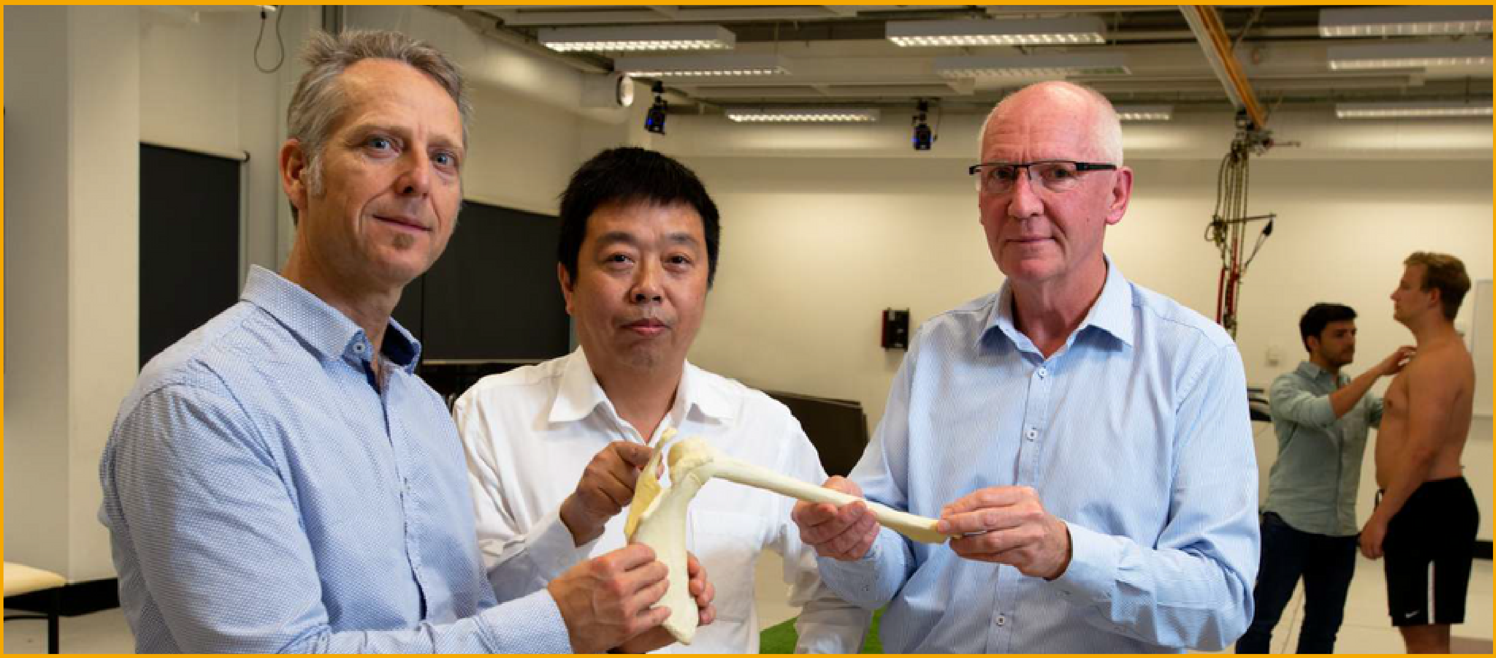
QUASR Joint Biomechanics Training Centre

2023 RESEARCH SYMPOSIUM

Australian Government
Australian Research Council



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Agenda

Session One

Atrium, P Block, QUT Garden's Point Campus

9:45 ***Registration***

10:10 ***Welcome***

10:25 ***Clinical Presentations Project Updates***

Dr Mirek Karel, Dr Hean Wu Kang, Dr Helen Ingoe, Dr Jashint Maharaj

10:40 ***Seed Grant Presentations***

Dr Bart Bolsterlee: Biomechanical characteristics of the human supraspinatus tendon in vivo under physiological loading

Dr Dermot O'Rourke: Toward precision tracking of the shoulder joint using ultrasound tomography

11:00 ***Panel Discussion***:

Innovating translation in the tech sector and the future of med-tech in Asia Pacific.

12:00 ***Networking Lunch***

Session Two

Theatre 512, P Block, QUT Garden's Point Campus

1:00pm Research Presentations

Program 1

Dr Max Lavaill: Insights Into The Different Optimisation Methods For Solving The Shoulder Muscle Redundancy Problem

Yilan Zhang: Three-Dimensional Architecture of Human Rotator Cuff Muscles

François Bruyer-Montéléone: Shoulder Morphologic Variations: Statistical Shape and Pose Estimates

Dr Laith Alzubaidi: AI for Industry

Program 2

Dr Dermot O'Rourke: Implant Stability in Shoulder Arthroplasty

Morgan Windsor: Forward Prediction of Target Localisation Failure Through Pose Estimation Artifact Modelling

Program 3

Dr Eleonore Bolle, Asawari Parulekar, Stephanie Belen Michelena Tupiza, Sepideh Shemshad: Develop a Tissue Engineered Scaffold to Improve Healing Outcomes Following Rotator Cuff Repair Surgery

Program 4

Dr Wolbert Van Den Hoorn: How Does the Central Nervous System Control the Deltoid Muscles

Arthur Fabre: A Wearable Magneto-Inertial Measurement Units-Based System for the Upper Limb and Shoulder Kinematics Assessment

Yuyao (Amy) Ma: Neuromuscular Control of the Shoulder Muscles in Healthy Individuals

2:10 Afternoon Tea
2:25 Awards Ceremony
2:35 Event Close

Welcome Message

On behalf of the ARC Training Centre for Joint Biomechanics and QUASR, it is our distinct pleasure to extend a warm welcome to our Annual Research Symposium, set to take place on November 28th at QUT's premier Science and Engineering Centre. This gathering marks a significant occasion for us to celebrate the remarkable achievements of 2023, as we continue to make strides towards our vision to become a leading global joint biomechanical research facility focusing on human shoulder mechanobiology.

Our centre has witnessed substantial growth and impact towards achieving our mission this year. Notably, we have expanded our high school engagement initiatives through the ASPIRE program with Mabel Park SHS supporting underprivileged and indigenous students to engage in STEM careers, fostering an early interest in biomechanics among the next generation. As QLD hosts of the BIOTech Futures Competition, we again saw success at the national finals with Mansfield SHS winning the national best prototype award for their app 'Sun Shield: Empowering Australian Youth Through AI-Assisted Digital Sun Safety.'

With regards to translational research impact, our collaborative, end-user-focused projects funded by the Seed Grant program have seen significant progress, demonstrating our commitment to innovative research with real-world applications in the fields of medical imaging and exploring the biomechanical properties of the supraspinatus tendon under loading, as selected at last year's symposium.

Prof. YuanTong Gu

Director, ARC Training Centre for Joint Biomechanics

Welcome

The completion of numerous centre and affiliate Ph.D. projects this year underscores our dedication to advancing knowledge in joint biomechanics. Further, our extended engagement with industry partners has been exemplified by students visiting and working at renowned institutions, including Stryker R&D Lab, HBI, NeuRA, GPH, MERF, and Akunah.

Our centre staff and students, appearing on stage at over 20 conferences and contributing to the publication of over 47 journal articles this year, demonstrates the depth and breadth of our research output with presence at several clinical conferences such as the 'International Congress on Shoulder and Elbow', ICSES in Rome in August this year.

Beyond our academic pursuits, our team has also enjoyed various engaging activities, contributing to a vibrant and collaborative research environment such as centre BBQs and international food lunches to foster internal collaboration and camaraderie.

As we reflect on these achievements with pride, we eagerly anticipate showcasing our progress towards the overarching mission of the ARC Training Centre for Joint Biomechanics/QUASR with you at this year's research symposium:

Mission: The mission of the ITTC-JB is to transform and translate biomechanical education using multisector collaboration and industry partnerships to empower the future workforce and improve patient outcomes.

Prof. Peter Pivonka

Deputy Director, ARC Training Centre for Joint Biomechanics,

Research Director QUASR

Foreword Message

I welcome you to the 2023 Queensland Unit for Advanced Shoulder Research (QUASR) Joint Biomechanics Training Centre Annual Research Symposium. We are thrilled to present this exciting event that showcases the talent and expertise in our multisector collaborative research transformation training Centre.

Our panel discussion will bring together leading Australian innovators in the field to highlight the opportunities for growth and development within the medical technology sector.

The panellists include Hon. Prof Greg Hunt who has been at the forefront leading Queensland through dynamic challenges in his role as the former Minister of Health; Prof Kate Jones, who has served previously as the Minister of Innovation amongst her other roles and is currently the Executive Director of the Tech Council of Australia looking to boost the tech sector growth along with regulatory support and talent attraction-retention in the field; Dr Vu Tran, CoFounder of Go1, an education and training portal that is bringing engaging online organisational learning to millions ARCoss the world; Ms Chris Went, the COO of Mater Private Hospital who has championed growth within local research and innovation in leading by example to setup and guide various hospital based research units, and; Prof Lyn Griffiths AM from the Queensland University of Technology Centre for Genomics and Personalised Health who leads her team of scientists exploring improved methods of diagnosis and novel systems for targeted individualised treatment strategies in health.

