlled trial of the effect conservative treatment for thoracic kyphosis.

Dr Perriman was a recipient of an NHMRC Dora Lush scholarship for this research. As clinical research coordinator Dr Perriman’s research interests lie in arthroplasty, knee kinematics and fracture outcomes in accordance with the main focus of the Trauma and Orthopaedic Research Unit. She also collaborates with other researchers investigating whiplash and hamstring injury in running sports.

Dr Perriman is a senior lecturer at the ANU Medical School and an adjunct Professor at the University of Canberra. In this role she supervises medical students, Physiotherapy students and higher degrees students from both disciplines. She sits on the scientific committee of the ACT Health ethics committee and is also the President of the ACT branch of the Australian Physiotherapy Association.

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Dr Rachel Li MD, PhD
Laboratory Research Lead

Dr Li is a molecular pharmacologist and osteoimmunologist with interests in understanding the processes that control a ‘foreign body reaction or response’ initiated by biomaterials implanted into bone or exposed to human cells.

Dr Li worked as a surgeon and senior liver diseases specialist at China Medical University. She led a number of clinical trials in anti-viral and anti-inflammatory drugs and successfully transferred an intellectual property to pharmaceutical industry. Dr Li completed her PhD at Southern Cross University and gained her postdoctoral experience in molecular pharmacology at John A Burns School of Medicine, University of Hawaii.

Dr Li established the TORU Laboratory which pioneered basic orthopaedic research at the ACT region. Her current research focus is to develop biocompatible, bioactive and biodegradable materials for future orthopaedic implants. She has made some major research contributions to the fields of osteoimmunology and also great contribution to medical education as a senior lecturer in CMU, Associate Professor (pharmacology) in University of Canberra, and Professor (Orthopaedic Surgery) in Shandong University, China.

Contact: rachel.li@anu.edu.au
Clinical Report

The mission of the clinical arm of TORU is to undertake impactful research and provide support and supervision for orthopaedic clinicians, medical students and higher degree scholars. Much of that work is reported in this annual report. The Trauma and Orthopaedic Research Unit is affiliated with the ANU medical School and our scholars are primarily ANU candidates. However, we also supervise and support University of Canberra (UC) scholars and collaborate with other scholars from UNSW.

We are overseeing a change in scholarship at TORU and witnessing a move towards training scholars to achieve impactful work through hard work and good communication. Exposure and impact are important in times when academic positions are difficult to achieve.

Catherine Galvin has been undertaking her PhD on knee kinematics since 2014. She was awarded a shared scholarship from UC and TORU and has submitted our first papers using the kinematic data from our healthy knee cohort. Catherine’s achievements are many. During the course of her PhD she has conducted and published a systematic review and meta-analysis of the literature on deep knee flexion kinematics (The Knee, 25 (2018) 514–530) which attracted editorial comment and has two further papers submitted for publication with two others prepared. She will complete by early 2019. She has also won prizes at UC for three minute thesis and also for teaching. Her presentations are always enjoyable because she projects passion and confidence. Catherine is a modern scholar. She is strategic and will graduate with a PhD but also with many more lines on her CV. She has demonstrated hard work but also strategic thinking which marks her out and has taught me to aim higher with our scholars.

Joe Lynch has now spent 20 months on his PhD at ANU Medical school. He has already presented his work at international conference in Dublin and this work was also presented at the Australian and New Zealand Orthopaedic Research Society in Perth this year. He has a supervisory panel which includes Thor Besier who is an internationally renowned biomechanist. Joe went to New Zealand this year to work with Thor’s team and develop his skills in shape analysis. Following this he has completed his first paper and is commencing his second. Joe is developing a valuable set of skills which we hope to benefit from into the future. Joe is also a strategic scholar and is looking firmly into his future as an academic.

Dr. Sumedha S Amarasekara will be awarded his MPhil on periprosthetic fractures this year. Sumedha was an orthopaedic registrar at TCH when he commenced his MPhil and is now a consultant orthopaedic surgeon in Sri Lanka. His journey was long but he overcame the obstacles and we are very proud to acknowledge his efforts by the addition of his name to our honours board for 2019. Congratulations Sumedha.

Dr Mitchell Kingston also completed ad submitted his MPhil on the lateral blood supply to the hip this year. He is currently finishing his responses to the reviewers and we are hopeful that he will be awarded his MPhil by the end of the year. Mitch is currently on the Australian Orthopaedic Training program which he partly achieved through his MPhil work. Congratulations Mitch.

We continue to support many medical students at TORU as part of our commitment to promoting excellence in research practice. This year we conducted a clinical trial following up Paul Smiths gluteal tendon repair patients with Dr Angie Fearon and Dr Wayne Spratford from UC. The lucky students involved in this project were Tom Sizeland and Sally Gilbert. We all toiled hard over the summer holidays to complete the project and both students submitted their papers which we hope to submit for publication early next year. Tom is continuing to work on the biomechanical analysis over the holidays on an ACTH vacation scholarship. Both papers will be presented at the ACT AOA annual scientific meeting this year.

Yi Ying Zheng is studying physiotherapy at the University of Canberra this year. She
Identifying Morphological Changes in the Cervical Spine Muscles in Whiplash

Injuries to the neck following whiplash trauma (whiplash injury) are one of the most common causes of neck pain and disability in the developed world. We are currently conducting a study which uses magnetic resonance (MR) imaging in combination with physical and psychological measures, to identify structural lesions of the neck following whiplash injury. The ability to identify and differentiate the relationship between structural lesions and physical and psychosocial measures in whiplash patients will potentially enable more specific and timely management. Recent results have found distinct morphological changes within neck muscles of patients who have either a chronic or acute whiplash injury. Muscle atrophy occurs in both groups while there are increases in 3D muscle volume acute patients. This could indicate possible inflammation within the muscle. Future work will continue to understand structural changes in the neck and to relate these changes to clinical measures.

TORU has continued to work with Jane Desborough and Anne Parkinson from the Research School of Population Health on the development of an application to support patients having knee and hip replacements through their journey. This project is a collaboration between the students in the techlauncher program at ANU and ‘industry’. The program has the dual advantage of giving students work experience and also using their skills for invention and development. The app is being trialled with patients and will be presented this year at the AOA scientific meeting in Canberra. OrthoACT and Dr Michael Gross from Calvary has aided in this development providing important IP and expert advice.

I have just picked out a few of the achievements for this year and we hope you will enjoy reading about our many ongoing and completed projects in the Annual report in the ensuing pages.

