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ACTIVE STABILITY OF GLENOHUMERAL JOINT DIMINISHES DURING THE END-RANGE MOTIONS

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INTRODUCTION

The lack of congruence between the involved articular surfaces causes the inherent instability of the joint. This joint is therefore the most commonly dislocated joint in the human body.[1] Anterior instability accounts for over 90% of the shoulder dislocations.[2] The reason of this almost unidirectional dislocation remains unknown. Few studies have quantitatively discussed the joint stability utilizing musculoskeletal models. The muscle contributions toward stability of the joint are assessed in[3] using a biomechanical model. Other studies mainly utilized either purely clinical[4] or cadaveric[5] approaches to address the joint stability. The aim of this study is to identify the key factors contributing to anterior instability through a quantitative analysis of the shoulder's dynamic stabilizers.

METHODS

The contributions of muscles as dynamic stabilizers of the shoulder are assessed by a model of the shoulder. The model includes all major muscles spanning the glenohumeral joint. To dissociate the stabilizing role of rotator cuff (RC) and deltoid muscles the locus corresponding to the intersection of their resultant forces and the glenoid fossa are separately derived, (Fig. 1). We reproduced abduction in the scapular plane (150°) combined with external rotation (35°) to expose the joint into the end-range posture where the anterior dislocation is more likely to occur.

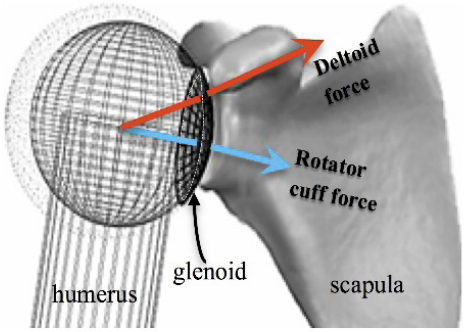

Fig 1: intersection of glenoid and resultant forces of muscles.

RESULTS

The glenohumeral contact force predicted by the model has been compared to in vivo [6,7] and analytical8 results, partially assuring the validation. The locus related to the muscles resultant force shifts from central location anteriorly while arm is approaching the end-range positions, indicating gradual decline in the active stability (Fig. 2). The locus associated with the deltoid muscles lie superoanteriorly during all the arm postures indicating that their action as the main movers coincides with destabilizing effects (Fig. 3). The locus associated with the rotator cuff muscles move anteriorly, expressing that their stabilizing function becomes less effective in the end-range (Fig. 4). However, during mid-range movements (60–70 % of elevation) they are well aligned to compensate the destabilizing effects of the deltoid muscles.

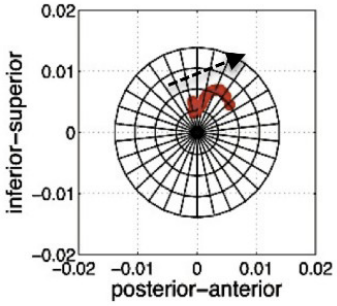

Fig 2: RC + deltoid muscles

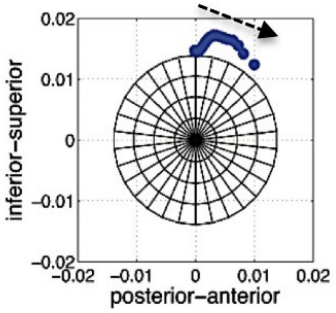

Fig 3: deltoid muscles only.

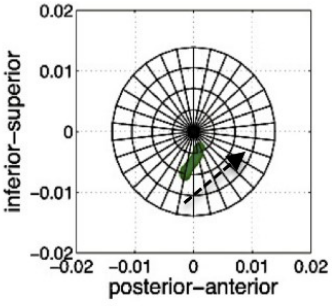

Fig 4: RC muscles only.

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DISCUSSION

The destabilizing effect of the deltoid muscles, as the prime movers of the arm, is compensated by the rotator cuff muscles during mid-range elevation. However, active stability diminishes in the end-range, leading to anterior dislocation if the capsuloligamentous structures are dysfunctional. The results of this study can broaden our insight into the contribution of different muscle groups toward joint stability and can consequently help improve physiotherapy procedures of anterior instability.

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