Subscapularis Dysfunction May Explain Clinically Observed Patterns Of Glenoid Erosion And Posterior Component Wear

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Introduction: Subscapularis dysfunction is reported in up to 67% of patients following shoulder arthroplasty via a deltopectoral approach with subscapularis release. A dysfunctional subscapularis disrupts the glenohumeral (GH) joint force couple and is believed to contribute to loss of functions and postoperative complications. However, its influence on eccentric GH joint loading and ultimately, joint instability remains unclear. This musculoskeletal modelling study aimed to identify the risk of eccentric loading at the GH joint in a subscapularis-deficient shoulder by assessing the GH joint reaction forces (JRF).

Methods: 'Washing the opposite axilla' was chosen as the activity to replicate in the model because this low-load activity resembles the 'bear-hug test' for testing the function and integrity of the subscapularis, thus resulting in a highly activated subscapularis. The motion dataset from five healthy subjects (age 29.2 ± 2.3 years) were applied to the inverse dynamic model to predict the muscle forces while adhering to the constraints of minimum muscle activation and a non-dislocating (stable) joint. The calculated GH JRF were decomposed in the glenoid coordinate system: compressive, superior-inferior shear, and anterior-posterior shear. Joint stability was defined as the ratio between the shear force and the compressive force. The subscapularis-deficient shoulder was simulated by removing the muscle element from the model, thus testing the worst-case pathology.

Results: Subscapularis deficiency was compensated by an increase in the other GH muscle forces, mainly the teres minor (157N) and the latissimus dorsi (76N), in an organised manner to balance the internal-external moment and the concavity compression at the GH joint (Figure 1). Although this mechanism resulted in an increased compressive force by 23% and a decreased superior force by 44%, the posterior force dramatically increased by 60%, shifting the net force vector towards the posterior glenoid rim. Consequently, the posterior stability ratio decreased by 25%.

Discussion: This study focused solely on one activity that posteriorly translates the humeral head. Investigating other activities involving anterior GH translation could yield varying biomechanical outcomes. Another key limitation, common to all MSK modelling approaches, is the optimization algorithm that the model uses to determine the muscles loads.

Significance/Clinical Relevance: This modelling study suggests that subscapularis dysfunction may lead to eccentric posterior loading of the GH joint, potentially contributing to the understanding of the posterior glenoid component wear observed in patients or the development of type B2 native glenoids that represent one of the biggest complications of shoulder joint replacement. The study also suggests that rehabilitation strategies should focus on strengthening the latissimus dorsi and teres minor muscles to enable patients to achieve a similar range of motion as healthy individuals.

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References

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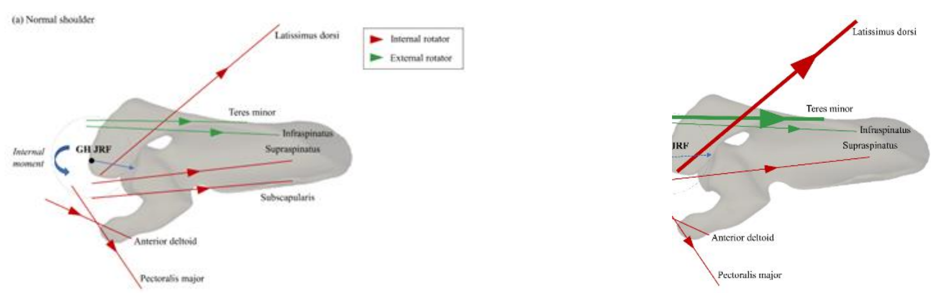

Figure 1 Subscapularis deficiency was compensated by an increase in the other GH muscle forces, mainly the latissimus dorsi and the teres minor, in an organised manner to balance the internal-external moment and concavity compression at the GH joint.