Thanks to all who have contributed to TORU this year and all our best for the coming year.
Clinical Team

TORU Staff
Ms Anna Davis - Office Manager
Mr Joe Lynch - Senior Research Officer

Fracture Liaison Officers
Ms Sayerah Deasey RN  Ms Krista Bridge RN

Clinical and Research Fellows
Professor Jennie Scarvell—Associate Dean of Research, University of Canberra

Clinical Collaborators

Prof Jennie Scarvell
Associate Dean Research, University of Canberra

Dr Wayne Spratford
Assistant Professor, Sport and Exercise Science, University of Canberra

Dr Phil Newman
Assistant Professor, Physiotherapy, University of Canberra

Dr Angie Fearon
Assistant Professor, Physiotherapy, University of Canberra

Prof Gordon Waddington
Physiotherapy and UCRiSE, University of Canberra

Prof Christian Cook
UCRiSE, University of Canberra

Prof Mark Pickering
School of Engineering and IT, UNSW@ADFA

A/Prof O’Byrne
School of Engineering and IT, UNSW@ADFA

A/Prof Heiko Timmers
School of Physical, Environmental and Mathematical Sciences, UNSW@ADFA

Dr Teresa Neeman
Statistical Consulting Unit, ANU

Dr Jane Desborough
Department of Health Services Research and Policy, Research School of Population Health, ANU

Dr Anne Parkinson
Health Services Research & Policy, Research School of Population Health, ANU

A/Prof Alexandra Webb
Medical School, ANU

Prof Kirsty Douglas
General Practice, Medical School ANU

Prof Ian Harris
UNSW South Western Sydney Clinical School, Whitlam Orthopaedic Research Centre

A/Prof Thor Besier
Auckland Bioengineering Institute, University of Auckland

Dr Chris Roberts
Orthopaedic Surgeon, OrthoACT

Dr Alexander Burns
Orthopaedic Surgeon, OrthoACT

Prof Nick Brown
Professor of Allied Health, University of Canberra

Dr Ben Serpell
Athletic Performance Director, ACT Brumbies
World Congress of Biomechanics - Dublin Ireland

Catherine Galvin and Joe Lynch both attended the World Congress of Biomechanics this past July in Dublin Ireland. The field of biomechanics sits at the interface of engineering and medicine and research. The World Congress of Biomechanics is held once every 4 years and is the premier meeting worldwide in it’s field. The meeting allowed researchers to listen to world leaders discuss their ground breaking discoveries, connect with old friends and develop new collaborations. During the meeting Joe Lynch presented his work entitled: A comparison between osteoarthritic and asymptomatic knees using statistical shape modelling. Catherine Galvin presented her work which looked at comparing healthy and osteoarthritic knee kinematics during deep kneeling on people over 50 years of age as a poster. Both Joe’s presentation and Catherine’s poster generated plenty of interest and discussion. While this was TORU’s first time attending this meeting, it will now be a regular on the conference calendar.

ARC Industrial Transformation Training Centre

Rachel was part of a successful grant to setup an ARC Industrial Transformation Training Centre. The centre will focus on Multiscale 3D Imaging, Modelling and Manufacturing. The grant will be overseen by Professor Mark Knackstedt from the ANU Research School of Physics and Engineering, and is worth nearly $4 million. This grant a scheme fosters close partnerships between university-based researchers and other research end-users to provide innovative Higher Degree by Research (HDR) and postdoctoral training for the end-user focused research industries vital to Australia’s future. The centre will connect ANU with 16 industry and research partners to train a new generation of researchers and practitioners in the emerging discipline of digital materials. The partners include local, national and international companies and research organisations. Congratulations Rachel!

Australian Orthopaedic Association Research Fellowship

Professor Smith’s extraordinary research achievements have recently been recognised by Australian Orthopaedic Association by being awarded the Research Foundation Fellowship. This award is the highest honour the Australian Orthopaedic Association can bestow upon a member and recognises individuals who have made significant contributions to the AOA Research Foundation.
Laboratory Report

The TORU Laboratory, based at the John Curtin School of Medical Research, bridges basic and clinical sciences and facilitates communication among TORU’s collaborative institutes, universities and orthopaedic industries. TORU is presently investigates chronic and complex bone diseases, some of which cause lifelong pain and disability. These chronic conditions can be rare, such as revision joint replacement and osteolysis or can be remarkably common, such as arthritis, trauma and osteoporotic fractures. Combined, they afflict millions of Australians and cause tremendous human suffering, and cost million dollars in health care.

The team utilizes a mix of conventional molecular biology approaches as well as global methods such as next generation sequencing to study mRNA expression and its regulation by non-coding RNA e.g. microRNAs with an ultimate goal of identifying novel molecules that regulate bone resorption, formation, fracture repair and bone homeostasis.

Osteoimmunology, miRNA regulation and genetic risk factors in biomaterial related chronic inflammation and osteolysis in total joint replacement surgery

Osteolysis is one of the causes that lead to the failure of total joint replacement (TJR). The failure of TJR requires revision surgery which is considered one of the most complex procedures in modern orthopaedics. Wear debris is known to impact on a variety of cellular responses and genes in multiple pathways associated with the development of the periprosthetic osteolysis and chronic inflammation. Negative regulation of mRNA translation by microRNA (miRNAs) has emerged as an important regulation of osteogenic signalling pathways, osteoblast growth and differentiation, osteoclast-mediated bone resorption activity and bone homeostasis in the adult skeleton. However, our understanding of how miRNAs control the regulatory interplay among multiple layers of mRNA regulation in osteolysis is minimal. We therefore propose that novel correlations exist between the differentially expressed mRNAs and miRNAs expressions of multiple signalling pathways in osteolysis/chronic inflammation. Using the latest Next Generation Sequencing technologies, we are investigating miRNA expression profiles in human trabecular bone, synovial fluid and plasma sourced from TJR revision surgery where wear particle associated osteolysis was evident. The ultimate goals are to contribute to the development of better predictive markers, treatments, and prevention strategies. This research has in part supported by Australian Orthopaedic Association (AOA) Research Foundation.
Antibacterial biomaterials for future orthopaedic implants

The rise of antibiotic resistance is a global health crisis and the most recent World Economic Forum Global Risks reports have listed anti-biotic resistance as one of the greatest threats to human health. Prosthetic related infection has been demonstrated as a biofilm correlated phenomenon, which is highly resistant to antibiotic treatment with poor prognosis. These infections involve a complex interplay among the biofilm-forming micro-organisms, host responses and the implant. Gristina has described the initiation of implant related infection as a “race for the surface”. The two issues of implant loosening and infection are therefore intimately related. Thus, promotion of osseointegration and prevention of bacterial colonization and subsequent biofilm formation are both clinically imperative and required for a successful implant. This project aims to move towards multifunctional coatings to simultaneously promote osseointegration and prevent infection of orthopaedic implants. In collaboration with RMIT University, we have been developing biomaterials with antibacterial activity. In these projects, the antibacterial activity of the materials will be tested for their in vitro inhibition biofilm formation of Staphylococcus aureus, S. epidermidis, Escherichia coli and Pseudomonas aeruginosa, among the most common pathogens in orthopaedic infections. The projects will also optimize the thickness of surface coating layer with respect to achieving the best antibacterial effects and biocompatibility.

