AUSTRALIAN & NEW ZEALAND
ORTHOPAEDIC RESEARCH SOCIETY

17TH ANNUAL SCIENTIFIC MEETING

The main lecture room, Institute of Health and Biomedical Innovation (IHBI)
Queensland University of Technology
60 Musk Avenue, Kelvin Grove, Brisbane, Qld 4059 AUSTRALIA

1 – 2 SEPTEMBER 2011
## ANZORS 2011

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President’s Welcome Address
Associate Professor Hala Zreiqat

Dear ANZORS members,

Welcome to the 17th Annual Scientific Meeting, Brisbane 1-2 September 2011.

**ANZORS is a multidisciplinary Society**

For ANZORS to continue to flourish and succeed it needs a serious commitment to basic science in orthopaedics and that means we have active interaction between basic scientists (bone /cartilage biology/biomechanics) and clinicians.

A successful plan towards achieving this goal is by forming a new active ANZORS committee with members reflecting the multidisciplinary nature of the society.

**To maximise exposure Nationally and Internationally**

We need to expose ANZORS to as many related societies as possible and ensure ANZORS presence by the board members where possible. ANZORS board members need to promote the society nationally and internationally at the conferences they attend.

**Credibility of ANZORS**

To ensure high reputation and credibility of ANZORS we must be careful with disclosure and declaration of any conflict of interest in any part of our scientific process.

**ANZORS expands our National and International profile**

ANZORS must maintain contact with our overseas colleagues and maintain cordial interaction between the associations particularly in the Asia Pacific relationship. During my 3 months travel in Europe and the USA (April-July 2011) I made sure to highlight ANZORS as frequently as possible.

We have decided against having a presence at the next AHMRC 2012. The concept of the mega-conference is a great one but we think we will get far more exposure through concentrating on only targeted Societies.

**ANZORS engagement Nationally and Internationally (2011):**

**Nationally:** This year we are holding a joint half-day symposium with the ANZBMS (first ever). I was actively involved in organising the symposium for this meeting with a Biomaterials theme.

**The Chinese Orthopaedic Association:** I followed up on emails to hold a joint symposium with the 6th International Congress of Chinese Orthopaedic Association. Once the joint symposium was approved I requested that our airfares, accommodation and registration be covered by the COA for the ANZORS speakers. The COA only approved waiving registration for the attendees plus waiving the accommodation for the ANZORS president, which I accepted. I see the need to purchase gifts to present to the key COA members.
Promoting PhD and Early Career Researchers (ECRs)

It is a pleasure to see the continuing support by ANZORS to PhD students where this year we awarded 17 Student Travel grants to attend the ANZORS annual conference.

We have implemented PhD and ECRs awards to be presented at the Conference. We are seeking sponsorship for these awards.

This year we have replaced the poster sessions with 3 + 2 min short talk formats.

ANZORS Board members:

When the board is appointed for 2012, it is imperative that the multidisciplinary nature of ANZORS is reflected in this board.

Showing gratitude:

To the invited speakers: ANZORS will continue to follow in its tradition to offer free registration and dinner to the invited speakers. Hopefully soon we will be able to offer airfares for one key international and one national speaker. This will ensure the growing status of ANZORS around the globe. Following up with letters of “thank you” is equally critical. This gratitude should be shown in as many ways as possible both at the meeting and after returning home.

Travel overseas: Highly advisable to take gifts mainly representing Australian culture. This is particularly true for the Asia-Pacific region.

Ensuring continuation of interaction: Future requests that overseas speakers attend ANZORS scientific meetings is also a sign of appreciation for continuing interaction.

I trust that in my year as President I have further cemented the high scientific reputation of ANZORS by many visits to key overseas Institutions.

Looking ahead: I would like to see more involvement with the AOA, AO (Davos), EORS and ESVOT. I have commenced planning to promote ANZORS at all these societies.

Abstracts reviews: My sincere thanks to all who contributed to the abstract review process

I am grateful to the enormous help given by the Secretary, Dr John Costi and the Treasurer, Professor Jiake Xu for working very closely with me throughout the year. My special thanks to Associate Professor Yin Xiao as he was solely responsible for securing the venue and organising the conference dinner.

Thank you for giving me the honour and privilege of being the President of ANZORS and I look forward to working closely with the President elect in 2012.

Hala Zreiqat
Australian & New Zealand Orthopaedic Research Society

17th Annual Scientific Meeting

President
Associate Professor Hala Zreiqat  
NH&MRC Senior Research Fellow  
Head: Tissue Engineering & Biomaterials Research Unit  
School of AMME/Faculty of Engineering and IT and  
Bosch Institute  
The University Of Sydney, NSW

Secretary
Dr John Costi  
Senior Lecturer  
Head: Biomechanics & Implants Research Group  
School of Computer Science, Engineering and Mathematics, Flinders University, SA

Treasurer
Professor Jiake Xu  
Winthrop Professor/Head of Molecular Laboratory  
School of Pathology and Laboratory Medicine  
The University of Western Australia, WA

2011 Host Organiser
Associate Professor Yin Xiao  
Institute of Health and Biomedical Innovation  
Queensland University of Technology, QLD

Immediate Past President
Associate Professor David Haynes  
Head of Anatomy and Pathology  
School of Medical Sciences  
The University of Adelaide, SA

Organising Committee

Hala Zreiqat  
John Costi  
Jiake Xu  
Yin Xiao  
Dominic Thewlis  
Brianna Martin
Scientific Committee (alphabetical surname order)

John Costi
Colin Dunstan
Nicola Fazzalari
David Findlay
David Haynes
Julia Kuliwaba
Ian Parkison
Nathan Pavlos
Dominic Thewlis
Gethin Thomas
Yin Xiao
Jiake Xu
Hala Zreiqat
ANZORS 2011 Travel Grant Recipients (alphabetical surname order)

Ekram Alias
Discipline of Anatomy and Pathology, School of Medical Sciences, The University of Adelaide, SA

Kaustav Bandyopadhyay
Biomechanics &Implants Research Group, School of Computer Science, Engineering and Mathematics, Flinders University, SA

Shek Man Chim
School of Pathology and Laboratory Medicine, and Centre for Orthopaedic Research, School of Surgery, The University of Western Australia, WA

Chris Christou
Surgical and Orthopaedic Research Laboratories, Prince of Wales Clinical School, Faculty of Medicine, The University of New South Wales, NSW

Katie Ewing
Biomechanics Research Group, Department of Mechanical Engineering, The University of Melbourne, VIC

Pazit Levinger
Musculoskeletal Research Centre, Faculty of Health Science, La Trobe University, VIC

ZuFu Lu
Biomaterials and Tissue Engineering Research Unit, School of AMME, the University of Sydney, NSW

Vivek Mahajan
Father Muller Medical College, Mangalore-575002, India

Fatemeh Malekipour
Department of Mechanical Engineering, The University of Melbourne, VIC

Angad Malhotra
Surgical and Orthopaedic Research Laboratories, Prince of Wales Clinical School, Faculty of Medicine, The University of New South Wales, NSW

Hossein Mokhtarzadeh
Department of Mechanical Engineering, Melbourne School of Engineering, University of Melbourne, VIC

Susan Neale
Department of Orthopaedics and Trauma, Royal Adelaide Hospital, Adelaide, SA

Egon Perilli
Bone and Joint Research Laboratory, SA Pathology and Hanson Institute, SA

Diana Perriman
Trauma and Orthopaedic Research Unit, Canberra Hospital, ACT

Seyed-Iman Roohani-Esfahani
Biomaterials and Tissue Engineering Research Unit, School of AMME, the University of Sydney, NSW
Nicholas Russell  Surgical and Orthopaedic Research Laboratories, Prince of Wales Hospital, University of New South Wales Clinical School, NSW

Kuyu Wang  School of Mechanical and Chemical Engineering, University of Western Australia, WA
ANZORS 2011 Transport Information

Please refer to the Busway transport map from Brisbane city to the venue (IHB – QUT). The bus number has been highlighted. Please take these buses and get off at QUT stop in Kelvin Grove Road (refer to map of QUT), then take the 2 minute walk to the venue.
The QUT Inter Campus Shuttle operates between the Kelvin Grove and Gardens Point Campuses. 

Show your QUT Student or Staff Card to use these free services. Timetables are available from the QUT website: www.qut.edu.au

Produced by QUT Facilities Management - Standards and Records: January 2010

QUT Security
Emergency: 3138 8888
Freecall: 1800 065 585

Orthopaedic Research Society - 17th Annual Scientific Meeting
**ADMINISTRATION AND SUPPORT UNITS**

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<td>Computer Lab – Human Movement Studies</td>
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<td>Computer Lab - Nursing</td>
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<td>Computer Lab – Public Health</td>
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<td>Conference Room</td>
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<td>Continuing Professional Education Training Room</td>
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<td>Office of Research</td>
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<td>QUT Printing Services (QPS)</td>
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<td>Research and Research Training Office</td>
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<td>Research Students’ Centre</td>
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<td>Security Office (24 hours) Level 1</td>
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<td>STUDENT CENTRE</td>
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<td>- Student Guild</td>
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<td>- Guild Bar</td>
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<td>- Student Resources</td>
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<td>- Student Recruitment</td>
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<td>- Careers and Employment</td>
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<td>- Counselling Services</td>
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<td>- Health Services – Medical Centre</td>
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<td>- International Student Services</td>
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<td>- Q-Step</td>
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<td>TILS Finance/HR team</td>
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<td>the glasshouse</td>
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<td>the lift</td>
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<td>the roundhouse theatre</td>
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<td>Woodward Theatre</td>
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**RESEARCH CENTRES AND INSTITUTES**

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<td>Australian CRC for Interaction Design Pty Ltd (ACID)</td>
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<td>Centre for Accident Research and Road Safety-QLD (CARRS-Q)</td>
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<td>Confucius Institute</td>
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<td>Dementia Collaborative Research Centre</td>
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<td>Institute of Health and Biomedical Innovation (IHBi)</td>
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<td>National Centre for Health Information Research &amp; Education</td>
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<td>QUT Creative Enterprises Australia</td>
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**FACULTIES AND SCHOOLS**

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<td>Art and Design</td>
<td>F, H, U Blocks</td>
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<td>Clinics – Optometry, Human Movement, Nutrition and Dietetics, Podiatry.</td>
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<td>- Communication Design</td>
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<td>- Creative Industries Faculty</td>
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<td>- General Enquiries</td>
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<td>- Dean’s Office</td>
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<td>- Student Information</td>
<td>Z2</td>
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<td>Creative Industries Precinct</td>
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<td>Education – Faculty</td>
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<td>Film and Television</td>
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<td>Health Research Services Office</td>
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<td>Human Movement Studies – School</td>
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<td>Humanities</td>
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**OTHER**

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**Wayfinding Directory**

Queensland Academy of Creative Industries (Education Queensland)

**KELVIN GROVE**

Queensland University of Technology
Brisbane Queensland Australia
ANZORS 2011 Dinner Venue Information

The ANZORS dinner will be held at the following venue:

China City Seafood Restaurant,
76 Queen Street, Queens St Mall, Brisbane, 4000

Refer to Google Map below for location
# AUSTRALIAN & NEW ZEALAND ORTHOPAEDIC RESEARCH SOCIETY

## 17TH ANNUAL SCIENTIFIC MEETING - PROGRAM AT A GLANCE

**SEPTEMBER 1-2, 2011**

**Venue:** The main lecture room, Institute of Health and Biomedical Innovation IHBI, Queensland University of Technology  
60 Musk Avenue, Kelvin Grove, Brisbane, QLD 4059 AUSTRALIA

<table>
<thead>
<tr>
<th>WED, 31 AUG</th>
<th>THURS, 1 SEPT</th>
<th>FRI, 2 SEPT</th>
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<tbody>
<tr>
<td><strong>08:00 – 08:45</strong></td>
<td><strong>REGISTRATION/TEA &amp; COFFEE</strong></td>
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<td><strong>08:45– 08:50</strong></td>
<td>Presidential Address: Assoc. Professor Hala Zreiqat</td>
<td><strong>08:45 – 09:35</strong></td>
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</table>
| **08:50 – 09:15** | Symposia Session 1 - Engineering in Orthopaedics  
Invited Speaker: Professor Marcus Pandy | **08:45 – 09:35** | Invited Speaker: Assoc. Professor Greg Roger  
Invited Speaker: Assoc. Professor Simon Pearce |
| **09:15 – 09:50** | Symposia Session 2 – Biomedical Engineering and Modelling | **09:35 – 10:50** | ECR Presentation Award Session |
| **09:50 – 10:35** | Symposia Session 3 – Biomedical Imaging | | |
| **10:35 – 10:55** | **MORNING TEA** | **10:50 – 11:10** | **MORNING TEA** |
| **10:55 – 11:55** | Symposia Session 4 – Clinical Orthopaedic Research 1  
Invited Speaker: Associate Professor Ross Crawford | **11:10 – 11:30** | Symposia Session 8 – Clinical Orthopaedic Research 2 |
| **11:55 – 12:05** | Symposia Session 5 – From Kinematics/Gait to the Clinic | **11:30 – 12:40** | Symposia Session 9 – Bone Biology 1  
Invited Speaker: Professor Jerry Feng |
<p>| <strong>12:05 – 12:50</strong> | LUNCH (program continued on next page) | <strong>12:40 – 13:25</strong> | LUNCH (program continued on next page) |</p>
<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>12:50 – 13:40</td>
<td>PhD Student Presentation Award Session 1</td>
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<td>15:40 – 16:10</td>
<td>PhD Student Presentation Award Session 5</td>
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<td>16:10 – 16:20</td>
<td>Short Break</td>
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<td>16:20 – 17:00</td>
<td>Annual General Meeting and Election of Office Bearers</td>
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<td>17:15 – 17:20</td>
<td>Presentation of ECR award</td>
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<td>17:20</td>
<td>Meeting close</td>
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<tr>
<td>18:00 – 20:00</td>
<td>Registration and Welcome</td>
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<tr>
<td>19:00 – 22:00</td>
<td>ANZORS Dinner Presentation of PhD Student award</td>
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</table>

**Symposia Session 6 – Biomaterials and Skeletal Tissue Engineering**
13:25 – 14:15
Invited Speaker: Professor Ming-Hao Zheng
Invited Speaker: Dr Gethin Thomas

**Symposia Session 10 – Joint Regeneration**
14:15 – 15:20
Invited Speaker: Associate Professor Colin Dunstan

**Symposia Session 11 – Bone Biology 2**
15:20 – 15:40
Symposia Session 12 – Bone Biology 3
15:40 – 17:15
Invited Speaker: Dr Gethin Thomas

**Symposia Session 12 – Bone Biology 3**
17:15 – 17:20
AUSTRALIAN & NEW ZEALAND
ORTHOPAEDIC RESEARCH SOCIETY

17TH ANNUAL SCIENTIFIC MEETING – FULL PROGRAM

SEPTEMBER 1-2, 2011

Venue: The main lecture room, Institute of Health and Biomedical Innovation (IHBI)
Queensland University of Technology
60 Musk Avenue, Kelvin Grove, Brisbane, Qld 4059 AUSTRALIA

WEDNESDAY, 31 AUGUST 2011

18:00 – 20:00  Registration and Welcome Reception (Location: Atrium, IHBI)

THURSDAY, 1 SEPTEMBER 2011

08:00 – 08:45  Registration/Tea & Coffee

08:45 – 08.50  Presidential Address: Associate Professor Hala Zreiqat

08:50 – 09:15  Symposia Session 1 - Engineering in Orthopaedics
   Chair: Dr John Costi
   Invited Speaker: Professor Marcus Pandy
   Title: “Biomechanics of the Knee Joint During Gait”

09:15 – 09:50  Symposia Session 2 – Biomedical Engineering and Modelling
   Chair: Dr John Costi

  09:15 – 09:30  Scholes, Corey
     A Model for Investigating the Medial Knee Joint Contact Force During Gait Following
     High Tibial Osteotomy (Abstract no. 1)

  09:30 – 09:35  Russell, Nicholas
     The Effect of Sterilisation Method on the Static and Dynamic Mechanical Properties
     of Rabbit Cortical Bone (Abstract no. 2)

  09:35 – 09:40  Chen, Junning
     Multi-Scale Modelling Of Implant Surface Morphology (Abstract no. 3)

  09:40 – 09:45  Bandyopadhyay, Kaustav
     Sub-modelling of the Intervertebral Disc to develop a Micro-Finite Element Model of
     the Annulus Fibrosus (Abstract no. 4)

  09:45 – 09:50  Christou, Chris
     Strain Gauge Analysis Of Sheep Tibial Sawbones For Use As In Vitro
     Replacements Of Cadaveric Bones (Abstract no. 5)
09:50 – 10:35 **Symposia Session 3 – Biomedical Imaging**  
Chair: Dr Ian Parkinson

09:50 – 10:05  
Muhit, Abdullah  
3D/2D Registration Software for Kinematic Analysis of Human Joints (Abstract no. 6)

10:05 – 10:20  
Rathnayaka, Kanchana  
Correction of the Step Artefact in 3d Bone Models Caused by the Random Movement of the Lower Limb During MRI (Abstract no. 7)

10:20 – 10:35  
Abel, Richard  
Development of Fetal Trabecular Micro-Architecture (Abstract no. 8)

**10:35 – 10:55** MORNING TEA

**10:55 – 11:55** **Symposia Session 4 – Clinical Orthopaedic Research 1**  
Chair: Dr Diana Perriman

10:55 – 11:20  
Invited Speaker: Professor Ross Crawford  
Title: “Research - A Clinician’s Perspective”

11:20 – 11:35  
Scholes, Corey  
Comparison of Tibial Coverage Achieved by Asymmetrical and Symmetrical Baseplates in Knee Joint Replacement (Abstract no. 9)

11:35 – 11:50  
Callary, Stuart  
A Novel Application of Radiostereometric Analysis in Orthopaedic Research (Abstract no. 10)

11:50 – 11:55  
Neale, Susan  
Femoral Osteolysis Adjacent to Total Hip Replacements (Abstract no. 11)

**11:55 – 12:05** **Symposia Session 5 – From Kinematics/Gait to the Clinic**  
Chair: Dr Dominic Thewlis

11:55 – 12:00  
Ewing, Katie  
A Comparison Between Dominant and Non-Dominant Leg Knee Kinematics and Kinetics During a Single-Leg Drop Landing from Different Heights in Female Athletes (Abstract no. 12)

12:00 – 12:05  
Negus, Jonathan  
Is The Wii Fit For Purpose? Validating Nintendo’s Chosen Measure Of Balance For Clinical Use (Abstract no. 13)

**12:05 – 12:50** LUNCH
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Chair</th>
<th>Presentations</th>
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</table>
| 12:50 – 13:40| **Symposia Session 6 – Biomaterials and Skeletal Tissue Engineering**<br>Chair: Associate Professor Hala Zreiqat |                        | Wu, Chengtie<br>Mesoporous Bioglass Scaffolds as the Platform for Drug Delivery and Bone Tissue Engineering (Abstract no. 14)  
Hu, Xiaozhi<br>Scaffold-Like Hydroxyapatite on Load-Bearing Zirconia Core for Bone Replacement Implant Applications (Abstract no. 15)  
Ji, Chengodong<br>Application of High Pressure CO2 in Fabrication Scaffolds for Cartilage and Bone Tissue Engineering (Abstract no. 16)  
Liu Chunli<br>Development of Bioactive 3D Block Copolymer Scaffolds for Repair of Bone Tissue (Abstract no. 17) |
| 13:40 – 14:40| **PhD Student Presentation Award Session 1**<br>Chair: Associate Professor Nathan Pavlos |                        | Roohani-Esfahani, Seyed-Iman<br>Novel Method for Preparation of Hierarchal Porous Structure Scaffolds (Abstract no. 18)  
Roohani-Esfahani, Seyed-Iman<br>Synthetic Nanocomposite Scaffold Alone Promotes in vivo Bone Regeneration in Critical Size Bone Defect (Abstract no. 19)  
Malekipour, Fatemeh<br>Effects of Subchondral Junction Microstructure on the Stress Distribution: A Finite Element Study (Abstract no. 20)  
Musson, David<br>In vitro Evaluation of Commercially Available Scaffolds for use in Musculoskeletal Regenerative Medicine (general presentation not eligible for PhD award) (Abstract no. 21) |
| 14:40 – 15:10| **AFTERNOON TEA**                               |                        |                                                                                   |
| 15:10 – 16:10| **PhD Student Presentation Award Session 2**<br>Chair: Professor Ming-Hao Zheng |                        | Wang, Kuyu<br>The Refractive Index of Articular Cartilage - Preliminary Study (Abstract no. 22)  
Perriman, Diana<br>A Comparison of Thoracic and Lumbar Erector Spinae Activity During Extension in Prone Lying and Sitting (Abstract no. 23)  
Alias, Ekram<br>Higher Expression of Osteoclast ITAM-Related Molecules is Associated with Human Polyethylene-Induced Periprosthetic Osteolysis (Abstract no. 24) |
15:55 – 16:10  Mokhtarzadeh, Hossein  
Muscle Coordination in One-Leg Landing From Different Heights (Abstract no. 25)