I look forward to you joining me at the annual symposium to network with industry leaders, form new connections and exchange ideas to advance med-tech ARCoss Asia-Pacific.

Adj. Prof Dr Ashish Gupta

Founder / CoDirector
QUASR

Subspecialised Shoulder
Orthopaedic Surgeon

Foreword Message

I'm Ken Cutbush, an orthopaedic surgeon specialising in shoulder surgery, arthroscopic procedures, and shoulder arthroplasty. Based on my 30 years in clinical practice, I firmly believe that strong basic-science research informs almost all significant clinical advances. As such, I'm particularly excited about the work happening with QUASR and the ARC ITTC-JB. QUASR and the ARC ITTC-JB are founded in the principles of collaborative research, with basic-science researchers working with both senior and junior clinicians. This relationship allows us to ask and answer questions in ways that are simply not possible in pure basic-science or clinical research groups.

All of our work, whether it be designing Latarjet shoulder models, developing new ultrasound imaging techniques, or assessing neurological control of rotator cuff muscles post-surgery using muscle EMG, is a result of this collaboration. We're very fortunate to have an enthusiastic partnership, with decades of both clinical and basic-science experience contributing to our research.

The work you will hear about during this symposium is the result of this collaboration. We're very excited to be sharing it with you as we move towards our goal of becoming the leading global biomechanical research facility on human shoulder mechanobiology.

Dr Kenneth Cutbush

Scientific Secretary Australian Orthopaedic Association (AOA)

Board Member AOA Chairman AOA Fellowships Committee

Chairman AOA Continuing Orthopaedic Education Committee National Vice

President Australian Society of Orthopaedic Surgeons Associate

Professor University of Queensland Professor Adjunct Queensland University of Technology

The ARC ITTC for Joint Biomechanics/QUASR and Stryker continue to collaborate on several exciting projects to transform the orthopaedic industry. Stryker’s groundbreaking R&D Lab, strategically positioned within the renowned Herston Health Precinct, opened in Brisbane in late 2022.

Stryker's R&D Lab has quickly become a hub for innovation, driven by its collaboration with leading institutions, including Queensland University of Technology, The University of Queensland, Metro North Hospital and Health Service, and Queensland Health. This collaborative ecosystem empowers researchers and engineers to work alongside clinicians, gaining valuable insights into the evolving needs of healthcare at the point of care. The R&D Lab focuses on four core areas: digital health, robotics, clinical software applications, and advanced manufacturing research. These areas have laid the foundation for the transformative projects undertaken in collaboration with the ARC ITTC for Joint Biomechanics within three of the four research areas:

- clinical outcomes of BIO-RSA procedure and the advantages of biologics in BIO-RSA (completed)
- computational analysis of the benefits of BIO-RSA in complex glenoid defects and revision RSA (completed)
- humeral revision, assessing range of motion for various implant positions (completed)
- biomechanical stability of inlay versus onlay techniques for the glenoid component of total shoulder arthroplasty (TSA).

Through this world-class facility, collaboration on research, industry input into the centre's strategic direction, and contribution towards Higher Degree Research (HDR) training and development has only become more accessible. This has been demonstrated in the success of centre Chief Investigator Dr Ted Pickering and the Medical Engineering Research Facility (MERF), when named industry REDI fellowship at Stryker's R&D Lab.

The union between the ARC ITTC for Joint Biomechanics and Stryker underscores the commitment to pioneering research and healthcare innovation. It signifies a shared dedication to advancing medical technology to make healthcare better. The possibilities for future projects and the potential for groundbreaking discoveries in healthcare are boundless, marking an exciting chapter in this collaborative journey.

Melissa Anenden

Robotics Manager, Research & Development

2

Australian Biotechnologies
Life Enhancing Allografts

In our quest to enhance patient outcomes and address pressing healthcare challenges, Australian Biotechnologies, a pioneer in the field of allograft tissue processing is proud to collaborate with the Training Centre for Joint Biomechanics/QUASR.

At the heart of our collaboration are two impactful projects. The first, 'Utilization of supercritical CO2 sterilised tendon allografts in addressing ARComioclavicular joint instability,' spearheaded by Associate Professor Ken Cutbush, focuses on restoring ARComioclavicular joint (ACJ) stability. This project showcases Australian Biotechnologies' groundbreaking approach to soft tissue allografts, processed using supercritical CO2 sterilization. This method, eschewing irradiation, holds immense promise in shoulder soft tissue reconstruction. Australian Biotechnologies aims to demonstrate the clinical effectiveness of this technique in ACJ stabilization, thus opening new avenues for improved patient care.

Our second project, 'Biological augmentation or superior capsular reconstruction in primary and revision rotator cuff repair using supercritical CO2 sterilised dermal allografts,' delves into the realm of rotator cuff repair (RCR) and superior capsular reconstruction (SCR). Australian Biotechnologies is pioneering a non-irradiated acellular dermal matrix allograft, intended to aid soft tissue reconstruction. The project, led by Dr Ken Cutbush, assesses the clinical effectiveness of using supercritical CO2 sterilised dermal allografts in addressing rotator cuff tears, potentially revolutionizing the landscape of RCR and SCR procedures.

Australian Biotechnologies, with its mission of "Honouring the gift of donation," has been a committed partner in the shared journey of the centre to enhance patient care in the orthopaedic field. Founded in 2000 and based in Sydney, Australia, we have established ourselves as a leader in allograft tissue processing. The company’s unwavering commitment to delivering optimal solutions for clinical biologic and allograft needs aligns seamlessly with our shared goals at the Centre for Joint Biomechanics. Through these partnerships, we are not only advancing the field of biomechanics but also honouring the spirit of innovation in healthcare. Together, we look forward to the transformative impact our ongoing work will have on patient care and clinical excellence.

Patrick May

Director of Engineering, Australian Biotechnologies

ZIMMER BIOMET

Zimmer Biomet is a proud partner of the 2023 Annual Research Symposium. As a global medical technology leader, we push the boundaries of innovation to redefine what's possible ARCoss all stages of the patient journey.

Our journey with ARC since 2020 has been marked impactful initiatives that align our mutual passions for innovation and excellence. Particularly, we have been encouraged with the team's contributions to validating our patient engagement app, mymobility™ and providing inputs to development to improve accuracy, functionality and patient experience.

These clinical validations have been shared various meetings such as the International Society of Arthroscopy, ISAKOS, ICSES and the subsequent publication of findings in the Journal of Shoulder and Elbow Surgery.

As we continue to innovate, inspire and develop medical technology, we value and appreciate the collaborative efforts of research and the opportunities available with QUASR and ARC for Joint Biomechanics. This unique partnership of research and industry partnerships can have a profound impact on advancing patient care.

We congratulate the ARC and QUASR on another successful year and Zimmer Biomet is proud to be part of this journey.

Laura Zieth

Commercial Manger ANZ

mymobility®

Care Management Platform

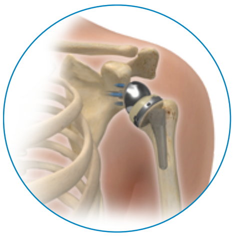
Skeletal Tracking

mymobility is a care management platform to help deliver support and guidance to transform the standard of care and create a new level of connection with your patients.

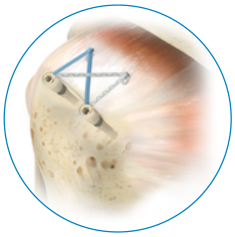
The Skeletal Tracking feature allows **Range of Motion** and **associated pain measurements** to be collected remotely and at a higher frequency using only your patient's smartphone.

It is available for all mymobility Upper Extremity and Shoulder Sports Medicine care plans and collects measurements for Flexion, Extension and Abduction.