Optimising the design and workflow of 3D printed orthopaedic implants

The use of 3-Dimensional (3D) printing technology has shown promise by aiding preoperative surgical planning, and in facilitating patient-specific intervention. The advantages of this technology include more accurate surgical procedures, decreased surgical times, and blood loss, thereby reducing the risk of acute complications. However, a lack of standardised frameworks available, particularly to monitor quality assurance, has been a main concern and major factor contributing to limited universal implementation of 3D printing. Consequently, there is a need to design a universal training program with standardised frameworks for future doctors to allow this technology to become incorporated into routine practice. This project aims to explore the major steps in the 3D printing workflow and the role of an educational program in relation to these. The implementation of such a program will allow future doctors to be equipped with the ability to access the benefits of 3D printing.
Staff

Dr Donghai Zhang

Dr Zhang is a Chinese Anaesthetist from Shandong University who travelled to Canberra to join the TORU lab team working specifically on ‘Biocompatibility of novel sensing materials for assessment of fracture healing.’ Donghai has finished with our unit this past year. We would like to thank Donghai for his help and wish him all of the best in the future.

Mr Jin Dai

Jin completed his Bachelor of Science (Cell and Molecular Biology) and Master of Biotechnology in Research School of Biology at the ANU. He has been working as a Senior Technical Officer in Cytokine Molecular Biology and Signalling Group for 11 years in John Curtin School of Medical Research (JCSMR), ANU. Jin’s main duties are induction of primary osteoblast cells form bone, mRNA and miRNA extraction from human bone tissue, animal sampling and μCT scanning.

Collaborators

Prof Dongsheng Zhou
Department of Trauma and Orthopaedics, Shandong University, Jinan, China

Prof Jiake Xu
School of Pathology and Laboratory Medicine and Head of molecular laboratory, UWA

Prof Chris Parish
Department of Immunology, John Curtin School of Medical Research, ANU

Prof Qinghua Qin
College of Engineering and Computer Science, ANU

Prof Brett Kirk
Faculty of Science and Engineering, Curtin University

Dr Gaétan Burgio
College of Health and Medicine, ANU

Prof Tim Senden
Director, Department of Applied Mathematics, Research School of Physics & Engineering, ANU

Prof Mark Knackstedt
Department of Applied Mathematics, ANU

Prof Julio Licinio
State University of New York Upstate Medical School

Prof Suresh Mahalingam
Principal Research Leader & ARC Future Fellow, Institute for Glycomics, Griffith University

Professor Nicholas Birilis
Dean of the Dept of Materials Engineering, Monash University

Dr Xiaobo Chen
School of Engineering, RMIT
Funding and Awards

Grants/Funding

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<tr>
<th>Awarding Body</th>
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<td>Industrial support to ARC</td>
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<td>Levi Beeching, Dr Robert Sok</td>
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Awards

Joe Lynch: Reginald Kitchin Scholarship
Catherine Galvin: Winner, University of Canberra, Early Career Educator of the year
Catherine Galvin: Winner, University of Canberra, Vice Chancellors Award for Teaching Excellence for Sessional Tutor
Mike Van Alphen: Gareth Long Prize for top mark in Orthopaedics for the graduating class of 2017

Conference Awards

2017 AOA ACT Research Meeting

Mark Porter: Best Paper – Augmentation of revision ACL reconstruction with modified ITB tenodesis.
Xuan Ye: Best Registrar paper – Radiographic analysis of implant position and articular subsidence tibial plateau fractures.
Robert Simic: Best Student paper – Optimising the Design and Workflow of 3-D Printed Orthopaedic Implants
Tom Cheng: Best Lab paper – Novel material against bacterial biofilms
Yi Deng: Best Discussion Generator – Ulnar Styloid Fractures at The Canberra Hospital: Should we do more?
Mustafa Altthir: Best Poster – Use of Dynamically locked Hindfoot Nail to allow weight-bearing post-operatively.

Australian Society of Medical Research (ACT Branch)

Catherine Galvin: Best Oral Presentation
Fused deposition modelling (FDM) is a technique of additive manufacturing (AM) which is capable of fast construction of plastic prototypes. AM technology has been utilised in orthopaedics and traumatology to fabricate patient-specific models, surgical guides, and implants. However, the layering build-up by FDM usually generates a deleterious rough surface that limits its application to items such as surgical guide and surgical operating guide, because these items require a highly resolved surface quality. The advancement of laser polishing has been offering a cost-effective and fast manufacturing solution for FDM-constructed patient-specific guides and implants. This investigation explores application potential using a contactless laser scanning to improve the surface quality of FDM-fabricated thermoplastics. The results show that a maximum [68%] reduction in surface roughness was achieved at 3 W CO2 laser power, 150 mm/s scan speed, 30 ms scan delay and 0.025 mm line gap. Laser polishing is suitable to treat the surface of polylactic acid (PLA). This study provides data which supports a new approach to the manufacture of AM-fabricated thermoplastics utilising a laser scanning technique to improve the surface quality.
**Aim:** To develop a practical model for classification bone turnover status and evaluate its clinical usefulness.

**Methods:** Our classification of bone turnover status is based on internationally recommended biomarkers of both bone formation (N-terminal propeptide of type1 procollagen, P1NP) and bone resorption (beta C-terminal cross-linked telopeptide of type I collagen, bCTX), using the cutoffs proposed as therapeutic targets. The relationships between turnover subtypes and clinical characteristic were assessed in 1223 hospitalised orthogeriatric patients (846 women, 377 men; mean age 78.1±9.50 years): 451 (36.9%) subjects with hip fracture (HF), 396 (32.4%) with other non-vertebral (non-HF) fractures (HF) and 376 (30.7%) patients without fractures.

**Results:** Six subtypes of bone turnover status were identified: 1 - normal turnover (P1NP>32 μg/L, bCTX<0.250 μg/L and P1NP/bCTX>100.0)[[median value]]; 2 - low bone formation (P1NP ≤32 μg/L), normal bone resorption (bCTX≤0.250 μg/L) and P1NP/bCTX>100.0 (subtype2A) or P1NP/bCTX<100.0 (subtype 2B); 3 - low bone formation, high bone resorption (bCTX>0.250 μg/L) and P1NP/bCTX<100.0; 4 - high bone turnover (both markers elevated ) and P1NP/bCTX>100.0 (subtype 4A) or P1NP/bCTX<100.0 (subtype 4B). Compared to subtypes 1 and 2A, subtype 2B was strongly associated with nonvertebral fractures (odds ratio [OR] 2.0), especially HF (OR 3.2), age>75 years and hyperparathyroidism. Hypoalbuminaemia and not using osteoporotic therapy were two independent indicators common for subtypes 3, 4A and 4B; these three subtypes were associated with in-hospital mortality. Subtype 3 was associated with fractures (OR 1.7, for HF OR 2.4), age>75 years, chronic heart failure (CHF), anaemia, and history of malignancy, and predicted post-operative myocardial injury, high inflammatory response and length of hospital stay (LOS) above10 days. Subtype 4A was associated with chronic kidney disease (CKD), anaemia, history of malignancy and walking aids use and predicted LOS>20 days, but was not discriminative for fractures. Subtype 4B was associated with fractures (OR 2.1, for HF OR 2.5), age>75 years, CKD and indicated risks of myocardial injury, high inflammatory response and LOS>10 days.

