CU Medicine HONG KONG

CUHK SPORTS MEDICINE
中大運動醫學

CUHK RESEARCH SUMMIT SERIES

CUHK 2024 SPORTS BIOMECHANICS RESEARCH SUMMIT

DATE: 27 JULY 8:20 AM – 5:10 PM (SAT)
28 JULY 9:00 AM – 1 PM (SUN)

PUBLIC LECTURE SERIES

- I. BIOMECHANICS OF ANKLE SPRAIN AND INSTABILITY
- II. COMPUTATIONAL BIOMECHANICS AND WEARABLE TECHNOLOGY TO MEASURE ANKLE BIOMECHANICS
- III. ANKLE AND FOOTWEAR BIOMECHANICS IN DANCE AND RUNNING
- IV. BIOMECHANICS OF THE SHOULDER JOINT
- V. CUHK PROJECT PRESENTATION
- VI. BIOMECHANICS OF ANTERIOR CRUCIATE LIGAMENT (ACL) INJURY
- VII. BIOMECHANICS OF KNEE OSTEOARTHRITIS AND REPLACEMENT

VENUE: 209, CHENG YU TUNG BUILDING,
THE CHINESE UNIVERSITY OF HONG KONG

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ACKNOWLEDGMENTS

Organizers:

CUHK SPORTS MEDICINE 中大運動醫學

CUHK RESEARCH SUMMIT SERIES

ACCREDITATION

Hong Kong Academy of Medicine (HKAM)
Hong Kong College of Orthopaedic Surgeons (HKCOS)
Hong Kong Physiotherapy Association (HKPA)
Physical Fitness Association of Hong Kong, China (HKPFA)

WELCOME MESSAGES

Prof. Patrick Yung

• **Professor and Chairman,**
Department of Orthopaedics & Traumatology,
Faculty of Medicine,
The Chinese University of Hong Kong, Hong Kong

Dear Esteemed Guests and Participants,

It is my great pleasure to welcome you to the CUHK Sports Biomechanics Research Summit 2024. On behalf of the organizing committee, I extend a warm greeting and express our sincere appreciation for your presence at this significant event.

Following the success of last year's summit, it is our great honor to once again organize the summit and also in parallel with the Sports Biomechanics Croucher Summer Course. This year, we have extended our invitations to include a wider range of experts from around the globe, and the positive feedback received is evident in the record-breaking number of registrations!

The summit will feature seven series of sessions, covering a wide range of topics. These include Biomechanics of ankle sprain and instability, Computational biomechanics and wearable technology to measure ankle biomechanics, Ankle and footwear biomechanics in dance and running, Biomechanics of the shoulder joint, Biomechanics of Anterior Cruciate Ligament (ACL) injury, Biomechanics of knee osteoarthritis and replacement. We have also dedicated a portion of the program to the CUHK Project presentation, where we will showcase the ongoing initiatives and achievements of CUHK in the field of sports biomechanics.

I wish you all a rewarding and memorable experience at the Sports Biomechanics Research Summit. May the interactions and connections established during this summit serve as the cornerstone for enduring collaborations, meaningful friendships, and impactful contributions to the field.

With warm regards,

Prof. Patrick Shu Hang Yung

WELCOME MESSAGES

Dr. Daniel Fong

- **Reader in Sports Medicine and Biomechanics, Loughborough University, UK**
- **Adjunct Associate Professor, The Chinese University of Hong Kong, Hong Kong**
- **Editor-in-Chief, Sports Biomechanics Journal**

Dear Colleagues and Friends,

Following the success last year, I would like to welcome all of you to join the Sports Biomechanics Research Summit 2024.

The summit will focus on the latest research utilising sports biomechanics technique in orthopaedics and sports medicine topics, especially surrounding the ankle, the knee and the shoulder joints. There is a mixture of the latest knowledge, the current practices, and the insight of future or developing advances.

One of the purposes is to promote international collaboration within this research topic. Last year we were successful in creating a few collaborations in different formats, such as co-authoring research publications, co-applying research projects, research student examining, and academic exchanges. We hope that we can further enhance this and extend this to more regional and international experts in this summit.

As the Summit Co-Chairperson, I would like to thank all the speakers for participating in the event, and look forward to more collaborations and success in this area in the coming years.

Sincerely,

Dr. Daniel Fong

DAY 1 PART 1

TIME	TOPIC	SPEAKER
08:00 – 08:20	Registration	
08:20 – 08:30	**Opening**	**Prof. Patrick Yung** **Dr. Daniel Fong**
Public Lecture Series I: Biomechanics of ankle sprain and instability		**Moderators: Prof. Qipeng Song** **Dr. Daniel Fong**
08:30 – 08:50	Mechanism and prevention of lateral ankle sprain	Dr. Daniel Fong
08:50 – 09:10	Surgical treatment of unstable ankle	Mr. Jitendra Mangwani
09:10 – 09:30	Ankle biomechanics and plantar pressure in Tai Chi exercise	Prof. Dewei Mao
09:30 – 09:50	Mechanisms of functional declines of peroneal muscles in people with chronic ankle instability	Prof. Qipeng Song
09:50 – 10:10	Arthrogenic muscle inhibition in chronic ankle instability	Ms. Ping Zhang
Break (10:10 – 10:25)		
Public Lecture Series II: Computational biomechanics and wearable technology to measure ankle biomechanics		**Moderators: Prof. Feng Wei** **Dr. Daniel Fong**
10:25 – 10:45	Studies of ankle ligamentous injuries using computational techniques	Prof. Feng Wei
10:45 – 11:05	Finite element analysis of ankle fusion surgery	Dr. Simin Li
11:05 – 11:25	Open Ankle Models for low-risk exploration of new surgical treatments	Dr. Elise Pegg
11:25 – 11:45	Textile sensor to detect and monitor joint motion	Dr. Lulu Xu
Lunch (11:45 – 13:15)		
Public Lecture Series III: Ankle and footwear biomechanics in dance and running		**Moderators: Prof. Veni Kong** **Prof. Samuel Ling**
13:15 – 13:35	Ankle injuries and long-term problems in dancers	Prof. Samuel Ling
13:35 – 13:55	Dance biomechanics: Challenges and considerations for motion capture of the foot and ankle	Dr. Alycia Fong Yan
13:55 – 14:15	Gait re-training and ankle biomechanics in running	Prof. Roy Cheung
14:15 – 14:35	Biomechanics of footwear and ankle stability in sports	Prof. Veni Kong

DAY 1 PART 2

TIME	TOPIC	SPEAKER
	Break (14:35-14:50)	
	Public Lecture Series IV: Biomechanics of the shoulder joint	**Moderators: Prof. Sakiko Oyama, Prof. Weerawat Limroongreungrat**
14:50 – 15:10	Biomechanical considerations in reverse shoulder arthroplasty	Dr. Jonathan Ng
15:10 – 15:30	Biomechanics of shoulder injury in overhead sports	Prof. Sakiko Oyama
15:30 – 15:50	Shoulder biomechanics in wheelchair sports	Prof. Weerawat Limroongreungrat
15:50 – 16:10	Motor skill intervention to improve throwing biomechanics	Dr. Allan Fu

TIME	TOPIC	SPEAKER
	Break (16:10 – 16:25)	
	Public Lecture Series V: CUHK Project Presentation	**Moderators: Dr. Xin He, Dr. Joe Liang**
16:25 – 16:40	The effects of pulsed electromagnetic field therapy on muscle strength, physical function and pain in patients with end-stage knee osteoarthritis: A randomized control trial	Ms. Alicia Wang
16:40 – 16:55	The clinical effects of pulsed electromagnetic field therapy on the management of chronic ankle instability: a double-blinded randomised controlled trial	Ms. Cheryl Chia
16:55 – 17:10	Imaging assessments for shoulder injuries in Hong Kong elite athletes	Mr. Ben Choi

DAY 2

TIME	TOPIC	SPEAKER
08:30 – 09:00	Registration	
	Public Lecture Series VI: Biomechanics of Anterior Cruciate Ligament (ACL) injury	**Moderators: Dr. Shiyi Yao, Dr. Jihong Qiu**
09:00 – 09:20	Biomechanics of the knee joint after ACL injury	Prof. Yuichi Hoshino
09:20 – 09:40	Is there an association between biomechanics and ACL injury?	Prof. Evangelos Pappas
09:40 – 10:00	Decision making, divided attention, and ACL injury	Prof. Gerwyn Hughes
10:00 – 10:20	Soft fall-landing technique for preventing ACL injury	Prof. Boyi Dai
10:20 – 10:40	‘Kissing knees’ show no association with ACL injury	Dr. Kam-Ming Mok
10:40 – 11:00	Knee wobbling biomechanics in patients with ACL injury	Dr. Xin He
	Break (11:00 – 11:20)	
	Public Lecture Series VII: Biomechanics of knee osteoarthritis and replacement	**Moderators: Prof. Wei-Chun Hsu, Prof. Michael Ong**
11:20 – 11:40	Robotic surgery for treating knee osteoarthritis	Prof. Michael Ong
11:40 – 12:00	The use of knee braces to adjust joint loading and improve clinical outcomes in the osteoarthritic knee	Prof. Jim Richards
12:00 – 12:20	Laterally wedged insoles to treat medial knee osteoarthritis	Prof. Wei-Chun Hsu
12:20 – 12:40	Biomechanics of total knee replacement systems	Prof. Michael LaCour
12:40 – 12:50	Conclusion Remarks	Prof. Patrick Yung, Dr. Daniel Fong

MODERATORS

Dr. Daniel Fong

- Reader in Sports Medicine and Biomechanics, School of Sport, Exercise and Health Sciences, Loughborough University, UK
- Adjunct Associate Professor, Department of Orthopaedics & Traumatology, The Chinese University of Hong Kong, Hong Kong
- Editor-in-Chief, Sports Biomechanics Journal

Prof. Qipeng Song

- Professor & Director of Biomechanics lab, Shandong Sport University, China

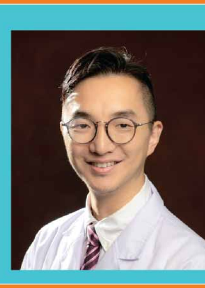
Prof. Feng Wei

- Assistant Professor, Orthopaedic Biomechanics Laboratories, Michigan State University, Michigan, United States

Prof. Veni Kong

- Associate Dean and Associate Professor at the National Institute of Education, Nanyang Technological University, Singapore

Prof. Samuel Ling



- Clinical Assistant Professor, Department of Orthopaedics & Traumatology, The Chinese University of Hong Kong, Hong Kong