16:10 – 16:20  Short Break

16:20 – 17:00  Annual General Meeting and Election of Office Bearers

19:00 – 22:00  ANZORS Dinner (Presentation of PhD student award)
FRIDAY, 2 SEPTEMBER 2011

08:00 – 08:45  Registration/Tea & Coffee

08:45 – 09:35  Symposia Session 7 – Commercialisation of Medical Devices
Chair: Associate Professor Colin Dunstan

08:45 – 09:10  Invited Speaker: Associate Professor Greg Roger
Title: “Commercialising Innovation in Medical Devices - Opportunities and Pitfalls”

09:10 – 09:35  Invited Speaker: Associate Professor Simon Pearce
Title: “In-vivo Evaluation of Medical Devices - Opportunities and Pitfalls”

09:35 – 10:50  Early Career Researcher (ECR) Presentation Award Session
Chairs: Associate Professor Greg Roger and Associate Professor Simon Pearce

09:35 – 09:50  Levinger, Pazit
Abnormal Gait Patterns at 12 Months Following Knee Replacement Surgery can be Predicted by Biomechanical Gait Parameters at 4 Months Post-Surgery (Abstract no. 26)

09:50 – 10:05  Perilli, Egon
Modic (Endplate) Changes in the Lumbar Spine: Bone Microarchitecture and Remodeling (Abstract no. 27)

10:05 – 10:20  Lu, ZuFu
Bone Biomimetic Microenvironment Induces Osteogenic Differentiation of Adipose Tissue Derived Mesenchymal Stem Cells (Abstract no. 28)

10:20 – 10:35  Chim, Shek Man
EGFL6 Promotes Endothelial Cell Migration and Angiogenesis through the Activation of Extracellular Signal -regulated Kinase (Abstract no. 29)

10:35 – 10:50  Mahajan, Vivek
The Use of Bone Marrow Aspirate Concentrated for Full-thickness Knee Cartilage Lesions in a One-step Procedure: A Prospective Study (Abstract no. 30)

10:50 – 11:10  MORNING TEA

11:10 – 11:30  Symposia Session 8 – Clinical Orthopaedic Research 2
Chair: Professor Jiake Xu

11:10 – 11:15  Mackie, Katherine
Histopathology of Femoral Head Donations: A Retrospective Review of 6161 Cases (Abstract no. 31)

11:15 – 11:20  Harith, Hazreen
Fit Analysis of a Precontoured Plate: Is There a Group for Borderline Cases? (Abstract no. 32)

11:20 – 11:25  Harith, Hazreen
Automated Fit Analysis of a Precontoured Fracture Fixation Plate: Potentials and Pitfalls (Abstract no. 33)
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<th>Title</th>
<th>Abstract No.</th>
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<td>11:25 – 11:30</td>
<td>Gladkis, Laura</td>
<td>Wear rates and wear morphology of knee prosthesis: a 3D study</td>
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<td><strong>11:30 – 12:40</strong></td>
<td><strong>Symposia Session 9 – Bone Biology 1</strong></td>
<td>Chair: Professor David Findlay</td>
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<tr>
<td>11:30 – 11:55</td>
<td>Invited Speaker</td>
<td>Professor Jerry Feng</td>
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<td>&quot;Osteocyte and Bone Health&quot;</td>
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<td>11:55 – 12:10</td>
<td>Tickner, Jennifer</td>
<td>Choline Kinase Beta is an Important Regulator of Bone Homeostasis</td>
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<td>12:10 – 12:25</td>
<td>McDonald, Michelle</td>
<td>Analysis of the High Bone Mass Phenotype and Fracture Repair in Mice</td>
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<td>with Homozygous Deletion of Dickkopf-1</td>
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<td>12:25 – 12:40</td>
<td>Smith, Paul</td>
<td>Heparanase is a Biomarker for RA Diagnosis and Therapeutic Interventions</td>
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<td><strong>12:40 – 13:25</strong></td>
<td><strong>LUNCH</strong></td>
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<td><strong>HALF-DAY JOINT SESSION WITH ANZBMS</strong></td>
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<td><strong>13:25 – 14:15</strong></td>
<td><strong>Symposia Session 10 – Joint Regeneration</strong></td>
<td>Chair: Professor Jerry Feng</td>
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<tr>
<td>13:25 – 13:50</td>
<td>Invited Speaker</td>
<td>Professor Ming-Hao Zheng</td>
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<td>&quot;The Dream of Biological Joint Reconstruction&quot;</td>
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<td>13:50 – 14:15</td>
<td>Invited Speaker</td>
<td>Dr Gethin Thomas</td>
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<td>&quot;New Bone Formation in Response to Inflammation&quot;</td>
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<td><strong>14:15 – 15:20</strong></td>
<td><strong>Symposia Session 11 – Bone Biology 2</strong></td>
<td>Chair: Associate Professor Yin Xiao</td>
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<td>14:15 – 14:35</td>
<td>Invited Speaker</td>
<td>Associate Professor Colin Dunstan</td>
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<td>&quot;New Strategies for Controlling Bone Loss&quot;</td>
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<td>14:35 – 14:50</td>
<td>Jaiprakash, Anjali</td>
<td>Altered Osteocyte Function in Osteoarthritis: A Possible Pathological Role in Subchondral Bone Sclerosis</td>
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<tr>
<td>14:50 – 15:05</td>
<td>Fong, Laura</td>
<td>Maternal Dietary Supplementation of Omega-3 Fatty Acids During Pregnancy and Lactation Transiently Affects Osteoclast Formation and Bone Mass in Male Offspring</td>
<td>39</td>
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<tr>
<td>15:05 – 15:20</td>
<td>Zhou, Yinghong</td>
<td>Stem Cell Reprogramming Genes are Differentially Expressed in BMSC, PDLC and DPC in Response to Hypoxic Environment</td>
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</table>
15:20 – 15:40  **AFTERNOON TEA**

15:40 – 17:15  **Symposia Session 12 – Bone Biology 3**  
Chair: Associate Professor David Haynes

15:40 – 15:55  Li, Rachel  
Osteoimmunological Response to Nanoscale Wear Particles (Abstract no. 41)

15:55 – 16:10  Cheng, Taksum  
Versatile Roles of V-ATPase Accessory Subunit Ac45 in Osteoclast Formation and Function (Abstract no. 42)

16:10 – 16:25  Mohan, Geetha  
Tibial Subchondral Bone Damage in Early-Stage Osteoarthritis is Reduced by Alendronate Treatment: An in vivo Micro-CT Study in a Rodent Model (Abstract no. 43)

16:25 – 16:40  Ying Ng, Pei  
Functional Analysis of the Microtubule-Binding Dynein-Dynactin Complex in Osteoclasts (Abstract no. 44)

16:40 – 16:55  Qin, An  
Prevention of Wear Particle-Induced Osteolysis by a Novel V-ATPase Inhibitor Saliphenylhalamide (Saliphe) Through Inhibition of Osteoclast Maturation and Bone Resorption (Abstract no. 45)

16:55 – 17:10  Chakravorty, Nishant  
Structurally and Chemically Modified Titanium Implant Surfaces Initiate Early Osteogenic Differentiation in Osteoprogenitor Cells (Abstract no. 46)

17:10 – 17:15  Malhotra, Angad  
Effect of Agonist Choice on Growth Factor Release From Platelet Rich Plasma (Abstract no. 47)

17:15 – 17:20  **Presentation of ECR award**

17:20  **Meeting Close**
THURSDAY, 1 SEPTEMBER 2011

09:15 – 09:50 Symposia Session 2 – Biomedical Engineering and Modelling
A MODEL FOR INVESTIGATING THE MEDIAL KNEE JOINT CONTACT FORCE DURING GAIT FOLLOWING HIGH TIBIAL OSTEOTOMY

Corey Scholes, Tom Whyte, Qing Li, Myles Coolican, David Parker

1 Sydney Orthopaedic Research Institute, Chatswood, NSW
2 School of Aerospace, Mechanical and Mechatronic Engineering, The University of Sydney, NSW
email: cscholes@sori.com.au

INTRODUCTION
High tibial osteotomy is a well-established joint preserving procedure for the treatment of unicompartmental knee osteoarthritis [1]. Of particular interest are the alterations in knee loading compartments during dynamic activities such as locomotion. Computer modelling can indirectly assess contact and muscle forces in the patient [2]. This study aimed to develop a valid model representative of high tibial osteotomy to assess the medial joint contact force at the knee during gait.

METHODS
Software for Interactive Musculoskeletal Modelling (version 2, SIMM Inc, USA) was used to develop a model to replicate the effects of high tibial osteotomy surgery on tibial alignment. The program was then used to perform a detailed analysis on gait data collected from two high tibial osteotomy patients preoperatively and 6 months post operatively. Inverse dynamics simulations were conducted to investigate knee joint contact force on the medial compartment of the two patients during the stance phase of their operated limbs.

RESULTS AND DISCUSSION
Significant decreases (p<0.05) in the medial joint contact force were observed during both early and late stance for both patients (Figure 1). Force generated in muscles crossing the knee was found to be the major contributor to the joint contact force. Total muscle force was found to increase significantly (p<0.05) following surgery, however decreased loads were calculated for the medial compartment (Table 1). The pattern and magnitude of joint reaction force was found to be consistent before and after surgery and replicated the results of previous studies. The HTO-specific model was valid and sensitive to changes in joint reaction force, medial joint contact force and muscle forces crossing the knee.

CONCLUSIONS
High tibial osteotomy reduced the medial joint contact force at the knee as a result of the coronal realignment of the limb. Osteoarthritis symptoms were relieved in terms of knee pain and function. Finally, a difference in compensatory strategies was observed between patients. This novel technique allows non-invasive assessment of the mechanical effect of procedures such as HTO. Future work should be directed to applying this approach to more accurate surgical planning and assessment.

REFERENCES

Table 1: Preoperative and Postoperative Muscle and Joint Contact normalized to body weight for 2 patients

<table>
<thead>
<tr>
<th>Patient</th>
<th>Muscle Force (N/Kg)</th>
<th>Medial Joint Contact Force (N/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>1</td>
<td>2.15 ± 0.13</td>
<td>3.10 ± 0.19</td>
</tr>
<tr>
<td>2</td>
<td>1.28 ± 0.06</td>
<td>1.73 ± 0.12</td>
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</tbody>
</table>
THE EFFECT OF STERILISATION METHOD ON THE STATIC AND DYNAMIC MECHANICAL PROPERTIES OF RABBIT CORTICAL BONE

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INTRODUCTION

Gamma Irradiation is currently considered the gold standard for sterilizing bone allografts; however its use results in a dose dependant decrease in mechanical properties. This study aimed to evaluate the effect of Supercritical Fluid (SCF) on the bending and torsional properties of cortical bone in quasi static and dynamic loading conditions.

METHODS

One-hundred and twenty paired 12-month old rabbit humeri were randomised to 3 treatments groups: Gamma Irradiation at 25kGy, SCF Control and SCF with Peracetic Acid (n=40 pairs per group). One side was treated while the other acted as a control. In each group, ten pairs were mechanically failed quasi statically in torsion, 3pt and 4pt-bending; and dynamically to 50000 cycles in 3pt fatigue bending. Maximum load, energy to failure and stiffness were calculated from the static tests, while the number of cycles to failure was measured in the fatigue tests. Statistical differences were determined using a 2-tailed t-test within pairs and an ANOVA between groups.

RESULTS AND DISCUSSION

Gamma irradiation has a deleterious effect on the torsion and bending properties of bone under static and dynamic conditions (P < 0.05) (Figure 1). The largest effect was in torsion where there was a 64% decrease in load to failure, a 75% decrease in energy to failure and a 45% reduction in stiffness. The SCF treatment had no significant effect on the mechanical properties of bone in any loading condition. The addition of peracetic acid to the SCF treatment resulted in slight increase in torsional properties, with a 9% increase in load to failure and a 4% increase in energy, though these were not statistically significant. In 3-point bending, 4-point bending and fatigue loading, SCF treatment did not alter the mechanical properties considerably in any parameter.

CONCLUSIONS

This study confirmed the deleterious effect of gamma irradiation on the mechanical properties of bone, raising concerns over the utility of this method for load bearing allograft. SCF treatment has a bactericidal and virucidal effect [1,2]; and the results of this study demonstrate it maintains the mechanical integrity of bone under both quasi static and dynamic loading conditions.

REFERENCES

MULTI-SCALE MODELLING OF IMPLANT SURFACE MORPHOLOGY

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INTRODUCTION
A porous implant surface created by sintering beads or powder particles onto a substrate core is believed to promote osseointegration by increasing contact surfaces for tissue ingrowth. Several empirical studies have shown improved stability of porous implants in terms of Young’s modulus in the bonding region [1-3]. Recently, computational simulations have also been carried out for morphology graded along an axial direction [4-6]. However, both empirical and simulation studies focus on a macroscopic level behaviour of bone, neglecting microscopic biomechanical responses.

This study aims to model bone response to a porous implant surface by multi-scale modeling, which links classic macroscale homogenization approach to microscale finite element (FE) analysis. Bone remodelling is scripted in terms of microscale bone-implant-contact (BIC) ratios, and examined by localized Tresca stress (related to a pull-out test for characterizing bonding strength).

METHODS
A macroscopic model is firstly created to present an implant with surrounding host bones, based on the anatomy involved. By selecting a 1 mm by 1 mm region across the bone-implant interface [7], a microscopic model is then created to present a transition from implant to bone by embedding a mixture of implant beads and hosting tissues (Figure 1 a).

Wolff’s Law formed the major governing rule in the remodelling process for both macroscale and microscale models. In this simulation, the time increment is set to be a month, and bone density change in this period is proportional to mechanical stimuli by the differences between local strain energy density (SED) and a reference SED [4,5]. A critical review of empirical BIC ratios from various in vivo studies is carried out to interpret human osseointegration outcomes, and this review provides literature support to bone remodelling parameter for more realistic and meaningful simulation.

In the macro FE analysis, loads and constrains are assigned to the macroscopic model to simulate a remodelling process through a period of 48 months, and 48 corresponding global displacement fields are generated subsequently. These displacements are used as the input to the microscopic model for a localized remodelling simulation [7]. Tresca stresses are extracted as a function of time and compared with the literature data obtained from pull-out tests.

RESULTS AND DISCUSSION
Taking a dental implant in human canine mandibular bone as an example, the micro FE based remodelling simulation is performed to generate a contour of density (E) distribution (Fig. 1b), indicating bone growth into the porous implant surface after 48 month remodelling. BIC ratio is determined as per the mature bone area (E > 6 GPa) over the total area across the transitional region. The average of top 10% elemental Tresca stresses in this local region is used to compare with the literature data. Both BIC ratios and averaged Tresca stresses are recorded at different time points.

CONCLUSIONS
Bone remodelling responses in a porous implant surface has been simulated by a multi-scale remodelling approach, to capture microscopic bone behaviour in bone-implant contact region. The BIC ratio and Tresca stress outcomes showed the compliance to empirical studies and reports, to provide a realistic model for further study and analysis on different surface morphologies.

REFERENCES
Sub-modelling of the Intervertebral Disc to develop a Micro-Finite Element Model of the Annulus Fibrosus

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INTRODUCTION
Understanding the micro-mechanical and functional properties of the annulus fibrosus (AF) of the intervertebral disc (IVD) micro-structure has gained importance for developing treatment for degenerative disc disease, herniation injury and for tissue engineering [1,2]. However, the mechanical behaviour and interactions between AF lamellae at the micro level are not well-defined due to physiological and experimental limitations. The main objective of this study is to develop a technique to derive the boundary conditions (BC) for different mechanical loads of a micro scale finite element (FE) model of the AF using the sub-modelling technique.

METHODS
Due to a lack of experimental data for the micro-FE model, a macro-FE model was first developed. The macro model was then validated using published experimental results. The boundary and loading conditions for the micro-FE model were derived using sub-modelling of the macro-FE model (Figure 1). The nonlinear, 3-dimensional and laterally symmetric FE models were developed using CAD software ProE v5 (PTC, Needham, MA, USA) and the FE analysis was conducted using ANSYS APDL v12 (ANSYS Inc., Canonsburg, PA, USA). The AF was meshed using nonlinear 8Node 3D Rebar elements with tension-only fiber reinforcements [3]. The elements in the anterior region were of length (radial) of 750µm, width (circumferential) of 450µm and depth (transverse) of 450µm and represented the dimensions of the micro-FE model [2]. The nucleus was modeled using 3D 8Node Solid187 with nonlinear viscoelastic material properties (with content fluid) [4]. The endplates were also modeled using 3D solid elements and the material properties were specified as, E=24MPa and υ=0.4 [5]. Simulations were conducted on an L4-L5 disc under quasi-static compressive and shear loading.

RESULTS AND DISCUSSION
Two independent published results were used to validate the model. Firstly, the radial disc bulge and axial displacement of the macro model were validated (Figure 2), producing similar values to published data. A slight deviation in the results for the lateral bulge of the macro-FE model from the published FE results was observed [3]. This difference can be explained based on the difference in material models of both analyses. Overall, the macro-FE model was in agreement with published experimental results, therefore the model specifications and assumptions were deemed to be satisfactory.

CONCLUSIONS
A technique to derive the boundary conditions of the annulus fibrosus at the microscale was developed. The model will be used to study the mechanical behavior of the AF at the microscale in order to elucidate tissue structure-function relationships.

ACKNOWLEDGEMENTS
We wish to thank the School of CSEM, Flinders University for providing a research internship for Mr KB to complete this work under the supervision of Dr JJC. Mr KB would also like to acknowledge Ms Preksha Sharma to aid the project.

REFERENCES
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5. Yin L, Elliot DM, J of Biomechanics. 38: 1674-1684, 2005
INTRODUCTION

The use of synthetic bone analogues helps in removing the inherent variability associated with the use of cadaveric tissues in the mechanical environment when testing new implant structures and materials. The aim of this study is to utilize an ovine specific fourth generation sawbone model for use as a replacement for cadaveric sheep tibias in the development of new fracture stabilization implants. The sheep tibia was chosen as its shape, size and physical properties closely resemble that of the human tibia [1], which is reported to be the most frequently broken long bone [2]. This process will allow, for the first time, a direct geometric comparison for in vivo and in vitro testing of ovine tibias.

METHODS

While Pacific Research Laboratories (PRL) manufacture and supply composite foam/fibreglass models to replace human bones [1-3], none exist for sheep. Accordingly an ovine specific fourth generation sawbone was developed in collaboration with PRL, using CT scans of six normal sheep tibias as a template. The resulting model tibia is being utilized in our laboratory. Strain gauges were chosen to record the forces acting at the surface of the sawbones to later allow for direct comparison of results with cadaveric sheep tibias.

Mechanical testing was performed using a servohydraulic testing machine (MTS, Eden Prairie, MA, USA). Two different loading regimens were used, the first applied axial compression of 4 cycles of loading from 25N of compression to 500N and back, each load being held for 10 seconds. The second applied axial compression of 25N to 1000N for 4 cycles [3]. The strain distribution during loading was recorded through strain gauges placed at 11 strategic locations on each sawbone.

The sawbones were potted using a low melting point alloy, such that the imprint left behind allowed for secure locking of the tibia under compression, yet allowed for removal and replacement of the tibia without the need for re-potting each sample.

An absolute strain was calculated for each gauge point and from these figures maximum and minimum principle strains and their angles were calculated.

