Altered Biomechanics of a Perthes' Hip Investigated by Contact Modeling

Salmingo, Remel A.; Skytte, T. L.; Traberg, Marie Sand; Mikkelsen, Lars Pilgaard; Henneberg, Kaj-Åge; Wong, C.

Publication date: 2014

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Monday Poster Session – General Session

M303 A Method for Validation of Finite Element Models in Scoliosis Bracing Simulation
C. Vergari1, G. Ribes1, B. Aubert1, C. Adam1, L. Millad1, B. Ilharreborde3, K. Abelein-Genevois4, P. Rouch1, W. Skalli1;
1Arts et Metiers ParisTech, LBM, Paris, FRANCE, 2Department of Pediatric Orthopedics, Necker Enfants Maladies Hospital, AP-HP, Paris, FRANCE, 3Pediatric Orthopaedics Department, Robert Debré Hospital, AP-HP, Paris Diderot University, Paris, France, 4Department of Paediatric Orthopaedics, Mother and Child Hospital, Hospices Civils de Lyon, Claude Bernard Lyon 1 University, France.

M304 Do Biomechanical Exam Variables Predict Response to Conservative Treatment of Non-Chronic Plantar Fasciitis?
J. Wrobel1, A. E. Fleischer2, J. Matzkin-Bridger2, J. Fascione2, R. Crews3, N. Bruning1, B. Jarrett4;
1University of Michigan, Ann Arbor, MI, 2Rosalind Franklin University of Medicine and Science, North Chicago, IL, 3Advocate Illinois Masonic Medical Center, Chicago, IL, 4University of Florida, Gainesville, FL.

M305 A Bandwidth Limitation in Joint Motion Simulator Control
P. J. Schimoler1, J. S. Vipperman1, M. C. Miller2;
1University of Pittsburgh, PA, 2Allegheny General Hospital, Pittsburgh, PA.

M306 Effects of ligature pretension in interspinous process spacer on stability and spinous process fracture risk
D. Choi, K. Kim, W. Park, Y. Kim;
Kyung Hee University, Yongin-si, Republic of Korea.

M307 Application of computational lower extremity model to investigate muscle activities and joint force patterns in knee osteoarthritis patients during walking
A. Dorj, K. Kim, Y. Kim;
Kyung Hee University, Yongin, Republic of Korea.

M308 Altered Biomechanics of a Perthes’ Hip Investigated by Contact Modeling
R. A. Salmeno1, T. L. Skytte2, M. S. Traberg1, L. P. Mikkelsen3, K. Henneberg1, C. Wong2;
1Biomedical Engineering, Technical University of Denmark, Kongens Lyngby, Denmark, 2Hvidovre University Hospital, Copenhagen, Denmark, 3Department of Wind Energy, Technical University of Denmark, Roskilde, Denmark.

M309 Caliper Method vs Digital Photogrammetry for Assessing Arch Height Index in Pregnant Women
K. Harrison, J. L. McCrory;
West Virginia University, Morgantown, WV.

M310 The Effect of Different Thumb Orthoses on Thumb Stabilization and Hand Function in Individuals with Carpometacarpal Osteoarthritis
N. Harman1, J. Heidemann2, K. Heinrich1, H. Wu3, J. Bleuel1, C. Gonska1, G. P. Brüggemann1;
1Institute of Biomechanics and Orthopaedics, German Sport University Cologne, Germany, 2Joint Centre Brühl, Germany.

M311 Loading rate during gait and stair descent for individuals with focal cartilage defects in the knee
The Ohio State University, Columbus, OH.

M312 Altered Landing Mechanics in Professional Athletes with Patellofemoral Pain
J. Stephen1, R. Sopher2, N. Caplan2, N. Phillips3;
1Imperial College London, United Kingdom, 2Northumbria University, Newcastle, United Kingdom, 3Cardiff University, United Kingdom.

M313 Understanding Knee Functionality: Simultaneous Assessment of Whole Body Kinematics, Videofluoroscopic Tibiofemoral Implant Kinematics, EMG and Ground Reaction Forces during Daily Activities
P. Schütz, H. Gerber, M. Hitz, S. Ferguson, W. R. Taylor, R. List;
Institute for Biomechanics, ETH Zurich, Switzerland.

M314 The Effect of Bone Preparation on Cementless Femoral Component Micromotion in Total Knee Arthroplasty
A. Gopalakrishnan, E. Hampp;
Stryker Corporation, Parsippany, NJ.

M315 A Comparison of Upper Extremity Joint Demands during Pediatric Lofstrand Crutch and Walker-Assisted Gait
B. A. Slavens1, A. J. Schnorenberg1, A. Graf2, J. Krzak2, P. A. Smith2, G. F. Harris2;
1Univ of Wisconsin Milwaukee, WI, 2Shriners Hospitals for Children - Chicago, IL, 3Marquette University, Milwaukee, WI.

M316 A Method for Assessing Accuracy in Tracking Foot Bones with Biplanar Videoradiography
M. J. Rainbow1, J. B. Schwartz2, I. S. Davis3, D. C. Moore3;
1Harvard Medical School, Cambridge, MA, 2Rhode Island Hospital, Providence, RI, 3Rhode Island Hospital / Brown University, Providence, RI.

M317 A Preliminary Evaluation of Shoulder Mechanics Using a Novel Wheelchair: The Influence of Pain
P. W. Hovis, M. D. Brown, C. J. Hass, M. D. Tillman;
University of Florida, Gainesville, FL.
Introduction

Perthes' disease is one of the most common hip disorders in young children characterized by malformation of the femoral head. Several studies have investigated the biomechanical alterations of Perthes' disease using Finite Element Analysis (FEA), however, most of them were 2D models and lack patient-specific details of the cartilage and necrotic bone. Thus, the objective of this study was to investigate the altered biomechanics of a Perthes' hip joint by finite element contact modeling using MRI to develop the patient-specific model of the cartilage and bones.

Methods

The MRI data of both hips of a unilateral Perthes' case was obtained to segment the bones and cartilages using Simpleware. A 3D point cloud data of the segmented parts were exported to SolidWorks to build the 3D models. FEA was performed using Comsol 4.3b. The same Poisson's ratio 0.30 was set for the femoral, pelvic and necrotic bones. The Poisson’s ratio 0.35 was set for the femoral and acetabular cartilages. The elastic modulus for the pelvis, femur, cartilages and necrotic bone were, 5 GPa, 500 MPa, 50 MPa and 20 MPa, respectively. For the loading conditions, the distal part of the femur was fixed while the pelvis was displaced 1.5 mm downwards in the axial direction (Fig. 1).

Results

The results show that the contact pressure in the femoral cartilage of normal hip (left) is more distributed than the Perthes' hip (right) (Fig. 1). Since the elastic modulus of the femur is higher than the necrotic bone in the affected hip, the maximum contact pressure 5.01 MPa was found in the normal hip (4.70 MPa for Perthes' hip). The von Mises stress distribution of the femoral cartilage was more localized in the Perthes' hip (3.45 MPa max.), i.e. where the junction of the necrotic and normal bone is located below the femoral cartilage.

Conclusion

In this study, we have found out that the increase and localization of stress significantly altered the biomechanics of the hip joint. This knowledge will help orthopaedic surgeons decide where to redistribute the localized stresses and thus important in the treatment planning of Perthes' disease.