Prof. Sakiko Oyama

- Associate Professor, Department of Kinesiology, University of Texas San Antonio, United States

Prof. Weerawat Limroongreungrat

- Associate Professor, College of Sports Science and Technology, Mahidol University, Thailand

MODERATORS

Dr. Xin He

- Part-time lecturer, Department of Orthopaedics & Traumatology, The Chinese University of Hong Kong, Hong Kong
- Doctor of Physiotherapy student of the University of Sydney, New South Wales, Australia

Dr. Joe Liang

- Post-doctoral fellow, Department of Orthopaedics & Traumatology, The Chinese University of Hong Kong, Hong Kong

Dr. Shiyi Yao

- Post-doctoral fellow, Ruijin Hospital, Shanghai, China

Dr. Jihong Qiu

- Lecturer, Shanghai University of Sport, Shanghai, China

Prof. Wei-Chun Hsu

- Vice Dean, College of Applied Science;
- Professor, Graduate Institute of Biomedical Engineering, National Taiwan University of Science and Technology, Taiwan

Prof. Michael Ong

- Clinical Assistant Professor, Department of Orthopaedics & Traumatology, The Chinese University of Hong Kong, Hong Kong

Public Lecture Series I:

Biomechanics of ankle sprain and instability

Mechanism and prevention of lateral ankle sprain

Dr. Daniel Fong

- **Reader in Sports Medicine and Biomechanics, School of Sport, Exercise and Health Sciences, Loughborough University, UK**
- **Adjunct Associate Professor, The Chinese University of Hong Kong, Hong Kong**
- **Editor-in-Chief, Sports Biomechanics Journal**

Biography

Dr. Daniel Fong studied his BSc in Physics, MSc in Exercise Science, and PhD in Orthopaedics and Traumatology at The Chinese University of Hong Kong, during 1997-2008, and then served as a Research Assistant Professor during 2008-2013. In 2012, Dr Fong joined University of Pittsburgh as a Visiting Scholar. In 2014, Dr Fong relocated to the UK and joined Loughborough University as a Senior Lecturer, and was promoted to Reader in 2021. Dr Fong's major research interests lie on the prevention and rehabilitation of ankle sprain and instability.

Abstract

Ankle sprain is very common in sports. Repeated sprains may lead to joint instability, osteoarthritis, and eventually the need of ankle fusion or replacement surgery. In this talk, we will first talk about the causes of sports-related ankle sprains, and a few forensic biomechanics methods to investigate the mechanism, leading to the design of two wearable devices for preventing ankle sprains. We will also introduce a few exercise interventions for prevention, and for treating some deficits in people with longer-term chronic ankle instability.

Surgical treatment of unstable ankle

Mr. Jitendra Mangwani

- **Consultant Trauma and Orthopaedic Surgeon, University Hospitals of Leicester, UK**

Biography

Mr. Jitendra Mangwani is an Internationally renowned Consultant Trauma and Orthopaedic Surgeon at the University Hospitals of Leicester, UK. He specialises in foot and ankle surgery and has a tertiary referral practice in a UK teaching hospital. He is the Honorary Secretary of the British Orthopaedic Foot and Ankle Society. He has served as the Chair of the Scientific Committee, BOFAS and led the James Lind Alliance Priority Setting Partnership 'Top-10' research priorities in foot and ankle conditions in the UK.

He has a keen interest in medical research and education. He is chief investigator for several outcome studies on ankle fractures, Achilles tendon rupture, Morton's neuroma and other foot and ankle conditions. He is Principal investigator for several multi-centre national studies. He is Visiting Professor in University of Bath and Honorary Adjunct International Professor. He has been conferred the title of ‘academic champion and honorary fellow’ by University of Leicester.

He is Editor-in-chief of BOFAS bulletin, Foot Print, Deputy Editor, Journal of Clinical Orthopaedics and Trauma and serves on the editorial board of several other reputable orthopaedic journals. His contribution towards research in foot and ankle conditions has been recognised with several national and international prizes. He has published numerous articles in high impact peer-reviewed journals and authored several chapters in books including AO manual of fracture management on Foot and Ankle Trauma.

He is passionate about medical education and is involved in both undergraduate and postgraduate teaching and training. He is regularly invited as a faculty to national and international courses and conferences. He is actively involved in the training and teaching of General Practitioners and Allied Health Professionals.

Abstract

Repeated ankle sprains in sports may lead to chronic ankle instability, repetitive frictional movement within the joint, wearing of the articulating cartilage, early osteoarthritis, joint deformity, and eventually the need of ankle replacement surgery at a relatively young age. In this presentation, we will introduce a few surgical options for treating unstable ankles, and discuss about the pros and cons, and the biomechanics considerations.

Ankle biomechanics and plantar pressure in Tai Chi exercise

Prof. Dewei Mao

- Director of the China Sports Science Society, China
- Deputy Chairman of the Sports Health Science Branch of the China Gerontology and Geriatrics Society, China

Biography

Prof. Dewei Mao graduated from the Department of Sports Science at the Chinese University of Hong Kong, where he obtained a doctoral degree. He was the former president of Shandong Sport University.

His academic research focuses on performance evaluation based on sports biomechanics, human factors and ergonomics and scientific fitness supervision. He has published over 60 papers in domestic and international academic journals, with more than 30 of them included in SCI papers. Prof. Mao has led more than 20 national and provincial research projects, obtaining a total research fund of over 96 million RMB.

Prof. Mao is the first recipient of the first prize of the Shandong Province Science and Technology Progress and of the China Sports Science Society Science and Technology Progress Award. He won the Best Research Output Award for Research Postgraduate Students in 2006 at The Chinese University of Hong Kong.

Currently, Prof. Mao hold positions such as the director of the China Sports Science Society, deputy chair of the Sports and Health Science Branch in China Gerontology and Geriatrics Society, member of the standing committee of the Biomechanics Branch in China Sports Science Society and vice chairman of the Shandong Province Sports Science Society.

Abstract

Tai Chi exercise improved the balance control and muscle strength of the lower extremities. The objective of this study is to quantify the plantar pressure distribution during the one-leg stance in Tai Chi compared to those in normal walking, and to elaborate the beneficial effect of Tai Chi on the ability to balance on one leg.

Sixteen experienced Tai Chi practitioners participated in this study. The Novel Pedar-X insole system was used to record the plantar forces during the execution of a set of 42-form Tai Chi movements and during normal walking. The plantar pressure distribution during the one-leg stance were analyzed.

In Tai Chi exercise, the medial–lateral and anterior–posterior displacements of the centre of pressure were greater ($p < 0.05$) than during normal walking. The peak pressure and pressure–time integral of the second and third metatarsal heads and the fourth and fifth metatarsal heads were significantly greater ($p < 0.05$) than those of other plantar regions during the one-leg stance in normal walking, whereas the peak pressure and pressure–time integral of the first metatarsal head and the great toe were significantly greater ($p < 0.05$) than those of other plantar regions during the one-leg stance in Tai Chi exercise.

Tai Chi has wider displacement of centre of pressure in medial–lateral and longer displacement in anterior–posterior. Larger displacement of centre of pressure during Tai Chi exercise may be associated with improved muscle strength in the ankle joint. The plantar pressure distribution characteristics during the one-leg stance in Tai Chi exercise may improve the ability to balance on one leg by training the muscles of foot and intensifying the feedback from the great toe area.

The findings may provide useful information toward the development of strengthening programs, strategies for the prevention of falls, and the promotion of a physically active lifestyle.

Public Lecture Series I:

Biomechanics of ankle sprain and instability

Mechanisms of functional declines of peroneal muscles in people with chronic ankle instability

Prof. Qipeng Song

- **Professor & Director of Biomechanics Lab, Shandong Sport University, China**

Biography

Prof. Song got his Ph.D at Shanghai University of Sport, worked as a postdoctoral fellow at Georgia Southern University, and works as research professor at Shandong Sport University. He serves as the director of the “Rehabilitation Biomechanics Laboratory” of Shandong Sport University, and the director of the “Biomechanical Engineering Laboratory” co-established with Loughborough University.

Prof. Song's research focuses on the effects of exercise interventions on chronic ankle instability and the effects and mechanisms of Tai Chi practice on fall prevention. He has published about 60 papers in SCI journals with a total IF of over 200 and a highest IF of 13.077, along with about 30 papers in Chinese "core" journals. He obtained 13 grants totaling about $1 million, won the Developing Countries Grant Competition Award issued by the International Society of Biomechanics, and the Science and Technology Progress Award issued by Shandong Provincial Government.

Abstract

Peroneal muscles are the primary muscles to prevent excessive ankle inversion, in which most ankle sprains occur. People with chronic ankle instability (CAI) show peroneal muscle functional declines, e.g., the decreased maximum strength and the prolonged reaction time. We aim to explore the two mechanisms by conducting two separate projects.

Project 1. Sixty-three people with CAI and another sixty-three without CAI conducted maximal voluntary isometric contraction (MVIC) and superimposed burst (SIB) tests during ankle eversion, electrical stimulation was applied to the peroneal muscles while the participants were performing MVIC, and the central activation ratio (CAR) was obtained by dividing MVIC torque by the sum of MVIC and SIB torques, representing the degree of arthrogenic muscle inhibition (AMI).The CARs were lower among people with CAI in the affected and unaffected limbs, compared with those without CAI (affected limb=82.54±9.46%, controlled affected limb=94.64±6.37%, $p<0.001$; unaffected limb=89.21±8.04%, controlled unaffected limb=94.93±6.01%, $p=0.016$). Inhibition of motor neuron activation as a mechanism of decreased peroneal strength.

Project 2. Thirty-one participants with and 32 without CAI were recruited. They conducted trapdoor test to measure the peroneal reaction time (PRT), and H-reflex test to simulate the PRT stage 2 time (ST2, peripheral nerve conduction time). The PRT stage 1 time (ST1, the time of mechanoreceptor to send signals) was calculated as the difference of them two. Longer PRT (CAI=85.6±18.9ms, non-CAI=70.3±7.1ms, $p<.001$) and TS1 (CAI= 42.9±19.0ms, non-CAI=28.9±9.7ms, $p<.001$) were detected in people with CAI compared to those without CAI. No significant group difference of the TS2 was detected (CAI: 42.7±5.6ms, non-CAI: 41.3±5.4ms, $p=.314$). The mechanism of prolonged peroneal reaction time among people with CAI is the delay of mechanoreceptor to sending signals, rather than the prolonged peripheral nerve conduction time.

