Altered Biomechanics of a Perthes' Hip Investigated by Contact Modeling

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Monday Poster Session – General Session

M303  A Method for Validation of Finite Element Models in Scoliosis Bracing Simulation
C. Vergari1, G. Ribes1, B. Aubert2, C. Adam1, L. Miladi2, B. Ilharreborde3, K. Abelino-Genevois4, P. Rouch1, W. Skalli3;
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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. Crews2, N. Bruning1, B. Jarrett2;
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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. Salmingo1, T. L. Skytte2, M. S. Traber3, L. P. Mikkelson3, K. Henneberg4, C. Wong5;
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. Hamann1, J. Heidemann2, K. Heinrich3, H. Wu4, J. Bleuel1, C. Gonska4, 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
L. M. Thoma, M. P. McNally, D. C. Flanigan, A. M. Chaudhari, R. A. Siston, T. M. Best, L. C. Schmitt; The Ohio State University, Columbus, OH.

M312  Altered Landing Mechanics in Professional Athletes with Patellofemoral Pain
J. Stephen1, R. Sopher2, N. Capilan2, 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. Smith3, G. F. Harris3;
1Univ of Wisconsin Milwaukee, WI, 2Shriners Hospitals for Children - Chicago, IL, 3Marquette Univ, 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 cartilages 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.