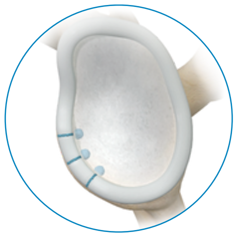
Total Shoulder Arthroplasty



Reversed Total Shoulder Arthroplasty



Rotator Cuff Repair

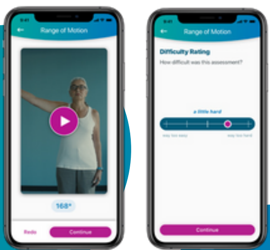


Shoulder Instability

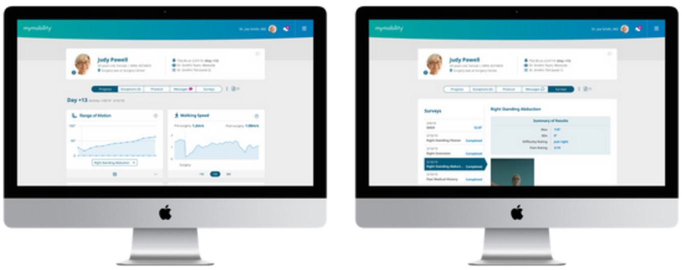
Skeletal Tracking is intended to:

- Help identify patients who are not progressing in order to intervene sooner and encourage favorable patient outcomes
- Reduce in-person appointments and drive clinic efficiency using virtual check-ins
- Support remote patient care by tracking patient outcomes and
- progress Engage patients and allow them to have more insight to their care
and recovery

Patient Experience



Clinician Experience



Legal Manufacturer
Zimmer U.S. Inc. Connected Health
601 5th St. NW, Suite 200
Grand Rapids, MI, 46504 USA

Authorised Representatives
Zimmer Biomet Pty Ltd
Level 3, 12 Narabang Way Belrose NSW
2085 Australia

Zimmer Biomet New Zealand Company
210 Khyber Pass Road Grafton Auckland
New Zealand

Scan here to learn more or request a demo

mymobility by ZIMMER BIOMET

materialise

Materialise and the Joint Biomechanics Training Centre/ Queensland Unit for Advanced Shoulder Research (QUASR) have established robust collaborations in the field of orthopaedics. These collaborations bring together a diverse range of experts from clinicians to engineers to foster a transdisciplinary approach that is vital for tackling complex healthcare challenges and achieving more effective, efficient, and personalised solutions for patients.

As a core industry partner of the centre, we have seen the collaboration grow from a small group of dedicated enthusiasts, including surgeons and biomechanists, who shared a vision of creating better solutions for patients with shoulder issues. By recognizing the need for a multidisciplinary approach, they approached industry partners who were equally intrigued by this vision and provided invaluable support. The centre is at the forefront of utilizing state-of-the-art technologies like robotics and simulations, to develop statistical shape models of the shoulder. This work is pivotal in refining prosthesis selection to align with the unique anatomy of individual shoulders.

Crucially, the tools and software used at the Centre, such as the Materialise Mimics Innovation Suite, have played a pivotal role in advancing research. These resources facilitate the anonymization, segmentation, and computational modelling of bones and muscles, empowering researchers, students, and graduates with the expertise needed to excel in the dynamic healthcare industry.

With the release of Mimics 26 in September 2023, the centre continues to work closely with the Materialise team and to collaborate on HDR training and development and high school outreach to the future generation of biomechanists with participation in the 2023 Biotech Futures Challenge.

As the centre looks to the future, its ambition is nothing short of groundbreaking. They aim to become a global leader in shoulder research, pushing the boundaries of personalized and accurate patient care. Their commitment to hosting industry events and celebrating the achievements of their students and graduates underscores the immense value of this unique training setup, which paves the way for a brighter, more patient-centric future in orthopaedics.
In future we look forward to exploring the potential of this collaboration further through modelling projects, training opportunities and further research and development.

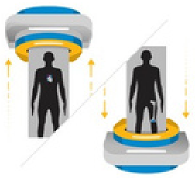
Monica Russell
Medical Account Manger

materialise mimics
innovation suite

Industry-standard software for segmentation, anatomical analysis, planning, and design

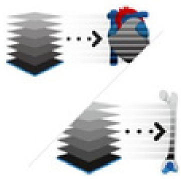
Mimics Innovation Suite makes using 3D medical image data easy and rewarding for clinicians, engineers and researchers who believe in improving care through technology that starts with anatomical geometry. Its advanced tools allow you to create and scale up your innovations for:

> Academic and Clinical Research
> Medical Device Design
> Pre-surgical Planning and Patient-Specific Implants



Import Images

Import 2D, 3D and even full 4D CT data sets. Our medical software supports following formats: DICOM, JPEG, TIFF, BMP, RAW, x-ray



Segmentation

Segment medical images and convert them to a 3D or 4D surface model to obtain an accurate 3D virtual representation of the patient's anatomy.

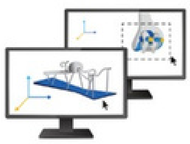
Planning

Precisely measure distances, angles, diameters, and densities on 2D/3D images. ellipses, centerlines, multi-planar or curve planar reslicing are just a click away.

Virtual Implantation

Simulating the implantation to evaluate the outcome of various approaches or to validate patient-specific implants without testing on an actual patient or cadaver. This includes plan cutting

planes
and reconstruct missing anatomy; reposition bone parts, placing plates/screws, fit and position implants; virtually implant cardiovascular devices for patient-fit analysis and etc.



Design

Engineer on anatomy by designing customized surgical instruments, patient-specific implants, cages, plates, realistic patient-based training tools, and much more

FEA, CFD, MSM

Meshing operations enable you to directly modify designs based on the simulation of local stresses, strains, and pressures the anatomical structure or implant will be exposed to. Export landmarks or muscle attachment points to MSM package and optimized anatomical meshes to the FEA or CFD package

Export for 3D Printing

Ensure manufacturability by defining wall thickness; design auxiliary components or internal structures; and finally, export the most complex geometries to any 3D printer

LOGEMAS

Logemas, a leader in motion capture and measurement technology in Australia, is proud to be an industry partner with QUT's Centre for Joint Biomechanics. Our role predominantly involves us offering our unmatched expertise in motion capture technology, with a specialisation in Vicon systems.

Our partnership with the Training Centre for Joint Biomechanics primarily focuses on the centre's program 4: 'In vivo assessment of upper limb movements. Physiology, rehabilitation.' This program's objectives are of utmost significance, aiming to improve shoulder movement measurement accuracy and motion capture for personalised patient care. Some of the specific projects we're involved with include:

- Validating Inertial Measurement Units for assessment of shoulder and upper limb movement;
- Investigating augmented reality to guide surgical interventions;
- The establishment of a functional movement database (joint and segmental kinematics, kinetics, and muscular activation) to serve as a reference for guiding implant design, surgical procedure development, post-surgical rehabilitation, and treatment evaluation.

As well as research and project contributions, Logemas is committed to knowledge sharing as a component of our collaboration. Led by Dr. Denny Wells and Dr. Scott Brennan, Logemas' Life Science specialists, we regularly undertake basic and advanced Vicon workshops for the centre's students at the state-of-the-art motion capture laboratory at QUT's Kelvin Grove campus. This educational collaboration reflects our dedication to nurturing the next generation of motion capture and biomechanics experts, right here in Southeast Queensland.
We believe our collaboration with QUT's Training Centre for Joint Biomechanics not only strengthens the biomechanical knowledge and research outputs of the Centre, but also significantly contributes to enhancing patient outcomes and optimising personalised care through innovative technology and expertise. We hope that our contributions will lead to the development, validation, and clinical uptake of innovative technologies for both assessing functional movement and rehabilitation. Together, we look forward to continued progress and transformative advancements in the field.

Dr Denny Wells

Biomechanist and Systems Engineer at Logemas

Clinical Presentations

Clinical Research at QUASR/ARC Training Centre for Joint Biomechanics: Let's put Brisbane on the Map - Connecting the Dots between Individualised Patient Care using Innovative Technology and Evidence-based Practice to Deliver Excellent Clinical Outcomes.

Clinical research at QUASR is conducted using multisector collaborative approach led by Prof (Adj) Ashish Gupta and A/Prof Kenneth Cutbush. Our orthopaedic shoulder surgeons treat patients with complex shoulder problems and are a handful of surgeons in Australia whose entire practice focus is subspecialised in shoulder surgery.

The orthopaedic surgeons along with senior academics from QUASR lead a team of international surgeons on fellowship training, orthopaedic registrars and residents, nurses, allied health professionals, medical students, biomedical engineers, postdoctoral fellows, PhD candidates, masters and undergraduate students, research fellows, clinical assistants and industry partners with local, national and international multicentric research collaborations.

The attachment of both clinical practices to a dedicated biomechanical and tech focussed orthopaedic research unit based at the Queensland University of Technology (QUT) in Brisbane, allows for evidence-based clinical research and integration of crucial biomedical data in the provision of world class patient care.

Dr Cutbush and Dr Gupta co-supervise an Australian Orthopaedic Association accredited advanced shoulder fellowship which is rapidly establishing itself as a in demand global training program comparable to offerings in Europe and the United States.

In this presentation, we will highlight the clinical achievements of the team over the past twelve months as we continuously strive to cement QUASR and the ARC Training Centre for Joint Biomechanics as a global clinical research leader.