Arthrogenic muscle inhibition in chronic ankle instability

Ms. Ping Zhang

- **Lecturer, The Chinese University of Hong Kong (Shenzhen), Shenzhen, China**

Biography

Ms. Zhang Ping was an elite volleyball athlete. She represented the national volleyball Team, winning the 2003 FIVB Volleyball World Grand Prix, 2003 Asian Championship, 2006 Asian Games, and 2003 FIVB World Cup, more importantly, she helped China to get the 31st gold medal in the 2004 Olympic Games in Athens. After retiring, she pursued her undergraduate and master's degrees at the Chinese University of Hong Kong, graduating in 2015. She is currently a PhD candidate at Loughborough University's School of Sport, Exercise and Health Sciences and serves as a lecturer at the School of Humanities and Social Science at the Chinese University of Hong Kong, Shenzhen.

Abstract

Lateral ankle sprains are the most common ankle injury, affecting approximately 70% of people at least once in their lifetime. Among athletes, 32-74% with a sprained ankle develop chronic ankle instability (CAI), leading to pain, limited movement, and balance issues. Treating these injuries costs the US around $11 billion annually. Arthrogenic muscle inhibition (AMI) is the inability to contract muscles around a joint post-injury, despite the muscles being undamaged. This condition impedes early active exercise in joint rehabilitation due to swelling, altered feedback, or pain, which acts as a protective mechanism but hinders recovery by reducing muscle strength, balance, and posture control.

Research on AMI has mainly focused on quadriceps activation failure in patients with ACL injuries, post-ACL reconstruction, and knee replacement surgery. Recent studies show that individuals with CAI exhibit bilateral AMI in the peroneal muscles, with a higher level in the affected limb compared to the unaffected limb. The Central Activation Ratio (CAR) measures the central nervous system's ability to activate muscles during maximum effort by comparing self-generated muscle torque with torque during additional electrical stimulation. A CAR value below 95% indicates AMI.

Treatment for ankle sprains is evolving to include the central nervous system's role, emphasizing changes in spinal reflexes and brain plasticity. This approach addresses central mechanisms involved in CAI, such as motor neuron suppression and altered neuromuscular control, to improve treatment outcomes. Transcranial direct current stimulation (tDCS) modulates cortical excitability through small electrical currents, enhancing neuron excitability, synaptic plasticity, and motor output. tDCS, combined with an appropriate motor task like balance ball training, enhances cortical excitability, neural plasticity, and motor performance, offering a comprehensive rehabilitation strategy for CAI. This study aims to highlight the necessity of CNS integration in CAI rehabilitation, calling for further research to validate this approach.

Public Lecture Series II:

Computational biomechanics and wearable technology to measure ankle biomechanics

Studies of ankle ligamentous injuries using computational techniques

Prof. Feng Wei

- **Assistant Professor, Orthopaedic Biomechanics Laboratories, Michigan State University, Michigan, United States**

Biography

Prof. Wei's research interests focus on injury biomechanics, forensic biomechanics, and computational biomechanics. Prof. Wei is the Co-Director of the Orthopaedic Biomechanics Laboratories (OBL) at Michigan State University. The OBL develops animal models of post-traumatic osteoarthritis in the knee joint and investigates potential pharmaceutical interventions. The OBL also studies ankle injuries using various novel methods. Recent research activities involve evaluation and interpretation of cranial fracture patterns and long bone fracture patterns using a combined biomechanical and forensic approach.

Abstract

Musculoskeletal injuries due to sports, recreation and exercise (SRE) have reached epidemic proportions as our society attempts to develop a healthier lifestyle. Participation in these activities requires maintenance of lower extremity joint health, yet such involvement presents an inherent risk of developing exercise-induced or traumatic musculoskeletal injuries. Acute injuries to the ankle are among the most frequent musculoskeletal injuries in all levels of SRE. As opposed to the most common lateral ankle sprains (LAS), high ankle sprains (HAS) are more problematic due to their potential for a significantly greater time lost and subsequent chronic ankle dysfunction. While excessive foot inversion and external rotation are suspected in LAS and HAS, respectively, the mechanisms of injury remain unclear. Previous experiments have largely been designed to measure ankle kinematics and kinetics. However, these studies fail to address in vivo ankle ligament behaviors accompanying excessive foot motions or moments. This talk will demonstrate a novel methodology that uses kinematic data from video or motion analyses of injury-producing events to drive computational models for estimations of ankle ligament strains and joint moments. The development of new prophylactic measures and targeted rehabilitation therapies will hinge on an accurate understanding of the injury mechanisms and knowledge of the injury-causing factors. These techniques have the potential to provide a better comprehension of LAS and HAS that may help reduce incidence and accelerate recovery for these injuries.

Public Lecture Series II:

Computational biomechanics and wearable technology to measure ankle biomechanics

Finite element analysis of ankle fusion surgery

Dr. Simin Li

- **Senior Lecturer in Biomechanical Engineering, Wolfson School, Loughborough University, UK**

Biography

Dr. Simin Li is senior lecturer in mechanics of biomaterials at Loughborough University, he is expert in mechanical testing and modelling of biomaterials across length-scales. He has developed novel capabilities for multi-scale modelling of damage and fracture in biological tissues. His research covers a broad area of mechanics of biomaterials, including musculoskeletal tissue/implant modelling; characterization of tissue engineered constructs; damage and fracture propagation of bone; wound healing; Mechano-regulated adaptation in vivo, Simulation driven prosthetic socket design and optimization. His research has led to multiple RCUK, government, and Royal society funded projects totalling over £4m in value, with £685k direct as PI and £3.3k as CoI. He is a member of European Society of Biomechanics (ESB), the secretary of the Technical Committee of the European Structural Integrity Society (ESIS) for biomedical and biological materials, and editorial board member for Cyborg and Bionic Systems Journals.

Abstract

Introduction: Ankle fusion surgery is a standard treatment for severe tibiotalar arthritis, aiming to relieve pain, stabilize the joint, and improve mobility. This study analyses the biomechanical behaviour of intramedullary (IM) nail and locking plate fixation in ankle fusion using finite element analysis (FEA).

Methodology: Three-dimensional finite element analysis (FEA) was employed to model the ankle-foot complex with IM nail and locking plate fixation. The full foot model included 28 bones, comprising both cortical shell and trabecular bone, along with 29 major ligament attachments. Using SolidWorks, we accurately modelled the IM nail and locking plate, assembling them into the Abaqus software. Material properties were assigned, including a Young's modulus of 110 GPa and a Poisson's ratio of 0.3. Realistic load conditions simulating double leg stance were applied at the proximal ends of the tibia and fibula, with boundary conditions fixing the distal ends of the calcaneus and metatarsal.

Results & discussion: IM nail surgery resulted in approximately 0.58 mm maximum talus micromotion, while locking plate fixation demonstrated superior stability with less micromotion. Stress distribution analysis revealed a maximum stress value of 22.7 MPa for IM nail fixation, primarily around the proximal screw insertion site. The locking plate provided a more even stress distribution. Both methods maintained stress values below the yield strength of the titanium alloy used. IM nail fixation promotes bone healing and reduces the risk of implant failure. The locking plate method offers better biomechanical performance in reducing micromotion and achieving even stress distribution.

Conclusion: Both IM nail and locking plate fixation in ankle fusion surgery offer biomechanically stable and reliable methods for treating severe tibiotalar arthritis. Additionally, this presentation showcases our team's work utilizing finite element analysis as a general tool, integrated with high-resolution imaging, machine learning, and in-vivo experimental tests for orthopaedics and rehabilitation applications. This highlights the potential of FEA in improving surgical/intervention techniques and patient outcomes. Future research should focus on clinical outcomes and the long-term effects of these methods.

Public Lecture Series II:

Computational biomechanics and wearable technology to measure ankle biomechanics

Open ankle models for low-risk exploration of new surgical treatments

Dr. Elise Pegg

- **Senior Lecturer, Department of Mechanical Engineering, University of Bath, UK**

Biography

Dr. Elise Pegg is a Senior Lecturer (Associate Professor) in the Department of Mechanical Engineering at the University of Bath in the UK, and an Orthopaedic Research UK Early-career Research Fellow. Dr Pegg's research is in the fields of Biomaterials and Biomechanics with a focus on orthopaedic applications. After completing her doctorate at the University of Nottingham, Dr. Pegg worked in the orthopaedic industry for three years as a research engineer, after which she decided to return to academia and moved to the University of Oxford to become a post-doctoral researcher within the Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences where she gained valuable insight into clinical practice. Dr. Pegg and her research team at the University of Bath are working on developing new computational tools to understand and improve healthcare treatment, with a particular focus on surgical repair of the ankle and knee joints, as well as looking into innovative materials for medical applications to improve performance.

Abstract

Ankle pathology gives rise to substantial disability and pain. Approximately 2% of people will injure their ankle during their lifetime and consequently they have a much greater risk of future injury and more rapid joint degeneration later on in life. We need more effective early-intervention treatments and improved understanding of the aetiology of ankle pathology to address these challenges. The focus of this project is to provide a user-friendly simulation tool which will enable researchers to test out new ideas without needing to put patients at risk and at no financial cost. The goal of the project is to create 20 Open Ankle Models from 20 patients to enable users to perform in-silico trials, we currently have created three. The models were created by first defining the bony geometry through segmentation of CT scans using Simpleware Scan IP software. The articular surfaces on each bone were projected out to a constant thickness to create the cartilage (0.5 to 1 mm). Fourteen ligaments were included in each model and represented by tension-only spring elements. Individual stiffness values and insertion locations were based on literature values and anatomical bone features. Heterogeneous material properties of the bones were mapped from the CT scan Hounsfield Units, and the modulus values based on the work by Sopher at al. [1]. Tied elastic contact was defined between the bones and associated cartilage, and frictionless sliding elastic contact between the cartilage surfaces. Parts were meshed with quadratic tetrahedral elements and the mesh size can be defined by the user for mesh convergence studies. The models have been created with FEBio software, which is an open-sourface finite element simulation package (febio.org). This talk will demonstrate the model, show the user options and the potential applications.