RESULTS AND DISCUSSION

Due to the unique anatomical structure of the tibia, both tensile and compressive strains are exhibited along the surfaces of the sawbone despite the testing being performed in pure compression. The maximum strains occurred in tension on the caudal aspect of the tibia and as compressive strains on the cranial and lateral surfaces, the angles at which these occurred aligned with the long axis of the bone except for the crest laterally and the proximal caudal gauge just below the tibial plateau.

As indicated in the results doubling the compressive force on the tibia did not necessarily produce a linear or easily predictable change in the expected surface strains achieved, further confirming the influence of the complex shape and surface structure of the tibia. This has important implications for the comparison and validation of computer modelling.

While all care was taken to maintain consistency throughout the testing process the multi-stepped procedure invariably produced some human and environmental variability. This included: The placement of the strain gauges from sawbone to sawbone including their rotational alignment, the preparation of each bonding site and quality of each adhesion process and the temperature of the gages at testing time.

The maximum and minimum strains and their angles for the tibial crest must be considered with the caveat that once potted the tibial tuberosity which is normally in tension from the patella ligament was in compression.

The next study in the process is to repeat all the above steps with cadaveric sheep tibias.

CONCLUSION

The use of a sawbone model has shown to be of benefit in replacing cadaveric tissue via its geometric similarities, its handling properties and its ability to be an easily accessed substitute for use in research; providing a good in vitro testing environment. This could be used as a standalone process or in conjunction with computer modelling.
09:50 – 10:35  Symposia Session 3 – Biomedical Imaging
INTRODUCTION
Kinematic analysis of human joints is vital for improving musculoskeletal treatments and implant design etc. To enable practical and dynamic kinematic assessment of pre/post-operative patients at Canberra Hospital, a 3D/2D Registration Software has been developed recently.

This software platform enables very accurate registration and kinematic analysis on human knee joints (both pre and post surgery) with minimal supervision, while other joints such as hip, shoulder etc will be the subject of future investigations.

METHODS
The 3D/2D Registration Software has been developed using MATLAB and C programming languages. It provides user-friendly graphical interfaces for performing various pre-processing, registration, kinematic analysis and dynamic visualization etc using 3D stationary volumetric data extracted from CT or CAD models and 2D dynamic images from a single fluoroscope.

RESULTS AND DISCUSSION
Our experiments using cadaver knees and prosthesis implanted on a sawbones knee show that the system is very accurate in terms of registration as well as kinematic information. The standard deviation of error is less than 0.5 degree for all rotations and between 0.5 mm (implants) and 1 mm (natural bones) for translations.

CONCLUSIONS
The new 3D/2D Registration Software is approaching the precision of RSA. Hence, it is adequately suitable for producing confident and reliable analysis of prospective kinematics studies.

REFERENCES
CORRECTION OF THE STEP ARTEFACT IN 3D BONE MODELS CAUSED BY THE RANDOM MOVEMENT OF THE LOWER LIMB DURING MRI

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INTRODUCTION
Magnetic resonance imaging (MRI) provides researchers with an opportunity to scan long bones of healthy volunteers for research purposes without exposing them to ionizing radiation, as it would be the case with computed tomography (CT). Such data is required for designing pre-contoured fracture fixation implants that fit the anatomy of bones of young age groups who make up more than half of the injured population. MRI of long bones faces a number of challenges due to the motion artefacts. Of these, the lateral shift artefact that can occur due to the random movements of the lower limb is important as this introduces geometric inaccuracies to the 3D models, hence, to the implants designed using them. Therefore, correction of this artefact is required before using the 3D models for such applications. As this artefact appears in the 3D models, the correction can be achieved with 3D surface aligning techniques such as the iterative closest point (ICP) algorithm. This study aimed to correct the step artefact associated with MRI scanning of long bones using the robust ICP algorithm to align the surfaces [1].

METHODS
Five intact ovine cadaver femora were scanned using a 3T MRI scanner with a 3D VIBE protocol (resolution = 0.5 × 0.5 × 1.0 mm). First, the complete femur was scanned in one go to use as the reference standard. Second, the femur was scanned in two half’s maintaining about 4.5 cm overlap between them (Figure 1). After the first half is scanned, the sample was shifted a few millimetres laterally to simulate a lateral shift. The MRI data was segmented using a multi-threshold segmentation method previously developed by the authors [2]. The correction of the simulated lateral shift was achieved by aligning the models using the robust ICP algorithm based function built into the Rapid from 2006 software package. The models of two half’s were first roughly aligned manually and then the ICP algorithm based function was used for the fine alignment. The 3D models with the corrected lateral shift artefact were then compared to the reference model by calculating the average deviation between two models.

RESULTS AND DISCUSSION
The results indicated that the correction of the artefact was achieved with an average error of 0.23 ± 0.07 mm when compared to the reference model. The errors were within the sub voxel accuracy. The ovine femora used for the study are shorter compared to human femora. Due to the spatial limitation of the scanner’s magnetic field, a human femur has to be scanned in at least three segments. The correction of two or more step artefacts in a single bone might results in a lower accuracy of the corrected model. Therefore, a validation with human long bones is recommended before using this method to correct the shift artefacts in human MRI scans.

CONCLUSIONS
The step artefact which resulted from the simulated movement was minimised using an ICP algorithm based aligning method. With further validations, the method can be used to correct the artefacts of MRI scanning of human long bones.

ACKNOWLEDGEMENT
The authors acknowledge the National Imaging Facility (NIF) for providing 100% subsidised access to the 3T MRI scanner at the University of Queensland, St Lucia, Queensland.

REFERENCES
DEVELOPMENT OF FETAL TRABECULAR MICRO-ARCHITECTURE

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INTRODUCTION
Fetal bone development is thought to have a significant impact on adult bone quality and senescent bone disease [1]. Optimising fetal growth might help reduce senile bone fractures and improve quality of life. However, very little is known about prenatal trabecular development, partly because of the lack of access to material. To this end we aimed to quantify the ontogeny of fetal trabecular micro-architecture.

METHODS
A sample of thirty-eight fetal human skeletons of known sex and age (4-9 months) was analysed. Trabecular architecture in the humerus and femur was visualised then measured using micro-CT scans. Trabeculae were thresholded using the half maximum height method, which has been validated against traditional microscopic histomorphometric techniques [2]. Measures of trabecular thickness (Tb.Th) number (Tb.N) and bone fraction (BF) were collected from two regions (transects) parallel to the long axis of the bone: proximal and distal. Tb.Th was defined as the distance along a transect that intersected trabecular tissue, Tb.N as the number of elements per millimetre along a transect and BF as the total width of bone in relation to the length of the transect. Micro-architectural data were compared across six age categories (4, 5, 6, 7, 8, 9 months). At each stage of development morphology was also compared between bones, regions and sexes.

RESULTS AND DISCUSSION
Fetal trabecular development is neither bone, region nor sex specific. During fetal ontogeny humeri and femora exhibit comparable trabecular micro-structure at each developmental stage. Proximal and distal aspects of the limb bones are also comparable, as are males and females. Overall, development of micro-architecture is characterised by an increase in trabecular thickness, which is matched by a decrease in trabecular number and, therefore, bone fraction remains constant (Figure 1).

Early postnatal development (0-2 years) is also characterised by an increase in thickness and decrease in number of trabeculae. However, the change is not balanced, leading to a decrease in bone volume fraction. In this context our findings suggest that there is some continuity in the pattern of micro-structural development before and after birth. However, the modelling process changes post partum. Published data suggest that bone deposition slows after birth, while resorption rates do not change [3]. Thus fetal development may be characterised by relatively high rates of bone deposition in comparison to postnatal.

CONCLUSIONS
Trabeculae become thicker and less numerous during fetal development, whilst bone volume fraction remains constant. The pattern appears to be comparable across upper and lower limb bones, proximal and distal aspects, and sexes. These findings suggest that (i) bone deposition rates are higher prenatally than postnatally and (ii) the loads imparted by sporadic muscular contractions (i.e. punching and kicking) are probably comparable across bones, regions and sexes.

ACKNOWLEDGEMENTS
The authors would like to thank Dr Lauren Howard and micro-CT lab at the Natural History Museum (London, UK).

REFERENCES
10:55 – 11:55  Symposia Session 4 – Clinical Orthopaedic Research 1
COMPARISON OF TIBIAL COVERAGE ACHIEVED BY ASYMMETRICAL AND SYMMETRICAL BASEPLATES IN KNEE JOINT REPLACEMENT

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INTRODUCTION
Optimal positioning of the prosthesis in a total knee arthroplasty correlates positively with good clinical outcome. Correct positioning must take into account the coverage of the tibia. Tibial components have traditionally been symmetrical in design; however the goal of optimising coverage as well as achieving optimal rotational alignment has seen the recent development of asymmetrical components [1]. The aim of this study was to determine whether an asymmetrical or symmetrical tibial component of a prosthetic knee is superior in terms of coverage area of the plateau and the effects of tibial component rotation on this.

METHODS
Sixteen tibial models were created using ScanIP. CT scans were obtained from patient’s pre-operatively for knee replacement surgery. Three-dimensional models were exported into SolidWorks for further evaluation. Each tibia was resected 10mm below the medial tibial joint surface. Templates representing the tibial baseplate of three symmetrical prostheses (Global Orthopaedic’s RBK, Stryker’s Scorpio, and Zimmer’s Next Gen) and two asymmetrical prostheses (Zimmer’s Natural Knee II and Smith & Nephew’s Genesis II) were matched to the tibial surfaces. Templates were applied to the tibial models under two conditions. In the no-overlap condition the template could not extend beyond the tibial boundary at any point, while this condition was relaxed for the overlap condition. The overlap was constrained to less than or equal to 2mm for a distance of less than 10 mm, the so-called surgical fit. Analysis of variance with Tukey’s HSD post-hoc comparisons were used to detect differences between templates.

RESULTS AND DISCUSSION
No significant difference in coverage between any of the templates (p=0.159) when there was no overlap permitted in the templates (Figure 1). In contrast, when overlap was permitted, the asymmetrical templates achieved significantly greater (p<0.05) coverage of only one of the symmetrical templates (Next Gen). In respect to rotational position, highest tibial coverage was achieved using the best fit scenario.

CONCLUSIONS
The tibiofemoral joint is known to be asymmetric in shape and dimension. However, the results of this study suggest that currently available asymmetrical tibial templates provide superior coverage for some, but not all of the symmetrical tibial baseplates. These results have implications for tibial baseplate design and surgical positioning of these implants; however more research is needed further understand the issue.

REFERENCES
INTRODUCTION
Radiostereometric analysis uses simultaneous radiographs taken above a calibration cage to measure the movement of two skeletal segments in vivo. The measurement technique has been in use for the last 40 years [1]. Numerous developments have been made to the technique and as a result the accuracy has improved and the application of the method has increased. The aim of this study was to apply the RSA technique in three novel areas of orthopaedic research which include in vitro, preclinical animal and clinical studies.

METHODS
Firstly, an attempt was made to apply the RSA technique to measure the in vitro movements of 12 cadaveric elbows through incremental degrees of flexion (0, 20, 40, 60 degrees). The movements of humerus relative to radius were measured while different elbow ligaments were dissected.

The RSA technique was applied in a preclinical animal model of tendon repair. Tantalum beads were inserted within a hip tendon which was detached and then reattached to its insertion point on the greater trochanter in nine sheep. The migration of the hip tendon relative to the greater trochanter was calculated at 0, 2, 4, 6, 12 and 18 weeks. Histological analysis of the soft tissue reaction to tantalum metal was undertaken ex vivo.

The RSA technique was applied in a clinical study to measure the movement of lateral tibial plateau fractures under weight-bearing load. Seven patients were included in the case series who had RSA radiographs taken while applying the maximum tolerated weight-bearing load at 2, 6, 12, 26, and 52 weeks.

RESULTS AND DISCUSSION
The application of the RSA technique in all three studies was successful.

The measurement of elbow flexion with the progressive dissection of ligaments allowed different movement patterns to be identified.

The migration of the repaired hip tendon relative to the greater trochanter identified failure of the repair (migration up to 30mm). Failure of repair was confirmed on retrieval of all nine specimens. Some beads did migrate within the soft tissue within the first two weeks. Further studies are required to improve the bead insertion technique and identify when beads migrate within the first two weeks. Histological analysis confirmed the beads were encapsulated with fibrous tissue by two weeks.

Finally, the RSA technique was successfully applied to measure in vivo fracture movement under weight-bearing loads in a series of lateral tibial plateau fractures. Small movements of the fracture fragments, that decreased with time, were recorded under load.

The RSA technique has certain advantages and limitations over other measurement methods. Advantages include the greatly superior accuracy and precision of the method that allow small cohort studies to be used; and the advantage of comparing RSA results from in vitro, preclinical and clinical studies within one area of interest.

A limitation is the cost of equipment necessary for the RSA technique; the specific knowledge required to use the software; and the time required to implant beads and take subsequent radiographs. Addressing these limitations will lead to further improvements in the software and developments of the technique.

CONCLUSIONS
The RSA technique has been successfully applied to measure movements of the elbow, tendon migration and fracture segment movement under load. These novel applications of this powerful technology will enable new knowledge that has direct application to improved patient outcomes.

ACKNOWLEDGEMENTS
The authors acknowledge the contribution of Zimmer Ltd, who assisted with the initial purchase of the RSA software and calibration cage. Smith and Nephew funded the purchase of the patient weight bearing platform used in fracture studies.

REFERENCES
INTRODUCTION
Periprosthetic osteolysis remains the most challenging complication of total hip replacement in the medium to long-term. Knowledge of how osteolysis develops and progresses is critical to develop optimal clinical management and therapeutic approaches to this condition. We have previously shown that osteolysis adjacent to an acetabular component is strongly related to the extent and rate of wear of the polyethylene (PE) liner [1], and that PE particles have potent bio-activity in bone cell cultures [2].

Linear osteolysis adjacent to a femoral stem is generally seen on plain radiographs as a radiolucent line and results in hip pain associated with the loose implant. In some cases, however, osteolysis occurs around well-fixed femoral stems as localised and ballooning-type lesions (Figure 1). These patients usually remain asymptomatic until the bone fails to support the implant and it becomes loose or the bone fractures. The dilemma for the orthopaedic surgeon is when to intervene and what is the preferred surgical treatment option.

The aim of this study was to compare the imaging techniques used to monitor femoral osteolysis and to discuss the impact the presence of osteolysis has on surgical decision making.

METHODS
The study cohort comprised nine patients who underwent a high-resolution multi-slice computed tomography (CT) scan with metal artefact suppression to determine the presence of femoral osteolysis. The location and volume of osteolytic lesions was measured by one blinded assessor. A second blinded observer examined anteroposterior and lateral plain radiographs taken at the same time as the CT scan and measured the location and area of osteolytic lesions. Seven of the nine hips underwent revision surgery.

RESULTS AND DISCUSSION
Femoral osteolysis was detected on both CT and plain radiographs in all nine patients. At revision surgery, three patients had full femoral revisions, three patients had a revision femoral stem cemented into the original cement mantle and one patient had a femoral head exchange and the existing stem retained. Debridement and bone grafting of proximal lesions was undertaken in all seven revision surgeries. In the three patients with distal osteolysis, the lesions were not accessed.

Removal of a cement mantle at the time of revision of a femoral stem can prolong the operative time, increase blood loss and predispose to femoral fracture or femoral cortex perforation [3]. To avoid these complications, a revision femoral stem can be cemented into the original cement mantle or the original femoral stem can be retained with a new femoral head. However, these techniques do not allow for the treatment of distal femoral osteolytic lesions. Further monitoring of these lesions will determine whether removal of the source of particles, in particular the polyethylene particles, slows or prevents the progression of these osteolytic lesions or results in their repair.

REFERENCES
THURSDAY, 1 SEPTEMBER 2011

11:55 – 12:05  Symposia Session 5 – From Kinematics/Gait to the Clinic
A COMPARISON BETWEEN DOMINANT AND NON-DOMINANT LEG KNEE KINEMATICS AND KINETICS DURING A SINGLE-LEG DROP LANDING FROM DIFFERENT HEIGHTS IN FEMALE ATHLETES

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INTRODUCTION
Landing is a high demand manoeuvre commonly performed in athletic activities. Both single-leg and double-leg landings have been associated with lower extremity injuries such as anterior cruciate ligament (ACL) rupture. The single-leg landing leads to a greater injury risk as it is performed with less knee flexion and provides less stability compared to a double-leg landing [1]. Although landing manoeuvres pose a risk for both genders, females have been shown to be more susceptible to ACL injury [2]. One possible explanation is that females exhibit leg dominance, which is an imbalance of leg muscle strength such that one side exhibits greater dynamic control [3]. Furthermore, landing height contributes to the risk of knee injury. Drop landing studies have shown increases in peak ground reaction forces (GRFs), knee flexion angles, and joint powers at greater landing heights [4,5]. The purpose of this investigation is to compare side-to-side differences in knee kinematics and kinetics during single-leg drop landings from two heights in an athletic female population.

METHODS
Eight female participants who regularly participate in a landing sport (e.g., volleyball, netball, gymnastics) were enrolled in the study, with a mean[SD] age of 23.8[3.7] years, height of 167.7[5.7] cm, and mass of 61.8[6.6] kg. The study was conducted in the Biomechanics Laboratory at the Australian Institute of Sport (Canberra, ACT). All participants signed an informed consent in accordance with the relevant human ethics research committees. Anthropometric measurements, including height, mass, ankle width, knee width, and leg length, were obtained. A total of 54 retro-reflective markers (14 mm diameter) were attached to specific locations on the participant’s lower limbs, trunk, and arms. The three dimensional kinematic data was collected using a motion analysis system (250 Hz; VICON Mx, Oxford Metrics, UK) consisting of ten optical infra-red cameras. Ground reaction forces (GRFs) were simultaneously collected with two synchronized force plates (1000 Hz; Model Z12697, Kistler Instrument Corporation, USA). Each participant identified her dominant limb as the preferred limb for kicking a ball. Following a standardised warm-up, the participant was instructed to step off the height-adjustable platform and land barefoot onto the force plate with her dominant or non-dominant limb, the order of which was randomised. The two drop landing techniques were performed at heights of 30 cm and 60 cm, respectively. Maximum GRF, knee flexion angles, and knee moments will be analysed across the participants.

RESULTS AND DISCUSSION
There were no significant side-to-side differences in peak GRF from both 30 cm and 60 cm landing heights, although significant increases were observed from 60 cm compared to 30 cm for both dominant and non-dominant leg landings (Figure 1). No significant differences in maximum knee flexion were found between dominant and non-dominant landings at both heights (Figure 2).

CONCLUSIONS
The results of this study will provide insight into factors influencing ACL injuries, such as leg dominance and landing height. Further analysis is required to better understand the differences between dominant and non-dominant single-leg landing tasks.

REFERENCES
INTRODUCTION
The Nintendo Wii-Fit is increasingly being incorporated into musculoskeletal rehabilitation protocols. The Wii Balance Board (WBB) has been shown to be a valid equivalent to a laboratory-grade force platform for the assessment of standing balance [1]. We investigated the validity and reliability of the balance tests included with the Wii-Fit software.

METHODS
Thirty subjects free of lower limb pathology were measured during a series of standing balance tests using different stances. Data was collected from one set of trials on the WBB using the Wii-Fit software and another set of trials using custom software on a laptop computer. The tests were then repeated on a second occasion within 2 weeks. Center of pressure data from repeated tests was collected simultaneously from a commercial force platform using its integrated software and from the WBB using the Wii-Fit software. The data from each was compared and analyzed, applying the equations of known, validated standing balance measurements.

RESULTS AND DISCUSSION
An algorithm was created that approximates a measure of variance of the centre of pressure changes during the test to the percentage score generated by the ‘Stillness’ test. This allowed direct comparison between raw centre of pressure data from the force platform and the ‘Stillness’ percentage scores. The percentage scores generated by the Wii-Fit ‘Stillness’ test did not correlate to the results predicted by any validated equation used as a measure of standing balance (Figure 1). The output from both pieces of software showed excellent test-retest reliability (ICC – 0.75-0.9). The minimum detectable change between tests was <20% for the double-stance eyes-open condition, 20-50% for double-stance eyes-closed and >90% for unilateral-stance eyes-open and unilateral-stance eyes-closed.

