HIP JOINT REACTION FORCE ESTIMATED USING OPENSIM - COMPARISON TO MEASURED DATA

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Introduction

Musculoskeletal models are used in surgery planning, gait treatment, customized joint development, ergonomics, etc. Estimated muscle forces, muscle moment arms, joint reaction forces and torques during motion can be used like an input data to the FEM modelling or for loading settings during implants testing consequently. However, the accuracy of the predictions done by the mathematical modelling of musculoskeletal system in given patient is questionable. The OpenSim software simplifying the process of biomechanical analysis has been introduced recently. The aim of this work is to verify the hip joint force prediction by OpenSim using data from implanted instrumented endoprosthesis [Bergmann, 2001] and to determinate effect of the musculoskeletal model scaling to the hip joint reaction forces estimation during gait.

Methods

OpenSim [Delp, 2007] musculoskeletal model consisting of lower limbs, pelvis and 93 muscles was adopted. . Body characteristic dimensions, segment weights, kinematics and external loading were taken from HIP 98 for a 76 years old female patient, 31 months after operation. [Bergmann, 2001]. Muscles activities were estimated using inverse dynamics quasistatic optimization approach and hip joint reaction forces were calculated by OpenSim subsequently. This approach was applied to musculoskeletal model that was scaled 1 – nonuniformly (NS), 2 – uniformly by body height (BH), and 3 – uniformly by body height and pelvis nonuniformly (BHP).

Results

A comparison between measured and calculated hip joint reaction force during normal walking is shown in Figure 1. Absolute and relative differences in measured and calculated peak hip force are shown in Table 1.

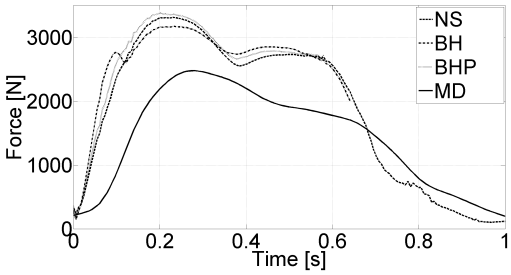

Figure 1: Hip joint reaction forces during walk – results from differently scaled models compared with measured data [Bergmann, 2001].

MD	NS	BH	BHP
2 479 N	3 313 N	3 172 N	3 381 N
	33.6 %	27.9 %	36.4 %

Table 1: Maximum hip joint reaction forces F_{max} [N]. MD – measured data; NS – nonuniform scaling; BH – uniform scaling (body height); BHP – uniform scaling (body height), nonuniform scaling (pelvis). Difference [%] between experimental data and calculated forces.

Discussion

Calculated hip joint reaction forces are approximately 33 % higher than measured forces. Various types of scaling provides no considerable differences neither for force magnitude nor for time progress of force.

Differences between measured and calculated hip joint reaction forces might be caused by simplified muscle wrapping in OpenSim model that yield to smaller muscle moment arms or by neglecting changes in femur angles. Furthermore body segments inertia moments are not influenced by scaling providing constant body segment mass

References

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