Public Lecture Series II:

Computational biomechanics and wearable technology to measure ankle biomechanics

Textile sensor to detect and monitor joint motion

Dr. Lulu Xu

- **Lecturer in Sport Technology, School of Mechanical, Electrical and Manufacturing Engineering, Loughborough University, UK**

Biography

Dr. Lulu Xu is a lecturer in Sport Technology, School of Mechanical, Electrical and Manufacturing Engineering at Loughborough University. Her research specializes in innovative wearable devices for healthcare, life-quality improvements, and athlete training, particularly focusing on e-textile technology. She received her PhD from the University of Manchester, where her studies were centered on the advancement of e-textile sensors and wireless communication devices. After graduating, she worked as a two-year postdoctoral research role at the Wellcome/EPSRC Centre for Interventional and Surgical Sciences (WEISS) at University College London (UCL). At WEISS, she focused on pioneering research related to direct write printing of wearable sensors specifically designed for healthcare and clinical applications.

Dr. Xu's research involves the development of multifunctional wearable sensors, with a focus on areas such as additive printing, e-textiles, 2D materials and their applications in human healthcare and sports monitoring. For example, she developed tactile sensors for human finger tracking, humidity sensor for human respiratory monitoring, strain sensor for sports detection, temperature sensors for breast cancer monitoring, and NFC and RFID antenna for wireless communication.

Abstract

Future wearable electronics aspire to be flexible, stretchable, biocompatible, and comfortable. Recently, clothing integrated with wearable sensors has enabled various smart functions, including joint motion sensing, gesture recognition and vital sign monitoring. Sensors for these applications need to offer rapid response, high sensitivity, wide sensing range, and stable data acquisition capabilities. These features allow for the automatic, convenient detection, logging, and analysis of human physical and biological information, which can be transmitted to smart devices (such as smartphones and watches) and further relayed to the cloud for more sophisticated diagnostics.

E-textiles made from natural fabrics have emerged as promising materials for constructing wearable sensors due to their comfort and breathability. However, commonly reported fabric-based e-textile materials, such as graphene-treated cotton, silk, and flax, often suffer from electrical and mechanical instability during prolonged wear. Fabrics worn on the human body must withstand heat variation, moisture evaporation from metabolic activities, and immersion in body sweat.

To address these challenges, we propose an rGO-based strain sensor that is highly stretchable, washable, and durable with rapid sensing response. This sensor demonstrates excellent linearity with more than 20% elongation and maintains good electrical and mechanical properties even in moisture conditions ranging from 30% to 90% humidity or when immersed in water. Furthermore, by integrating this material with a near-field communication (NFC) system, we can construct a batteryless, wireless wearable body movement sensor. This material has significant potential for smart garment applications.

Public Lecture Series III:

Ankle and footwear biomechanics in dance and running

Ankle injuries and long-term problems in dancers

Prof. Samuel Ling

- **Clinical Assistant Professor, Department of Orthopaedics & Traumatology, The Chinese University of Hong Kong, Hong Kong**

Biography

Prof. Samuel Ling, an Orthopaedic Surgeon, heads the Foot and Ankle Surgery team at the Prince of Wales Hospital at the Chinese University of Hong Kong. He is a core CUHK sports medicine team member led by Prof. Patrick Yung, who looks after most HK athletes. His research focuses on innovative Foot and Ankle Surgery and Regenerative Technologies. He has received prestigious awards and training worldwide. Prof. Ling holds significant leadership positions, has presented extensively at international conferences, and published numerous articles and textbook chapters.

Abstract

This presentation aims to provide a comprehensive overview of ankle injuries and long-term challenges commonly encountered by dancers. The discussion will encompass a detailed exploration of the ankle's anatomy and the unique stressors placed upon it, particularly in the context of dancers with ligamentous laxity. Furthermore, a thorough review of prevalent injuries in the foot-ankle region, with an emphasis on the associated structural complications arising from chronic ankle instability, will be presented. The discussion will also delve into the distinct injury patterns observed in various dance genres, highlighting the differences in ankle problems between ballet, contemporary, and Chinese dance. Specifically, the prevalence of ankle instability in the Chinese dance genre, characterized by its unique artistic style, will be explored. The presentation will culminate with an overview of both non-operative and surgical treatment modalities, with a focus on techniques specifically tailored to address the needs of dancers.

Public Lecture Series III:

Ankle and footwear biomechanics in dance and running

Dance biomechanics: Challenges and considerations for motion capture of the foot and ankle

Dr. Alycia Fong Yan

- **Senior Lecturer, Faculty of Medicine and Health, University of Sydney, Australia**

Biography

Dr. Alycia Fong Yan is a senior lecturer in the Discipline of Exercise and Sports Science, School of Health Sciences. Dr. Alycia is a former professional dancer with qualifications in dance performance, dance teaching, and First Class Honours Bachelor's Degree in Applied Science (Exercise and Sport Science). Her PhD explored the effect of different dance shoe designs on lower limb biomechanics during jumps.

Dr. Alycia's current research program encompasses projects that crosscut both dance and lower limb biomechanics. She has an interest in finding optimal methods to analyse complex movements such as dance and in-shoe foot motion. Current projects explore innovative solutions in tracking the motion of the segments of the foot within close-fitting footwear, determine acute and long-term biomechanical and functional impacts of a variety of footwear designs, and exploring the possibility of athletes learning how to land from jumps with similar technique to dancers in order to reduce injury risk in athletes.

Dr. Alycia also seeks to explore the use of dance as an alternative physical activity modality to increase physical activity adherence, and in turn improve all aspects of health. Her research has demonstrated dance to be a safe and effective physical activity that can help people achieve the same benefits of standard exercise modalities, improving cardiorespiratory outcomes, metabolic outcomes, flexibility, balance, cognition, psychological wellbeing, and social connectedness, with the added benefits of music and creativity.

Dr. Alycia is a member of the Research Committee of the International Association for Dance Medicine and Science. In this role, she aims to encourage high quality research in dance biomechanics and dance for health fields.

Abstract

3D motion capture is commonly performed for movements that are cyclical and have large ranges motion in the sagittal plane, such as gait and jumping. The ankle joint complex does not perform like a hinge and the multiple bones in the foot also do not move conveniently along the cardan axes.

Dancers perform complex movements often at the limit of joint range of motion and, depending on the genre of dance, will require dancers to wear a variety of footwear. Dance movements do not adhere to the cardan planes of motion, with joints using a combination of the six degrees of freedom at any one time. These present numerous challenges that should be considered carefully when designing and interpreting biomechanical research studies The biomechanics of dance is still a relatively new field compared to other sports.

This presentation will highlight the main challenges of capturing dance motion, describe some approaches that have attempted to better describe foot and ankle motion during dance movements, and propose areas where future studies can work to expand biomechanics of dance knowledge and improve the quality of research in dance science.

Public Lecture Series III:

Ankle and footwear biomechanics in dance and running

Gait re-training and ankle biomechanics in running

Prof. Roy Cheung

- **Professor of Physiotherapy,
  School of Health Sciences,
  Western Sydney University, Australia**

Biography

Prof. Roy T.H. Cheung is a Professor of Physiotherapy and he is currently the Head of Discipline (Physiotherapy) of the School of Health Sciences, Western Sydney University. Being a biomechanist, Professor Cheung has extensive experience in traditional lab-based motion analysis, and more recently wearable sensor development for both clinical and sports application. He has published for more than 200 peer-reviewed journal articles, book chapters, and conference papers. In addition, Prof. Cheung's research deliverables include US patents and international invention awards. His future research direction is to "break down laboratory walls" and facilitate biomechanical analysis in natural environments using advanced technology such as wearable sensors and computer vision.

Abstract

This talk will explore the intricate relationship between gait retraining and ankle biomechanics in running, focusing on my previous research into running injury biomechanics among distance runners. The objective is to provide an in-depth understanding of how various factors such as surface type and footwear choice influence running mechanics and injury risk, and to introduce innovative methods for modifying gait biomechanics using wearable sensors.

Our investigation into surface types has revealed distinct differences in running biomechanics on roads versus trails. Trail running, with its uneven terrain, demands greater ankle stability, while road running often leads to repetitive stress on specific musculoskeletal structures. Footwear choice also plays a crucial role, with minimalist shoes encouraging a more natural foot strike pattern and traditional cushioned shoes potentially increasing the risk of certain injuries.

This talk will also delve into gait retraining strategies aimed at improving ankle biomechanics to prevent injuries. Utilizing wearable sensor technology, we can provide real-time feedback on gait patterns, enabling the monitoring and modification of key biomechanical parameters. By integrating wearable sensors into gait retraining programs, runners can adopt safer and more efficient running mechanics, reducing their risk of injury.

Biomechanics of footwear and ankle stability in sports

Prof. Veni Kong

- **Associate Professor, Physical Education and Sports Science, National Institute of Education, Nanyang Technological University, Singapore**

Biography

Prof. Pui Wah (Veni) KONG is an Associate Dean and Associate Professor at the National Institute of Education, Nanyang Technological University, Singapore. She obtained her PhD in Sports Biomechanics at Loughborough University in the United Kingdom. Her research interests include sports biomechanics, human performance, and musculoskeletal health. She works closely with sports teams, hospitals, clinics, government agencies and industrial partners to conduct interdisciplinary research that can make a positive impact on society. In 2020, she was the recipient of the Fellow of International Society of Biomechanics in Sports (FISBS). She is currently an Associate Editor for Sports Biomechanics and Journal of Mechanics in Medicine and Biology. She also serves on the editorial board for Research in Sports Medicine, Sports Engineering, Journal of Exercise Science and Fitness, and World Scientific Annual Review of Biomechanics.

Abstract

Wearing appropriate shoes for sport participation is important, as athletic footwear plays a role in enhancing physical performance and reducing the risk of injury. This presentation focuses on the biomechanical interactions of the human body with footwear and their implications for ankle stability during sports activities. An overview of biomechanical methods used to assess footwear stability, including plantar pressure distribution and centre of pressure variables, will be provided. Examples of footwear evaluations during sports movement (e.g. side-cutting, landing, basketball-specific tasks) will be used to illustrate how biomechanical knowledge informs sports footwear design, enhancing performance and reducing injury risks. The relevance of these findings for clinicians, researchers, and sports practitioners will be discussed. Additionally, the presentation will highlight the industrial relevance for footwear manufacturers, demonstrating how biomechanical insights can support product development and innovation.