Adj. Prof Dr Ashish Gupta

Biomechanical Characteristics of The Human Supraspinatus Tendon in Vivo Under Physiological Loading

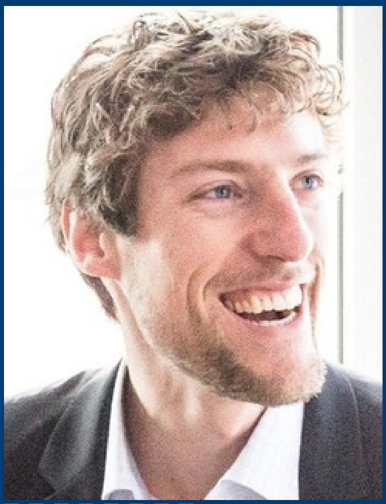
Rotator cuff tendons (RCTs) frequently tear, requiring surgical re-attachment to the bone. Re-tear rates, however, are reported to be ~21% after two years. To improve surgical outcomes, we need to know the mechanical load the tendon experiences under normal loading conditions. This information is currently lacking, as it is difficult to measure tendon loading in living humans.

The overall aim of this Seed Grant project is to develop a computational framework that can estimate stresses and strains in the human supraspinatus tendon (SPT) under physiological loading conditions in vivo. Specifically, we aim to:

1. determine the linear and viscoelastic mechanical properties of human SPT ex vivo;
2. measure SPT strain and muscle activation under physiological loading conditions in humans in vivo; and
3. develop and validate a finite element model of the SPT muscle-tendon complex.

Our approach is to provide proof-of-principle of an anatomically and physiologically relevant computational model (finite element model) of the supraspinatus muscle-tendon complex, informed by ex vivo mechanical property testing and validated by in vivo tendon strain measurements during a range of shoulder activities.

In this presentation, we will give a progress update on what we have achieved so far. This will include the first results of ex vivo testing the mechanical properties of the human supraspinatus tendon and in vivo imaging of the supraspinatus, and steps taken towards development of a computational framework that integrates ex vivo and in in vivo data to simulate muscle-tendon mechanics.



Dr Bart Bolsterlee

Toward Precision Tracking of the Shoulder Joint Using Ultrasound Tomography

Dr Dermot O’Rourke

Ultrasound (US) tomography is a recent and innovate technology that provides promise for precise measurement of positions and orientations of the bones in the shoulder joint. US is a safe and non-invasive imaging method for visualising underlying bone that could provide a cheaper, non-ionising radiation alternative to dynamic in vivo imaging and mitigate the effects of soft-tissue artifact in marker-based motion capture systems. The work in this seed project is a first step toward translating US technology to accurately track the shoulder joint dynamically, by:

1. establishing a protocol for measurement of humerus and scapular position with a US tomography and;
2. quantify the accuracy of US tomography in determining the bone positions in static poses.

In this project, bony landmarks of the scapula and humerus were identified with a US probe on a cadaveric participant at varied angles of elevation. Reflective marker trajectories attached to intracortical pins in the bones were recorded with high accuracy at the same time using a 3-camera motion capture system. This talk will highlight development of the protocol and provide preliminary results on the accuracy of the US-based system in determining the bone positions with respect to the motion capture system. The work done in this project, to date, provides the foundations for translating US-based tracking of the shoulder joint to enhance routine clinical assessment, post-op rehabilitation, and experimental shoulder biomechanics. Future work will investigate the accuracy of US in dynamically tracking the bones of the shoulder joint during movement.

Panellists

Prof. Hon. Greg Hunt
Former Minister for Health (2017-2022)

Dr. Vu Tran
Co-founder of Go1

Ms Chris Went
COO of Mater Private Hospital

Distinguished Prof. Lyn Griffiths
QUT Centre for Genomics and Personalised Health

Adj. Prof Dr Ashish Gupta
Akunah, QOC

Hon Kate Jones
Executive Director, Tech Council of Australia

Discussion

'Leadership in the Face of Change'

Innovation & the future of med-tech in Australasia

Our distinguished panellists will deliberate on crucial aspects, unraveling how effective leadership plays a pivotal role in navigating the sector through transformative shifts. Explore with us as our experts discuss fostering innovation, navigating technological advancements, and addressing regulatory changes. Gain insights into the strategic approaches that drive adaptability and cultivate a visionary mindset. Join this compelling discussion to understand how the panelists envision leadership shaping the industry's trajectory, ensuring it remains a pioneering force in healthcare advancements ARCoss AustralAsia.

Panellist

Prof. The Hon Greg Hunt

Former Minister for Health (2017-2022)

Professor Hunt was appointed Honorary Enterprise Professor in the Faculty of Medicine, Dentistry and Health Services and the Faculty of Business and Economics at the University of Melbourne in December 2022. Greg is also the inaugural Chair of the Advisory Council for the Turner Institute for Brain and Mental Health at Monash University. He advises a wide range of businesses and not for profits in the areas of innovation, leadership, strategic planning, health and the environment.

Greg is a highly experienced former Cabinet Minister in the Australian Government, having served as Australia's Minister for the Environment, Innovation and Health ARCoss three major portfolios over almost nine years. As Minister for Health from 2017 to 2022, he oversaw Australia's response to the global COVID-19 pandemic, established telehealth as a permanent and universal centre piece of Medicare, reformed private health and established long-term plans for mental health, aged care, medical research and primary care and listed over 2,000 new and amended medicines for public access.

He oversaw an annual budget of $132 billion, 17 portfolio agencies and 7,000 staff.
As Minister for Industry, Innovation & Science, he laid the foundation for the Australian Space Agency.
As Minister for the Environment, he established the Emissions Reduction Fund, the Green Army, the $1 billion Reef Trust and helped lead Australia's negotiations for the Montreal Protocol update and Paris Climate Change Accord. For his work as Environment Minister, Greg was named Best Minister in the World at the World Government Summit in 2016.

As the longest serving Federal Member for Flinders (over 20 years), he is a nationally and internationally experienced legislator, negotiator, strategic thinker, stakeholder manager and administrator.

Greg was elected as the Federal Member for Flinders in 2001 and became Parliamentary Secretary to the Minister for the Environment and Heritage and then Parliamentary Secretary to the Minister for Foreign Affairs as a young Member of Parliament in the Howard Government. He was Shadow Minister for the Environment from 2007-2013.
Prior to Parliament, Greg worked with Mallesons Stephen Jacques before becoming Associate to the Chief Justice of the Federal Court.

Between 1994 and 1998, Greg worked as a Senior Adviser to the then Opposition Leader and subsequent Minister for Foreign Affairs, Alexander Downer. He then headed Australia's electoral mission to Cambodia in 1998.
Greg then worked with McKinsey & Co for almost three years, during which time he became an Engagement Manager and specialised in telecommunications, start-ups, government reform and the banking sector.
Greg is a Fulbright Scholar with a Masters from Yale University and First Class Honours in Law from the University of Melbourne. He has given over 10,000 speeches and interviews at local, national and international level and was runner up at the 1990 World Debating Championships, as well as Australian Universities Debating Captain.

Greg has completed seven marathons and five 500km walks for charity.
He lives on Victoria's Mornington Peninsula with his wife Paula and two children, 91 year old Italian Nonna and cavoodle Charlie.

As published at https://www.greghunt.com.au/about-greg/biography/

Panellist

The Hon Kate Jones

Executive Director, Tech Council of Australia

With extensive experience in senior government and leadership roles, Hon Kate Jones is a prominent figure in the technology landscape. As the Executive Director of the Tech Council of Australia and an Independent Director on the Paralympics Australia board, Kate plays a crucial role in shaping the future of tech and sporting industries.

Her involvement as a Strategic Advisor at Australian tech company Soda further highlights her commitment to fostering innovation. Additionally, Kate's contributions extend to the realm of sports, serving as a Commissioner of the Australian Rugby League Commission and a board member of the Institute of Molecular Bioscience.

Previously, as a Minister in the Queensland Government, Kate held diverse portfolios including State Development, Education, Innovation, Tourism, and Major Events. Her visionary leadership led to the successful implementation of significant policy reforms, such as the whole-of-government's innovation agenda, "Advance Queensland," and Queensland's inaugural climate change strategy.

Notably, Kate played a crucial role in the triumph of the Gold Coast Commonwealth Games in 2018, showcasing her adeptness in delivering major events. Her involvement in the Olympic Candidature Leadership Group secured the 2032 Olympic Games for Queensland, underscoring her unwavering dedication to advancing Queensland's position on the global stage. Through her multifaceted roles, Kate Jones continues to leave an indelible mark on technology, sports, and beyond.

Panellist

Dr Vu Tran

Co-founder at Go1

Vu Tran the CGO and co-founder at Go1. He is also a medical doctor working in General Practice and has passion for developing new and innovative ways to promote healthcare in the broader community.

GO1's origin dates back to a garage in the suburbs of Brisbane, Australia, where Andrew Barnes and Vu Tran started a web development company. After submitting a last-minute application to the prestigious Y-Combinator accelerator, GO1 was accepted in 2015, and triggered the worldwide expansion of the organization with offices opening ARCoss the world in The United States, South Africa, Vietnam, The United Kingdom and Malaysia.

Aside from Go1, Vu Tran is also a co-founder and director of Aduro Learning Management System and Go Catalyse.

