HOW DOES THE GLENOID SIZE AFFECT ROTATOR CUFF LOADING ? A MUSCULOSKELETAL ANALYSIS

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Introduction

The stability of the shoulder joint, being a ball and socket joint with a wide range of motion, is predominantly given by the surrounding rotator cuff (RC) muscles. The smaller the glenoid compared to the humeral head, the stronger the RC needs to act to provide the required stability against subluxation. The resulting excessive loading of the tissue might be a possible explanation why clinical studies have shown a correlation between glenoid size (GS) and RC tear incidence [1,2]. Biomechanical studies, however, have not yet investigated the effect of GS on the RC forces.
Therefore, we aim to understand the influence of the GS on RC forces during shoulder abduction, flexion, internal and external rotation using musculoskeletal modeling.

Methods

The musculoskeletal modelling was performed in Anybody 7.3 using the generic model (male,75kg, 1.80m) of the repository AMMR v.2.3.1. Muscle forces were calculated based on inverse dynamics for shoulder abduction and flexion from 0° to 120° and internal and external rotation from -50° to 50° with the elbow flexed at 90°. All motions were performed against a resistance of 25N. The resulting maximum forces were subsequently extracted from each motion and compared. The glenohumeral joint was kinematically constrained to prevent translations of the humeral head on the glenoid. The GS was determined based on the glenoid width (GW). This was defined as the A-P distance in the inferior portion of the glenoid which was altered from 24 mm to 36 mm according to population variations [3,4]. The glenoid height changed proportionally. The humeral head remained at a constant diameter of 53 mm to solely investigate the influence of the GS to humeral head ratio.

Results

GS variations have an influence on maximum RC forces during abduction and flexion. Throughout internal and external rotation, maximum RC forces remain unchanged despite the varying GS, represented by the respective GW (Figure 1).
When comparing the smallest GW with the mean, the infraspinatus (IS) and subscapularis (SB) both experience the strongest load increase of 46% during abduction and 18% and 99% during flexion, respectively. The supraspinatus (SS) shows only little sensitivity to GS variations.
An increase of the GS does not significantly alter the RC forces, except for the SB force which additionally decreases by 60% during flexion.

Discussion

Various morphological parameters as the acromion shape or glenoid inclination have been investigated in the past and their relation to RC loading have been established [5]. It appears that the GS plays a similarly important role in the evaluation of RC forces. The strong effect on the SB and IS particularly give reason to assume that a reconstruction of their biomechanics is crucial to regain functionality after a RC tear which has also been clinically observed [6]. An impairment could lead to shoulder instabilities or pseudoparalysis which should be further investigated with a model allowing for glenohumeral translations.

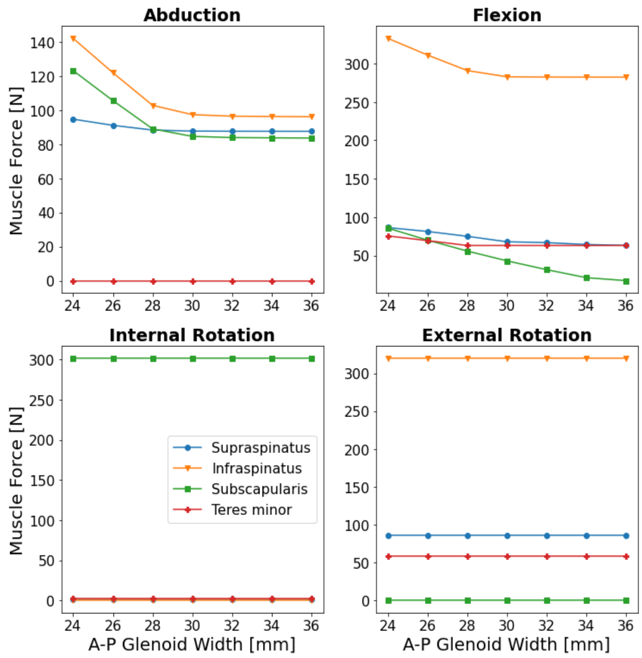

Figure 1: Maximum RC muscle forces during abduction and flexion from 0° to 120° and internal and external rotation from -50° to 50 for various glenoid sizes represented by the A-P glenoid width.

References

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