**Conclusions:** We proposed a classification model of bone turnover status and demonstrated that in orthogeriatric patients altered subtypes are closely related to presence of nonvertebral fractures, comorbidities and poorer in-hospital outcomes. However, further research is needed to establish optimal cut points of various biomarkers and improve the classification model.

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**BACKGROUND:** While several studies describe kinematics of healthy and osteoarthritic knees using the accurate imaging and computer modelling now possible, no systematic review exists to synthesise these data.

**METHOD:** A systematic review extracted quantitative observational, quasi-experimental and experimental studies from PubMed, Scopus, Medline and Web of Science that examined motion of the bony or articular surfaces of the tibiofemoral joint during any functional activity. Studies using surface markers, animals, and in vitro studies were excluded.

**RESULTS:** 352 studies were screened to include 23 studies. Dynamic kinematics were recorded for gait, step-up, kneeling, squat and lunge and quasi-static squat, knee flexion in side-lying or supine leg-press. Kinematics were described using a diverse range of measures including six degrees of freedom kinematics, contact patterns or the projection of the femoral condylar axis above the tibia. Meta-analysis of data was not possible since no three papers recorded the same activity with the same measures. Visual evaluation of data revealed that knees with osteoarthritis maintained a more adducted position and showed less posterior translation of the lateral femoral condylar axis than healthy knees. Variability in activities and in recording measures produced greater variation in kinematics, than did knee osteoarthritis.

**CONCLUSION:** Differences in kinematics between osteoarthritic and healthy knees were observed, however, these differences were more subtle than expected. The synthesis and progress of this research could be facilitated by a consensus on reference systems for axes and kinematic reporting.

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The process of spatially aligning two or more images acquired from different devices or imaging protocols is known as multi-modal image registration. As the similarity measure used is one of the most significant aspects of this process, certain measures have been proposed to enhance multimodal image registration. However, the currently available measures are either not sufficiently accurate or are very computationally expensive. In this paper, a new hybrid multimodal registration approach is proposed. The new approach combines a fast measure, based on matching image edges, with a robust, but slow measure, which uses the joint probability distribution of the two images to be registered. Our experimental results reveal that using this hybrid approach provides a performance equivalent to the previously best measures but with a significantly reduced computational time.

Ye X., Huang D., Perriman D.M., Smith P.N., The influence of screw to joint distance on articular subsidence in tibial plateau fractures. ANZ Journal of Surgery, 2018

**Background:** Tibial plateau fractures with depressed osteochondral fragments have a high incidence of articular subsidence post reduction. Locking plates aim to prevent this via ‘raft’ screws below the subchondral bone. However, differences in plate design and patient anatomy result in variability of screw position in relation to the fragments they are designed to support. We evaluate the effect of screw placement and articular subsidence with this fracture pattern.

**Methods:** A retrospective cohort study of operatively treated tibial plateau fractures with free osteochondral fragments was performed to determine if screw placement was correlated with articular subsidence. Primary outcome was the relationship between screw to joint distance and articular subsidence. Secondary outcomes were whether bicortical fixation, presence of bone graft, fracture characteristics and patient age was correlated with articular subsidence.

**Results:** Sixty-eight of 309 tibial plateau fractures had depressed osteochondral fragments (22%). The average thickness of these fragments was 10.2 mm. Fractures with raft screws placed closer to the joint than the thickness of the osteochondral fragment were less likely to subside (1.8 vs. 3.4 mm; p=0.02). The proportion of fractures with no radiographic subsidence was also greater in this cohort versus fractures with distal screw placement (33% vs. 8%; p=0.02). Articular comminution (p=0.04) and female patients aged over 65 years (p=0.03) were associated with increased articular subsidence.

**Conclusion:** Fractures fixed with screws closer to the joint than the thickness of the osteochondral fragment were correlated with less articular subsidence. The ‘screw-joint distance’ may help guide screw placement intraoperatively.


Animal models of ischemia/reperfusion (I/R) injury have been widely applied to the study of myocardial, liver, renal and skeletal muscle ischemia, I/R injury and drug efficacy. However, these require large numbers of experimental animals and human resources in performing the surgical procedures. Animal models described for experimental research regarding multiple-organ I/R injury are relatively sparse. Therefore, there is a clear potential to evaluate the drugs for protection against I/R injury of multiple organs in an established multiorgan I/R injury animal model. Here we provide useful information for medical researchers who are learning the surgical process of establishing I/R injury animal models. We demonstrate a novel multi-organ procedure for both skeletal muscle I/R injury and kidney I/R injury in a rat model. The surgical process is described from an anesthetized animal to the completion of reperfusion, including detailed descriptions of each step throughout the procedure. It should also be noted that this video guide is focused towards procedures conducted in rodent models. Modifications of the described procedures are applicable to other animal models.


In this chapter, common inflammation processes and mediators are presented briefly before a detailed study of potential natural product lead compounds on targeting the inflammation processes and mediators for the discovery and development of antiinflammatory agents with two approaches: traditional “one molecule one target one disease” and currently emerging “one molecule multiple targets several diseases.” The inflammatory processes outline the cellular and molecular changes of inflammatory responses, whereas the inflammatory mediators include those involved in arachidonic acid pathways, nuclear transcription factor κB (NF-κB) pathways, inducible nitric oxide, and proinflammatory cytokines. Natural products targeting the inflammation processes and mediators are surveyed in groups of phenolics, terpenes, and alkaloids. Finally, antiinflammatory natural products with multiple targets are highlighted by citing examples of curcumin, (−)-epigallocatechin-3-gallate, trans-resveratrol, quercetin, and racemosic acid. Mother nature has created these unique molecules, each possessing bioactivities against multiple molecular targets, including cyclooxygenases, lipoxygenases, microsomal PGE2 synthase-1, NF-κB signaling, and inducible nitric oxide.

INTRODUCTION: The data on predictive value of the routinely obtained preoperative biochemical parameters in hip fracture (HF) patients are limited. The aims of this study were to examine in older HF patients (1) the relationships between a broad set of routine laboratory parameters at admission and in-hospital mortality, and (2) evaluate the prognostic value the biomarkers and clinical characteristics (alone or in combination) provide to predict a fatal outcome.

PATIENTS AND METHODS: In 1820 consecutive patients with low-trauma osteoporotic HF aged >60 years (mean age 82.8 ± 8.1 years; 76.4% women; 65% community-dwelling) 35 laboratory variables along with 20 clinical and socio-demographic characteristics at admission were analysed. The validation cohort included data on 455 older (≥60 years of age) HF patients (mean age 82.1 ± 8.0 years, 72.1% women).