Vu Tran obtained his MBBS in Medicine from Bond University.

Panellist

Chris Went

COO of Mater

Chris Went, an accomplished healthcare executive, currently holds the role of Chief Operating Officer (COO) at Mater since June 2023. In 2018, she made history by becoming the first Queenslander to be awarded the prestigious Chief Executive Women (CEW) scholarship, granting her the opportunity to study Leading Change in Complex Organizations at MIT Sloan, Cambridge, USA. Her selection was a testament to her exceptional leadership abilities and dedication to healthcare innovation.

Before joining Mater, Chris Went served as CEO at Greenslopes Private Hospital from December 2017 to May 2023. During her tenure, she led a team responsible for managing a 650-bed private teaching hospital with over 2000 staff. Her leadership was marked by a relentless focus on patient-centered care, even in the face of complex healthcare challenges and government reviews.

In addition to her role at Greenslopes Private Hospital, Chris Went concurrently served as the Deputy Chair of the Gallipoli Medical Research Foundation and as a Board Member at Ipswich Grammar School, starting in October 2016. Her involvement in nonprofit organizations underscores her commitment to her community and the healthcare industry.

Chris Went's educational journey laid a strong foundation for her career. She obtained a Bachelor of Nursing from Australian Catholic University, followed by a Graduate Certificate in Emergency Nursing from Griffith University. Furthering her commitment to leadership development, she completed an Executive Programme at the Massachusetts Institute of Technology. Her academic pursuits also included Graduate Certificates in Critical Care Nursing from the University of Central Queensland and Business Administration and Management from the University of Southern Queensland.

With an unwavering commitment to the healthcare sector and a strong dedication to enhancing her leadership skills, Chris Went's role as COO of Mater exemplifies her ability to bring extensive experience and dynamic leadership to this esteemed institution. Her journey serves as a testament to her resilience and her ongoing contributions to advancing healthcare in Australia.

Distinguished Prof. Lyn Griffiths

QUT Centre for Genomics and Personalised Health

Distinguished Professor Griffiths is an active and respected molecular geneticist with more than 30 years' experience. DProf Griffiths has brought a translational focus to medical research to increase QUT's influence and its impact on human health as Director of the Centre for Genomics and Personalised Health which is focused on translating knowledge from genomics research. The Centre aims to discover better methods of diagnosing disease, develop targeted treatments based on genetic information, and train the next generation of translational genomics scientists.

In addition, DProf Griffiths is a passionate advocate of the translation of medical research through commercialisation and is currently the Director of the MTP Connect and industry led Bridge and BridgeTech programs, undertaking commercialisation training for the pharmaceutical and medical devices-technology fields ARCoss Australia, respectively. DProf Griffiths' own genetics research at the Genomics Research Centre has led to diagnostic breakthroughs for several neurogenetic disorders, including familial migraine, ataxia, epilepsy and hereditary stroke.

Her research has appeared in more than 400 peer-reviewed international journals and she has obtained significant competitive and industry research funds to support her research team.

As published at https://research.qut.edu.au/grc/about/team/lyn-griffiths/

Panellist

Adj. Prof Dr Ashish Gupta

Shoulder Surgeon, Queensland Orthopaedic Clinic;
Director, QUASR, Akunah

Professor Ashish Gupta is a Sub specialist shoulder surgeon working in Brisbane Australia. His practice solely comprises of shoulder surgery. He Completed his Orthopaedic training in Queensland. Dr Gupta completed advanced shoulder arthroscopy and arthroplasty fellowships with Dr Lafosse (France), Dr Seebauer (Germany) and at Fowler Kennedy sports clinic and / Hand and Upper Limb Clinic G Athwal/R Litchfield (Canada) where he also completed his Masters.

Prof Gupta now practices in Brisbane. He is a dedicated clinician and teacher. He is the Co-Director of the Australian Shoulder Arthroscopy and Arthroplasty Clinical Fellowship. He is actively involved with training registrars. His passion for clinical research has led to the development of a clinical research unit-Shoulder Surgery Research Institute which fosters teaching and clinical research to improve patient outcomes. http://drashishgupta.com.au/research-institute/

Prof Gupta is actively involved in basic science research at the Queensland University of Technology and is the founding Director of QUASR - Queensland Unit for Advanced Shoulder Research. QUASR is a dedicated research organisation with over 70 personnel with a key focus on biomechanical, tissue, 3 D printing, robotics and computational research into the shoulder. This is now the parent organisation for Australian Research Council Training Center in Joint Biomechanics (ARC ITTC JB) https://www.quasr.com.au https://jointbiomechanics.org

His interest in commercialising computer modelling, patient outcome / AI driven Pre Op planning and Mixed Reality driven surgical intervention has led to the scale up Akunah which Ashish is the CEO of Akunah is driving towards bringing Australian Health tech to a global market with its products been used in over 5 countries now. https://akunah.com/

As published at https://www.ramsayhealth.com.au/Specialists/greenslopes-private-hospital/orthopaedic-surgery---shoulder/104657/prof-ashish-gupta

Centre Programs

Computer modelling and simulation

Computer models that accurately represent both individuals and patient groups and can be used for optimismsing the design of implants and clinical decisions making for surgery and rehabilitation

Program 1

Robot- assisted testing and surgery

Advanced knowledge of shoulder function and medical device performance. Precision tools for execution of planned surgical procedures using robotic and ultrasound technologies.

Program 2

Tissue-engineered scaffolds

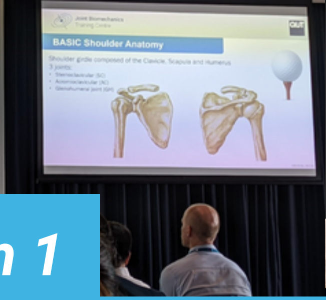
Optimised and validated engineered scaffolds for rotator cuff repair. Improved understanding of for-for-purpose rehabilitation protocols to enhance tissue repair.

Program 3

In-vivo Joint assessment

Improved understanding of upper limb movement to inform personalised rehabilitation. Clinically- relevant VR/AR and wearable technologies for joint assessment and rehabilitation.

Program 4


Program 1

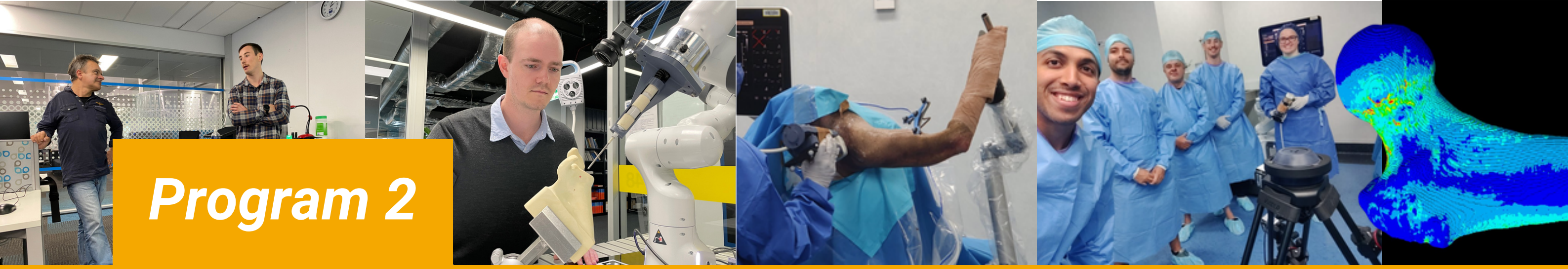
Under the joint leadership of Professor Peter Pivonka (QUT) and Prof Lynne Bilston (UNSW; NeuRA), Program 1 at our centre is at the forefront of advancing computational models for shoulder function. Our initiative aims to comprehensively model shoulder anatomy ARCoss diverse populations, incorporating bony and soft tissue mechanics in various scenarios.

Notable achievements in 2023 within Program 1 include the acceptance of six abstracts at ANZORS, with one centre member nominated for the ECR Best Presentation Award. We also celebrate the conferral of the PhD degree to affiliate Dr. Corey Miller, showcasing our commitment to academic excellence. Mr. Luka Bai's accomplishment in securing a prestigious post-doctoral position at a Chinese university underscores our program's global impact. Additionally, affiliate Ph.D. student Miss Natalia Muhl Castoldi's dual success in winning the Queensland University of Technology (QUT) 3 Minute Thesis competition and securing a post-doctoral position at our centre, exemplifies our dedication to growth in the In silco modelling space and innovation within the sector. Max Lavaill's securing of the CBT ECR grant and collaboration with FAU, Erlangen, Germany further highlights the program's dynamic contributions to advancing shoulder health research.

The program continues to thrive, reaching groundbreaking milestones such as Dr. Laith Alzubaidi's publication, "A survey on deep learning tools dealing with data scarcity," in the Journal of Big Data, marking the centre's most cited publication of 2023. This achievement showcases our commitment to innovation in the rapidly evolving field of deep learning AI for medical imaging analysis. As the centre's largest program, we look forward to further innovation in the biomechanics for orthopaedics field.