CONCLUSIONS
The Wii-Fit ‘Stillness’ score is reliable but does not appear to be based on a valid measure of standing balance. It has potential as an affordable, clinic-based balance-screening tool to be used in conjunction with the WBB, although the validity of the score needs to be investigated further.

REFERENCES
12:50 – 13:40  Symposia Session 6 – Biomaterials and Skeletal Tissue Engineering
MESOPOROUS BIOGLASS SCAFFOLDS AS THE PLATFORM FOR DRUG DELIVERY AND BONE TISSUE ENGINEERING
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INTRODUCTION
Mesoporous bioactive glasses (MBG) are considered the third-generation of bioglasses and were developed in 2004 by the combination of sol-gel method and supramolecular chemistry of surfactants [1]. These materials are based on a CaO-SiO$_2$-P$_2$O$_5$ composition and have a highly ordered mesopore channel structure with a pore size ranging from 5–20 nm. Compared to non-mesopore bioactive glass (BG), MBG possesses a more optimal surface area, pore volume, improved \textit{in vitro} apatite mineralization in simulated body fluids and excellent cytocompatibility [2]. These significant advantages suggest that MBG is the excellent candidate material to be used as a platform for efficient drug delivery and bone tissue repair. Therefore, the aim of study is to investigate MBG scaffolds for drug delivery and bone tissue engineering application. For this aim, pure MBG scaffolds and MBG/silk composite scaffolds have been developed and their \textit{in vitro} and \textit{in vivo} osteogenesis has been systematically studied.

METHODS
Pure MBG scaffolds were prepared by a novel 3D-plotting technique. MBG/Silk composite scaffolds were prepared by using a freeze-drying method. The composition and porous structure were characterized. Dexamethasone (DEX) loading and delivery in the scaffolds were evaluated. The \textit{in vitro} bioactivity of MBG and its composite scaffolds were investigated by evaluating the attachment, proliferation, differentiation and bone cell-relative gene (alkaline phosphatase activity (ALP) and osteocalcin (OCN)) expression of bone marrow stromal cells (BMSC). The \textit{in vivo} osteogenesis of MBG and its composite scaffolds were explored by evaluating their new bone formation in rat bone defects.

RESULTS AND DISCUSSION
The prepared MBG scaffolds possess highly porous structure with controllable large pores and mesopores (Figure 1). 3D-plotting MBG scaffolds possess excellent mechanical strength with compressive strength of 16MPa. They have sustained drug delivery until to 8 weeks. The sustained delivery of DEX significantly improved the proliferation, ALP activity and bone-relative gene expression of BMSC. MBG and its composite scaffolds have excellent in vivo bone-formation ability. After implanting scaffolds in the tibia defects of rat models, MBG and its composite scaffolds induce new bone ingrowth (Figure 2).

CONCLUSIONS
MBG and its composite scaffolds are very promising platform for drug delivery and bone repair and tissue engineering.

ACKNOWLEDGEMENTS
Vice-chancellor Research Fellowship from Queensland University of Technology and Alexander von Humbolt Foundation, Germany.

REFERENCES
SCAFFOLD-LIKE HYDROXYAPATITE ON LOAD-BEARING ZIRCONIA CORE FOR BONE REPLACEMENT IMPLANT APPLICATIONS

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INTRODUCTION

Hydroxyapatite (HA) scaffolds would be excellent candidates for bone replacement implants if they had sufficient bending strength matching that of natural bones. Unfortunately, the actual bending strength of a typical HA scaffold with open pores larger than 100 μm required for bone tissue ingrowth is near zero, which basically rules out the possibility of direct applications of HA scaffolds as bone replacement implants, despite of other attractive properties of HA such as being bio-resorbable and osteoactive.

To overcome the low bending strength of HA scaffolds, we have recently developed a new manufacturing technique [1,2], which can deposit scaffold-like HA-coatings on strong zirconia cores. The bending strength of such HA-coated bio-ceramics is over 300 MPa, matching the upper bending strength limit of natural bones, and is stronger than fully dense HA with a typical bending strength around 100 MPa.

METHODS

First, zirconia-based substrates were pre-sintered at 900 °C, which removes the polymer additives in the green ceramic cores creating micro-pores suitable for HA-coating deposition. At this stage, the green ceramic cores can be easily machined into any required shape and dimension.

Then, water-based low-density HA-slips with polymer additives for micro-pore generations are prepared, and applied onto the micro-porous zirconia cores. HA-coatings with graded micro-porosity and material compositions are deposited using HA-slips of different material compositions and polymer vol %.

After slow drying, the HA-coated zirconia-core is sintered at 1,300 °C. The coating and substrate co-sintering process results in strong interface bonding between the HA-based coating and zirconia-based substrate/core. At the same time, graded micro-pores are generated in the coating layered due to polymer burn-out.

RESULTS AND DISCUSSION

To test the feasibility of our new processing method, we have deposited thin HA-based coatings between 20 to 200 μm onto different zirconia-based strong cores. At the present trial stage, the micro-pores in the HA-based coatings are between 5 to 50 μm. In principle, thicker HA coatings measured in mm and with open pores larger 100 μm can also be deposited on those existing thin HA-based coatings. Figure 1 shows one example of such a HA-coated zirconia-core.

Figure 1: (a) surface view of micro-porous HA-based coating with open pores around 20 μm, (b) cross-section view of the HA-based coating and zirconia-based core.

The cross-section view of the HA-coating on zirconia-core in Figure 1 (b) shows the resin (dark phase) has penetrated into the HA-based coating (around 30 μm in thickness) through the open pore system, and a strong interface has been formed between the HA-based coating and the zirconia-based core. Recently, we have successfully deposited HA-coatings over 500 μm in thickness with open pore larger than 50 μm on 3-D bar samples.

CONCLUSIONS

A simple processing method has been developed, which can be used to deposit scaffold-like HA-coatings on load-bearing zirconia cores. The bending strength of such bio-ceramics, over 300 MPa, is sufficient for bone replacement implants.

ACKNOWLEDGEMENTS

The authors would like to thank the Australian Research Council for the financial support (DP110105296: 2011-2013).

REFERENCES
INTRODUCTION
Every year millions of people are at risk of bone fracture due to osteoporosis, suffer from the loss or failure of an organ or tissue. Bioengineering is an emerging science that has the potential to address these health issues in reducing the incidence of such diseases and preparing a cost effective treatment.

Tissue engineering is an alternative method for the treatment of organ implants. It consists of growing live cells into 3D scaffolds to form whole tissues capable of normal biological functions. A number of challenges remain in fabricating and applying off-the-shelf tissue engineering organs. These include the need for biomaterials with desired mechanical, chemical, and biological properties for scaffold fabrication; the generation of 3D scaffolds with desired porosity and pore interconnectivity for cell differentiation and proliferation; and the process that reduce or eliminate the use of organic solvents in the synthesis and processing of biomaterials to promote their biocompatibility.

This paper will give an overview of our research in engineering scaffolds with desired properties and also synthesis of polymers using high pressure CO$_2$.

METHODS
Fabrication of porous hydrogels
Different synthetic and natural polymers were crosslinked under high pressure CO$_2$. Pore morphology of the scaffolds, fabricated with this technique was manipulated by controlling the operating parameters, i.e. saturation pressure and temperature; soaking time and depressurization rate. Several techniques such as SEM, XPS, and ATR FTIR, and mechanical testing were used to determine the effect of operating parameters on the architecture of pores created within three the dimensional structure of hydrogels.

Synthesis of polymers
Reactants, initiators and catalysts were placed in high pressure vessel and the reaction took place under high pressure CO$_2$ at predetermined pressure and temperature. The usage of organic solvents was eliminated in this technique, led to fabrication of more biocompatible synthetic polymers.

RESULTS AND DISCUSSION
Hydrogels fabrication
Homogenous pores were produced in chitosan hydrogels, when using CO$_2$ at 60 bar and moderate temperatures. The pores size and porosity were tuned by controlling the depressurization strategy and surfactant concentration in the range of 32 µm to 140 µm, and porosities from 59% to 87%. Interpenetrated composite mixture of chitosan and bioactive glass (BG) were also fabricated under high pressure CO$_2$. BG was used to promote osteoconductivity and osteoinductivity of chitosan hydrogel. The average pore size of the composite hydrogel was 140 µm and the results of EDX analysis confirmed uniform distribution of BG in chitosan structure.

Semi interpenetrated composite scaffolds of poly(ε-caprolactone) (PCL) and elastin was prepared using the technique developed in this study. Elastin fibers were impregnated throughout the 3D structure of PCL under high pressure CO$_2$. In vitro studies show that these composites can support primary articular cartilage chondrocyte adhesion and proliferation within the 3D structures.

Synthesis of polymers
High pressure CO$_2$ was used as an alternative solvent for the fabrication and purification of synthetic polymers such as poly (l-lactic acid) (PLLA), poly(propylene carbonate), and poly (lactide-co-ethylene oxide-co-fumarate) (PLEOF). The fabricated PLLA and PLEOF, using this technique, had a high yield and a low polydispersity index. In this study, usage of toxic organic solvent was reduced, resulted in formation of more biocompatible biomaterial, suitable for tissue engineering. We were also modified the surface of these polymers with natural hydrogels to enhance surface properties of polymer and enhanced osteoblast cell adhesion and proliferation.

CONCLUSIONS
Dense gas CO$_2$ was used as a foaming agent to create porosity within the 3D structure of different natural hydrogels that were dissolved in an aqueous solution. High pressure CO$_2$ was also used as an alternative solvent and carrier; a reagent for the synthesis and purification of polymers successfully. The techniques developed has eliminated and substantially reduced the consumption of organic solvent in processing biomaterials for tissue engineering application.

ACKNOWLEDGEMENTS
The authors acknowledge the financial support of Australian Research Council.
INTRODUCTION

Cells grown in vitro in three dimensions (3D) on a polymeric scaffold have been extensively investigated in tissue engineering applications. Recently, 3D cultures are suggested as a better model to study complex biological processes than cells grown in monolayers. To engineer a tissue or organ with a specific function, a matrix material (natural or synthetic) plays a critical role in allowing for the appropriate cell distribution and in guiding the tissue regeneration in three dimensions.

We have synthesized amphiphilic triblock copolymers of methoxy-poly(ethylene glycol)-poly(L-lactide)-poly(L-lysine) (MPEG-b-PLL-b-PLL) (\(M_n = 8500-22200\)). Films were fabricated by bending PLLA with the triblock copolymers. No cytotoxicity was detected on the films and the triblock copolymers MPEG-b-PLL-b-PLL showed better surface properties in promoting osteoblast adhesion and proliferation compared with pure PLLA and PLLA modified with MPEG-PLL will be casted on the porogen. After the solvent was removed, EDTA was added to leach the porogen, leaving porous polymeric scaffold.

RESULTS AND DISCUSSION

Monodispersed hydrogel beads have been fabricated using microfluidic device (Fig 2). PLLA scaffolds were also prepared (Fig 3).

CONCLUSIONS

Monodispersed calcium-alginate beads have been synthesized and employed to fabricate polymeric 3D scaffold. The scaffold will be further optimized by controlling the pore parameters. Then the scaffolds will be used for biologic test.

ACKNOWLEDGEMENTS

The authors thank the Queensland State Government for funding under of the International Biomaterials Research Alliance, Australian Research Council, University of Queensland for financial support and Australian National Fabrication Facility, Queensland Node for access to equipment.

REFERENCES

2. X. Liu, P. Ma, Biomaterials 2009, 30, 4094–4103
THURSDAY, 1 SEPTEMBER 2011

13:40 – 14:40 PhD Student Presentation Award Session 1
Novel Method for Preparation of Hierarchal Porous Structure Scaffolds

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INTRODUCTION

Pore structure is one of the important element in scaffold architecture. Recent research effort is focused on the development of scaffolds with hierarchal and gradient pore architecture mimicking the natural bone structure. Different methods have been developed for preparing the hierarchal pore structured scaffolds. Unfortunately, all of these developed methods have their own drawbacks such as complexity, non-reproducibility, decreased interconnectivity and low porosity (<80%) and compromised mechanical properties.

METHODS

A macroporous Sr–Hardystonite (Sr–Ca2ZnSi2O7, Sr–HT)
scaffold with the average pore size of ~1200 µm and porosity of ~95% was prepared using polymer sponge method. The struts of the scaffold were coated with a viscous paste consisted of salt (NaCl) particles and polycaprolactone (PCL) to provide a layer with thickness of ~300-800 µm (Fig1). Different groups were prepared based on different salt particle sizes (table 1). The compressive strength of the scaffolds was determined using the Instron machine. Image analysis and FE-SEM were used to measure pore characteristics of the scaffolds.

Table 1: Designation, composition and physical properties of prepared scaffolds.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Salt to PCL Weight Ratio</th>
<th>Salt Milling Time(h)</th>
<th>Macropores Size Range(µm)</th>
<th>Micropores Size Range(µm)</th>
<th>Nanopores Size Range(µm)</th>
<th>Porosity(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sr–HT</td>
<td>0</td>
<td>0</td>
<td>1000-1200</td>
<td>5-10 (micron pores)</td>
<td>5-500</td>
<td>95±1</td>
</tr>
<tr>
<td>Sr–HT8h</td>
<td>0.8</td>
<td>8</td>
<td>400-500</td>
<td>0.8-10</td>
<td>85±2</td>
<td>86±2</td>
</tr>
<tr>
<td>Sr–HT24h</td>
<td>0.8</td>
<td>24</td>
<td>400-600</td>
<td>4.76-33</td>
<td>0.98±0.4</td>
<td>86±4</td>
</tr>
<tr>
<td>Sr–HT12h</td>
<td>0.8</td>
<td>12</td>
<td>400-500</td>
<td>4.16-21</td>
<td>0.07±0.39</td>
<td>86±2</td>
</tr>
<tr>
<td>Sr–HT72h</td>
<td>0.7</td>
<td>72</td>
<td>400-500</td>
<td>4.36-11</td>
<td>0.04±0.29</td>
<td>85±1</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

As shown in Fig. 2(A) to (D), the prepared scaffolds are composed of different scaled pores uniformly distributed within the scaffold with high degree of interconnectivity. Macropores are provided by the ceramic scaffolds while the micro to nanopores are created by leaching out the salt particles from inside the PCL layer.

CONCLUSIONS

Hierarchical pore structured composite scaffolds have been successfully fabricated by the development of a new and simple method. The resulting porous structure could cover a full range of porosity and pore sizes (from nano, micro to macro scale) by adjusting the process variables.

Acknowledgements

The authors acknowledge the Australia National Health and Medical Research Council, Rebecca Cooper Foundation Australian Center for Microscopy and Microanalysis at University of Sydney.
Synthetic nanocomposite scaffold alone promotes in vivo bone regeneration in critical size bone defect

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INTRODUCTION
Replacing extensive local bone defects presents a significant challenge. Current treatments with bone grafts or with synthetic bone substitutes have major limitations. In particular, currently available synthetic bone substitutes have inadequate mechanical strength and less than optimal osteoconductive and osteoinductive properties. It has become clear that if we are to achieve truly effective bone substitutes for the repair of bone defects, nanocomposite materials are required that mimic cancellous bone in architecture, material and biological properties. Previously we developed scaffolds that reproduce cancellous bone architecture and porosity (patented #2007905843), comprises Baghdadite (Ca3ZrSi2O9). Over the past year, we developed a nanocomposite coatings that can be combined to produce composite scaffolds that duplicate the mechanical strength, elasticity and bioactivity of cancellous bone.

METHODS
Struts of Baghdadite scaffold were coated with a nanocomposite layer consisting of nanoparticles of either bioactive glass (nBG) or nano hydroxyapatite (nHA) and polycaprolactone (PCL) (BCP/PCL-nBG) to enhance its mechanical and biological behavior. Similar coatings we reapplied to the clinically used hydroxyapatite/tricalcium phosphate ceramic scaffolds (HA/TCP). The mechanical strength and elasticity of the scaffolds were determined. The scaffolds were implanted in a critical size bone defect in the rabbit radius for 12 weeks.

RESULTS AND DISCUSSION
We have shown that there is a several fold magnitude increase in the compressive strength of the developed scaffolds when 10% nBG or nHA is incorporated, compared to Baghdadite and the clinically used HA/TCP, with each ceramic of similar levels of porosity (90%), pore diameter (300-500μm), and interconnectivity (99%). The nanocomposite coatings provided the scaffolds with superior elastic properties and bioactivity, compared to the uncoated scaffolds. We demonstrated that Baghdadite scaffolds and their nanocomposites (Baghdadite/PCL-10wt%nBG) were well tolerated when implanted into rabbit radius for 12-weeks and provided superior osteoconductivity and osteoinductivity compared with the clinically used HA/TCP controls (Fig 1) with substantially greater bone filling of the defect. Only remnants of the Baghdadite scaffolds (modified and unmodified) remain after 3 months.

CONCLUSIONS
We have produced elastic nano-composite ceramic scaffolds with improved compressive strength and elasticity. We demonstrated that, in an in vivo load bearing model, these scaffolds are superior in their bioactivity, osteoconductivity and osteoinductivity, compared to the clinically available scaffolds.

ACKNOWLEDGEMENTS
The authors acknowledge the generous funds received for the NHMRC and the Rebecca Cooper foundation. We are grateful to for Barbara James for her technical assistance. The authors report no conflict of interest.
Effects of subchondral junction microstructure on the stress distribution: A finite element study

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INTRODUCTION
Impact-induced trauma to the knee joint is a key factor leading to post traumatic knee osteoarthritis. Such injuries are common during anterior cruciate ligament rupture in the form of articular cartilage (AC) fissures and subchondral bone (SB) micro-cracks [1]. Computational studies have been performed to understand the biomechanical factors associated with such damages [2]. The interface between the AC and the SB is often described by an idealised straight line (2D) in such finite element (FE) studies. However, the subchondral junction has a complex geometry that may affect the intra-tissue stress state. In this paper, the effects of this complex geometry at the AC/SB interface under impact load were studied using a 3D FE model. The mechanical response of a model containing the detailed microstructure of the subchondral junction was compared with that of an idealised flat interface model.

METHOD
A 5mm diameter osteochondral plug was extracted from an ovine tibial plateau and scanned using a micro computed tomography machine (MicroXCT-200, Xradia) at a resolution of 9.5microns. The acquired images were imported to a 3D image reconstruction software (Simpleware 4.2, UK) and segmented into AC and SB. The microstructure in one of the segmented slices is as shown in Fig. 1. Two FE models were developed using the 3D reconstructed images. Model 1 (Fig. 2a) includes the detailed geometry of the AC/SB interface while in Model 2 (Fig. 2b) the microstructure features in the AC/SB interface from model 1 were substituted with a flat surface.

Figure 1: Micro-CT slice of osteochondral plug showing the microstructure of the subchondral junction.

Figure 2: Meshed volumes of the true geometry (Model 1) and the idealized geometry (Model 2)

Both models were meshed such that a similar element size was obtained (see Table 1). The created volume meshes were imported to a FE package (Abaqus 6.9-2). Abaqus/Explicit was used to simulate a drop test by dropping a mass onto the osteochondral explants for both models. Boundary conditions were applied to simulate a confined compression experiment of the osteochondral explants. Frictionless contact was defined between impact surface and cartilage surface. AC and SB were modeled as linear isotropic materials in both models, with Young's modulus of 20MPa and 3GPa and Poisson’s ratio of 0.49 and 0.3 respectively.

RESULTS AND DISCUSSION
Peak apparent stress did not change noticeably between two models (2% higher in model 1). However, the maximum stress over the entire model was 79% higher in model 1. The stress on the SB interface varied from 37-14MPa in model 1 whereas in model 2 it was distributed almost evenly (25-21MPa).

Table 1: Mesh properties for both models and computed stresses in the SB interface.

<table>
<thead>
<tr>
<th></th>
<th>No. of Elements</th>
<th>No. of Nodes</th>
<th>Element type</th>
<th>Max. stress</th>
<th>Avg. stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>17623</td>
<td>26095</td>
<td>C3D10M</td>
<td>37</td>
<td>22.2</td>
</tr>
<tr>
<td>Model 2</td>
<td>16808</td>
<td>25848</td>
<td>C3D10M</td>
<td>24.7</td>
<td>22.9</td>
</tr>
</tbody>
</table>

The value of von Mises stress in AC was 51% higher in model 1 while the average of stress changed only by 3%. Fig. 3 shows the distribution of stress in the deep layer of cartilage. The location of high stresses is around the micro features as expected. Further mesh convergence studies confirmed the mesh size which was used.