RESULTS: The mortality rate was 6% (n = 109). On univariate analysis 14 laboratory and 8 clinical parameters have been associated with in-hospital mortality. Multiple regression analyses determined 7 variables at admission as independent indicators of a fatal outcome: 4 biomarkers (albumin <33 g/L; alanine aminotransferase/gamma-glutamyl transferase ratio [GGT/ALT] >2.5; parathyroid hormone [PTH] >6.8 pmol/L; 25(OH)vitamin D < 25 nmol/L) and 3 pre-fracture clinical conditions (history of myocardial infarction, chronic kidney disease [GFR <60 ml/min/1.73 m²] and chronic obstructive pulmonary disease); the area under the receiver operating characteristic curve (AUC) was 0.75 (95%CI 0.70-0.80). The risk of in-hospital death was 1.6-2.6 times higher in subjects with any of these risk factors (RFs), and increased by 2.6-6.0-fold in patients with any two RFs (versus no RFs). The mortality rate increased stepwise as the number of RFs increased (from 0.43% -none RF to 16.8%- ≥4RF). The prognostic value of a single RF was low (AUC ≤0.635) but combination of 2 or more RFs improved the prediction significantly; AUC reached 0.84(95%CI 0.77-0.90) when ≥4 RFs (versus 0-1RF) were present. In the validated and main cohorts the number of predicted by 1, 2, 3 or ≥4 RFs and observed deaths were practically similar.

CONCLUSIONS: In HF patients, seven easily identifiable at admission characteristics, including 4 biomarkers, are strong and independent indicators of in-hospital mortality and can be used for risk stratification and individualised management.


Background: Physical therapists assess joint movement by observation and palpation. New imaging technologies that enable vision of bones and joints during functional activities can be used to analyse joint kinematics and review traditional assumptions.

Purpose: To measure relationships between flexion, rotation and translation at the knee and to validate this visually.

Design: Prospective observational study.

Methods: 25 healthy participants over 45 years (13 males) knelt from upright kneeling to full flexion, with the foot free. Fluoroscopy recorded movement at 30 frames per second of x-ray. A CT scan provided 3-dimensional data which was registered to the fluoroscopy frames to provide a moving model. Motion in 6-degrees-of-freedom was analysed for coupling of movements.

Results: Participants reached 142 (6)º flexion in kneeling (mean (SD)). Posterior femoral translation was coupled to flexion (r=0.96, p<0.01). From 90º to 150º flexion the femur translated posteriorly by 36 (3) mm to finish 23 (3) mm posterior to the centre of the tibia at 150º flexion. From 90º to 150º flexion the femur externally rotated from 8 (6)º to 16 (5)º. Flexion was coupled to rotation (r=0.47, p<0.01). Abduction was less than 3º and lateral translation was less than 3mm. Visually, the femur appeared to translate posteriorly until the femoral condyles rested on the posterior rim of the tibial plateau, with concurrent external rotation so that the popliteal fossa aligned with the posterior margin of the medial tibial plateau.

Limitations: Knee flexion can include squat and lunge as well as kneeling.

Conclusion: Deep flexion requires femoral posterior translation and external rotation. These findings invite review of the concave-convex rule as it may apply to manual therapy of the knee.
Conference Presentations

AOA ACT Branch Scientific Meeting, Canberra 2017

- Radiographic analysis of implant position and articular subsidence in tibial plateau fractures
  Xuan Ye, Aung Lynn, Dawei Huang, Diana Perriman, Paul Smith

- Outcomes Of Arthroscopic Bursectomy
  Shamshuddin Mohammed Ali, Al Burns, Diana Perriman

- CROSSFIRE: Progress Report and Lessons Learned at The Canberra Hospital
  Luke Barr, Ian Harris, Justine Naylor, Dr Rajat Mittal, Andrew Lawson, Paul Smith, Diana Perriman

- Kinematics of knees with osteoarthritis show reduced lateral femoral roll-back and maintain and adducted position. A systematic review
  Jennie Scarvell, Robert Van Deursen, Joe Lynch, Catherine Galvin, Mark Pickering, Paul Smith

- Does the shape, size and location of the deformity affect outcomes in femoroacetabular impingement?
  Sarah Ellis, Diana Perriman, Al Burns, Teresa Neeman, Joe Lynch, Paul Smith

- Intra-Tendinous Arterial Supply of Gluteus Medius and Minimus
  Mitchell Kingston, Diana Perriman, Alexandra Webb, Paul Smith

- Use of patient reported outcome measures as predictors of predictors of manipulation under anaesthetic following total knee arthroplasty
  Laura Sofoulis, Diana Perriman, May Soo, Paul Smith

- Healthy vs osteoarthritic knee kinematics in 6 degrees of freedom during loaded deep kneeling for participants over 50 years of age
  Catherine Galvin, Mark Pickering, Joe Lynch, Diana Perriman, Paul Smith, Jennie Scarvell

- Ulnar Styloid Fractures at Canberra Hospital: Should we do more?
  Yi Deng, Igor Polincinski, Polson Sua, Sindy Vrancic, Diana Perriman, Paul Smith

- Open versus minimally invasive hallux valgus surgery - proposal for a randomized controlled trial
  May Soo, Dawei Huang, Yeong Joe Lau, Diana Perriman

- Seven day per week physiotherapy service for hip fracture patients improves outcomes
  Corrine Coulter, Diana Perriman

- Is the capsule implicated in FAI? - POSTER
  Thomas Staniforth, Diana Perriman, Al Burns, Karnie Falk, Paul Smith

World Congress of Biomechanics, Dublin Ireland

- A comparison between osteoarthritic and asymptomatic knees using statistical shape modelling

- A comparison of healthy and osteoarthritic knee kinematics in six-degrees-of-freedom during loaded deep kneeling for participants over 50 years—POSTER
  Catherine Galvin, Mark Pickering, Joe Lynch, Diana Perriman, Paul Smith, Jennie Scarvell

Australia and New Zealand Orthopaedic Research Society, Perth

- A comparison between osteoarthritic and asymptomatic knees using statistical shape modelling
  Joe Lynch, Marco Schneider, Diana Perriman, Jennie Scarvell, Mark Pickering, Md. Asikuzzaman, Catherine Galvin, Thor Besier, Paul Smith

- Healthy ageing does not change knee kinematics. A medical-imaging cross-sectional observation study
  Catherine Galvin, Mark Pickering, Joe Lynch, Diana Perriman, Paul Smith, Jennie Scarvell

- Weighing In: Does Size Matter In Knee Kinematics?
  Alice Churchill, Diana Perriman, Mark Pickering, Catherine Galvin, Joe Lynch, Nicola Hribar, Terry Neeman, Paul Smith, Jennie Scarvell

- Laser polished fused deposition poly-lactic acid objects for personalized orthopaedic application—POSTER
  Yuan Chai, Robert Simic, Donghai Zhang, Joe Lynch, Paul Smith, Qing-Hua Qin, Rachel Li

- Radiographic analysis of implant position and articular subsidence in tibial plateau fractures —POSTER
  Dawei Huang, Xuan Ye, Aung Lynn, Diana Perriman, Paul Smith
AOA National Scientific Meeting, Perth

- Ulnar Styloid Fractures at Canberra Hospital: Should we do more?
  Yi Deng, Igor Policinski, Polson Sua, Sindy Vrancic, Diana Perriman, Paul Smith

- A biodegradable alloy for orthopaedic implants –in vivo rat model.
  Paul Smith, Rachel Li

- Susceptibility of orthopaedic materials to bacterial biofilms
  Paul Smith, Rachel Li