Prof Peter Pivonka

Prof Lynne Bilston



Program 2

Program 2 two focuses on image-based technologies for advancing methods for testing orthopedic implants, guiding robotic surgery, and precision bone tracking during activity.

In order, a micro-CT protocol for visualizing micrometric displacements of the whole volume of reverse shoulder implants as they deform and fracture under load. The current analysis focuses on how preserving bone in different surgical procedures determines the stability and failure of the implant (slide 1, right).

In collaboration with the Hertston Biofabrication Institute (PhD project), new testing equipment by ASTM standards has been developed to track bone-implant motion during cyclic loading in glenoid implants. The analysis of the stability of inlay and onlay surgical procedures is currently under investigation. At the time of writing, the project is four days of testing from completion (slide 1, left).

The method developed for obtaining an ultrasound tomography demonstrated the clinical validity of ultrasound tomography for visualizing musculoskeletal structures, particularly bones, muscles, and tendons (slide 2, left).

The latest advances in computer vision have developed and demonstrated an algorithm for self-assessing localization performance, a safety-critical aspect of computer vision for application in robotic surgery (slide 2, right).

The data collection in a cadaver pilot study funded the previous year by the Centre has been completed by combining ultrasound and motion analysis technologies for tracking bones during movement within millimeter accuracy. Processing of the data is currently in progress (slide 3).

Finally, the inter-program collaboration with Zimmer Biomet has resulted in QCMS Linkage Spark grant from the Centre for Material Science (QCMS), funding a 2-year master of philosophy project ($50k) for the development of smart orthopedic implants.

A/Prof Saulo Martelli

Program 3

The overarching aim for Program 3 is to develop tissue engineered scaffolds to improve healing outcomes for rotator cuff tears. Towards this end, we are combining computational and in vitro cellular models and advanced materials.

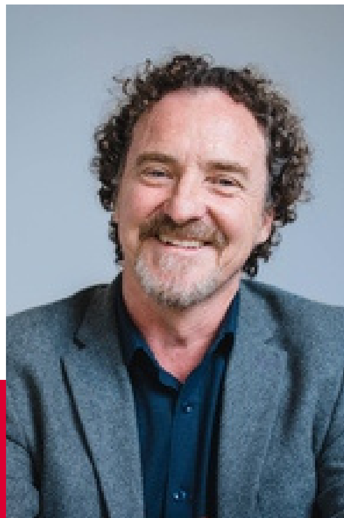
Highlights of this work include the successful development of a first-in-field anatomical model of the rotator cuff, inclusive of biomechanical properties. The model comprises all four rotator cuff muscles and tendons, as well as major bones and articular cartilage and can be used to understand physiological loads in the healthy shoulder.

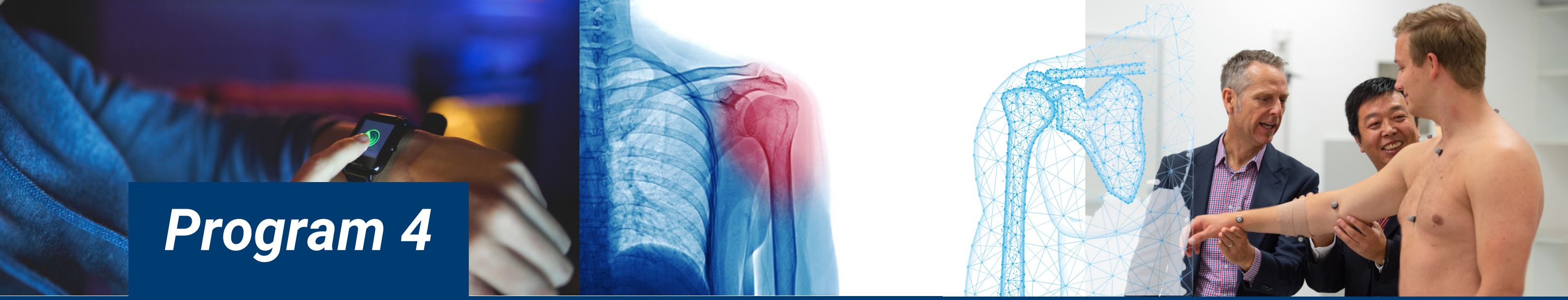
We developed two cellular models: a novel induced pluripotent stem cell derived model which mimics features of aged and fibrotic tissue and are using this model to understand the effects of fibrosis in the context of impeded rotator cuff tear healing. Further, we developed a protocol for the differentiation of stem cells to tendon cells. While stem cells are present at rotator cuff injury sites, it is the tendon cells that maintain tissue homeostasis and thus the knowledge of how to differentiate stem cells into the tenogenic lineage is crucial to promote tendon healing and function.

Lastly, we have developed scaffolds that closely match the mechanical properties and anatomical crimping pattern of the native supraspinatus tendon tissue and developed a prototype smart drug delivery vehicle which can be utilised to reverse the effects of underloading following a rotator cuff tear.

We will use the combined understanding of this work to develop bespoke scaffolds, with the aim to restore tissue functionality following a rotator cuff tear.

Prof Justin Cooper-White





Program 4

This year saw the commencement of PhD students Amy Ma (UQ), Arthur Fabre (QUT), Giacomo Nardese (QUT), Laura Perez (Malaga, Spain). Eric Su also commenced as a postdoctoral researcher with the group. Masters student Anna Moyle has also been accepted and will commence next year.

A major outcome has been completion of a series of studies to validate the Zimmer Biomet Mymobility app. This provides objective quantification of active shoulder range of motion using a smartphone camera. Comparisons were made against 3D motion capture and clinical visual assessment. Three papers have been written and the first has been submitted for publication.

Development of a wearable IMU system for assessing upper limb function and shoulder range of motion has commenced. A wearable sensor upper limb kinematic model has been developed (including glenohumeral motion) to bridge the potential gap between clinic and real-world behaviour.

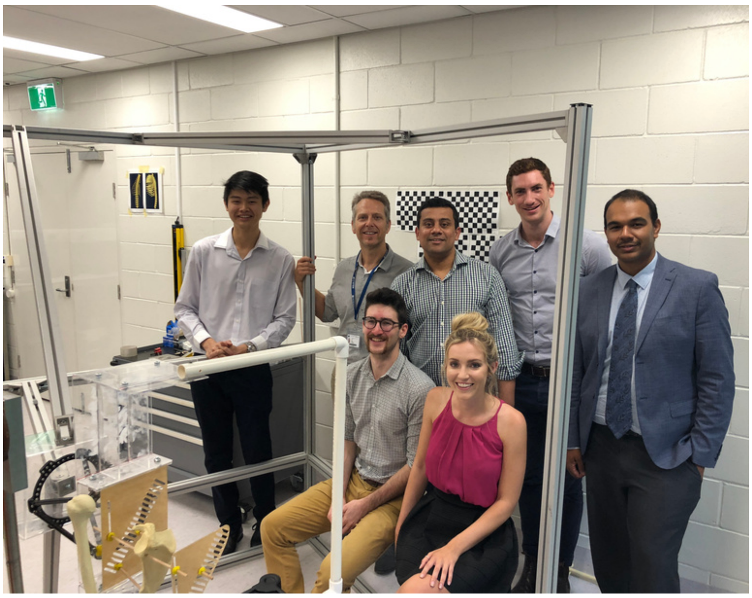
Two studies that directly assess neural drive to shoulder muscles are almost finalised. The developed paradigm will be used to determine the relation between neural control of the deltoid and functional outcome pre- and post-total reverse shoulder replacement.

To explore the neural changes that might underpin deficits in shoulder muscle control two projects are under way at the University of Queensland. The first study that explores shoulder muscles' brain representation is finished. Pilot studies have begun to determine the motor cortex organisation of the whole deltoid muscle.

In Spain, a randomized control trial to examine exercise effectiveness aimed at lowering fatigue in unstable shoulder patients has started. A scoping review and a protocol paper have been submitted for publication.

The program hosted workshops on how to undertake 3D motion capture using the Vicon system and on how to use IMUs for recording unconstrained movements.

Prof Graham Kerr



Rapid Fire Presentations

Program 1

Insights Into The Differant Optimisation Methods for Solving Shoulder Muscle Redundancy Problem

Dr Max Lavill

Quantifying muscle forces in vivo is critical for understanding shoulder biomechanics. Current state-of-the-art musculoskeletal models estimate muscle forces by solving the muscle redundancy problem either by static optimisation (SO), computed muscle control (CMC), 3) EMG-assisted optimisation (CEINMS) and stochastic sampling. Our work aims to benchmark and validate the predictions of muscle and glenohumeral joint contact forces (GHJ-CF) against EMG and GHJ-CF measurements. Moreover, we aim to provide a technical guide in using SO, CMC, EMG-assisted and stochastic methods for shoulder modelling.

