The Influence of Altered Mechanical Properties in Hypertoned Fascia on Muscle Activational Strategies

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Purpose: Recent interpretation of musculoskeletal dynamics has highlighted the important involvement of fascia. Moreover, various authors have isolated and quantified altered passive mechanical properties in hypertoned muscle groups when compared with healthy patients, while others speculate and explore the possibility of myofascial force transmission. However, the influence of fascial mechanics on muscle adoption techniques has yet to be investigated. The purpose of this study was to explore the effect of fascial properties on muscle activational strategies.

Methods: A finite element model of the humeroradial joint was developed using mean morphological and mechanical properties from published literature. A gravitational load was introduced over the humeral head while boundary conditions of respective physiological degrees of freedom were selected. An iterative control system, that minimized the sum of cubed muscle stresses, was programmed to maintain and govern the model's stability. The fascial (passive) mechanical properties of the biceps and triceps were then varied to mimic those observed in patients with degenerative musculoskeletal disorders such as cerebral palsy. Prior to interpretation of results, the model was validated by comparing predictions of humeroradial joint stress with published literature and a sensitivity analysis was performed. Stress distributions in the biceps and triceps were compared and the influence of altered fascial modulus was correlated.

Results: The model with healthy properties returned internal stress distributions and a stability configuration that corroborate with similar studies. The model with fascial properties representative to those of a musculoskeletal disorder showed non-physiological stresses within the biceps and triceps following stability. More specifically, the increase (1.5x) in the passive modulus of the biceps reduced the triceps/biceps internal stress ratio by up to 50 %. Further, the final stability position showed a convincing correlation with the manipulation of fascial properties ($r = 0.9$). The humeral radial angle reduced from the 120 degrees (healthy model) to 70 degrees (model with the greatest offset in fascial modulus between the biceps and triceps) as regulated by the adopted muscle activation strategy.

Conclusion: It appears that altered fascial properties influence musculoskeletal mechanics by shifting internal muscular stress distributions. Therefore, the presence of irregular mechanical properties of connective tissues may invoke restrictions on muscular performance as a result of altered adoption patterns. Acknowledgement of this phenomenon may provide insight into the pathomechanism of progressive musculoskeletal disorders.