Figure 3: Uneven (left) and uniform (right) distribution of stress in deep layer of cartilage.

CONCLUSIONS
This study showed that the micro architecture in AC/SB interface has an important effect on the FE predicted intra-tissue stress and should be considered if the damage is studied at the micro level. The developed true geometry model will be used in future studies to quantify the impact-induced damage in specimen-specific geometry models.

REFERENCES
INTRODUCTION
Injuries to bone and tendons can cause major morbidity in healthy, active people. The ability to provide a scaffold that encourages appropriate cell attachment, growth, and ultimately tissue regeneration, could improve the clinical outcomes from injuries such as rotator cuff tears and non-union fractures. Several scaffold materials of both natural and synthetic origin have been tested in this study to evaluate their potential utility in musculoskeletal regenerative medicine.

METHODS
Four scaffolds were evaluated as biomaterials: Spidrex® 543 (Oxford Biomaterials Ltd, UK), a spider-like silk fabric; Endoform™ (Mesynthes, NZ), a decellularised ovine forestomach matrix; three-dimensional (3D) collagen gels and FiberWire® (Athrex. Inc, US), a polyethylene and polyester composite suture, currently utilised in orthopaedic surgery.

Scaffold immunogenicity was determined by exposing primary human dendrocyte cells to the scaffold materials and measuring the activation of cell-surface markers. Attachment and growth of primary osteoblasts and tenocytes were analysed using live-dead staining and alamar blue fluorescence. Morphological phenotype was assessed using confocal microscopy, while real-time PCR was employed to evaluate cell differentiation.

RESULTS AND DISCUSSION
FACS analysis determined that the spider-like silk fabric, Spidrex® 543, invoked a high immune response in the primary human dendrocytes, while Endoform™ and the 3D collagen gels had relatively low immunogenicity. FiberWire®, the synthetic suture material currently used in orthopaedic surgery produced relatively high immune activation within these cells.

Osteoblasts and tenocytes both successfully adhered to and grew on the Endoform™, Spidrex® 543 and within the 3D collagen gels, whereas the orthopaedic suture material proved unsuitable for cell attachment/growth (Figure 1). Gene analysis and morphology in the three permissible scaffolds suggest cells retain their phenotype when cultured in them.

The 3D culture systems support and amplify proliferation and differentiation. Notably, the effect of potent osteoblast-stimulating factors lactoferrin, TGFβ and PDGF were significantly enhanced in osteoblasts cultured within 3D gels (P≤0.05) compared to osteoblasts in 2D cultures, while gene expression of key osteoblastic markers alkaline phosphatase, osteocalcin and bone sialoprotein were increased 7-, 350- and 22-fold, respectively, in osteoblasts cultured within 3D collagen gels for 48hrs (P≤0.05).

CONCLUSIONS
Through systematic in vitro evaluation we have identified a number of commercially available biomaterial scaffolds that support and promote target cell growth. These have the potential to significantly improve the clinical outcome of both bone and tendon regeneration.

However, further in vitro and in vivo testing will be required to determine if they are clinically viable and to determine which may perform best.

ACKNOWLEDGEMENTS
Maurice Wilkins Centre, NZ
Dunbar Lab, School of Biological Sciences, University of Auckland, NZ
Auckland Bioengineering Institute, University of Auckland, NZ
THURSDAY, 1 SEPTEMBER 2011

15:10 – 16:10 PhD Student Presentation Award Session 2
THE REFRACTIVE INDEX OF ARTICULAR CARTILAGE

PRELIMINARY STUDY

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INTRODUCTION

Refractive index (RI) characterizes the manner of light interaction with materials during its propagation which is the unique property to a material. Articular cartilage (AC) is highly inhomogeneous and diffuse. The consistent change of the composition and microstructure in the normal direction may induce various RIs in different zones which further influences the image resolution and quality in optical microscopy.

Confocal microscope is a specialized optical microscopy which enables imaging of the internal microstructure of biological tissues without physical section and dehydration. However, it is well accepted that the change of RI of the AC with the depth from the surface causes imaging distortion such as the elongation of the microstructure in the direction, particularly, when a low numerical aperture objective is used for the image acquisition. Despite of this, little work has been carried out to detailed study the RI of AC. Utilizing a Leica TCS SP2 confocal microscope (Leica Microsystems, Germany), the present study developed a sub-pixel edge detection based method to measure the RI of AC, which was an improved work of the precious paper of Dirckx [1]. The method can potentially be used to monitor the early osteoarthritic change of AC.

METHODS

To find the relationship between the mismatch of RI and the focal shift during confocal imaging, a simplified point spread function (PSF) model was built by customized MATLAB programs [2]. The distilled water was adopted to verify the precision of the current method.

There were two specimens in the experimental mount. One was a drop of immersion oil with known RI and the other was a drop of distilled water stained by Rhodamine B. The two specimens was placed side-by-side. After covering with a coverslip, the two specimens with identical physical thickness were scanned by the confocal microscopy from the upper surface to the bottom.

A sub-pixel edge detection based method was developed to measure the optical thickness of the confocal slices accurately. In this algorithm, the confocal slice was firstly smoothed. Then, a traditional Canny operator was implemented to find the rough edges of the specimens. For each column of the rough edges, the area covering the edge step was picked out and the accurate positions of the edges were located by a Tabatabai’s sample moment based one-dimensional edge operator [3]. The distance between the linear fitted upper and lower edges is the optical thickness.

In our PSF Model, the RI of the immersion oil is a constant. For any input RI of the specimen to be measured, the corresponding focal shift will be acquired. The focal shift has linear relationship with the ratio of optical thicknesses of the two specimens. A group of possible RIs of the specimen were input the PSF model and a curve defined the relationship between the input RIs and the corresponding ratio of optical thickness was built.

Therefore, once the accurate optical thicknesses of the two specimens were acquired, the unknown RI of the other specimen could be interpolated from the curve we had built. To decrease the impacts of system noise and calculation errors, hundreds of such procedures were repeated to obtain the average RI of different confocal slices.

By replacing the distilled water with AC layer from the superficial to radial zones and repeating the procedure, the RI of AC in different zones can be calculated.

RESULTS AND DISCUSSION

The overall refractive index of distilled water measured by this method was $1.3340 \pm 0.0068$, which showed no more than 0.0045% of error compared to the authoritative measure $(1.3334, 0.1\text{MPa}, 20^\circ\text{C}, 589\text{nm})$ [4].

CONCLUSIONS

We developed a method using confocal microscope to measure the accurate RI of distilled water. This method can be extended to study the RI of inhomogeneous biological materials, such as AC, and may have the potential to detect early intrinsic pathological changes of AC (osteoarthritis).

REFERENCES

A COMPARISON OF THORACIC AND LUMBAR ERECTOR SPINAE ACTIVITY DURING EXTENSION IN PRONE LYING AND SITTING.

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INTRODUCTION
Thoracic hyperkyphosis (excessive anterior curvature) is associated with decreased physical function and increased mortality [1]. It has been suggested that back extension exercises in prone lying reduce thoracic hyperkyphosis [2]. However, prone extension exercises are also used to strengthen the lumbar extensors [3]. The effectiveness of seated extension exercises on thoracic extension has not been examined. The primary aim of this study was to assess the relative contribution of the thoracic erector spinae (TES) and the lumbar erector spinae (LES) during extension from prone and to compare this to extension in sitting.

METHODS
Twenty healthy subjects (10 aged < 30 and 10 aged > 70 years, equal males and females in each group) participated in the study. Surface electromyography (sEMG) was used to measure the amplitude of muscle activity in the LES during extension in prone lying with the arms in three positions (P1, P2, P3), and during sitting extension without, and with, scapular retraction (S1 and S2) (Figure). Because TES activity cannot be measured directly with sEMG [4], the log-ratio of normalised moment / normalised LES amplitude (reflecting the relative contribution of LES to the total moment) for each extension task was used as a surrogate marker of TES activity. Amplitudes and moments were normalised to the maximum value measured for each subject over all five extension tasks.

RESULTS AND DISCUSSION
The LES were significantly more active in prone than they were in sitting but the moments generated for all of the tasks were similar (Table). The log-ratio of normalised moment to normalised LES amplitude was significantly higher for the sitting tasks than for the prone tasks (0.51 ± 0.08 vs 0.003 ± 0.06; p < 0.001) indicating that the TES contributed more to extension in sitting. Retracting the scapulae in sitting, resulted in significantly increased LES activity (p < 0.001) (Table) but there was a trend to greater extension moment and a higher Nmoment/LES log-ratio indicating greater TES contribution.

CONCLUSIONS
The results indicate that extension exercises in prone primarily activate the LES while extension in sitting, especially with scapular retraction, results in greater TES activation. Extension in sitting with scapular retraction may therefore be the better exercise for reducing thoracic hyperkyphosis and improving posture in the elderly and osteoporotic.

REFERENCES

Table. The sEMG amplitudes for the lumbar erector spinae (LES) and the moments, normalised moments and log ratio of normalised moment/normalised LES amplitude for the five extension tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>N.LES</th>
<th>Moment</th>
<th>Nmoment</th>
<th>Log-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>0.87 ± 0.02*</td>
<td>106.66 ± 11.16</td>
<td>0.85 ± 0.05</td>
<td>-0.13 ± 0.13</td>
</tr>
<tr>
<td>P2</td>
<td>0.79 ± 0.03***</td>
<td>109.87 ± 10.51</td>
<td>0.88 ± 0.03</td>
<td>0.06 ± 0.06</td>
</tr>
<tr>
<td>P3</td>
<td>0.75 ± 0.03***</td>
<td>100.65 ± 12.73</td>
<td>0.79 ± 0.05</td>
<td>0.09 ± 0.09</td>
</tr>
<tr>
<td>S1</td>
<td>0.37 ± 0.03</td>
<td>93.20 ± 8.96</td>
<td>0.75 ± 0.04</td>
<td>0.52 ± 0.11</td>
</tr>
<tr>
<td>S2</td>
<td>0.43 ± 0.04*</td>
<td>102.27 ± 9.90</td>
<td>0.84 ± 0.05</td>
<td>0.50 ± 0.12</td>
</tr>
</tbody>
</table>

Note: * significantly greater than all other task values (p < 0.001); ** significantly greater than S1 and S2 (p < 0.001); † significantly greater than S1 (p < 0.001).
Higher expression of osteoclast ITAM-related molecules is associated with human polyethylene-induced peri-prosthetic osteolysis

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INTRODUCTION
Peri-prosthetic osteolysis (PO) leading to implant loosening and failure is associated with an inflammatory response to prosthetic wear debris. This inflammatory response induces cytokines that increase expression of the crucial osteoclast differentiation factor receptor activator of NF kappa B ligand (RANKL) that stimulates osteoclast differentiation and activity. Polyethylene (PE) is a common example of particles liberated from prostheses and linked to the pathology of PO. In addition to the crucial RANK/RANKL/OPG axis, optimal osteoclastogenesis requires co-stimulation of immunoreceptor tyrosine-based activation motif (ITAM)-associated receptors like osteoclast-associated receptor (OSCAR) and triggering receptor of myeloid cells-2 (TREM2) [1]. We have found increased expression of OSCAR, TREM2 and FcR γ mRNA and protein in human peri-implant tissues from patients undergoing revision surgery. This study aimed to investigate the expression of these ITAM-associated receptors and their respective associated adaptor molecules, Fc receptor common gamma subunit (FcRγ) and DNAx-activation protein-12kDa (DAP12) in response to PE particles in an in vitro collagen-embedded model of peri-implant osteolysis.

METHODS
The direct effect of PE particles on the expression of ITAM adaptor and receptor molecules and osteoclast formation and activity was investigated in a collagen-embedded cell culture system described in Atkins et al. (2009) [2]. Monocytes from human buffy coats (three donors) were exposed to 500 µg/mL PE particles in collagen over three days before being isolated and subsequently differentiated into osteoclasts in presence of 50ng/mL RANKL and 25ng/mL macrophage-colony stimulating factor (M-CSF) up to Day 17. The effect of PE particles on osteoclast formation, resorption activity and mRNA expression was assessed using tartrate-resistant acid phosphatase (TRACP) staining, pit resorption analysis and quantitative reverse-transcription polymerase chain reaction (qRT-PCR).

RESULTS AND DISCUSSION
In presence of RANKL and M-CSF, PE particles appeared to further increase the number of multinucleated TRAP-positive cells formed and total resorption pit areas in three donors assessed were observed (insert figure if possible). Examination at mRNA level suggested that PE particles also induced the expression of OSCAR, TREM2 and FcRγ Day 17. Specific primers for human DAP12 could not be designed due to the gene sequence. This data supports our previous observation of PE particles inside and in close proximity to cells expressing those molecules in human peri-prosthetic tissues.

Figure 1: mRNA expression (in relative to hARP, ∆Ct) of osteoclast ITAM-related molecules, OSCAR (a), its adaptor molecule FcRγ (b) and TREM2 (c) in collagen-embedded culture of PBMC-derived osteoclast with (filled columns) and without PE (blank columns) at Day 17 in presence of 50ng/mL RANKL, * if p<0.05

CONCLUSIONS
Data from our in vivo analysis in conjunction with the current study indicates that PE particles induce an increase in osteoclast formation and bone resorption activity via ITAM signalling pathway. Regulation of the molecules in this pathway may provide therapeutical approach for attenuating PE-induced peri-implant osteolysis.

ACKNOWLEDGEMENTS
To Gerald Atkins for his assistance with primer design, Ghafar Sarvestani from Detmold Family Trust Cell Imaging Centre and Hans Scorpe from Discipline of Anatomy and Pathology, The University of Adelaide

REFERENCES
MUSCLE COORDINATION IN ONE-LEG LANDING FROM DIFFERENT HEIGHTS

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INTRODUCTION
Anterior Cruciate Ligament (ACL) injury is one of the most debilitating injuries among young and professional athletes. Knee failures have been known to result from the impact of landing from a jump. To date, most studies focused on the landing kinematics, as opposed to the landing kinetics [1]. In this study, we aim to compute muscle forces during single leg landing in order to understand their co-activation in combination with the ground reaction force (GRF). Peak GRF is often considered to be the main cause of ACL injury during landing. Therefore we hypothesize that peak GRF and peak Quadriceps (Q) / Hamstrings (H) force ratio occur at the same time during landing. We also hypothesize that Q and H forces will increase with greater landing heights but their co-activation Q/H force ratio will remain the same.

METHODS
Eight male subjects were recruited with the following mean (SD): age of 22.9(0.6) years, height of 1.70(0.03) m, and weight of 65.9(6.9) kg. Informed consent was obtained from the subjects, in compliance with the University’s Institutional Review Board. Subjects performed landing maneuvers by stepping off an adjustable block, landing with their dominant leg. Two force plates embedded on the ground were utilized to collect the dominant foot GRF at a sampling rate of 1000 Hz. The marker data was collected using six camera motion analysis system (Vicon MX, Oxford Metrics, UK) at a sampling rate of 400 Hz based on the Plug-in-Gait Marker Set. Subject-specific biomechanical models were developed using the OpenSim software, an open-source 3D musculoskeletal modeling software [2, 3]. Muscle forces were calculated based on the inverse kinematics and the static optimization method in OpenSim software for each subject. Matlab (MathWorks Inc.) and Minitab (Minitab Inc.) software packages were utilized to export data from OpenSim software and to perform statistical analysis.

RESULTS AND DISCUSSION
Figure 1 shows the mean Q/H ratio against the mean GRF during the landing phase, which is defined by the period when the foot strikes the ground to the time when the knee achieves maximum flexion angle. Peak mean GRF occurred between 20% to 40% of the landing phase for both landing heights. However, maximum Q/H ratio occurred almost at the end of the landing phase where subjects began to extend their knees. The first peak in the mean Q/H force ratio was closer to the peak GRF in the case of landing from 60cm when compared to that from 30cm. It appears that as GRF increases due to an increase in landing height (i.e. potentially a more injurious situation), the shift in Q/H peak to coincide with peak GRF may help lessen the abrupt effects on the ACL. Figure 2 shows the increase in Q and H muscle forces at peak GRF with respect to landing heights. The peak mean Q/H ratio is also higher when landing from a lower height. However, Q/H ratio was not significantly different at peak GRF for both types of landing heights (p=0.149) (Figure 2 B).

CONCLUSIONS
Results of this study showed that peak GRF, Q and H muscles forces increase with increase landing heights. However, the Q/H ratio at peak GRF did not differ significantly for the two landing heights (p=0.149). In addition, the peak GRF and peak Q/H ratio did not occur at the same time. Further study is needed to relate ACL injury to Q/H muscles force ratio at the onset of impact loading.

REFERENCES
FRIDAY, 2 SEPTEMBER 2011

09:35 – 10:50 Early Career Researcher (ECR) Presentation Award Session
ABNORMAL GAIT PATTERNS AT 12 MONTHS FOLLOWING KNEE REPLACEMENT SURGERY CAN BE PREDICTED BY BIOMECHANICAL GAIT PARAMETERS AT 4 MONTHS POST-SURGERY

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INTRODUCTION
An abnormal flexor moment pattern is often evident in people before and after knee replacement surgery. Due to the potential influence of abnormal biomechanics on prosthetic loosening and further lower extremity joint degeneration, early identification of factors that predict abnormal knee biomechanics post-operatively is important to optimise longer term outcomes. We investigated whether a flexor moment pattern at 12 months post-surgery could be predicted using biomechanical gait measures assessed before surgery and at 4 months post-surgery.

METHODS
Thirty two patients scheduled for knee replacement surgery (mean ± SD age 68.0 ± 6.4 years, height 167.7 ± 8.7 cm, mass 85.3 ± 12.7 kg and body mass index of 30.4 ± 5.0 kg/m²) were tested before surgery and at 4 and 12 months post-surgery. Patients were classified into a normal (biphasic pattern) and an abnormal (flexor moment pattern) based on knee sagittal plane moment at 12 months post-surgery (Figure 1). The following variables taken before surgery and at 4 months post-surgery were analysed and compared between the groups using t-tests: knee angle at initial contact, peak knee flexion and extension during stance, knee range of motion and peak knee flexion and extension moments. All variables with a significance level of p < 0.05 were retained for further discriminant function analysis. Chi square and odds ratios were also used to investigate the differences in the probability of developing a flexor moment pattern at 12 months post-surgery between those who demonstrated a flexor moment pattern pre-surgery and 4 months post-surgery.

RESULTS AND DISCUSSION
The gait pattern at 4 months post-surgery was significantly associated with the 12 month post-surgery gait pattern (χ² = 7.7, df = 1, p = 0.008) with an odds ratio of 10.7 (95% confidence interval 1.7 – 65.3, p = 0.01). Over half of the patients who exhibited a flexor moment pattern at 4 months retained this pattern 12 months post-surgery. Discriminant function analysis indicated that peak knee flexion during early stance, peak knee extension and peak knee extension moment at 4 months post-surgery were significant and independent discriminators between the groups. The combination of these three measures correctly classified patients of having an abnormal knee flexor moment pattern with 78.1% accuracy (75% accuracy after validation; Wilks’ Lambda 0.605, p = 0.002).

Figure 1: Biphasic knee moment pattern (solid line) and knee flexor moment pattern (dashed line) in the sagittal plane.

CONCLUSIONS
An abnormal knee flexor moment pattern at 12 months post-surgery can be predicted by biomechanical analysis of knee function early after surgery. The observed flexion moment pattern may be an indication of lack of sufficient knee extension motion during walking. Prevention of abnormal biomechanical function of the knee during walking may require intensive post-operative rehabilitation and gait retraining with the focus on active extension to be implemented early after the operation, particularly in the first 4 months.

ACKNOWLEDGEMENTS
This study was funded by the Clive and Vera Ramaciotti Foundation and the Arthritis Foundation of Australia. HBM is currently a National Health and Medical Research Council fellow (Clinical Career Development Award, ID: 433049).
INTRODUCTION
This is a report on the bone microarchitecture and remodeling characteristics associated with Modic changes in human lumbar vertebrae, of adults undergoing spinal surgery for degenerative disease.

