

The Effect of Fatigue on Shoulder Muscle Strength Ratios in Collegiate Water Polo Players
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Introduction: A proposed mechanism of shoulder injuries is imbalances in the strength of the shoulder muscles, however, the effects of fatigue on these imbalances are unknown. The purpose of this study was to investigate the relationship of isokinetic-induced fatigue on the development of shoulder muscle imbalances using both the conventional and functional ratio. **Methods:** Participants: Twelve male and 13 female injury-free collegiate water polo players (age 19.9 ± 1.1 yrs) were recruited for participation. Protocol: Dominant shoulder strength was evaluated concentrically and eccentrically for 30 repetitions at 120 degrees/second for abduction, adduction, and internal and external rotation movements. Mean peak torque was computed for the first five repetitions (First 5) and for the last five repetitions (Last 5). Using these values, fatigue, conventional and function ratios were computed. Statistical Analysis: Paired t-tests were used to determine differences in values and their corresponding angles and in fatigue, conventional and functional ratios ($p < 0.05$). **Results:** For all four movements there was a significant difference in the First 5 and Last 5 values concentrically and eccentrically indicating that the protocol induced fatigue. Additionally, the angle at which the average peak torque occurred was different when fatigued for concentric abduction ($139.7 \pm 7.6^\circ$ versus $121.2 \pm 29.6^\circ$) and for concentric external rotation ($29.6 \pm 21.6^\circ$ versus $37.8 \pm 25.0^\circ$). The fatigue ratio was significantly different between concentric and eccentric internal rotation (1.01 ± 0.19 and 0.84 ± 0.24 , respectively; $p < 0.05$). A significant difference was found between the pre-fatigue and fatigue abduction to adduction conventional ratio ($p < 0.05$) with the ratio being larger pre-fatigue indicating that the abductor muscles fatigued proportionally more than the adductor muscles. No significant difference was found between the pre-fatigue and fatigue functional ratios for abduction and adduction. **Discussion:** This suggests that

the muscles involved in throwing fatigued proportionally. As these subjects were injury-free, this might suggest that the functional ratio may be a good indicator for decreased risk for injury or pain.