We utilised previously collected data from a male participant with an instrumented shoulder hemiarthroplasty during a shoulder abduction task. Shoulder landmark trajectories were spatially tracked and EMG signals were simultaneously recorded from superficial shoulder muscles. A previously developed upper-limb musculoskeletal model was used to compute joint angles and moments in OpenSim. Then, muscle recruitment was optimised using 1) SO, 2) CMC, 3) a calibrated EMG-assisted and 4) a stochastic approach. The experimental total GHJ-CF was compared against the stochastic range to determine whether the solution was part of the model solution space. Then, each method was validated against the experimental instrumented GHJ-CF.

Overall, different muscle recruitment strategies have been benchmarked and validated against experimental GHJ-CF during a shoulder abduction task. We propose a guide to best select muscle recruitment strategy techniques based on the application. CMC and CEINMS were the two methods presenting the most advantages. In addition, stochastic muscle sampling provided critical information on the shoulder model capabilities and should be used as part of future validation studies.

Three-Dimensional Architecture of Human Rotator Cuff Muscles

Yilan Zhang

Muscle architecture, encompassing parameters like muscle volume, fascicle length, pennation angle, and physiological cross-sectional area (PCSA), profoundly determines muscle function. However, rotator cuff muscle architecture has yet to be clearly described in living humans due to its complexity and limitations of conventional imaging techniques. This knowledge gap, along with the subsequent difficulty in assessing muscle function at the time of shoulder surgery, likely contributes to a high failure rate.

Musculoskeletal models are widely used to integrate architectural measurements with experimental motion data, enabling assessment of muscle function. Yet, due to difficulties in obtaining in vivo measurements of human rotator cuff muscle architecture, most models rely on generic data from a single cadaver specimen, sometimes scaled to fit an individual's anthropometry. However, this approach may fall short in capturing inter-individual differences in muscle architecture, potentially resulting in inaccurate model predictions. This underscores the imperative for precise, subject-specific evaluation of rotator cuff muscle architecture for both clinical and computational studies.

Our study utilized diffusion tensor imaging (DTI) and anatomically constrained fibre tractography to reconstruct and quantify the 3D architecture of rotator cuff muscles in 20 healthy adults. The qualitative reconstructions closely resembled the known human rotator cuff anatomy. Moreover, we present the first quantitative measurements of in vivo human rotator cuff muscle architecture, aligning with values reported in cadaver studies. These intricately detailed whole-muscle reconstructions offer a platform to gauge the impact of joint surgery on muscle architecture and to propel the development of accurate musculoskeletal models for the human shoulder.

Rapid Fire Presentations

Program 1

Shoulder Morphologic Variations: Statistical Shape and Pose Estimates

François Bruyer-Montéléone

The shoulder demonstrates the largest human joint range of motion (ROM) to position the hand in space. However, this ROM comes at the cost of a high rate of dislocations compared to any other joint in the human body. One of the most common shoulder problems arises from the glenohumeral joint (GHJ) instability which frequently leads to shoulder dislocations. In cases of severity, a range of surgical procedures can be employed to address these dislocations.

Yet, the biomechanical origins of successful surgical procedures remain unknown. Information of muscle activation patterns, i.e. internal biomechanical loads, is substantial to improve our understanding of the musculoskeletal (MSK) system. Unfortunately, obtaining information on internal joint loading in vivo is very challenging, invasive and difficult to justify ethically in healthy people. One alternative is to perform in silico MSK simulations to estimate internal joint loading and assess joint stability and motion.

However, most of these models are based on generic scaling which do not encompass inter-subject morphological variability. Similarly, individual bony segment scaling does not account for variability of bone neutral pose. To account for these differences, statistical shape models (SSM) can be employed. The latter consider a population anthropometry by deriving mean and shape variations of three-dimensional objects. Statistical models of the upper limb have enhanced our knowledge of shape and material properties and allowed reconstruction of pathological structures. However, little is still known about the variation in bone (neutral) pose, i.e. the relationship between the GHJ bones. Thus, it is not clear how anatomical pose combined with shape variations overall contribute to the stability of the joint and further impact surgical procedures.

Hence, this project aims at exploring the anatomical variations of a healthy population to further develop accurate SSM-based MSK models of the shoulder. These refined models will enable the assessment of diverse biomechanical impacts of a particular surgical intervention based on individual anatomical variations.

AI for Industry

Dr Laith Alzubaidi

Artificial Intelligence (AI) has demonstrated outstanding performance in various applications and has significantly enhanced people's lives. It has transformed several aspects of society, such as the economy, healthcare, education, and transportation, making our daily lives more convenient. However, recent studies have highlighted potential dangers and risks associated with AI.
These include the possibility of AI making opaque and unreliable decisions in safety-critical situations, exacerbating bias and unfairness, particularly toward underrepresented groups or individuals, and even violating user privacy by disclosing sensitive business information. This talk will address the trustworthy requirements necessary to move AI from the lab to the real world.

Rapid Fire Presentations

Program 2

Implant Stability In Shoulder Arthroplasty

Dr Dermot O'Rourke is a post-doctoral fellow in Program 2 at the ARC Training Centre for Joint Biomechanics, based at QUT.

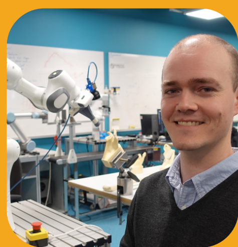
His research interests are in musculoskeletal biomechanics, with a focus on applying computational and experimental methods to investigate joint function and assess implant stability in joint arthroplasty. In this talk, Dr O'Rourke will highlight work done during the year on two experimental-based projects investigating the biomechanics of implants in shoulder arthroplasty. In the first project, he will discuss comparing the mechanical loosening of inlay and onlay implantation techniques for glenoid components in total shoulder arthroplasty. In the study, dynamic mechanical testing was performed to determine the stability of the glenoid components under the 'rocking-horse' motion caused by cyclic displacement of the humeral head to opposite glenoid rims. Findings from this study will provide vital data on the stability of the inlay implantation technique for reducing long-term glenoid loosening.

Dr Dermot O'Rourke

In the second project, he will discuss the biomechanics of the Grammont-style inlay humeral stem design and the Grammont-style onlay humeral stem in reverse shoulder arthroplasty. In the study, time lapse micro-CT images were taken of the designs under mechanical load were obtained to quantify the deformation of the implant-bone constructs. Findings from this study provides insight into the effect of preserving bone in the onlay design on joint stiffness and failure.

Forward Prediction of Target Localisation Failure Through Pose Estimation Artefact Modelling

Contributors: Morgan Windsor, Alejandro Fontan, Peter Pivonka, and Michael Milford



Morgan Windsor

Orthopaedic surgical robots offer the potential to improve patient outcomes though more accurate and repeatable procedures, assisting surgeons to translate patient specific plans to precise execution. A key challenge in this area is trustworthy localisation, finding where target bones are relative to the robot and knowing if the estimate is accurate enough for the task.

Previous methods have been developed to identify when localisation is underperforming, but these detect failure as it occurs or after it occurs. In our work, recognising that reaching the point of failure, even if detected, may be unacceptable, we propose instead to predict where localisation failures are likely to occur, enabling a robot to anticipate and avoid them.

We present an approach to predict the performance of a target localisation system at locations unexplored by a robot by modelling trends in internal pipeline artefacts that are predictive of localisation accuracy. We use this model to predict where acceptable localisation performance is possible and where failure is likely. We show that our method provides significant improvements over a baseline approach in offline experiments and when deployed to a live robot significantly reduces the likelihood of localization failure while maximising the available robot working space.

Rapid Fire Presentations

Program 3

Develop a Tissue Engineered Scaffold to Improve Healing Outcomes Following Rotator Cuff Repair Surgery

Program Leads: Professor Justin Cooper-White, Professor Lisbeth Grøndahl
Investigators: Dr Eleonore Bolle, Ms Stephanie Belen Michelena Tupiza, Ms Asawari Parulekar, Ms Sepideh Shemshad

Collaborators: Professor Sandy Brauer, Professor Cameron Brown, Professor Simon Cool, Dr Ken Cutbush, Professor Tim Dargaville, Associate Professor Craig Engstrom, Dr Ashish Gupta, Professor Peter Pivonka, Professor Bill Vicenzino

The overall aim is to develop tissue engineered scaffolds to improve healing outcomes for rotator cuff tears. The rotator cuff is a complex interfacial musculoskeletal tissue, comprising bone, cartilage, muscle and tendon and its function relies on zonal functionality of all tissues.

To inform the design of the tissue engineered scaffolds, we firstly study the native tissue using computational modelling techniques and histological techniques. Additionally, we utilise an induced pluripotent stem cell model which mimics features of ageing cells to investigate factors leading to the formation of scar tissue in ageing rotator cuff tissues following tears.