Biomechanical considerations in reverse shoulder arthroplasty

Dr. Jonathan Ng

- **Resident Specialist, Department of Orthopaedics and Traumatology, Prince of Wales Hospital, Hong Kong**
- **Clinical Assistant Professor (Honorary), Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong, Hong Kong**

Biography

Dr. Jonathan Ng obtained his Bachelor of Medicine and Bachelor of Surgery degree from Trinity College,Dublin in 2014. He pursued his interest in sports medicine and obtained the Master of Science (Sports Medicine and Health Sciences) from CUHK in 2016. Dr. Ng joined the Department of Orthopaedics and Traumatology at Prince of Wales Hospital in 2017. During his training, he was awarded gold medals for the Hong Kong Intercollegiate Board of Surgical Colleges Membership Examinations (MHKICBSC), as well as the Sir Harry Fang Gold Medal for HKCOS-RCSE Joint Specialty Fellowship Examinations. He was also awarded the Distinguished Young Fellow of the year in 2023 by the HK Academy of Medicine. He is currently working under the leadership of Professor Patrick Yung as an Associate Consultant at Prince of Wales Hospital and Honorary Clinical Assistant Professor at CUHK. He is a passionate educator and is regularly involved in undergraduate and postgraduate medical training.

Abstract

Indications for Reverse Shoulder Arthroplasty (RSA) has expanded from rotator cuff arthropathy to massive irreparable rotator cuff, and comminuted proximal humerus fractures in the last two decades. The classic Grammont design with medialization of the joint center of rotation (COR) increases the moment arm of the deltoid, putting it at a mechanical advantage for forward flexion and abduction. However, drawbacks such as reduced rotation and range of motion (ROM), scapular notching, instability and loss of shoulder contour has led to the development of lateralised designs. This review will summarize the current strategies to overcome these drawbacks and analyze the use of glenoid-sided, humeral-sided or global bipolar lateralization in producing different ROM profiles. manufacturers. There is evidence that lateralization addresses the initial drawbacks of the Grammont design, improving stability, rates of notching, ROM and shoulder contour, but the ideal extent of lateralization of the glenoid and humerus remains unclear. In addition, the delicate balance between over-tensioning resulting in acromial stress fractures and under-lateralisation is still an area of debate. Further well executed biomechanical studies are crucial in solving this complex topic.

Biomechanics of shoulder injury in overhead sports

Prof. Sakiko Oyama

- **Associate Professor, Department of Kinesiology, University of Texas San Antonio, United States**

Biography

Prof.Oyama is an Associate Professor at the University of Texas at San Antonio. She is originally from Nagoya, Japan. After graduating from high school in Japan, Prof. Oyama went to Oregon State University to become a nationally certified Athletic Trainer and earned a Bachelor of Science in Exercise Science. She earned a Master of Science in Rehabilitation Science from the University of Pittsburgh and a PhD in Human Movement Science from the University of North Carolina at Chapel Hill. Prof. Oyama's overall professional goal is to improve clinical practice in preventing and rehabilitating injuries. Her primary research involves identifying risk factors for shoulder and elbow injuries in adolescent baseball pitchers by assessing pitching biomechanics and physical function. More recently, Prof. Oyama has been working on analyzing motion in individuals with disabilities using a markerless motion capture system. Prof. Oyama has authored/co-authored over 40 peer-reviewed papers.

Abstract

The shoulder is one of the most commonly injured joints in overhead sports. Understanding the biomechanics of the shoulder during these activities is important in preventing these injuries. This presentation will discuss the current research on kinematic contributions to shoulder motion, mechanical loading on the shoulder in overhead sports, and kinematics associated with higher mechanical loading during overhead sports.

Biomechanics of the shoulder girdle is complex because of its anatomy involving glenohumeral, acromioclavicular, and sternoclavicular joints, and scapulothoracic articulation. The large range of motion of the shoulder required in overhead sports is permitted by the coordinated movement of the thoracic spine and the shoulder joints/articulation. Thus, restricted movement in one area can potentially impact movement and mechanical stress on the anatomical structures in the other regions. During a throwing motion in overhead sports, the upper limb moves rapidly "like a whip." The high acceleration and deceleration involved in the movement results in high mechanical loading on the joint and stress within the anatomical structures around the joints. Research on baseball pitching mechanics investigates movement patterns associated with higher joint loading. Findings from these studies provide a direction for injury prevention efforts in overhead athletes.

Shoulder biomechanics in wheelchair sports

Prof. Weerawat Limroongreungrat

- **Associate Professor, College of Sports Science and Technology, Mahidol University, Thailand**

Biography

Prof. Weerawat 'Wat' Limroongreungrat is an Associate Professor at College of Sports Science and Technology, Mahidol University, Thailand. He received his BSc in Physical Therapy from Chiangmai University, Thailand. He continued his MSc degree in (Physical Therapy) at Georgia State University, Atlanta, USA and finished PhD in Sports Science from Georgia State University, USA in 2005. Prior to his appointment at the Mahidol University, he was a part-time instructor at Department of Kinesiology and Health, Georgia State University and postdoctoral researcher at Division of Physical Therapy, College of Health and Human Science, Georgia State University; Center of Assistive Technology and Environmental Access, Georgia Institute of Technology; and Clinical Researcher, Shepherd Center, Atlanta, GA, USA. He also serves as the president of Asian Society of Sports Biomechanics (ASSB) and the board director of Asian Society for Adapted Physical Education and Exercise (ASAPE). He also serves as the editorial board member of Sports Biomechanics journal. He published several papers in preferred Journals and chapters in books in biomechanics as well as sports injury and rehabilitation. His research interests include both sports and clinical biomechanics. Currently, he is interested in improving teaching quality of sports biomechanics in undergraduate students.

Abstract

Wheelchair athletes rely on their ability to propel and maneuverer their wheelchairs; both in competitive sports and in their daily activities. Many wheelchair sports require high demands on athletes to propel their wheelchair forward, change of direction and speed. These repetitive high forces and torques can lead to a high risk of musculoskeletal injuries particularly the shoulder joint. Understanding biomechanics of wheelchair propulsion provides useful information for coaches and athletes. Pushrim and shoulder kinematics can be examined with a typical 3D motion capture system. However, to estimate shoulder kinetics during wheelchair propulsion, a special equipment is required to record 3D pushrim forces. The design of this equipment particularly for racing wheelchairs is quiet challenge for researchers. It has been reported that as speed increases, shoulder forces moments increase. Wheelchair-athlete interface is also crucial for proper technique and force optimization. Improper setting could lead to risk of injuries. Wearable technology such as inertial measurement unit (IMU) has gain more popularity since it allows more freedom to collect kinematics data and estimate activities. Ecological studies may provide more insights for maximizing performance and injury prevention in wheelchair sport research.

Motor skill intervention to improve throwing biomechanics

Dr. Allan Fu

- Lecturer, Physiotherapist, Sydney School of Health Sciences/Discipline of Movement Sciences, Faculty of Medicine and Health, The University of Sydney, Australia

Biography

Dr. Allan Fu serves as a physiotherapy lecturer at The University of Sydney's Faculty of Medicine and Health, where his expertise in physiotherapy and clinical biomechanics informs his dedicated research and teaching. His work delves into the analysis of movement skills and the development of motor skill interventions, with a special focus on sports training, rehabilitation and musculoskeletal physiotherapy.

In his academic endeavours, Dr. Fu seeks to idnetify the fundamental movement skills and interventions essential for promoting active sports participation, preventing injuries, and encouraging healthy lifestyle choices. His comprehensive approach also addresses the management of movement disorders for pathological groups. Dr. Fu's aspiration to make a significant impact on both clinical and athletic populations is evident in his advocacy for the acquisition of movement skills that are crucial to the core of physical activity and overall health.

Abstract

Overarm throwing is an essential manipulative skill, vital for participation in various sports, and is a crucial lesson for children and adolescents worldwide. Despite the existence of a well-recognised set of criteria for overarm throwing that adolescents should master, proficiency rates remain below 50%. This highlights the necessity of a targeted approach to teaching this fundamental skill to ensure a higher rate of mastery from a young age. The study in question involved two groups of adolescents, aged 12-13: the FMS Group, which included 97 less-skilled, non-sports-active pupils, and the Sports Group, comprising 129 skilled, sports-active pupils. The research analysed demographic and anthropometric data, as well as whole-body kinematic data, including discrete and time-series angular displacement and velocity, motor coordination through segmental sequencing, and motor performance as measured by maximum ball release speed. Initial comparisons utilized T-tests and Chi-Square tests, while interaction effects were examined through repeated-measure ANOVAs, and changes in kinematic data were assessed by the areas within the 95% confidence intervals.

The results indicated a slight improvement in motor competency among the less-skilled participants, particularly in some aspects of shoulder biomechanics. The FMS Group showed significant gains in 4 out of 6 shoulder discrete kinematic variables and movement patterns, yet there were no significant improvements in the overall motor coordination or performance. Additionally, the study revealed that the descriptions of the critical skill criteria were inappropriate, likely contributing to the lack of enhancement in coordination and performance.

The current recommended skill criteria do not seem suitable for adolescents in terms of developmental and age appropriateness. The use of quantitative 3D motion data provided a more accurate set of shoulder movements compared to content-validated skill criteria. Consequently, it is recommended to use the biomechanics-informed skill criteria to better aid teachers and coaches in delivering effective education.

The effects of pulsed electromagnetic field therapy on muscle strength, physical function and pain in patients with end-stage knee osteoarthritis: A randomized control trial

Ms. Alicia Wang

- PhD student, Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong, Hong Kong

Biography

Ms. Alicia Wang is in the third year of PhD in Department of Orthopaedics & Traumatology at the esteemed Chinese University of Hong Kong. Her research interests are primarily focused on innovative approaches and exercise therapy for musculoskeletal degenerative diseases, as well as the diagnosis, prevention, and treatment of sarcopenia in older adults.

In her current PhD project, she is investigating the effects of pulsed electromagnetic fields on muscle strength, function, and pain in patients with end-stage knee osteoarthritis. This research aims to explore the potential benefits of this non-invasive intervention in improving the quality of life and functional outcomes for individuals suffering from this debilitating condition.

She has had the privilege of presenting my project at the Gerontech and Innovation Expo cum Summit (GIES), a prestigious event dedicated to promoting gerontechnology and fostering public education in Hong Kong. Additionally, her research has garnered attention from prominent media outlets, including Radio Television Hong Kong (RTHK) and Techapple, a renowned local technology website in Hong Kong.

Through her work, she aspires to contribute to the advancement of knowledge in the field of orthopaedics and traumatology, with a particular focus on enhancing the well-being and functional abilities of individuals affected by musculoskeletal degeneration diseases and sarcopenia.

Abstract

Background: Osteoarthritis (OA) of the knee is one of the most common chronic degenerative joint conditions affecting our aging population. Improving knee extensor strength has been noted as an effective means for relieving pain and improving function in patients with OA knee.