- Does the shape, size and location of the deformity affect outcomes in femoroacetabular impingement?
  Sarah Ellis, Diana Perriman, Al Burns, Teresa Neeman, Joe Lynch, Paul Smith

- Radiographic analysis of implant position and articular subsidence in tibial plateau fractures
  Dawei Huang, Xuan Ye, Aung Lynn, Diana Perriman, Paul Smith

- Use of patient reported outcome measures as predictors of predictors of manipulation under anaesthetic following total knee arthroplasty
  May Soo, Laura Sofoulis, Diana Perriman, Paul Smith

Canberra Health Annual Research Meeting

- A comparison between osteoarthritic and asymptomatic knees using statistical shape modelling
  Joe Lynch, Marco Schneider, Diana Perriman’ Jennie Scarvell, Mark Pickering, Md. Asikuzzaman, Catherin Galvin’ Thor Besier, Paul Smith

- Do Kneeling Knee Kinematics change as we age from 20 to 90? What does healthy ageing of knees look like in deep flexion under load?
  Catherine Galvin, Mark Pickering, Joe Lynch, Diana Perriman, Paul Smith, Jennie Scarvell

- Weighing In: Does Size Matter In Knee Kinematics?
  Alice Churchill, Diana Perriman, Mark Pickering, Catherin Galvin, Joe Lynch, Nicola Hribar, Terry Neeman, Paul Smith, Jennie Scarvell

- Use of patient reported outcome measures as predictors of predictors of manipulation under anaesthetic following total knee arthroplasty—POSTER
  Laura Sofoulis, Diana Perriman, May Soo, Paul Smith —POSTER

- Is the capsule implicated in FAI? POSTER
  Thomas Staniforth, Diana Perriman, Al Burns, Karnie Falk, Paul Smith

- Ulnar Styloid Fractures at Canberra Hospital: Should we do more? - POSTER
  Yi Deng, Igor Policinski, Polson Sua, Sindy Vrancic, Diana Perriman, Paul Smith

- Radiographic analysis of implant position and articular subsidence in tibial plateau fractures—POSTER
  Xuan Ye, Aung Lynn, Dawei Huang, Diana Perriman, Paul Smith—POSTER

- Knee kinematics predict pain and function score during stair ascent - POSTER
  Henry Williams, Diana Perriman, Catherin Galvin, Jennie Scarvell, Paul Smith

- Mechanical and biocompatible characterisation of laser polished Poly-lactic acid for surgical guide fabricated by 3D printing—POSTER
  Yuan Chai, Robert Simic, Donghai Zhang, Joe Lynch, Paul N Smith, Qing-Hua Qin, Rachel Li

BIT’s 7th Annual World Congress of Advanced Materials, Xiamen, China.

- Laser polishing of thermoplastics fabricated using fused deposition modelling.
  Yuan Chai, Rachel W. Li, Diana M. Perriman, Song Chen, Qing-Hua Qin and Paul N. Smith.

International Society of Biomechanics in Sport, Auckland New Zealand

- Laser Late Swing Knee Mechanics in Elite Rugby Union Players and Trained Sprinters.
  Claire Kenneally-Dabrowski, Nicholas Brown, Adrian Lai, Diana Perriman, Benjamin Serpell, Wayne Spratford
Doctor of Philosophy

Claire Kenneally-Dabrowski - ANU

Hamstrings in Elite Rugby Union

Claire is in her final year of her PhD. Her PhD is a collaborative effort encompassing the ANU, AIS, and ACT Brumbies focussing on hamstring injuries. Hamstring injuries are common in running based sports and rates of initial injury and recurrence are high. Injuries usually affect the biceps femoris long head (BFlh) muscle during sprinting and the personal and financial consequences are significant. This project aims to examine the relationship between running mechanics, hamstring function during running, and hamstring injury. Claire has secured a position as a performance scientist with the Queensland Academy of Sport responsible for athletics and softball programs. She will complete her thesis part-time while she takes up this prestigious position.

Catherine Galvin - University of Canberra

Healthy and Osteoarthritic Knee Kinematics

Catherine is an engineer who is in her final year of her PhD at TORU. Catherine’s area of interest is the biomechanics of the knee, specifically, how the biomechanics of the tibiofemoral joint changes due to ageing and knee osteoarthritis. Her research looks at the movement of the femur and tibia while a knee is straightening and deeply bending. Using a non-invasive imaging process, she is combining the data from fluoroscopy and CT scan to generate 4D images of the knee. She has developed a normative data for the kinematics of healthy ageing knees and knees with OA. This data set will help inform the improved design of knee replacement prosthesis and the development of healthy knee programs that can delay the symptoms of knee OA and keep healthy knees healthy.

Joe Lynch - ANU

Influence of knee shape on kinematics before and following total knee replacement

Joe is completing the second year of his PhD at the ANU. Prior to this, Joe worked as a Senior Research Officer at TORU. He completed his Bachelor of Science in Exercise Science, and a Master of Science in Biomechanics at the University of Ottawa. Joe’s main interests are understanding the clinical and functional outcomes of patients suffering from osteoarthritis or following total joint replacement using novel measurement techniques. Specifically, his thesis examines the role that knee shape plays in influencing how the knee moves before and after joint replacement. To-date Joe has found unique shape features which distinguish between healthy and osteoarthritic knees. These results form the basis of understanding how those features influence the kinematics of deep
Song Chen - ANU
Prediction of Bone cell Probability Distribution in Weak Electromagnetic Field

Song gained his bachelor of applied physics from Shanghai JiaoTong University in China and master of engineering from ANU. He has a background in theoretical physics and computational analysis of engineering materials. Song’s project is to formulate frameworks for building a theoretical structure of the hypothesis and verification of the hypothesis (math theory) using experimental data. His work is currently focusing on re-building signalling pathways in osteoblasts and osteoclasts by mathematical description and proving this description by designing the experiment to treat osteoblasts, osteoclasts and co-culture of osteoblasts and osteoclasts under physical stimulus from low frequency Electromagnetic field (EMF). EMF effects on the cell membrane level, general and specific gene expression and signal pathways of bone cells have been examined in numerous studies. These studies were conducted on bioprocesses such as cell proliferation, cell cycle regulation, cell differentiation, and metabolism. Genotoxic effects and apoptosis were observed during in vitro experiments. However, several observations after EMF exposure have been irreproducible and contradictory with other studies. Song is currently investigate interactions at the interfaces among pathways of multiple systems in bone remodelling.

Yuan Chai - ANU
Personalized polymer surgical guide and orthopaedic metal implant manufacturing method that centred with 3D printing

Yuan is a PhD student of ANU. Yuan gained his bachelor of engineering from China University of Mining and Technology. He has a background in mineral powder processing and 3D printing technology. Yuan’s PhD project is to establish an effective way of manufacturing orthopaedic metal implant by investigating the interaction between laser energy and metal powder during selective laser melting process, and researching the biomedical respond to the manufactured item within different fabrication conditions and post processes. His work is currently focusing on modelling of the energy distribution of laser beam scanning on material surface, trying to build a universal optimized model of laser-material interaction for our current equipment. This work includes numerical simulation of laser sintering process, experimental manufacture validation, and mechanical property/ biocompatibility test.
ANU Medical Student Research 2017-2018

Sally Gilbert

**Functional outcomes of gluteal tendon repair surgery compared to healthy age and sex matched controls**

**Background:** Gluteal Tendon Repairs (GTRs) have been shown to be effective for the disabling symptoms of gluteus minimus/medius tendon tears within a subset of the Greater Trochanteric Pain Syndrome (GTPS) population. There has been no research on whether surgery returns patients to pre-morbid function.