Modic et al. in 1988 first described characteristic magnetic resonance imaging (MRI) changes in the vertebral body bone marrow and endplates, adjacent to degenerating intervertebral discs. Depending on the changes in T1 and T2 MRI signals, three types of lesions were identified: type I lesions (low T1 and high T2 signal) are thought to be clinically active, due to increased blood flow within the bone. Type II lesions (high T1 and T2 signals) possibly reflect fatty degeneration of the bone marrow. Type III lesions (low T1 and T2 signals) are assumed to correlate with subchondral bone sclerosis / thickening [1]. Their occurrence appears to increase with age [2] and is associated with low back pain.

No thorough histological or microarchitectural analysis of such changes has, however, been published.

METHODS
Thirty-one patients underwent elective spinal surgery with lumbar vertebrae showing Modic changes on pre-operative lumbar MRI. The cases were subdivided as follows: Modic I (n=8), Modic II (n= 19), Modic III (n=4). The age of the patients was 59±12 years. A transpedicular vertebral body endplate biopsy (25 mm long, 3 mm in diameter), was taken using an 8G Jamshidi needle. The patients were asked to read an information package and to sign an Ethics Committee approved specific Informed Consent Form prior to surgery.

A micro-computed tomography (micro-CT) scan of the biopsy was carried out to provide a 3D analysis of the bone microarchitecture, for calculation of bone volume fraction, trabecular thickness and trabecular number.

Then, histological sections (von Kossa and H&E) were prepared for analysis of tissue-level bone remodeling. The erosion surface to bone surface ratio, osteoid surface to bone surface ratio, and osteoid surface to erosion surface were determined.

RESULTS AND DISCUSSION
Micro-CT analysis revealed a significantly higher bone volume fraction in Modic type III compared to Modic I and II (Fischer’s PLSD test, p<0.05, Figure 1). The increase in bone volume fraction was related with increase in trabecular number ($R^2 = 0.73$, $p<0.05$) and trabecular thickness ($R^2 = 0.40$, $p<0.01$).

Histological analysis showed a reduced osteoid surface to bone surface ratio in Modic II, compared to Modic I and III ($p<0.05$). In Modic III, a trend towards reduced erosion surface to bone surface ratio was found compared to Modic II and II, although not reaching statistical significance ($p=0.13$). In Modic III a significantly higher osteoid surface to erosion surface ratio was found, compared to Modic I and II ($p<0.05$, Figure 1).

CONCLUSIONS
These findings show bone microarchitectural differences between Modic types. It can be postulated, different Modic types represent different stages of the same pathological process linked to the adjacent disc.

Modic III changes showed significant increases in BV/TV and bone formation to bone erosion ratio, compared to Modic I and II. This suggests that Modic III changes are consistent with a more stable sclerotic phase of the pathology, with significantly higher bone volume fraction compared to Modic I and II, which might be linked to reduced bone resorption.

REFERENCES
BONE BIOMIMETIC MICROENVIRONMENT INDUCES OSTEOGENIC DIFFERENTIATION OF ADIPOSE TISSUE- DERIVED
MESENCHYMAL STEM CELLS

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INTRODUCTION
Repairing the non-union bone defects and replacing the critical-sized bone defects present a significant challenge for orthopedic surgeons around the world. Tissue engineering approach emerges as a promising treatment strategy. A critical strategy for bone tissue engineering is to create the conditions mimicking the bone microenvironment, which provides the signals necessary for bone repair and regeneration.

In this study, a bone biomimetic microenvironment was created by combining trabecular bone structure-mimicking scaffold, a biphasic calcium phosphates (BCP) scaffold coated with a nanocomposite layer consisting of hydroxyapatite nanoparticles (nHA) and polycaprolactone (PCL) (BCP/PCL-nHA), and a soluble microenvironment mediated by primary human osteoblasts (HOBs). We investigated whether and how this bone biomimetic microenvironment affects the osteogenic differentiation of adipose tissue-derived mesenchymal stem cells (ASCs).

METHODS
First, ASCs were seeded on PCL coated BCP scaffold (BCP/PCL) or BCP/PCL-nHA scaffolds, and cell attachment was determined by SEM after 2 and 24 hours of seeding. Second, ASCs were seeded on BCP/PCL or BCP/PCL-nHA scaffolds and cultured alone or co-cultured with HOBs in an indirect co-culture system for 4 and 14 days, and osteogenic gene expression of ASCs in these four groups were determined by real-time PCR. Third, integrin-α2 gene expression and mitogen-activated protein kinases (MAPKs)/extracellular signal-regulated kinase (ERK) phosphorylated proteins in ASCs were compared between the ASCs on BCP/PCL and BCP/PCL-nHA scaffolds. Finally, the functional blocking of integrin-α2 of ASCs was performed by incubating ASCs with 10µg/ml neutralizing antibody at room temperature for 30 min before seeding them on BCP/PCL-nHA scaffolds. After ASCs were cultured alone or co-cultured with HOBs for 4 and 14 days, the effects of integrin-α2 functional blocking on MAPK/ERK signaling pathways and osteogenic gene expression of ASCs were determined.

RESULTS
After 2 hours of seeding, ASCs on BCP/PCL-nHA scaffolds spread better comparing with the ASCs on BCP/PCL scaffolds (figure 1). Among the four groups (ASCs seeded on BCP/PCL or BCP/PCL-nHA scaffolds and cultured alone or co-cultured with HOBs), after ASCs were cultured alone for 4 and 14 days, ASCs on BCP/PCL-nHA scaffolds expressed significantly higher Runx2, osteopontin and bone sialoprotein than the ASCs on BCP/PCL scaffolds (figure 2); co-culturing with HOBs also significantly enhanced Runx2, osteopontin, bone sialoprotein and osteocalcin gene expression of ASCs on BCP/PCL scaffolds in an indirect co-culture system (figure 2). The most significant osteogenic gene expression was observed in the ASCs which were seeded on BCP/PCL-nHA scaffolds and co-cultured with HOBs (Figure 2). In addition, BCP/PCL-nHA scaffolds elicited the up-regulations of integrin-α2 gene expression and MAPK/ERK phosphorylated proteins in ASCs, and the functional blocking of integrin-α2 in ASCs significantly abrogated the upregulations of MAPK/ERK phosphorylated proteins and osteogenic gene expression, and the deduction of osteogenic gene expression by integrin-α2 functional blocking could not be rescued by co-culturing with HOBs.

CONCLUSION
We created a bone biomimetic microenvironment via combining trabecular bone structure-mimicking scaffold, BCP/PCL-nHA scaffold, and a soluble microenvironment fostered by HOBs, and demonstrated that the most significant osteogenic differentiation can be achieved by combining these two factors in bone microenvironment, suggesting the critical and distinct role of different component within bone microenvironment which should be taken into consideration for bone tissue engineering approach.
EGFL6 Promotes Endothelial Cell Migration and Angiogenesis through the Activation of Extracellular Signal-regulated Kinase

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INTRODUCTION

Angiogenesis is required for bone development, growth, and repair. It is influenced by the local bone environment that involves cross-talks between endothelial cells and adjacent bone cells. However, data regarding factors that directly contribute to angiogenesis by bone cells remain poorly understood. Here, we report that EGFL6, a member of the epidermal growth factor (EGF) repeat superfamily proteins, induces angiogenesis by a paracrine mechanism in which EGFL6 is expressed in osteoblastic-like cells but promotes migration and angiogenesis of endothelial cells.

METHODS

RT-PCR and Western blot were used to determine the gene and protein expression profile of EGFL6. Co-immunoprecipitation assay was used to examine protein interactions. Scratch wound healing and transwell assays were used to examine the effect of EGFL6 in SVEC (A simian virus 40-transformed mouse microvascular endothelial cell line) cell migration. In addition, the angiogenic activities of EGFL6 were examined by tube formation assay on Matrigel in vitro and chick embryo chorioallantoic membrane (CAM) assay in vivo.

RESULTS AND DISCUSSION

Co-immunoprecipitation assays revealed that EGFL6 is secreted in culture medium as a homodimer protein. Using scratch wound healing and transwell assays, we found that conditioned medium containing EGFL6 potentiates SVEC cell migration. In addition, EGFL6 promotes the endothelial cell tube-like structure formation in Matrigel assays and angiogenesis in a chick embryo chorioallantoic membrane. Furthermore, we show that EGFL6 recombinant protein induces phosphorylation of ERK in SVEC endothelial cells. Inhibition of ERK impaired EGFL6-induced ERK activation and endothelial cell migration.

CONCLUSIONS

Together, these results demonstrate, for the first time, that osteoblastic-like cells express EGFL6 that is capable of promoting endothelial cell migration and angiogenesis via ERK activation. Thus, the EGFL6 mediates a paracrine mechanism of cross-talk between vascular endothelial cells and osteoblasts and might offer an important new target for the potential treatment of bone diseases, including osteonecrosis, osteoporosis, and fracture healing.

ACKNOWLEDGEMENTS

This work was supported in part by the National Health and Medical Research Council of Australia and the Sir Charles Gairdner Hospital Research Fund.
The Use of Bone Marrow Aspirate Concentrated for Full-thickness Knee Cartilage Lesions in a One-step Procedure: 
A Prospective Study

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Introduction: The purpose of our study was to determine the effectiveness of cartilage repair utilizing one-step surgery with autologous Bone Marrow Aspirate Concentrate (BMAC) and a collagen I/III matrix.

Methods: We prospectively followed up 25 patients (mean age 46 years) operated for grade IV cartilage lesions of the knee, for an average follow-up of 2 years. All patients underwent a mini arthrotomy and concomitant transplantation with BMAC covered with the collagen matrix (Chondro-Gide®Geistlich Wolhusen, CH). Bone marrow was harvested from ipsilateral iliac crest and subjected to concentration and activation with Batroxobin solution (Plateltex®act-Plateltex S.R.O. Bratislava, SK). Co-existing pathologies were treated before or during the same surgery. All patients followed the same specific rehabilitation program for a minimum of 6 months. Ten of the patients had multiple chondral lesions. Average lesions size was 8.3 cm². X-rays and MRI were collected preoperatively and at 1 year and at final follow-up. VAS, IKDC, KOOS, Lysholm, Marx, SF36 and Tegner scores were collected at pre-op and at 6-12 months and final follow-up; nonparametric analysis was performed with the Wilcoxon rank test to compare these variations. Six patients gave their consent for second look arthroscopy and five of them for a concomitant biopsy.

Results and Discussion: Patients showed significant improvement in all scores at final follow-up (p < .005). Mean preoperative values were: VAS 5.2, IKDC subjective 43.6, KOOS Scores P=66.2/ S=68.2/ ADL=70.0/ SP=41.6/ QOL=37.2, Lysholm 60.4, Marx 4.2, SF36 (P/M) 40.4/ 51.5 and Tegner 2.0. At final follow-up mean scores were: VAS 0.7, IKDC subjective 80.7, KOOS P=94.0/ S=90.1/ ADL=95.1/ SP=71.3/ QOL=77.5, Lysholm 92.9, Marx 10.3, SF36 (P/M) 55.5/54.0 and Tegner 4.9. MRI showed good coverage of the lesion and tissue quality in all patients in accordance with clinical results. Good histological findings were reported for all the specimens analysed who presented hyaline-like features. No adverse reactions or post-operative complications were noted.

Conclusions: This study showed that the use of autologous bone marrow derived and collagen I/III matrix in a one-step procedure could represent an improvement on the currently available techniques for cartilage transplantation could be a viable technique in the treatment of grade IV knee chondral lesions.
FRIDAY, 2 SEPTEMBER 2011

11:10 – 11:30  Symposia Session 8 – Clinical Orthopaedic Research 2
HISTOPATHOLOGY OF FEMORAL HEAD DONATIONS: A RETROSPECTIVE REVIEW OF 6161 CASES

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INTRODUCTION
Total joint arthroplasty is one of the most common orthopaedic surgical procedures, although it is still not clear if histopathological examination adds to the quality of the patient care. We propose that assessment of bone tissues from resected femoral heads may give a profile of femoral head pathology, providing potential benefit to total hip arthroplasty patients and bone donors.

METHODS
This study retrospectively analysed the reported histological findings of 6161 femoral heads donated for allografts between 1993 and 2006. Specimens taken at the time of total hip arthroplasty and bone donation were reviewed. Follow-up investigations from histopathological findings were also reviewed. The Western Australian Cancer Registry was used to investigate all patients with suspected neoplasms. Review of histopathology was conducted to evaluate and reclassify all previous observations.

RESULTS AND DISCUSSION
A total of 105 femoral heads demonstrated abnormal or reactive histopathological features, which were not reported prior to surgery, and thus were rejected for allograft (Table 1). Reactive lymphocytic infiltrates most likely due to osteoarthritis were most commonly identified (45 cases). Observations in 27 cases were most likely due to the presence of severe osteoarthritis. Ten cases showed plasmacytosis which may have been related to osteoarthritis. Two patients were diagnosed with Paget’s disease and two with rheumatoid arthritis. There were 19 cases with suspected neoplasms. Of these, 8 cases of Non-Hodgkin’s Lymphoma and Chronic Lymphocytic Leukemia, and one case of myelodysplastic syndrome were confirmed upon further investigation. It is noteworthy that confirmed malignancies accounted for 1 in 770 patients undergoing total hip arthroplasty in this cohort.

CONCLUSIONS
Our findings indicate that, even with detailed historical and medical review, clinically significant diseases, including neoplasms and Paget’s disease, are observed in cases diagnosed with osteoarthritis prior to total hip arthroplasty. Histological examination plays an integral part in quality assurance in femoral head banking, and as a possible early diagnostic device of bone and marrow related diseases for total hip arthroplasty patients.

ACKNOWLEDGEMENTS
We would like to thank Joyleen Winter and Anne Cowie from the Perth Bone and Tissue Bank and Dr Timothy Threlfall from the Western Australian Cancer Registry for helping with data collection and procurement.

Table 1: Details of the reviewed diagnosis for the 105 histopathology failed femoral head donations.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neoplasms</td>
<td></td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma (NHL)</td>
<td>6</td>
</tr>
<tr>
<td>Chronic Lymphocytic Leukaemia (CLL)</td>
<td>2</td>
</tr>
<tr>
<td>myelodysplastic syndrome</td>
<td>1</td>
</tr>
<tr>
<td>suspected myeloma</td>
<td>2</td>
</tr>
<tr>
<td>suspected B cell lymphoma</td>
<td>8†</td>
</tr>
<tr>
<td>Osteoarthritis with reactive bone marrow changes</td>
<td></td>
</tr>
<tr>
<td>plasmacytosis</td>
<td>10</td>
</tr>
<tr>
<td>reactive lymphocytic infiltrates</td>
<td>45</td>
</tr>
<tr>
<td>Severe Osteoarthritis</td>
<td>27†</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>2</td>
</tr>
<tr>
<td>Paget’s disease of bone</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>105</td>
</tr>
</tbody>
</table>

†denotes one case from a deceased donor
FIT ANALYSIS OF A PRECONTOURED PLATE: IS THERE A GROUP FOR BORDERLINE CASES?

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INTRODUCTION
Quantitative fit analysis of precontoured plates is important for design validation of the plate shape. In general, fit analysis is performed through manual fitting of an implant to a set of cadaver bones, where the fit is then qualitatively assessed. More recently, quantitative methods were proposed for more accurate assessment of implant fitting. Despite the methods, previous studies on fit analysis had only divided their results into fit and no-fit cases [1,2,3]. This raises the question of whether there is a considerable number of borderline cases for which minor shape alteration would significantly improve the implant fitting. The aim of this study was to investigate the extent of borderline fitting cases for a tibia plate.

METHODS
We used 3D models of a distal medial tibial plate and 45 computer tomography (CT) based Japanese tibiae, as well as four clinical-based criteria for fit analysis from a previous study [2]. Fit assessment were performed by obtaining the maximum plate-to-bone distances at the plate’s proximal (P), middle-third (M) and five small areas in the distal (D) regions, as well as the proximal angle (A). A Matlab program was developed to perform automated fit analysis on the 45 tibia-plate pairs. A global fit required all four criteria to be satisfied, where the maximum distance was ≤4mm (P), ≤6mm (M), ≤2mm (D) and maximum angle of ≤10° (A). In order to investigate the borderline cases, the non fit cases for each criterion were further grouped into specific tolerance ranges (Figure 1). The acceptable tolerance for borderline cases for each criterion was set to 4-5mm (P), 6-8mm (M), 2-3mm (D) and 10-12° (A).

RESULTS AND DISCUSSION
Based on the specified fit criteria, only 2 tibia-plate pairs achieved global fitting, while the number of fit cases for each criterion was: 28 (P), 29 (M), 11 (D) and 18 (A). The borderline group contained: 6 (P), 15 (M), 10 (D), and 5 (A) cases, resulting in 9 additional globally fitting cases. Despite this significant increase, the fitting plus borderline cases only amount to approximately a quarter (n=11) of the dataset used, which still leaves at least 75% of bones where the plate did not fit. The graphs in Figure 1 illustrate a gradual increase in fitting cases with a relaxation of the fitting tolerances for each criterion. These results indicate that minor changes to the plate shape are inadequate to significantly increase the percentage of fit cases. This observation is confirmed by results of a study where a fit of 67% was achieved for the same dataset after significant alterations to the plate shape [4].

CONCLUSIONS
The obtained results demonstrate that introducing a group for borderline cases can aid the process of implant design. Determining the number of borderline fit cases gives an indication of whether a minor shape change is sufficient or whether a major review of the plate design is required. In addition, reporting the number of cases in a specified borderline group will provide a more detailed and informed analysis of the no-fit cases.

ACKNOWLEDGEMENTS
This research was supported under the Australian Research Council’s Linkage Projects Funding Scheme (LP0990250).

REFERENCES
INTRODUCTION
The quantitative analysis of the fit between bones and anatomically precontoured plates is important for the design validation of the implant shape. Virtual quantification methods were introduced recently, however, with certain limitations such as simplified fit criteria or manual data processing [1,2]. Clinically relevant fit criteria and the ability to automatically process large bone dataset will greatly facilitate the development of optimal fitting implants for the intended patient populations. The aims of this study were to develop an automated fit analysis method based on clinical criteria and to compare its outcomes and processing time with a semi-automated fit analysis method.

METHODS
We used 3D models of a distal medial tibial plate and 45 computer tomography (CT) based Japanese tibiae, as well as four clinically-based criteria for fit analysis from a previous study [1]. A Matlab program to automate a fit analysis procedure and batch-process all 45 tibia-plate pairs was developed. The program executed the following tasks: first, the bone and plate models were imported; next, the maximum plate-to-bone distance at the plate’s proximal (P), middle-third (M) and five small areas in the distal (D) regions, as well as the proximal angle (A) were calculated and evaluated for fit; and finally, a report containing the measurements and fit analysis results was recorded on an Excel spreadsheet. A global fit was achieved when all four criteria were satisfied.

RESULTS AND DISCUSSION
The number of global fit cases was lower for the automated than the semi-automated method (2 and 6, respectively). The number of fit cases for each fit criterion were (automated vs. semi-automated): 28 vs. 28 (P), 29 vs. 26 (M), 11 vs. 18 (D), and 18 vs. 20 (A). The largest discrepancy was seen in the distal region, in which for the conflicting cases, at least one of the assessed areas was not fitting, although the surrounding areas generally fit (Figure 1). A reason for this is that the semi-automated method gives user the flexibility to make the final decision, while with the automated method, strict evaluation is applied regardless of the clinical relevance of the conclusion. Strict assessment of these distance maps resulted in 6 of the 7 cases as not fitting in the distal region. The discrepancy in the middle-third and proximal angle fit criteria is mainly attributed to operator errors of the semi-automated method. In contrast, the automated method performs exact and consistent operation for the analysis.

CONCLUSIONS
Automated plate fit analysis allows efficient analysis for large bone datasets through batch-process and short processing time. Although the number of global fit cases was different, the fit cases for each fit criterion were close except for the distal fit criterion, where strict assessment is applied. To address this, we recommend that surgeons review the no-fit cases in order to draw clinically relevant conclusion.

ACKNOWLEDGEMENTS
This research was supported under the Australian Research Council’s Linkage Projects Funding Scheme (LP0990250).