Aim: To compare the effectiveness of home-based exercises alone vs. the combination of home-based exercises and pulsed electromagnetic field (PEMF) therapy to improve muscle strength and pain.

Methods: Sixty patients were randomly assigned to either home-based exercise alone (control group; n=30) or combined with PEMF therapy (treatment group; n=30) twice a week for eight weeks. Knee extension and flexion muscle strength and self-reported pain assessment by Visual Analogue Scale (VAS), gait speed test, and 5-time chair stand test were recorded at baseline and 4 and 8 weeks following the commencement of the intervention.

Results: Significant improvements in symptomatic knee extension muscle strength (SKE, $p=0.001$, partial $\eta 2=0.212$), flexion strength (SKF, $p=0.011$, partial $\eta 2=0.145$), contralateral knee extension muscle strength (CKE, $p=0.002$, partial $\eta 2=0.198$), and flexion strength (CKF, $p=0.009$, partial $\eta 2=0.151$) were observed for the PEMF treatment group at 8 weeks. Significant reductions in VAS pain scores were observed in both the treatment ($p<0.001$, partial $\eta 2=0.505$) and control ($p<0.001$, partial $\eta 2=0.268$) groups. Significant differences between groups in SKE, $p=0.004$, partial $\eta 2=0.136$; SKF, $p=0.028$, partial $\eta 2=0.082$; CE, $p=0.029$; and CKF, $p=0.052$, partial $\eta 2=0.081$ were observed at 8 weeks. Significant differences were reported between groups in the 4 ($p=0.010$, partial $\eta 2=0.111$) and 8 ($p=0.046$, partial $\eta 2=0.068$) week assessment in VAS pain. No significant group difference was found in gait speed test and chair stand test.

Conclusions

The combination of PEMF therapy and home-based exercise improved knee muscle strength and reduced pain more than home-based exercise alone in end-stage knee OA patients.

The clinical effects of pulsed electromagnetic field therapy on the management of chronic ankle instability: a double-blinded randomised controlled trial

Ms. Cheryl Chia

- PhD student, Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong, Hong Kong

Biography

Ms. Chia Shu Ming Cheryl is graduated from University College London with a Masters in Clinical and Public Health Nutrition. Currently, she is a PhD student at the Department of Orthopaedics and Traumatology, the Chinese University of Hong Kong, researching the treatment effects of pulsed electromagnetic field therapy and peroneal muscle in the chronic ankle instability population.

Abstract

Introduction:

Chronic ankle instability (CAI) is a debilitating condition characterised by pain, muscle weakness, poor postural control, and recurrent ankle sprains that persist for more than 1 year after the initial injury. The peroneal muscle is the first to contract during a sudden ankle inversion. Peroneal muscle weakness is associated with poor postural control. 70% of CAI individuals do not respond well to strengthening and balance training. Pulsed electrical magnetic field therapy (PEMF) is a novel biophysical therapeutic modality that improves muscle function gain through myogenesis and stimulation of type I and IIa muscle fiber. The primary aim was to investigate the clinical effects of PEMF therapy and standard rehabilitation on peroneal muscle strength, postural and dynamic stability in the CAI population.

Methods:

Sixty-two individuals with CAI were randomly allocated into standard rehabilitation or PEMF therapy and standard rehabilitation. The outcomes included the area of centre of pressure, anterior-posterior and medio-lateral sway during single leg stance test, peroneal muscle strength assessed by handheld dynamometer, and dynamic balance assessed by Y balance test. They were captured at baseline, mid-point, and 8th weeks after the intervention.

Results:

A significant reduction of the area of the centre of pressure (p=0.003) in week 4 and week 8 (p=0.046), and reduction of anterior-posterior excursion sway in week 4 (p=0.042), and at week 8 (p=0.005) during single leg stance with eyes closed between the PEMF and control group. A significant increase in eversion strength (p=0.009) was depicted between the PEMF and control group. Only a significant increase in posterolateral (%) of the Y balance test (p=0.047) was elicited between the PEMF and control group.

Conclusions:

The addition of PEMF therapy to the standard rehabilitation did augment the gains in peroneal muscle strength, static balance, and dynamic stability with the posterolateral (%) direction on the Y balance test exceeding the minimal clinically significant change.

Imaging assessments for shoulder injuries in Hong Kong elite athletes

Mr. Ben Choi

- **Research Assistant (Project Manager), Department of Orthopeadics and Traumatology, The Chinese University of Hong Kong, Hong Kong**

Biography

Mr. CHOI, Ben Chi-Yin is currently a Project Manager in the Department of Orthopeadics and Traumatology at the Chinese University of Hong Kong. He's main research interest is about the application of imaging modalities for knee and shoulder injury risk assessment in athletes. He has also actively participated the research related the improving knee function and muscle strength in athletes before and after anterior cruciate ligament reconstruction, and the exercise prescription for elderlies with frozen shoulders

Abstract

Overuse shoulder injury is common in athletes with repetitive shoulder motion and threating the athletes' career. The current shoulder functional assessment for overhead athletes which mainly consists of questionnaire and measurement for shoulder strength and range of motion throughout the season. However, the impaired shoulder strength and disfunction may be due to the developing shoulder pathology. Thus, detection for underlying pathophysiological changes is necessary for shoulder injury prevention.

Previous studies reported that shoulder pathologies would alter to the shoulder muscular activation pattern which may leading to excess activation and compensation of Upper trapezius (UT). Muscle oxygenation level is the percentage of oxyhaemoglobin in the muscle. The decrease of UT oxygenation after repetitive overhead motions with loading in asymptomatic population. Thus, monitoring UT Oxygenation level and vascularity maybe a screening method for insidious shoulder pathology.

In this study, our objective is to detect the association of UT oxygenation level and vascularity by photoacoustic imaging and compared with ultrasound imaging, Shoulder Pain and Disability Index(SPADI), shoulder strength and ROM as the reflection of shoulder pathological changes in athletes with repetitive shoulder motion. By integrating imaging modalities into shoulder functional assessment, the shoulder pathological changes could potentially be identified earlier and reducing the risk of suffering overuse shoulder injury.

Public Lecture Series VI:

Biomechanics of Anterior Cruciate Ligament (ACL) injury

Biomechanics of the knee joint after ACL injury

Prof. Yuichi Hoshino

- **Lecturer, Department of Orthopaedic Surgery, Kobe University, Graduate School of Medicine, Kobe, Japan**

Biography

Prof. Yuichi Hoshino, M.D., Ph.D., is a distinguished orthopaedic surgeon and researcher, currently a lecturer at Kobe University Graduate School of Medicine. With 23 years of clinical experience, he specializes in sports-related injuries, focusing on knee ligament injuries. He earned his Ph.D. in 2007 after researching knee biomechanics at Kobe University under Prof. Masahiro Kurosaka. From 2009 to 2011, he continued his biomechanics research at the University of Pittsburgh under Prof. Freddie H. Fu.

He has published eighty@seven articles on anterior cruciate ligament (ACL) injury and treatment, with seventeen as the first author. His main research interest is rotational laxity and instability after ACL injury and reconstruction. He developed two measurement systems for rotational laxity and authored fifteen papers on the topic. His research has received multiple grants, including from the Japanese Grant-in-Aid for Scientific Research and ISAKOS-OREF.

He is a member of ISAKOS, ESSKA, AAOS, and the ACL Study Group. He also serves as an associate editor for the Journal of Experimental Orthopaedics, the Journal of the AAOS Global Research & Reviews, and the Journal of Mechanics in Medicine and Biology (JMMB). Additionally, he is on the editorial board of five journals, including the American Journal of Sports Medicine (AJSM) and Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA).

Abstract

Rotational instability, commonly known as the pivot-shift phenomenon, is a complex knee movement and a primary symptom of an anterior cruciate ligament (ACL) injury. This instability often prevents patients from participating in high-demand sports activities, particularly those that involve cutting movements. ACL reconstruction is widely regarded as the preferred treatment for addressing ACL injuries. However, current surgical techniques do not completely eliminate rotational instability. Surgeons typically evaluate this instability using the pivot-shift test, which is a clinical assessment. The challenge with this test is that it relies heavily on the surgeon's subjective judgment and tactile feedback, as objective and quantitative evaluation methods have not been fully established. This lack of objectivity is mainly due to the biomechanical complexity involved in assessing knee movements.

In response to this challenge, we developed a knee kinematics measurement system utilizing an electromagnetic system to analyze knee movement during the pivot-shift test. Our analysis revealed a significant increase in tibial anterior translation and acceleration during the pivot-shift, indicating rotational instability. To enhance the objectivity of the assessment, we also developed a custom image analysis application for the iPad. This app successfully detected abnormal tibial translation associated with the pivot-shift phenomenon. These innovative measurement systems for the pivot-shift test can be utilized not only to compare different types of ACL reconstruction techniques but also to identify other anatomical structures potentially affecting rotational instability, such as the meniscus and the anterolateral capsule.

In conclusion, the development and refinement of these pivot-shift measurement systems represent a significant advancement in the objective assessment of knee rotational instability. The clinical potential of these systems is promising, as they offer the possibility of achieving a more accurate and comprehensive evaluation of ACL injuries and their subsequent treatments. This progress paves the way for improved surgical techniques and better clinical outcomes for patients suffering from ACL injuries.

Public Lecture Series VI:

Biomechanics of Anterior Cruciate Ligament (ACL) injury

Is there an association between biomechanics and ACL injury?

Prof. Evangelos Pappas

- **Professor and Associate Dean (intoHealth), University of Wollongong, Wollongong, Australia**

Biography

Prof. Evangelos Pappas (he/him) is currently a Professor and Associate Dean (intoHealth) at the University of Wollongong where he works on developing the Health and Wellbeing Precinct at the Innovation campus. He has previously held academic positions at Long Island University (Brooklyn Campus), including serving as the chair of the department, and at the University of Sydney, where he has held positions as Musculoskeletal teaching team leader, Postgraduate Studies Coordinator and Head of the Discipline. He teaches in the areas of musculoskeletal biomechanics and anatomy.
His research focuses on the aetiology, prevention and treatment of athletic knee injuries. He has published extensively in this area utilizing biomechanical, epidemiological and clinical approaches to address anterior cruciate ligament (ACL) injuries. His work attracted funding (>1.8 million Australian $ in the last 3 years), including a National Institutes of Health grant to investigate biomechanical risk factors for ACL injuries.

