UNIVERSITÄT ZU LÜBECK

FACH HOCHSCHULE LÜBECK
University of Applied Sciences

Program: Biomedical Engineering

Master's Thesis

Title: Modeling and Simulation of the Shoulder to study the Influence of the Acromion Length in Glenohumeral Stability

Summary:

Purpose: The glenohumeral joint is the most frequently dislocated major joint compared to others of the body. Tearing and inflammation of tendons, also known as tendinopathay, is the result of damage to these otherwise strong tissues. Within the shoulder joint, the rotator cuff most commonly experiences tendinopathy, known as rotator cuff tears (RCT). This has severe consequences for the patients' quality of life and can lead into arthopathy. In a clinical study by Moor et al. shoulders with RCT were associated with significantly larger critical shoulder angles (CSA) when compared to disease free shoulders. The aim of this study is therefore to investigate, if there is a biomechanical correlation between the individual anatomy of the scapula, and the development of RCT or osteoarthritis (OA) of the glenohumeral joint.
Methods: An existing rigid-body-model of the shoulder was used and modified for this investigation. Three different models with different CSAs were configured to represent shoulders with either a shoulder with normal CSA 33°, angles characteristic to shoulders with RCT (38°), or angles associated with OA (28°). Comparing the latter two by means of joint reaction forces and shoulder stability during a glenohumeral arm elevation (0 to 80° in scapular plane), differences in rotator cuff forces required to provide stability were then examined.
Results: Moment arms and joint reaction forces of shoulder muscles were compared to experimental data from literature to assess the accuracy of the model. The results of this study support the concept, that a high CSA can induce RCT. Maximum force of the middle deltoid increased in the CSA 28° model by 6.0 N. The sum of the rotatory cuff muscle forces was 15.7 N higher in the RCT CSA 38° model. However it cannot be proven, that a smaller CSA leads to higher compression forces in the glenoid which is assumed to cause OA. It was also observed that other anatomical peculiarities, independent of the CSA strongly influenced the biomechanical behavior of this model.
Conclusion: This model of the shoulder has promising potential for biomechanical investigations but needs further optimization. For a more detailed study of this hypothesis, additional investigation on the influence of other factors needs to be conducted. Moreover, the transferability of this model on the human musculoskeletal system is limited in the fact that it is not possible to estimate the modeling error.

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