INTRODUCTION: The pronator quadratus (PQ) and supinator muscles have been speculated to influence forearm rotation based on measurements of muscle moment arms (1,2), physiologic cross-sectional area (pCSA) (1,2), and electromyography (EMG) (3,4). The effect of varying these muscle loads on forearm kinematics, and in particular, the influence of varying PQ and supinator loads on distal radioulnar joint (DRUJ) instability has not been reported. Therefore, the purpose of this study was to investigate the effect of PQ and supinator loads on forearm kinematics in both an intact and unstable DRUJ model.

METHODS: Eight fresh-frozen cadaveric upper extremities (mean age 73.5 ± 14.3 years) were mounted in a custom-designed motion-controlled joint simulator. Cables were attached via sutures to the tendons of the pronator teres, biceps, pronator quadratus, supinator, triceps, extensor carpi radialis longus, extensor carpi ulnaris, flexor carpi radialis and flexor carpi ulnaris. Lines of action for the pronator quadratus and supinator muscles were maintained by routing cables through customized delrin sleeves placed in their respective tendon origins and passing the cables through the intramedullary canal of the ulna. Pronation was simulated by loading the pronator teres (PT) muscle at a constant velocity, while simultaneously applying PQ loads in increments of 10% from 0% to 80% of the PT load. The 80% load limit was the estimated loading ratio using EMG (5) and pCSA (1) data. Similarly, the biceps muscle was loaded to induce supination, with the supinator contributing 0-50% of the biceps load, where 50% was again the estimated loading ratio. Pronation and supination trials were performed in the intact forearm, and following surgical removal of the distal ulnar head (Darrach procedure).

RESULTS: The average results for neutral forearm rotation position are shown graphically in Figure 2 (n=8).

![Figure 2](image)

Figure 2: Effect of PQ and supinator load on RUR and diastasis for an intact and ulnar head removed DRUJ (error bars represent standard deviations) (n=8).

With regard to the RUR ratio, 80% load on the PQ muscle resulted in a significantly lower RUR ratio compared to both 0% and 10% load in both the intact and unstable DRUJ (p<0.05). No differences in diastasis were found in the intact DRUJ due to incremented PQ loading (p>0.05), but with the ulnar head removed increasing PQ load decreased diastasis (p<0.01). Activation of the supinator muscle had no effect on forearm kinematics during supination in either the intact or unstable DRUJ (p>0.05).

DISCUSSION: Increasing the load on the pronator quadratus muscle caused a significant alteration in DRUJ kinematics in both the intact and unstable joint, while altering supinator load did not. We speculate this outcome may be due to the location of the PQ muscle, situated distal on the forearm near the DRUJ. In contrast, the supinator muscle is found more proximal where it wraps around the forearm, creating less mechanical influence on the DRUJ. As a result, increased load on the pronator quadratus muscle aggravated DRUJ instability caused by ulnar head removal, resulting in a greater palmar translation of the radius and greater radioulnar convergence.

In summary, biomechanical modeling and testing of forearm kinematics that focus on DRUJ stability should include active simulation of the pronator quadratus muscle to more closely represent normal loading. While the supinator muscle does not significantly alter DRUJ kinematics, it may play a larger role in studies related to the proximal radioulnar joint. From a clinical perspective, the PQ muscle appears to aggravate the unstable DRUJ, suggesting patients with DRUJ instability and/or who have undergone surgical removal of the ulnar head should be rehabilitated in supination to limit the influence of the PQ muscle.


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