Together, this knowledge is utilised to inform material choices, manufacturing techniques and the overall geometry of the scaffold to closely resemble the native tissue.
Another aspect of successful tissue engineering is to enhance healing. To address this aspect, we are studying biological factors that drive stem cells to differentiate into rotator cuff tissue specific cells. This knowledge will be applied towards incorporating biological factors into the scaffolds and harness the presence of stem cells surrounding the native tissue to restore zonal functionality of the rotator cuff tissue.

Restoring the tissue functionality requires not only an understanding of the native tissue, healing following tendon tears and how healing can be enhanced, it also requires an understanding of the current clinical practices and the effects on the tissue. The standard clinical approach following a rotator cuff repair surgery is to immobilise the shoulder. Recent studies, however, suggest that immobilising tendon tissue causes ossification of the tendon. To impede ossification in the context of underloading we are developing a smart drug delivery system for the targeted delivery of ossification inhibitors.
Together, this work will allow us to develop bespoke scaffolds which address all aspects of successful tendon healing.

Dr Eleonore Bolle

Sepideh Shemshad

Asawari Parulekar

Stephanie Belen Michelen Tupiza

Rapid Fire Presentations

Program 4

How do We Activate Our Deltoid Muscles?

Wolbert van den Hoorn, François Hug, Ella Hill, Frederique Dupuis, Ashish Gupta, Ken Cutbush, Graham Kerr, Kylie Tucker

Dr Wolbert van den Hoorn

Deltoid function is key to movement recovery after total reverse shoulder replacement, however, functional outcomes after this surgery are variable. To understand how the central nervous system controls the deltoid muscles we first assessed this in individuals with normal shoulder function (n=8 so far).

We aimed to map the neural drives of deltoid muscle activity by changing the level at which we observe this activity; from whole muscle to spinal motoneurons. Each muscle contains hundreds of muscle fibres, of which groups are innervated by a single spinal motoneuron, together defined as a motor unit. We can observe the direct neural control signal to the muscle via measurement of correlated activity of multiple individual motor neurons. Using this approach, it has been shown that some skeletal muscles can receive multiple control signals; linked with motor control flexibility. This remains unknown for the deltoid muscles.

High density electromyography measured activity of the anterior, lateral, and posterior deltoids during force matched tasks (abduction directions). Signals were decomposed into motor unit spike trains and smoothed to retain dynamics below 2.5Hz (linked to force production). Common dynamics among multiple motoneurons (up to 40 motor units in some individuals) were extracted using factor analysis to investigate the underlying neural control organisation. Preliminary findings showed that deltoid muscles receive individual neural drive with some common input ARCoss deltoid heads, likely linked to force production and stabilisation functions. Findings provide key insights into the neural control of healthy deltoid muscles.

A Wearable Magneto-Inertial Measurement Units-based System for the Upper Limb and Shoulder Kinematics Assessment

Arthur Fabre, Graham Kerr, Peter Pivonka, Glen Lichtwark, Ashish Gupta, Kenneth Cutbush, Wolbert van den Hoorn.

Arthur Fabre

The evaluation and understanding of the upper limb (UL) function is an essential aspect of neurorehabilitation research and practice as it provides the foundation for the assessment of new rehabilitation programs, medications, and patient-specific interventions. While current UL functional assessments continue to heavily rely on subjective, bounded, and limited methods (e.g. visual assessment, clinical tests, rating scales), Magneto-Inertial Measurement Units (MIMUs) represent a clinically and everyday life applicable promising solution offering a range of advantages. This includes objective feedback, remote monitoring, continuous tracking, and long-term accessibility. However, several challenges hinder its adoption in UL kinematics assessment. Key issues include the lack of standardised protocols for data collection, ensuring the accurate representation of skeletal orientation through the sensors and selecting suitable sensor fusion algorithms (SFA) and parameters for data processing. This first PhD project aims to propose and validate a novel MIMUs-based measurement method to obtain meaningful UL and shoulder joint angles. It involves;

- The computation of anatomically relevant joint angles using a sensor to segment calibration procedure using bony landmark identification,
- The identification of an appropriate SFA and fine-tuning its parameters to ensure its accurate orientation estimation under various conditions
- The estimation of the end-effector position relative to the thorax.

For this first validation project, UL kinematics including the range of motion (ROM) and joint angles measured by the MIMUs-based system from participants without shoulder issues will be compared to the gold standard optical motion capture (OMC) system during a range of clinical and functional tasks.

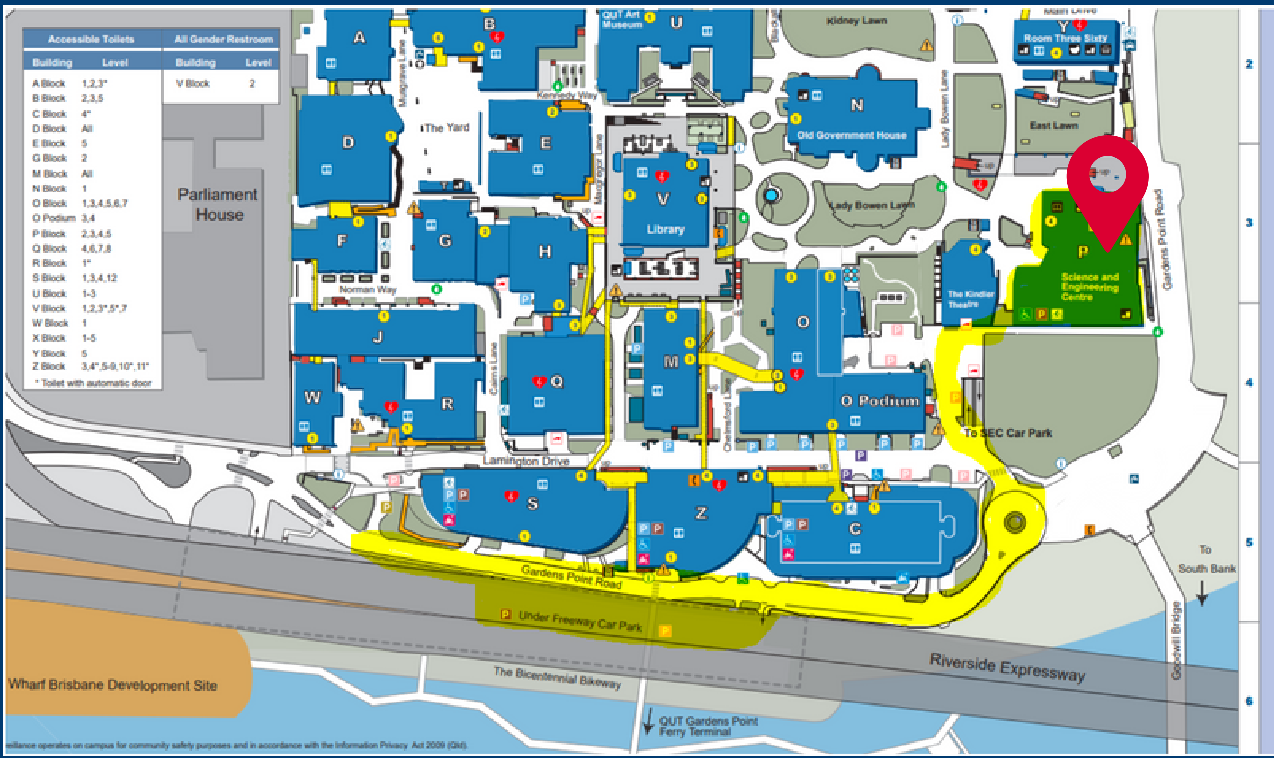
The Neuromuscular Control of the Shoulder Muscles In Healthy Individuals

Shoulder pain is one of the most common musculoskeletal conditions which affects up to 55% individuals in the general population. Impaired neuromuscular control has been proposed as a contributing factor to the development and persistence of shoulder pain. There is evidence on parallel research that changes in neuromuscular control are related to the modified organisation of the motor regions of the brain. Such observations have implications for clinical management of these conditions as they can guide the target of interventions.

However, whether modification of the motor cortex is present in should pain conditions has not been evaluated. The present project aims to provide insight into how neuromuscular control of the shoulder is coordinated by the motor cortex of the brain in healthy individuals as a foundation for future investigation of people with pain. This study will involve one-off experiments on volunteers in the lab using Transcranial Magnetic Stimulation (TMS) accompanied by Electromyography (EMG).

The findings of this project will help create a theoretical framework on the role of central nervous system on neuromuscular control of the shoulder, and in later phases, how shoulder pain may be developed and/or progressed. This can inform the assessment and intervention regime with an objective to improve the management of patients with shoulder pain and ultimately reduce the burden of this condition.

Yuyao (Amy) Ma



Thanks You for your attendance

Please find videos from today linked in QR code

Australian Government
Australian Research Council

QUASR

Joint Biomechanics
Training Centre