REFERENCES
Wear rates and wear morphology of knee prosthesis: a 3D study
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INTRODUCTION

Walking is the most common form of human gait. The kinematics of the movement is distinctly complex (see Figure 1), the load during the stance phase can reach 2600N, and the flexion-extension during the swing phase reaches 60 degrees [1]. Patients after knee reconstruction surgery are expected to resume walking within reasonably time. The wear dynamics and wear morphology associated with walking at different stages of the patient recovery are not known. In this study, in-vitro simulations of walking will show how knee prostheses will wear after 6 and 12 months after surgery. This could forecast how prostheses wear depending on patients’ post surgery activity. This may assist in anticipating early failure of prosthesis and thus prepare the surgeon and the patient for a less invasive second intervention and/or other treatment.

METHODS

Simulations representing walking were achieved with a state of the art knee simulator, using bovine serum as lubricant. The simulation was stopped at 500000 and 1000000 cycles, where wear rates were obtained by gravimetric method and an aliquot of the lubricant was separated for further studies. For each aliquot protein from the serum bovine was separated from wear debris chemically. Fractionation of particles according to size was achieved by following a novel protocol [2]. Atomic force microscopy (AFM) and scanning electron microscope (SEM) was used to fully characterize the wear debris in three dimensions.

RESULTS AND DISCUSSION

The three-dimensional AFM information indicates that for the prosthesis and the conditions studied here, debris particles tend to be elongated independent of their volumetric size. Results of the analysis of debris generated with a state of the art knee simulator with water as lubricant will also be presented.

CONCLUSIONS

Size and shape in three dimensions of UHMWPE debris were established for walking, at different stages of the experiment. Differences in wear rates and wear morphology could help to advice patients better when making activity choices.

Figure 1: Walking flexion-extension (top) and load (bottom) parameters as published in ISO standard 14243-1 and [1].

ACKNOWLEDGEMENTS

Johnson & Johnson are acknowledged for the knee prosthesis provided.

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OSTEOCYTE AND BONE HEALTH

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INTRODUCTION

Bone is often viewed as a mineral reservoir to releases calcium and phosphate in response to hormones (like PTH or 1,25 (OH)2 Vitamin D3) secreted from other organs such as the parathyroid gland and kidneys. Osteocytes, the terminally differentiated cell of the mesenchymal derived osteoblast lineage, account for over 90% of entire bone cells. In comparison to the well-studied surface bone cells, osteoblasts and osteoclasts, our understanding of the physiological functions of osteocytes is incomplete due to their longevity and relative inaccessibility within mineralized matrix.

METHODS

In this study, we will focus on newly discovered roles of osteocytes in mineralization, regulation of phosphate homeostasis, genetic diseases, and potential linkages with bone loss in periodontal diseases, the most common disease in medicine. Specifically, we will use multiple knockout mouse modes to document novel functions of osteocyte in development and diseases. The targeted genes include: Dentin matrix protein 1 (DMP1, a non-collagenous matrix proteins highly expressed in osteocytes), sclerostin (SOST, a potent inhibitor of Wnt/b-catenin, mainly expressed in osteocytes), and periostin (a gene highly expressed in periodontal ligament in jaw). We will also present multiple techniques, which are either developed or improved in our laboratory, to prove our hypothesis:

RESULTS AND DISCUSSION

Osteocytes play critical functions in development and diseases. This presentation will be beneficial for both basic and clinical researchers in orthopedic investigators.

CONFLICT OF INTEREST DECLARATION

In the interests of transparency and to help reviewers assess any potential bias, ANZORS requires authors of original research papers to declare any competing commercial interests in relation to the submitted work. Referees are also asked to indicate any potential conflict they might have reviewing a particular paper.

If you have accepted any support such as funds or materials, tangible or intangible, concerned with the research by the commercial party such as companies or investors, choose YES below, and state the relation between you and the commercial party.

Do you have a conflict of interest to declare?

NO
CHOLINE KINASE BETA IS AN IMPORTANT REGULATOR OF BONE HOMEOSTASIS

Jasreen Kular, Jennifer Tickner, Nathan Pavlos, Tamara Abel, Baysie Lim, Minghao Zheng, and Jiake Xu

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INTRODUCTION
The maintenance of bone homeostasis requires a tight balance between bone formation and bone resorption by osteoblasts and osteoclasts. The molecular mechanism(s) underlying the fundamental activities of these cells still remains largely unclear. In search of novel molecules that potentially play an important role in bone homeostasis we screened a number of ENU-induced mutant mouse lines. We identify choline kinase beta, a kinase that phosphorylates the first reaction in the biosynthesis of phosphatidylcholine, as a novel candidate regulator of bone homeostasis.

METHODS
Mice were generated at the Australian Phenomics Facility at ANU. In vivo bone parameters were assessed by microCT analysis using a Skyscan 1174 instrument at 6um resolution. Osteoclasts for in vitro analysis were generated from bone marrow and spleen precursors by treatment with M-CSF and mRANKL. Osteoblasts for in vitro analysis were generated from bone marrow or sequential enzymatic digestion of calvaria, and induced to differentiate and form mineralised nodules by the addition of dexamethasone, beta-glycerophosphate and ascorbate. In vivo rescue experiments were performed by injecting CDP-choline intraperitoneally into 8 week old mice for a total of 3 weeks prior to analysis.

RESULTS AND DISCUSSION
Choline kinase beta mutant mice exhibit an osteoporotic phenotype as evidenced by microCT and histological assessment. In vivo and in vitro analysis reveals elevated osteoclast numbers in the mutant mice. Osteoclast precursors from the mutant mice have an increased sensitivity to RANKL during osteoclastogenesis. Furthermore, osteoclasts from choline kinase beta mutant mice exhibit increased resorptive activity as compared to those of littermate controls. Treatment with CDP-choline in vivo and in vitro reduces osteoclast numbers, thereby rescuing the osteoclast phenotype. In vitro assays show a reduction in bone mineralisation in osteoblast cultures derived from both the bone marrow and calvaria of mutant mice.

CONCLUSIONS
Taken together, our data document, for the first time, that choline kinase beta plays an important role in bone homeostasis by regulating both osteoclasts and osteoblasts. Further investigation into the mechanisms regulating the effects of choline kinase beta in bone is ongoing.
Analysis of the High Bone Mass Phenotype and Fracture Repair in Mice with Homozygous Deletion of Dickkopf-1

INTRODUCTION
Dickkopf-1 (DKK1) antagonizes Wnt/β-catenin signaling activity via interaction with the Lrp5/6 co-receptor and is thus a negative regulator of osteoblast differentiation and bone formation. Complete deletion of Dkk1 activity leads to early embryonic lethality precluding a proper investigation of its role in postnatal bone. Recently, adult mice with complete absence of Dkk1 function have been generated by genetically reducing the activity of Wnt3 during embryonic development. Over 50% of mice of the Dkk1-/-; Wnt3+/+ genotype (HOM/HET) are found viable. We examined the bone phenotype associated with complete loss of Dkk1 in comparison to Dkk1+/+;Wnt3+/+ (WT/WT), Dkk1+/--;Wnt3+/+ (HET/WT) and the Dkk1+/+;Wnt3+-/- (WT/HET) mice. In addition we examined fracture repair in this Dkk1 null mouse model.

METHODS
Male and female mice were examined for skeletal changes at 15 weeks of age. Mice were dosed with dual calcein labels to examine bone formation parameters. Samples of long bones were harvested and fixed for radiographic and histological analysis. RNA was extracted from calvaria of all mice to assess the presence of Wnt3 in postnatal bone.

Radiographs were used to measure femoral length. DXA scans examined whole body BMC and BMD. QCT scans examined BMD, BMC and bone volume in individual femora. µCT scans were used to examine trabecular and cortical bone volume and architecture. Tibiae were processed for decalcified histology and femora for undecalcified histology to assess both bone formation and resorption parameters. Further a closed tibial fracture with external fixation was used to examine fracture repair in 15 week old male mice.

RESULTS AND DISCUSSION
Analysis of calvarial RNA showed no postnatal expression of Wnt3 in any genotype, as such this tissue in HOM/HET mice is functionally null only for Dkk1. Both male and female HOM/HET mice showed no change in body mass compared to WT/WT, however male HOM/HET mice showed a 3% reduction in femur length along with a 16% decrease in growth plate height compared to WT/WT (p<0.05).

Cortical bone volume in the femoral midshaft was also increased 19% and cortical thickness 13% in female HOM/HET mice compared to WT/WT (p<0.05). Histological analysis of distal femora showed a 39% increase in trabecular MAR in female and a 58% increase in male HOM/HET mice compared to WT/WT (p<0.05). Further BFR was increased 67% in female HOM/HET compared to WT/WT mice (p<0.05). Differences in bone resorption have not been revealed between genotypes. Importantly no skeletal phenotype has been detected in WT/HET control mice for any parameters measured. Preliminary radiographic analysis of fractures suggests delayed healing in HOM/HET mice compared to WT/WT at 4 and 6 weeks.

Complete deletion of Dkk1 in the presence of reduced Wnt3 expression produces viable mice with an extremely high bone mass. Increases of up to 4 fold were demonstrated in trabecular bone volume with increased trabecular number as a direct result of increased bone formation. Both the lack of postnatal skeletal expression of Wnt3 and absence of a skeletal phenotype in WT/HET mice suggest Wnt3 does not have a functional role in the postnatal skeleton. Fractures in mutant mice showed impaired healing.

CONCLUSION
This study is the first to present data on the postnatal skeletal phenotype of mice homozygous for deletion of Dickkopf-1. The extreme high bone mass phenotype seen in these mice due to enhanced bone formation confirms a pivotal role for Dkk1 as a negative regulator of bone formation. In contrast bone repair appears impaired in the absence of Dkk1.

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Acknowledgements
Dr McDonald is supported by the Bone Growth Foundation fellowship.
HEPARANASE IS A BIOMARKER FOR RA DIAGNOSIS AND THERAPEUTIC INTERVENTIONS

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INTRODUCTION
Early changes in rheumatoid arthritis (RA) are characterized by neovascularization, a marked infiltration of inflammatory cells, and associated synoviocyte hyperplasia, which produces a pannus of inflammatory vascular tissue. However, there is no reliable predictor of the neo-angiogenic progress. Our team has pioneered the research in heparanase expression in synovium of RA patients, which offers a new insight of the potential role of heparanase in the disease activity of RA [1]. This study aimed to examine heparanase activity, expression and its correlation with angiogenic gene expression in synovium of RA patients and their blood, with an ultimate goal of developing heparanase as a potential biomarker and predictor of RA progression and a new drug target.

METHODS
Blood and synovial specimens were collected from patients with RA, osteoarthritis (OA) and normal subjects. Synovial fluid specimens were collected if patients undergoing drainage at the hospitals and tissue specimens were collected from the knees of patients with RA or OA and ‘normal’ patients, i.e. subjects with sports injury or fracture with no documented history of degenerative or inflammatory joint diseases. Heparanase activity was determined using an enzymatic assay, heparanase protein expression was detected using western blotting and angiogenic gene expression was profiled using RT-qPCR array.

RESULTS AND DISCUSSION
We report a highly significant increase of heparanase activity and expression in synovial fluid and synovial tissue of RA patients (Figure 1), and the increase of the heparanase activity positively correlates with angiogenic gene expression. In addition, we have gained preliminary evidence showing that heparanase activity is higher in RA sera, but not in plasma compared to the normal subjects (Figure 2). We postulate that the involvement of heparanase in gene regulation in the development of pannus in RA may be reflected in the patients’ blood, which makes heparanase a potential predictor of RA progression.

CONCLUSIONS
Heparanase activity reflects the disease development in the synovial tissue. Heparanase may be used as a biomarker in RA diagnosis and potential target for therapeutic interventions.

ACKNOWLEDGEMENTS
This study was supported by a grant from Private Practice Fund of ACT Health.

REFERENCES
FRIDAY, 2 SEPTEMBER 2011

HALF-DAY JOINT SESSION WITH ANZBMS

13:25 – 14:15   Symposia Session 10 – Joint Regeneration
NEW BONE FORMATION IN RESPONSE TO INFLAMMATION IN ANKYLOSING SPONDYLITIS

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The spondylarthropies are a group of arthritic diseases in which the inflammatory process is targeted to the spine and pelvis. The prototypic example of these conditions is ankylosing spondylitis (AS). In this common condition, inflammation ultimately leads to bone formation around and ultimately across affected joints, resulting in joint fusion (ankylosis). No therapies are currently available that prevent or even slow this inevitable progression that results in significant disability.

It is well established that AS has two phases, an initial inflammatory phase followed by an osteoproliferative/ankylosing phase where the joint fusion is initiated and progresses. Very little is known about the progression from the initial inflammatory stages of the disease to this pathologic bone formation. The inflammatory phase has similarities with other inflammatory arthrites such as RA with high levels of pro-inflammatory cytokine production and joint damage through osteoclast activity. However, the extent of joint destruction though the cytokine/osteoclast axis is significantly less than in RA with the dominant joint impact stemming from ankylosis occurring as a result of osteoproliferation.

Recent work has suggested that changes in Wnt signalling, the key bone regulatory pathway, may contribute to joint ankylosis in AS. Using the proteoglycan-induced mouse model of AS (PGISp) we have demonstrated ectopic matrix formation in the axial joints and characterised the underlying molecular changes. Both SOST and DKK1, inhibitors of Wnt signalling, are downregulated in affected joints thereby providing a permissive environment where excessive bone formation might occur. These changes provide potential new targets for novel therapeutic approaches for this debilitating disease.
FRIDAY, 2 SEPTEMBER 2011

HALF-DAY JOINT SESSION WITH ANZBMS

14:15 – 15:20  Symposia Session 11 – Bone Biology 2
NEW STRATEGIES FOR CONTROLLING BONE LOSS

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Over the past fifteen years, new scientific discoveries have provided insights into the mechanisms of bone loss during aging and disease and have provided new strategies for the development of drug candidates to control bone loss. The discovery of the RANKL, RANK and osteoprotegerin pathways has led to the clinical availability of denosumab as a potent inhibitor of bone resorption, that provides an alternative to the bisphosphonates. New inhibitors of osteoclast function targeting cathepsin K or the osteoclast proton pump are in development.

However the potent anti-resorptive treatments available have shown inability to reverse bone loss sufficiently to renew bone to young adult levels, and their use in treatment of local bone defects due to cancer or inflammation is valuable to arrest bone loss, but does not lead to bone repair.

In this presentation some of the new anabolic therapeutic strategies will be reviewed to assess their potential in treating both systemic and local bone loss. In particular, the modulation of wnt signalling as a therapeutic bone building strategy will be described. One target is the protein sclerostin which is secreted by osteocytes and is an inhibitor of wnt signalling. Parathyroid hormone, the only currently approved systemic anabolic therapy, may work at least in part by suppressing sclerostin secretion by osteocytes. Sclerostin acts to suppress bone formation. Inhibiting its activity, either by gene mutation or by treatment with a neutralising antibody, can result in increased in bone formation and thus profound increases in bone mineral content.
ALTERED OSTEOCYTE FUNCTION IN OSTEOARTHRITIS: A POSSIBLE PATHOLOGICAL ROLE IN SUBCHONDRAL BONE SCLEROSIS

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INTRODUCTION
Osteoarthritis (OA) is the most common musculo-skeletal disorder but its aetiology is largely unknown. Regardless of the aetiology the disease is progressive and is characterised by disorder but its aetiology is largely unknown. Regardless of the disease severity.

Subchondral bone is made up of a specialized connective tissue formed by a mineralized matrix containing specific type I collagen, proteoglycans, and several growth factors, as well as bone specific cell types: osteoblasts, osteocytes, and osteoclasts. It has been reported that OA subchondral bone shows dysregulated osteoblast [2] and osteoclast phenotypes [3]; The osteocyte-canalicular cell network is now considered to play a central and multi-functional role in regulating skeletal homeostasis [4]; however, it is currently not known whether the integrity of the osteocyte cell network is altered or dysregulated in OA patients. The aim of this study was to investigate and report the morphological and phenotypic differences as contributors to bone remodelling of osteocytes in tissue samples collected from OA patients.

METHODS
To determine the pathophysiology of osteocyte network in OA at the organ level, knee tibial biopsy specimens were obtained from five patients undergoing knee replacement surgery. The subchondral bone was classified using a scoring system set by the American College of Rheumatology and the cartilage was classified using Mankin’s score. Type1 control vs. type4 OA subchondral bone volumes were assessed using microCT. Osteocyte cell numbers and lacunae per unit area were assessed. Scanning electron microscopy (SEM) was performed to detect any morphological variations. Immunostaining techniques were applied to observe the relative expression strength of osteocyte specific markers and matrix metalloproteinases (MMPs) in samples graded according to disease severity.

RESULTS AND DISCUSSION
Compared with type1 controls, type4 OA subjects showed increase in the average number of osteocyte lacunae (Avg.OS.Lac); there was an increase in the average osteocyte nucleus (Avg.OS.N) in the type4 OA patient group but failed to meet statistical significance. Morphological SEM images showed defective organization of osteocyte-canalicular system in OA patients compared to controls. Immunohistochemical analysis revealed that the type4 OA patients had a lower proportion of sclerostin (SOST: a negative bone regulator) positive osteocytes compared to type1 controls. Conversely, the expression of Dentin Matrix Protein-1 (DMP1: a positive bone regulator), Matrix Metalloproteinase-1 (MMP1), Matrix Metalloproteinase-9 (MMP9), and A disintegrin and metalloproteinase with thrombospondin motifs 4 (ADAMTS4) were all expressed significantly higher in type4 OA osteocytes. MicroCT results showed 20% increase in the bone volume of type4 OA patient group compared to Type 1 controls.

Dysregulation of osteocytic proteins occur in the course of OA development and appear to be central to altered bone and mineral metabolism in this patient population, which is likely to be a critical determinant contributing to OA subchondral bone pathological changes.

CONCLUSIONS
Our study provides evidence that osteocytes in OA patients undergo major phenotypical and morphological changes. Osteocytes are clearly targets for novel therapies that may include activation/deactivation of osteocyte signaling molecules in the pathogenesis of OA.

ACKNOWLEDGEMENTS
We thank Prince Charles Hospital Foundation, Brisbane, Australia for financially supporting the research.

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MATERNAL DIETARY SUPPLEMENTATION OF OMEGA-3 FATTY ACIDS DURING PREGNANCY AND LACTATION TRANSIENTLY AFFECTS OSTEOCLAST FORMATION AND BONE MASS IN MALE OFFSPRING

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INTRODUCTION

It is increasingly evident that nutrient supply before birth and in early infancy is important for ensuring long-term health outcomes, and achieving optimal bone growth and peak bone mass during childhood/adolescence is important for ensuring good bone health in adult life. While dietary supplementation with long chain omega-3 polyunsaturated fatty acids (n3FA) has been previously shown to improve bone deposition and bone mass in growing animals, it remains unknown whether supplementing the maternal diet with n3FA improves bone health in the offspring.

This study used a rat model to investigate whether n3FA dietary supplementation to mothers during pregnancy and lactation would improve offspring’s bone growth and adult bone mass.

METHODS

Female Albino Wistar rats were acclimatised to a diet with fatty acid composition comparable to a typical Australian Western diet (0.1% Docosahexanoic acid (DHA)). At commencement of pregnancy, dams continued on the same diet (Control, n=10) or a tuna oil n3FA-supplemented diet which provided 25mg/kg/day DHA (n3FA, n=11). Dams were maintained on these diets for the duration of pregnancy and lactation, and the offspring were weaned onto the control diet (Figure 1).

Effects of maternal dietary treatments on offspring serum n3FA levels and on structure and function of the bone growth unit (growth plate and metaphysis), osteoblast and osteoclast densities and gene expression were analysed in tibia of offspring at 3 weeks (weaning), 6 weeks and 3 months.

RESULTS AND DISCUSSION

Compared to the control diet, n3FA supplementation to the dams elevated DHA serum levels in the offspring at 3- and 6-weeks of age. Histomorphometric analysis revealed no changes in overall growth plate height at all time points, but a thicker resting zone in the 3-week offspring which was no longer observed by 6 weeks of age. In male offspring, but not in females, the number and thickness of bone trabeculae were increased in the n3FA group. These 3-week old males also exhibited a decreased osteoclast density on trabecular surface and an increased bone volume (BV/TV%). Consistently, RT-PCR analysis revealed increased mRNA expression of osteoclastogenesis inhibitor OPG and decreased levels of osteoclastogenic cytokines RANKL, TNF-α and IL-6 in bone of n3FA group. However, as in growth plate, all changes in metaphysis in n3FA 3-week males returned to control levels by 6 weeks of age.