Abstract

Several studies have investigated the association between biomechanics and anterior cruciate ligament (ACL) injury in athletes with mixed findings. Four theories have been proposed that suggest that a) excessive knee valgus, hip adduction and internal rotation (ligament dominance), b) poor trunk control (trunk dominance, c) greater reliance on the quadriceps than the hamstrings (quadriceps dominance), and d) side-to-side asymmetries (leg dominance) may predispose athletes to a higher risk of injury. Longitudinal studies that assess ACL injury risk factors are rare and limited by the low incidence of ACL and its multifactorial nature. This presentation will discuss the relevant literature and objectively evaluate the links between biomechanics and ACL injury. We will explore the findings of video analysis, biomechanical and injury prevention studies appreciating the methodological challenges associated with injury prediction. Some of the presenters' work will be discussed, particularly on identifying latent biomechanical profiles and exploring the mechanism of effectiveness of injury prevention programs. The challenges of predicting a multifactorial injury with low incidence and suggested risk factors that can be difficult to measure will be presented. Examples will be borrowed from other areas of medicine with a longer history of disease prediction and prevention.

Decision making, divided attention, and ACL injury

Prof. Gerwyn Hughes

- **Associate Professor, Kinesiology, University of San Francisco, California, United States**

Biography

Prof. Gerwyn Hughes is an Associate Professor in the Kinesiology Department at the University of San Francisco. Prof. Hughes's main area of research is sex differences in landing and/or cutting biomechanics associated with non-contact anterior cruciate ligament injury. He has also published research in the areas of golf ball kinematics during putting, the biomechanics of simulated ankle sprains and the use of mobile technology for in-field monitoring of athletes. Prof. Hughes currently serves as an Associate Editor for the journal Sports Biomechanics and is a member of the International Society of Biomechanics in Sports.

Abstract

This presentation will discuss two main research areas related to anterior cruciate ligament (ACL) injury; 1) the effects of divided attention on lower limb biomechanics during landing and 2) asymmetries in landing biomechanics following ACL reconstruction.

Previous research has shown dividing attention between multiple tasks when landing/cutting results in changes to lower limb biomechanics which are associated with increased ACL injury risk. This presentation will highlight the methodological issues that should be considered when designing dual-task paradigm studies as well as discussing the direction of future research in this topic.

After sustaining an ACL injury, athletes wishing to return to sport typically require surgery to repair the injured ACL. Despite considerable efforts to improve outcomes after ACL reconstruction, secondary ACL injury is common. One of the main risk factors for secondary ACL injury is asymmetry in landing mechanics. Previous research has shown that after ACL reconstruction, asymmetry during landing is more commonly identified in variables related to the loading experienced by the lower limb, rather than variables that describe the movement of the lower limb. This presentation will describe how this information can be used to inform return to sport criteria following ACL reconstruction and discuss opportunities for future research aimed to reduce asymmetry in lower limb biomechanics following ACL reconstruction.

Public Lecture Series VI:

Biomechanics of Anterior Cruciate Ligament (ACL) injury

Soft fall-landing technique for preventing ACL injury

Prof. Boyi Dai

- **Professor, Division of Kinesiology and Health, University of Wyoming, United States**

Biography

Prof. Boyi Dai holds a Ph.D. in Human Movement Science from the University of North Carolina at Chapel Hill. Prof. Dai is a professor at the University of Wyoming and will soon start a new position as the Chair of the Department of Rehabilitation and Movement Science at the University of Vermont in August 2024. Prof. Dai's research focuses on injury biomechanics, sports biomechanics, and ergonomics, particularly investigating injury mechanisms and risk factors to develop prevention strategies. He has published more than 80 peer-reviewed articles and has been a principal and co-investigator on several research projects funded by agencies such as the NSF and NIH. He contributes to the field through editorial positions with Sports Biomechanics, Journal of Biomechanics, Research in Sports Medicine, and BMC Musculoskeletal Disorders. Prof. Dai is a fellow and serves as a vice president for the International Society of Biomechanics in Sports.

Abstract

An anterior cruciate ligament (ACL) rupture commonly occurs when an athlete lands on a single leg in a suboptimal landing posture, characterized as an upright and laterally bent trunk to the injured leg, with the injured knee supporting most of the body weight in an extended and abducted position. These suboptimal landing postures often result from mid-flight self-initiated (reaching for a ball) or external trunk perturbation (pushing from an opponent). The current presentation will introduce safe falling techniques, which are defined as initially landing softly and then smoothly falling toward the movement direction. The first study quantified how Parkour athletes landed from a drop height as high as 2.7 meters using a falling and rolling technique. The second study compared ACL loading variables during natural landings, soft landings, and falling techniques after forward and vertical jumps under single-leg and double-leg conditions. The last study evaluated the effects of natural, soft, and falling landing techniques on ACL loading variables with and without mid-flight external trunk perturbation in single-leg landings. Overall, falling techniques decreased peak landing forces, knee joint moments, and increased knee flexion angles, which were associated with decreased ACL loading. Falling removed the constraint between the body's center of mass and base of support and allowed the body to decelerate linear momentum over a longer time, as well as the involvement of other body segments to dissipate landing forces. It is recommended that falling techniques be incorporated into jump-landing training programs to provide an alternative strategy to potentially decrease non-contact ACL injury risk when the sports environment allows.

Public Lecture Series VI:

Biomechanics of Anterior Cruciate Ligament (ACL) injury

‘Kissing knees’ show no association with ACL injury

Dr. Kam-Ming Mok

- **Senior Lecturer, the School of Interdisciplinary Studies, Lingnan University, Hong Kong**

Biography

Dr. Mok Kam-Ming is currently the Senior Lecturer at the School of Interdisciplinary Studies, Lingnan University. He published over 30 articles in peer-reviewed international journals, and contributed to 4 book chapters in the field of Sport Injury Biomechanics and Motion Analysis. He is currently the Co-Op member of Asian Federation of Sports Medicine and the Vice-President of Sports Medicine and Sports Science Association of Hong Kong, China.

Abstract

Anterior cruciate ligament (ACL) injuries are a common occurrence in sports that require sudden changes in direction and jumping. The knee has been identified as a significant contributor to ACL injury risk, and various biomechanical factors have been linked to ACL injury. One such factor is the "kissing knee" phenomenon, where the knees come into contact during a jump or landing. However, the association between kissing knee and ACL injury is still not fully understood. This study aimed to investigate the relationship between the kissing knee phenomenon and ACL injury risk. We utilized motion analysis techniques to assess knee biomechanics during vertical drop jump and single-leg squat tasks. Frontal plane biomechanics, including knee valgus and external rotation, were analyzed for accuracy and reliability. Our results showed no significant association between kissing knee and ACL injury risk. Further research is needed to confirm these findings and examine the role of other biomechanical factors in ACL injury risk.

Public Lecture Series VI:

Biomechanics of Anterior Cruciate Ligament (ACL) injury

Knee wobbling biomechanics in patients with ACL injury

Dr. Xin He

- **Part-time lecturer, Department of Orthopaedics & Traumatology, The Chinese University of Hong Kong, Hong Kong**
- **Doctor of Physiotherapy student of the University of Sydney, Australia**

Biography

Dr. Xin He is currently a part-time lecturer of Department of Orthopaedics & Traumatology, The Chinese University of Hong Kong and Doctor of Physiotherapy student of the University of Sydney. Between 2021 and 2023, she worked as a postdoctoral fellow and the person in charge of the Sport Injury Research Lab. She is a registered Chinese Medicine Practitioner in Hong Kong. She obtained her master degree of science in Musculoskeletal Medicine and Rehabilitation in 2016 and joined the CUHK sport medicine team in 2017. She obtained her PhD in Orthopaedics & Traumatology in 2021. Her PhD study was about muscle recovery and dynamic knee stability after Anterior Cruciate Ligament Reconstruction. Her current research area is sports rehabilitation, knee biomechanics after ACL injury and sports injury prevention.

Abstract

We propose using the single-leg squat-and-hold (SLSH) task with kinematic analysis to objectively measure dynamic knee stability after anterior cruciate ligament (ACL) injury. There are three objectives of this study: to compare the knee kinematics of ACL-deficient patients and healthy controls by capturing knee wobbling during the SLSH task, to detect kinematic changes after ACL reconstruction, and to correlate the kinematic variables with self-reported knee function. Twenty-five ACL-deficient participants and 18 healthy matched participants were recruited. The knee kinematics involving both the magnitudes and frequency of motion fluctuation was captured during the holding phase of SLSH by 3D motion analysis system (Vicon). Compared to the limbs of the control participants, the ACL involved limbs exhibited a greater wobbling magnitude of flexion-extension (4.33 ± 1.96 vs. 2.73 ± 1.15; $p = 0.005$) and varus-valgus (2.52 ± 0.99 vs. 1.36 ± 0.42; $p < 0.001$). It also inhibited higher frequency of wobbling in flexion-extension (4.87 ± 2.55 vs. 2.68 ± 1.23; $p = 0.003$) and varus-valgus (3.83 ± 2.59 vs. 1.42 ± 0.55; $p < 0.001$). The wobbling magnitude of flexion-extension (4.50 ± 2.24 vs. 2.90 ± 1.01; $p = 0.018$), frequency of flexion-extension (4.58 ± 2.53 vs. 3.05 ± 1.80; $p = 0.038$) and varus-valgus (3.46 ± 2.11 vs. 1.80 ± 1.23; $p = 0.022$) was reduced after ACL reconstruction. Increased wobbling frequency of knee varus-valgus was correlated with lower IKDC score ($r = −0.328$; $p = 0.034$). Knee wobbling was more prominent in ACL-deficient patients, which was associated with poor knee function. SLSH task with kinematic analysis appears to be a potential assessment method for monitoring dynamic knee stability after ACL injury.

Public Lecture Series VII:

Biomechanics of knee osteoarthritis and replacement

Robotic surgery for treating knee osteoarthritis

Prof. Michael Ong

- **Clinical Assistant Professor, Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong, Hong Kong**

Biography

Prof. Ong, Michael Tim-Yun joined the Department of Orthopaedics and Traumatology as a Clinical Assistant Professor in October 2018. He obtained his MBChB degree with an Intercalated BSc degree in Genetics from The University of Leicester, United Kingdom. Prof. Ong joined the Department of Orthopaedics and Traumatology of the New Territories East Cluster in 2010 and he received his training in Orthopaedics at the Prince of Wales Hospital and the Alice Ho Miu Ling Nethersole Hospital. He obtained his MSc of Sports Medicine and Health Science from The Chinese University of Hong Kong in 2012 and completed his specialist training in 2014.