**Research Question:** Does GTR surgery return patients to the equivalent pain scores, functional ability and quality of life as healthy age- and sex-matched controls?

**Methods:** Sixty-six participants completed Patient Reported Outcomes Measures (PROMs) and of these, 59 had functional testing as part of a broader cohort assessor blinded study. Thirty-six GTR patients were recruited from a single surgeon, but were excluded if <12 months since surgery or had recent pelvic or lower-limb fracture. Thirty control group participants were age- and sex-matched volunteers from the community.

Outcome measures included: visual analogue pain scale (VAS), VISA-G, modified Harris Hip Score (mHHS), Intermittent and Constant Osteoarthritis Pain score (ICOAP), Timed Up and Go (TUG), 6-minute-walk test (6MWT), maximal ipsilateral isometric hip abductor strength, and the Assessment of Quality of Life (AQoL).

**Results:** The GTR group performance was significantly worse than the control group for VAS (1.39; p<0.002), VISA-G (-12.32; p<0.005), mHHS (-9.17; p=0.004), ICOAP (9.16; p=0.023), 6MWT (-42.07; p=0.044) and abductor strength (-59.87; p=0.001). There was no between-group difference for TUG. The GTR group scored significantly lower on the AQoL (-0.05; p=0.037).

**Significance:** GTR is an effective treatment option for gluteus medius/minimus tears although GTR surgery does not return individuals to equivalent pain and functional ability of healthy controls. Falls risk is not increased in a GTR cohort at a mean of 6 years post-surgery.

Tom Sizeland

**Gait analysis after gluteal-tendon repair: A comparison with an age and sex matched control group**

**Background:** Gluteal-tendon repair (GTR) appears to be effective in relieving pain and improving function in patients with gluteal-tendon tears (GTT). However, post-operative three-dimensional gait analysis has never been conducted on GTR patients.

**Aim:** The primary aim was to investigate the different gait characteristics of GTR patients compared to healthy controls. The secondary aim was to determine if fatigue results in greater exacerbation of gait abnormalities in GTR patients.

**Methods:** Motion analysis technology was used to measure gait characteristics of 25 GTR patients and 29 healthy controls. A generalised linear model was used to compare stride length, velocity, hip-adduction moment, and range of movement in hip adduction, hip internal rotation, pelvic obliquity and trunk lean, of both cohorts throughout stance. Participants were fatigued before repeat analysis.

**Results:** There were no differences between the groups in hip-adduction moment, pelvic obliquity, hip adduction and hip internal rotation. GTR patients had a shorter stride length (P=0.031) and reduced walking velocity (P=0.015). Ipsilateral trunk lean was reduced in GTR patients at the first-peak hip-adduction moment (P=0.016), mid-stance minimum hip-adduction moment (P=0.029) and second-peak hip-adduction moment (P=0.006). Fatigue did not exacerbate gait characteristics of GTR patients more than controls.

**Significance:** There were no significant differences between GTR and control participants for hip-adduction moment and pelvic obliquity, which are factors affected by GTT. Slower walking speed, smaller stride length and reduced ipsilateral trunk lean may reflect persistent gait abnormalities in patients after surgical repair. This study’s findings suggest GTR can return the gait characteristics of GTT patients to a status similar to matched healthy controls.
Ka Man Au leong

The Effect of Whiplash on Semispinalis Capitis, Splenius Capitis and Spinalis Capitis Morphometry

Objective: To determine whether semispinalis capitis, splenius capitis and spinalis capitis muscle volumes are different in patients with acute and chronic whiplash compared to control; and to determine whether standard cross-sectional area (CSA) measured using a single axial image slice correlates with total muscle volume.

Summary of Background Data: Previous studies using 2-dimensional CSA have reported wide variation in muscle size changes in whiplash injury. Muscle atrophy and fatty infiltrates are potentially responsible for these muscle size changes. However, CSA is not a reliable indicator of muscle volume. Therefore, the use of 3-dimensional volumetric measurements is needed to provide a more accurate depiction of the muscle size changes in whiplash injury.

Methods: T1-weighted magnetic resonance images were obtained for 14 participants, including four controls, five acute whiplash patients and five chronic whiplash patients. Muscle CSA were determined via manual segmentation. Muscle volumes were subsequently computed.

Results: Semispinalis capitis volume was smaller than control in both the acute and chronic whiplash groups. Spinalis capitis volume was larger in the acute group than control. No volume difference was detected in splenius capitis. CSA and volumetric measurements were not consistently correlated.

Conclusions: Muscle atrophy in semispinalis capitis could be a persistent change in whiplash injury. The larger spinalis capitis volume in acute whiplash injury is possibly secondary to inflammation. No consistent correlation between CSA and muscle volume could be established. Therefore, 2-dimensional CSA measurements are not a reliable surrogate for 3-dimensional volume measurements in these muscles.

Kyle McCabe

Morphological changes in cervical multifidus, semispinalis cervicis and spinalis cervicis in chronic and acute whiplash injury

Objective: Several studies have used CSA to measure the morphological changes associated with WAD. However, these data may be misleading as CSA only represents part of a muscle. It is thought that muscle size is increased in chronic WAD due to muscular fatty infiltration, and that it is increased in acute WAD due to inflammation. The aim of this study was to determine if there are differences in multifidus, semispinalis cervicis and spinalis cervicis volume between patients with acute whiplash associated disorder (WAD), chronic WAD and controls. We also aimed to determine if muscle cross-sectional area (CSA) and volume were correlated.

Methods: Cervical MRIs of five patients with acute WAD, five with chronic WAD and four controls were studied. Multifidus, semispinalis cervicis and spinalis cervicis were manually segmented at every level they were visible between the occiput and C7, and muscle volumes were digitally reconstructed. A mixed linear model was used to analyse the data. Observers were blinded to the identity and group of the patients.

Results: Spinalis cervicis had a larger volume in chronic WAD than acute WAD (P=0.004). There were no other differences in muscle volume between the groups. There were no differences in either semispinalis cervicis or spinalis cervicis CSA between the groups. Multifidus CSA was larger in chronic WAD than the other groups at C4 (P<0.05) and C5 (P<0.05), but smaller at C6 (P<0.05). Muscle CSA only weakly correlated with whole-muscle volume. Cervical extensor morphology in WAD.