CONCLUSIONS

An offspring sex difference is present in effects of perinatal maternal dietary supplementation with omega-3 fatty acids on offspring’s bone mass, and this early dietary intervention has no lasting effects on bone mass in the offspring.

ACKNOWLEDGEMENTS

This work was funded in part by funding from NHMRC project grants, University of South Australia and University of Adelaide. LF is a recipient of PhD Scholarship of University of Adelaide. BM is a recipient of NHMRC CDA Award, and RAG and CJX are recipients of NHMRC Senior Research Fellowship.

Figure 1: A rat study on effects of maternal dietary omega-3 fatty acids during pregnancy and lactation on offspring postnatal bone growth and adult bone health outcomes.

Figure 2: Effects of maternal dietary omega-3 fatty acids (n3FA) during pregnancy and lactation on numbers of bone trabeculae and osteoclast density in tibia of 3-week-old male offspring.
INTRODUCTION
The stem cell niche is a unique tissue microenvironment that regulates the self-renewal and differentiation of stem cells [1]. Recent evidence suggests that stem cells are localized in the microenvironment of low oxygen [2], suggesting that hypoxia may be important for stem cell maintenance. Bone marrow-derived mesenchymal stem cells (BMSCs), periodontal ligament cells (PDLCs) and dental pulp cells (DPCs) have shown promising potential in related tissue repair and regeneration. However, during in vitro culture, these cells undergo replicative senescence which may lead to significant alteration in cell proliferation and differentiation. Recently, the transcription factors of Oct-4, Sox2, c-Myc and Klf4 have been reported to be essential in the stem cell self-renewal process, namely cell reprogramming. Therefore, it is interesting to know whether hypoxia plays a role in maintaining the undifferentiated phenotype of BMSCs, PDLCs and DPCs.

METHODS
Human BMSCs, PDLCs and DPCs were isolated and cultured in normoxia (20% O₂) and hypoxia (2% O₂) for 24h and 1w. Cell proliferation assays were performed every 2 to 3 days from day 0 to day 7.

The expressions of the reprogramming markers, Oct-4, Sox2, and c-Myc, were detected in the in vitro cultured BMSCs, PDLCs and DPCs by western blot and real-time polymerase chain reaction analysis (qRT-PCR).

RESULTS AND DISCUSSION
BMSCs, PDLCs and DPCs proliferated significantly more in hypoxia than in normoxia (p<0.05). The stem cell reprogramming genes, Oct-4, Sox2 and c-Myc were differentially expressed in BMSCs, PDLCs and DPCs in response to hypoxic environment.

CONCLUSIONS
Our findings suggested that hypoxia plays an important role in fostering proliferation and maintaining the stemness of BMSCs, PDLCs and DPCs. However, the biological mechanisms that mediate stem cell maintenance in specific niches still need to be further investigated.

REFERENCES
FRIDAY, 2 SEPTEMBER 2011

HALF-DAY JOINT SESSION WITH ANZBMS

15:40 – 17:15    Symposia Session 12 – Bone Biology 3
OSTEOIMMUNOLOGICAL RESPONSE TO NANOSCALE WEAR PARTICLES

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INTRODUCTION
Wear is an inevitable consequence of total joint arthroplasty. The size of wear particles derived from the prosthesis at the joint replacement interfaces is critically important to the interfacial properties and the responses of the osteoimmunological environment. About 90% of the wear particles generated in hip or knee replacements are less than 1 µm (i.e., nanometre size) [1]. The role and impact of nanoscale wear particles in particular require further investigation. This project aimed to evaluate the osteoimmunological response to nanoscale ultra high molecular weight polyethylene (UHMWPE) wear particles in vitro.

METHODS
The wear particles generated from a constant-load knee prosthesis actuator were profiled using atomic force microscopy and fractionated into sizes of 0.05-0.2, 0.2-0.8, 0.8-1, 1-5 and 5-10 µm [2]. The each fraction, a mixture of nanoscale fractions and mixture of all fractions were exposed to dendritic cells (DCs) and macrophages isolated from mice, human osteoclasts (OCs), and co-cultured human OCs and osteoblasts (OBs). Effects of wear particles on the cells were determined.

RESULTS AND DISCUSSION
Exposure to nanoscale UHMWPE wear particles induced significant DC activation (p < 0.05) and consequently increased cytokine IL-6 and IL-1β secretion (p < 0.05). Exposure to nanoscale particles promoted OC maturation (Figure 1), resulting in a suppression of OB proliferation in OB and OC co-cultures. Therefore, the results of this study may contribute to a more mechanistic understanding of wear-debris associated prosthesis failure.

CONCLUSIONS
Nanoscale UHMWPE wear particles as mediators of periprosthetic inflammation should be considered in future development of biomaterials for joint replacement bearing surfaces.

Figure 1: Representative images of OCs treated with different sizes of UHMWPE wear particles and medium control, and detected by TRAP staining. Typical mature OCs are identified by yellow arrows and PBMCs by red arrows. Scale bars represent 200 µm. (A) Medium control. (B) Cultures treated with a mixture of nanoscale particles. (C) Cultures treated with 0.05–0.2 µm sized particles. (D) Cultures treated with 1–5 µm sized particles.

ACKNOWLEDGEMENTS
This study was supported by a grant from the Australian Orthopaedic Association Research Grant Fund 2010. We would like to thank Anne Prins, Cathy Galllespie and Dr. Harpreet Vohra at the Microscopy and Cytometry Resource Facility in the John Curtin School of Medical Research of the Australia National University for their assistance.

REFERENCES
Versatile roles of V-ATPase Accessory subunit Ac45 in osteoclast formation and function

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INTRODUCTION

Vacuolar-type H+-ATPases (V-ATPases) are multisubunit proton pumps that acidify intracellular cargos and deliver protons across the plasma membrane of a variety of specialized cells, including bone-resorbing osteoclasts. In osteoclasts, V-ATPases functions in extracellular acidification a process that initiates the dissolution of mineralized bone matrix and crucial for osteoclastic bone resorption. While the importance of V-ATPases in osteoclastic resorptive function is well-defined, whether V-ATPases facilitate additional aspects of osteoclast function and/or formation remains largely obscure.

METHODS

Here, using in vitro silencing and molecular biology techniques, we report that the V-ATPase accessory subunit Ac45 participates in both osteoclast formation and function.

RESULTS AND DISCUSSION

Using a siRNA-based approach, we demonstrate that targeted suppression of Ac45 impairs intracellular acidification and endocytosis, both are prerequisite for osteoclastic bone resorptive function in vitro. Interestingly, knockdown of Ac45 also attenuates osteoclast formation owing to a reduced fusion capacity of osteoclastic precursor cells. In an effort to gain more detailed insights into the functional role of Ac45 in osteoclasts, we attempted to generate osteoclast-specific Ac45 conditional knockout mice using a Cathepsin K-Cre-LoxP system. Surprisingly, however, insertion of the neomycin cassette in the Ac45-FloxNeo mice resulted in marked disturbances in CNS development leading to embryonic lethality thus precluding functional assessment of Ac45 in osteoclasts and peripheral bone tissues.

CONCLUSIONS

Based on these unexpected findings we propose that, in addition to its canonical function in V-ATPase-mediated acidification, Ac45 plays versatile roles during osteoclast formation and function.

Figure 1: Ac45 is important for osteoclast bone resorption and F-actin ring formation (A) Knockdown of Ac45 impairs bone resorption. (B) The area of bone resorptive pits in each bone disc was quantified as a percentage of the whole bone disc area. (C) The resorptive activity per osteoclast was quantified as the average bone resorption area per osteoclast (%; total area/total osteoclast number). *P-values<0.05. (D - G) F-actin ring formation in Ctrl and Ac45 siRNA treated osteoclasts cultured on bone discs. The average number of F-actin ring per osteoclast (H) and the average area (μm2) of F-actin rings (I) were quantified. Data represented as mean ± SEM. *P-values<0.05.
INTRODUCTION
In this study, the efficacy of Alendronate (ALN) treatment on tibial subchondral bone was evaluated using in vivo micro-CT in a rat model of low-dose monosodium iodoacetate-induced (MIA) osteoarthritis (OA), at an early stage of the disease.

METHODS
Rats (n=24) received a single intra-articular injection of 0.2mg MIA in the right knee to induce OA, and sterile saline in the left knee. Twelve out of the 24 rats (OA+ALN group) received twice-weekly subcutaneous injections of 15µg/kg ALN for 2 weeks. Control rats (n=4) received saline injection in the right knee and received no treatment. All the rats were scanned in vivo by micro-CT at 2 weeks post MIA-injection (early-stage OA), to assess architectural changes in the tibial subchondral bone. The serum bone turnover marker, C-terminal telopeptide of type I collagen (CTX-I) was assessed at 2 weeks. Changes in hind paw weight distribution was determined up to day 14 as an index of OA joint discomfort.

RESULTS
Micro-CT analysis showed that subchondral bone volume fraction, trabecular number, and trabecular separation in the OA+ALN group did not differ significantly compared to the control group. Conversely, in the untreated OA group there was significantly decreased subchondral bone volume fraction (p<0.05), trabecular number (p<0.001) and increased trabecular separation (p<0.0001) compared to the OA+ALN and control groups. In addition, the serum CTX-I level of the untreated OA group was significantly elevated (p<0.05) compared to the OA+ALN and control groups. ALN also reversed a shift in weight-bearing of MIA-injected knee observed in the OA group (p<0.0001 for day 3).

CONCLUSIONS
These findings demonstrate that ALN treatment prevents tibial subchondral bone changes observed in early-stage OA. Therefore, ALN could be used as an OA disease-modifying drug to enhance subchondral bone quality. Further investigations are planned, which will determine if ALN halts disease progression in this rat model of OA.

ACKNOWLEDGEMENTS
The authors wish to acknowledge the support of the Bone and Joint Research Laboratory staff and funding from Endeavour Postgraduate Scholarship from the Australian Government, Department of Education, Employment and Workplace Relations.
FUNCTIONAL ANALYSIS OF THE MICROTUBE-BINDING DYNEIN-DYNACTIN COMPLEX IN OSTEOCLASTS

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INTRODUCTION
Bone resorption by osteoclasts relies on the co-ordinated interplay between acidified carrier vesicles laden with osteolytic enzymes (e.g. Cathepsin K), motor proteins and the underlying cytoskeleton in order to sustain the specialized structural and functional segregation of the ruffled border membrane. Cytoplasmic dynein, a processive mechanochemical motor comprising heavy, intermediate and light chains coupled to the dynactin co-factor complex, powers retrograde motility of diverse cargos to microtubule minus-ends. Despite its crucial involvement in a wide range of fundamental cellular processes, the contribution of the dynein-dynactin motor complex in osteoclasts remains unknown.

METHODS
Here, using a combination of complementary biochemical and morphological assays we have dissected the intracellular localization and function of the dynein-dynactin complex in osteoclasts.

RESULTS AND DISCUSSION
By subcellular fractionation and immunofluorescence confocal microscopy we demonstrate that the dynein-dynactin complex is highly expressed in mature osteoclasts and is intimately coupled to microtubules, undergoing dramatic reorganization upon the onset of osteoclastic polarization. In bone-resorbing osteoclasts, p150\textsuperscript{Drod} and CLIP170, both major constituents of the dynactin and CAP-Gly domain-containing microtubule plus end-associated proteins, exhibit distinct polarization at the osteoclastic resorptive front, thus orientating the ruffled border as the microtubule plus-end domain. Interestingly, disruption of the dynein-dynactin complex via p50/dynamitin-over-expression retards the formation and maturation of osteoclasts, owing to a delay the mitotic stasis of mononuclear progenitor cells. Moreover, uncoupling of the dynein-dynactin motor from microtubules coincides with a drastic redistribution of key osteoclastic intracellular organelles, including the Golgi and lysosomes. Finally, we provide evidence that the dynein-dynactin complex is required for the targeted positioning and delivery of cathepsin K to the ruffled border membrane, and thus constitutes an integral component of the osteoclastic bone resorption machinery.

CONCLUSIONS
Collectively, these data unveil an unexpected yet versatile role for the dynein-dynactin motor in osteoclast formation and function.

Figure 1: Localization of dynein in bone-resorbing osteoclasts. Dashed lines and asterisks demarcate resorption pits.
PREVENTION OF WEAR PARTICLE-INDUCED OSTEOLYSIS BY A NOVEL V-ATPASE INHIBITOR SALIPHENYLHALAMIDE (SALIPHE) THROUGH INHIBITION OF OSTEOCLAST MATURATION AND BONE RESORPTION

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INTRODUCTION
Wear particle-induced peri-implant loosening (Aseptic prosthetic loosening) is a major complication after total joint arthroplasty. It is well established that extensive bone destruction (osteolysis) by bone-resorbing osteoclasts is the cause of wear particle-induced peri-implant loosening. Thus, inhibition of osteoclastic bone resorption should prevent wear particle induced osteolysis and may serve as a potential therapeutic avenue for prosthetic loosening.

METHODS
Here, we demonstrate that two selective V-ATPase inhibitors, saliphenylhalamide and bafilomycin, attenuate wear particle-induced osteolysis in a mouse calvarial model.

RESULTS AND DISCUSSION
In vitro biochemical and morphological assays revealed that the inhibition of osteolysis is partially attributed to a disruption in osteoclast acidification and polarization, both a prerequisite for osteoclast bone resorption. Interestingly, V-ATPase inhibitors also impaired osteoclast differentiation via the inhibition of RANKL-induced NF-κB signaling pathway.

CONCLUSIONS
In conclusion, we showed that V-ATPase inhibitors affected multiple physiological processes including osteoclast differentiation, acidification and polarization, leading to inhibition of osteoclast bone resorption in vitro and wear particle-induced osteolysis in vivo. The results of the study provide proof that V-ATPase inhibitors, such as saliphenylhalamide, are potential anti-resorptive agents for treatment of peri-implant osteolysis.
STRUCTURALLY AND CHEMICALLY MODIFIED TITANIUM IMPLANT SURFACES INITIATE EARLY OSTEOGENIC DIFFERENTIATION IN OSTEOPROGENITOR CELLS

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INTRODUCTION
Implant surface micro-structure and hydrophilicity are known to influence the osteogenic differentiation potential of osteoprogenitor cells [1]. Micro-roughened titanium implant surfaces show better osteoblastic differentiation and osseointegration properties [2]. Gene expression studies conducted on human osteoprogenitor cells cultured on modified titanium surfaces have revealed a differential expression of several genes at 72 hours [3]. The aim of this study was to determine whether modified titanium implant surfaces stimulate an initial osteogenic response in osteoprogenitor cells, which leads to superior osteogenic properties.

METHODS
Statistical analysis of gene expression profile available from microarray studies conducted on osteoprogenitor cells cultured on sand-blasted, large grit acid etched (SLA) surfaces (compared with those cultured on smooth surfaces) was performed using GeneSpring GX (Version 11) software. Further studies were conducted using primary osteoprogenitor cells obtained from human alveolar bone. Cells were cultured on SLActive (hydrophilic SLA), SLA and polished titanium surfaces for 24 hours, 72 hours and 7 days. The expression of BMP2, BMP6, BMP2K, SP1, ACVR1, FZD6, WNT5A, PDLIM7, ITGB1, ITGA2, OCN, OPN, ALP and RUNX2 were studied using quantitative real-time polymerase chain reaction (qPCR). The data was normalized using the house-keeping gene GAPDH. Statistical significance in the levels of expression of genes between surfaces was determined using un-paired Student's t test and p-value <0.05 was considered significant.

RESULTS AND DISCUSSION
Statistical analysis of microarray data revealed a fold change ≥1.5 (p-value ≤0.05) for several genes in cultures on SLA surfaces compared with those cultured on smooth surfaces at 24 hours. Functional clustering analysis of these genes using DAVID (online bioinformatics tool: The Database for Annotation, Visualization and Integrated Discovery) highlighted clusters related to ossification, bone morphogenesis, bone development, skeletal system development, endochondral ossification and endochondral bone morphogenesis, thereby indicating that the process of differentiation begins very early on micro-roughened surfaces.

qPCR analysis of BMP2, BMP6, BMP2K, SP1, ACVR1, FZD6, WNT5A, PDLIM7, ITGB1, ITGA2, OCN, OPN, ALP and RUNX2 mRNA expression, revealed significant differential expression for several genes on different surfaces at the 24 hour time-point. Relative expression levels of BMP6, SP1, ACVR1 and FZD6 showed significant differences after 24 hours in cultures on the different titanium surfaces. Activin A receptor, type I (ACVR1), which transduces signals of the BMP pathway and Frizzled-6 (FZD6), a member of the family of receptors for Wnt signalling proteins were seen to be significantly up-regulated in cultures on the SLActive surface compared to the other surfaces. The BMP and Wnt pathways are known to play pivotal role in the process of osteogenesis and our results show differential expression of genes related to these pathways. ACVR1 also showed significant up-regulation on SLA surface compared with polished titanium. Specificity Protein-1 (SP1), a transcription factor involved in the TGF-β pathway was also observed to be significantly up-regulated in cultures on SLActive surface. WNT5A and ITGB1 also showed differential expression on different surfaces, although not statistically significant. The OCN, OPN, ALP and RUNX2 genes did not show significant expression levels. The gene expression pattern at 72 hours and 7 days did not reveal significant differences between cultures on different surfaces.

CONCLUSIONS
These results suggest that the initial molecular response of osteoprogenitor cells to the modified titanium surfaces may be responsible for the improved osteogenic response on chemically and topographically modified titanium implants. Modified titanium surfaces seem to initiate an early osteogenic response through the BMP and Wnt pathways.

ACKNOWLEDGEMENTS
The project is partly supported by ITI foundation.

REFERENCES
EFFECT OF AGONIST CHOICE ON GROWTH FACTOR RELEASE FROM PLATELET RICH PLASMA
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INTRODUCTION
The release of growth factors from α-granules within platelets is thought to accelerate connective tissue regeneration (1). Bovine thrombin is a commonly used activator of Platelet Rich Plasma (PRP); however, concerns exist regarding its clinical use (2). This study compared the effect of alternative platelet agonists on growth factor release.

METHODS
PRP and Platelet Poor Plasma (PPP) were produced from three sheep using a clinically relevant one step, 800xG, 12 minute centrifugation. Autologous Thrombin (AT) was produced from both PRP (AT-PRP) and PPP (AT-PPP) by collecting the supernatant after the addition of CaCl2 to PRP and PPP respectively.

AT-PRP, AT-PPP, Bovine thrombin and CaCl2 were added to PRP to produce a clot. Release of Vascular Endothelial Growth Factor (VEGF) and Transforming Growth Factor β1 (TGF-β1) were measured at 12, 24, and 120 hours using ELISA. Clots were submersed in Dulbecco’s Modified Eagle’s Medium with 2% antibiotic-antimycotic solution and incubated at 37°C for the duration.

Clot retraction was measured by weighing clot samples over time.

RESULTS AND DISCUSSION
Mean times to clot formation for alternative agonists were considerably higher than Bovine thrombin. Clots produced with autologous thrombin retracted slower, and had less total retraction than Bovine thrombin and CaCl2 over 120 hours. Bovine thrombin and CaCl2 had similar clot retraction profiles, as did AuThrPRP compared to AuThrPPP.

At all time points, the mean TGF-β1 release was higher for all agonists when compared to Bovine thrombin. For most cases, TGF-β1 release was greatest within the first 24 hours of clot formation, and the majority of VEGF was released between 12 and 24 hours. The mean VEGF release was slightly higher for all agonists when compared to Bovine thrombin between 12 and 24 hours. From 0 to 12 hours, and 24 to 120 hours, mean VEGF release was similar between all agonists.

CONCLUSIONS
The data suggests Bovine thrombin does hold an advantage with respect to time to clot formation. However, when considering growth factor release, both CaCl2, and autologous thrombin made from PPP, may be practical alternatives to Bovine thrombin.

REFERENCES
## ANZORS 2011

List of Delegates (surname alphabetical order)

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