Given his surgical expertise in ACL reconstruction and joint replacement, Prof. Ong is interested in basic and clinical research related to the bone tendon junction healing of ACL graft and improving surgical outcomes for joint replacement patients. In addition, Prof. Ong is interested in the application of artificial intelligence to the prevention, diagnosis, and management of knee osteoarthritis. Prof. Ong also has an active interest in regenerative medicine research, including the use of biomaterials and tissue engineering approaches to optimize treatments and reduce recovery time. He has authored over 50 papers in numerous international journals and has been invited to present at numerous local and oversea conferences.

Abstract

The demand for knee replacement is observed to have a younger trend. Approximately 20% of patients remain unsatisfied with complaints of knee pain and poor functional outcomes, prompting the development of new implants. Bi-cruciate retaining (BCR) total knee arthroplasty (TKA) was designed for more kinematically functional implants by preserving both the ACL and PCL while Bi-cruciate substituted (BCS) TKR is a convenient design that substitutes the sacrificed ACL and PCL with a unique dual cam-post design to preserve normal knee kinematics and increase anterior-posterior stability throughout knee flexion. Improvement of biomechanical properties to mimic the normal knee may solve the patient's dissatisfaction. This is a retrospective case-controlled study. Measured outcomes included kinematic analysis, proprioception, and functional outcomes. Twenty-two subjects for each surgical method were recruited. There was a significantly larger maximum flexion angle and range of flexion to extension in sit-to-stand and stairs in BCR when compared to BCS. Further analysis revealed more similarities between BCR and normal native knees. Proprioception and functional scores did not have any statistical difference. The design of the Bi-Cruciate Retaining total knee arthroplasty has promising results in mimicking the natural kinematics of the knee.

Public Lecture Series VII:

Biomechanics of knee osteoarthritis and replacement

The use of knee braces to adjust joint loading and improve clinical outcomes in the osteoarthritic knee

Prof. Jim Richards

- **Associate Dean for Research & Knowledge Exchange, School of Health, Social Work and Sport, University of Central Lancashire, , UK**

Biography

Prof. Jim Richards is the Associate Dean for Research and Knowledge Exchange for the School of Health, Social Work and Sport at the University of Central Lancashire, UK. Professor Richards' research includes the clinical application of biomechanics, the development of new assessment tools for chronic disease, and the management of orthopaedic and neurological conditions. He has led the development of evidence-based approaches to improve the clinical management and rehabilitation with a focus on improving pain, function and motor control, and is the President of the International Society of Biomechanics' Motor Control Technical Group.

Prof. Richards' work encourages inter-professional research and his work has had a direct impact on the clinical management of individuals with musculoskeletal and neurological disorders. Prof. Richards' has authored over 270 peer reviewed journal papers which have been cited over 8,500 times. He has written and edited 2 textbooks which are now in their second and sixth editions. Biomechanics in Clinic and Research which became The Comprehensive Textbook of Clinical Biomechanics in 2018 and Whittle's Gait Analysis (2012, 2022). He has also contributed to 3 editions of Tidy's Physiotherapy, the 10th edition of Mercer's Textbook of Orthopaedics and Trauma, Experimental Research Methods: A Guidebook for Studies in Trauma Care, Patellofemoral Pain: A Clinical Guide, and the Guide to Sports Physiology and Injury.

Abstract

Management of medial compartment osteoarthritis (OA) of the knee in active individuals who do not yet require surgery, or individuals who are unsuitable for surgery due to associated medical conditions is a challenge. Various non-surgical management interventions have been introduced in an attempt to reduce excessive medial compartmental loading in the knee joint and improve clinical outcomes to try and offer some relief in symptoms for individuals with medial compartment knee OA. Such interventions include valgus knee bracing, proprioceptive knee bracing, lateral wedging of the foot and modified footwear. This talk will highlight the evidence for the efficacy (Biomechanical Outcomes) and effectiveness (Clinical Outcomes) of Functional and Proprioceptive Knee Bracing for individuals with medial compartment knee OA, and how these interventions compare to other conservative and surgical options. This talk will also highlight what we don't know, and what we need to know going forwards, to help improve the selection criteria and provision of the most effective interventions for a given individual's presentation.

Public Lecture Series VII:

Biomechanics of knee osteoarthritis and replacement

Laterally wedged insoles to treat medial knee osteoarthritis

Prof. Wei-Chun Hsu

- **Vice Dean, College of Applied Science ;**
- **Professor, Graduate Institute of Biomedical Engineering, National Taiwan University of Science and Technology, Taiwan**

Biography

Prof. Hsu earned her Ph.D. and B.S. from National Taiwan University and her M.S. from Université Paris XII. Her research expertise encompasses the biomechanics of the human neuromusculoskeletal system and motor control.

Prof. Hsu currently serves as Vice Dean of College of Applied Science, Professor of Graduate institute of Biomedical Engineering of National Taiwan University of Science and Technology, Adjunct Professor in the Department of Sport Performance at National Taiwan Normal University and in the Medical Engineering Discipline at the National Defense Medical Centre. She is also a Supervisor for the Taiwan Society of Sports Biomechanics and the Taiwan Health Promotion Technology Association. Professor Hsu's dedication to education is evident in her 22 years of teaching experience, with 19 years designated by Taiwan Ministry of Education. She has been a faculty member at National Taiwan University of Science and Technology for 14 years, consistently earning accolades for her teaching and research excellence.

In Taiwan, Prof. Hsu is involved as an Associate Editor for the Journal of Chinese Sports Biomechanics and an Editor in Biomechanics for the Journal of Chinese Physical Education. She has been a keynote speaker at events such as the IPC E-Textiles 2021 Virtual World Tour and the Asia-Pacific Conference on Sports Biomechanics. Her contributions to the field have been recognized with numerous awards, including the Outstanding Research Award from National Taiwan University of Science and Technology in 2020 and the Mr. Wu Ta-You Memorial Award from the Taiwan Ministry of Science and Technology in 2018.

Prof. Hsu's clinical experience includes roles such as Physical Therapy Supervisor for the 50th Volleyball Championship in 2023, Team Leader at the ITTF Fa20 Finland Para Open 2022, and various academic positions at Taipei Municipal University of Education from 2003 to 2016. Her earlier career included serving as a physiotherapist at Shin Kong Wu Ho-Su Memorial Hospital and an Assistant Instructor at EFOM Physical Therapy School in France.

Abstract

Medial knee osteoarthritis, being the most common joint disease among the middle aged adults and the elderly, seriously affects the function of daily living. Laterally-wedged insole may reduce knee joint moments and joint pain with reduced lever arm between ground reaction force and knee joint center through altering the alignment of foot and ankle as well as the contact point of ground reaction force. Laterally-wedged insole was the conservative therapy for mild and moderate medial knee osteoarthritis. Studies with well-designed experimental methods was needed to validate the effects and benefits of laterally-wedged insole, and to comprehensively investigate the effect on gait during functional activities. The session aimed to report studies which investigated the immediate and long-term effects of laterally-wedged (LW) insoles on the knee loadings, the knee abductor moment (KAM) in particular, and the compensatory changes at other lower limb joints in patients with bilateral medial knee osteoarthritis during level walking with and without LW insoles.

In our previous studies, older adults with bilateral medial knee OA were studied using computerized gait analysis initially (Baseline) and 6 weeks after using LW insoles (Follow-up) during barefoot walking and walking with LW insoles (7° of lateral inclination, with medial arch support). The three-dimensional angles and internal moments at the lower limb joints, as well as the ground reaction forces, were obtained using a motion analysis system and two forceplates. Key features of all the variables were compared using paired t tests for immediate effects (barefoot vs. LW) and for long-term effects (Baseline vs. Follow-up). It was reported that after long-term use of LW insoles, the pain and physical function were improved with decreased peak KAM. A specific gait adaptation with reduced KAM was also found when walking without LW insoles. These results indicate a positive long-term effect in persons with bilateral medial knee OA, both as an orthosis to assist walking, and as a treatment intervention to facilitate gait adaptations in favor of reduced KAM.

Public Lecture Series VII:

Biomechanics of knee osteoarthritis and replacement

Biomechanics of total knee replacement systems

Prof. Michael LaCour

- **Research Professor, Biomedical Engineering, The University of Tennessee, Knoxville, United States**

Biography

Prof. Michael LaCour, PhD is a research professor at the University of Tennessee – Knoxville in Biomedical Engineering. He received his PhD in 2017 by performing experimental and theoretical evaluations on the stability of various total hip replacement designs. Prof. LaCour currently manages a biomechanics research lab, and he also teaches Advanced Biomechanics, Graduate Biodesign, and Experimental Lab courses at the University. Prof. LaCour has been doing kinematic research on total joint replacements for approximately 12 years, working under the mentorship of Prof. Richard Komistek. Together, their lab analyzes the performance of current and past total joint replacement systems, often providing design consultation services. Prof. LaCour's group specializes in the development and implementation of three-dimensional modeling and computational analysis software.

Abstract

Total knee arthroplasty (TKA) researchers have consistently tried to design and implant TKAs to mimic the kinematic patterns of healthy, non-implanted knees. Unfortunately, TKAs typically fall short compared to non-implanted knees in a variety of ways. The objective of this research is to study a database of 1,586 total knee replacements and compare the weight-bearing kinematics to a separate dataset of 114 non-implanted knees.

This study evaluated 656 Posterior Stabilized (PS), 546 Posterior Cruciate Retaining (PCR), 300 Bi-Cruciate Stabilized (BCS), and 84 Bi-Cruciate Retaining (BCR) TKAs. The dataset also included 324 Mobile Bearing (MB) and 1262 Fixed Bearing (FB) TKAs. Weight-bearing kinematics were gathered using 3D-to-2D fluoroscopic registration techniques for a deep knee bend activity. Parameters of interest include condylar motion patterns, axial rotation patterns, and weight-bearing range of motion (ROM).

Non-implanted knees typically experience posterior condylar rollback of both condyles, resulting in a medial pivot and external femorotibial axial rotation. All implanted knees experienced less condylar motion, less axial rotation, and less weight-bearing ROM than non-implanted knees. Of the implanted knees, the BCS knees experienced the most posterior rollback while the PCR knees experienced the most anterior sliding. All implant types experienced similar weight-bearing ROM. There were no significant differences between FB and MB TKAs.

Common differences between implanted and non-implanted knees include paradoxical anterior sliding, reverse axial rotation, condylar liftoff, and reduced ROM. Although some implant types performed more similar to the non-implanted knee, all systems displayed incidences of these differences.

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