Conclusions: Spinalis cervicis had a larger volume in chronic WAD than acute WAD, but this needs to be validated in a larger cohort. We also found that CSA is not a good surrogate for muscle volume. This study is not conclusive, but we believe it brings us closer to an objective diagnostic test for WAD.
The effect of coronal alignment on the frictional heating on an ultra-high molecular weight polyethylene bearing in TKA

**Background:** Polyethylene wear-induced osteolysis is a causative factor of aseptic loosening in Total Knee Arthroplasties (TKA). Increased temperature within the polyethylene bearing is associated with increased wear rates. Coronal alignment of the tibial plateau is known to affect distribution of pressure on the polyethylene bearing, but the effect of coronal alignment on frictional heating is not well studied. The purpose of this study was to take in vitro temperature measurements of a polyethylene bearing to determine if there was a difference in temperature change between neutral and +/- 3° coronal alignment.

**Methods:** 30 minutes of walking was simulated with a constant-load knee simulator in five coronal alignments - neutral, 1° and 3° varus and valgus. Holes were drilled in the medial and lateral compartment and intercompartmental ridge of the polyethylene bearing to contain thermocouples to measure temperature during activity. Measurements were taken during activity four times in each compartment for all alignments.

**Results:** Increasing varus angles resulted in increased temperature in the medial compartment, with an average temperature increase between neutral and 3° varus of 2.58 °C (P < 0.001). Larger valgus deviation was correlated with increasing temperature in the lateral compartment, with mean temperature increases between neutral and 3° valgus of 3.05 °C (P < 0.001).

**Conclusion:** The study demonstrated that there was an increased temperature change in the medial compartment in varus alignment and lateral compartment in valgus alignment. Further in vivo studies are required to understand the significance of these temperature changes on polyethylene wear within patients.

Harrison Slockee

Orthopaedic Engagement with the Aboriginal Liaison Officers at Canberra Hospital: A Qualitative Study

**Background:** At the Canberra Hospital (TCH) the Aboriginal Liaison Officer role was introduced in 1994. ALOs provide services and support to Aboriginal and Torres Strait Islander patients and their families. The ALO reports low levels of engagement with the orthopaedic unit despite being one of the busiest clinical units at TCH.

**Methods:** Qualitative research was conducted to investigate this low level of engagement and to better understand the attitudes of staff to the ALO. Nine participants from the orthopaedic department were interviewed about their perception and experience with the ALO. The participants were three nurses, three orthopaedic registrars and three orthopaedic consultants. Analysis of the interviews revealed several common themes raised by the participants.

**Results:** Communication was the major theme that emerged. Participants believed that communication was the ALO’s primary role. Procedural differences between the orthopaedic department and the ALO was an apparent theme. The ALO’s operating hours had restricted engagement with orthopaedics on occasion. Knowledge was another common theme that emerged during analysis of the interviews. Many participants admitted a lack of knowledge of the ALO and its services. One participant was not aware that TCH had an ALO. Some participants who had direct experience with the ALO believed that the ALO staff lacked clinical knowledge. The ALO believe that their clinical knowledge makes them well suited to be advocates for patients.

**Conclusions:** Enablers included the ALO’s proactive approach to identifying patients. Among the enablers was how easy orthopaedic staff found contacting the ALO. Barriers to engagement included a lack of knowledge about the ALO’s services. A preference to contact social workers instead of the ALO seemed to be due to a lack of knowledge of the ALO. A major barrier, although not a prevalent one, was a perception of low effectiveness of the ALO. Education about the ALO and their provided services may be useful to address issues identified by this research. Sharing of stories of cases where the ALO has had a very positive involvement may solidify the role that the ALO plays in the patient journey.
While 3D printing is becoming more widely adopted for clinical applications, it is yet to be accepted as part of standard practice. A key application of this technology is orthopaedic surgical planning for trauma cases. Through relatively inexpensive methods, anatomically accurate replicas of patient’s fractures are produced to guide interventional approach. These high quality models are also used to enhance medical education. Furthermore, the technology is being extended for the design and printing of patient-specific implants and surgical devices. Therefore, by facilitating personalised intervention, 3D printing has the potential to improve patient outcomes both during and post-surgery. Currently, access to an uncomplicated, inexpensive workflow that allows surgeons to generate their own high-quality 3D printable models of complex fractures is lacking. In this study, we devised a novel simple, and open-source rapid-modelling process suitable for surgeons. Application of the Drishti software to aid anatomical education was also explored. Using this process, we undertook patient-specific implant design using. Utilising Drishti software, patient computed tomography data from complex fracture cases were converted into high-quality anatomical replicas suitable for 3D printing. A virtual model was reconstructed using third-party software following which implant design was trialled. While we did not proceed to producing an implant, the reconstructed model serves as a powerful design template. The open-source Drishti suite could potentially be incorporated into routine practice by surgeons to aid preoperative planning through a single site de novo setup. The software package is a powerful, inexpensive image-processing tool that could also be considered in other design workflows using open source software.
## ANU Medical Student Research 2017-2018

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<td>Establishing the important factors when measuring the impact of waiting for care</td>
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<td>Ahmed Tafsirul Hussain</td>
<td>In-vivo kinematics of Cruciate Retaining, Cruciate Substituting and Rotating Platform Knee Replacements: a randomized controlled trial</td>
<td>Prof Paul Smith, Dr Diana Perriman</td>
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<td>Sybil Yeung</td>
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<td>Quoc (Andrew) Hung</td>
<td>Evaluating an online resource to support patients after lower limb arthroplasty</td>
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## University of Canberra Physiotherapy

Yi Ying Zeng recently graduated as a physiotherapist from the University of Canberra. Yi Ying completed her honours thesis with our unit over the last 12 months. Her project applied the 4D healthy knee flexion findings from the PICKLeS study into clinical practice by comparing an arthrokinematic-modelled intervention to the traditional intervention. She found that the arthrokinematically-informed intervention may be more effective at increasing knee flexion in patients with stiff knees. Next year Yi Ying is looking forward to putting four years of studies into practice as a clinical physiotherapist.

## Master of Philosophy (MPhil)

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<td>Supercable Fatigue Testing for Simulated Femoral Fracture</td>
<td>Prof Paul Smith, Dr Diana Perriman</td>
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<td>Dr Claire Bolton</td>
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<td>Dr Yi Deng</td>
<td>miRNA profiling in particle induced osteolysis around total joint replacement</td>
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<td>Miss Kate Phillips</td>
<td>Relationships of sex and activity to bone quality: A modern approach to bioarchaeological questions</td>
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ACT Health Medical Officers

ACT Health have a number junior medical officers and orthopaedic registrars who are interested furthering orthopaedic research. TORU facilitated these doctors by giving them an opportunity to work on their own research or collaborate on a larger projects we running within the unit.

Luke Barr - CROSSFIRE: Combined Randomised and Observational Study of Surgery for Fractures In the distal Radius in the Elderly; Paediatric Osteoarticular Infection

Sarah Ellis—Outcomes following arthroscopic surgery for femeroacetabular impingement.

Jason Sczepanski—Outcomes following surgery for pelvic discontinuity

Dawei Huang— Radiographic analysis of implant position and articular subsidence in tibial plateau fractures; Paediatric Osteoarticular Infection

Yi Bong - Novel Oral Anticoagulants (NOACs)