The Effect of Regional Bicep Brachii Muscle Volume on Angle-Specific Isometric Torque Expression

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PURPOSE

The present study aimed to investigate the relationship between joint-specific torque (60°, 90°, 120° flexion) and region-specific muscle volume (MV) (proximal [0%-33%], medial [34%-67%], distal [68%-100%]).

RESULTS

For regional MV (determined as longitudinal area and expressed in cm^2), the intraclass-correlation coefficient (ICC) range (95% Confidence Interval [CI95%]) was: 0.50 - 0.86, 0.39 - 0.80 and 0.55 - 0.88 for proximal, medial, and distal, respectively. For Maximal voluntary isometric contraction (MVIC) torques, the ICC range was: 0.87 - 0.97, 0.90 - .98 and 0.92 - 0.99 at 60°, 90°, and 120°, respectively.

For the models examining torque at 60°, the isolated effects of proximal (β [CI95%] = 0.74 $N{\cdot}m/cm^2$ [-1.08, 2.56], p = 0.415, $_{Marginal}R2$ = 0.04), medial (β [CI95%] = 0.90 $N{\cdot}m/cm^2$ [-0.92, 2.72], p = 0.322, $_{Marginal}R2$ = 0.06), and distal (β [CI95%] = 0.61 $N{\cdot}m/cm^2$ [-1.28, 2.50], p = 0.519, $_{Marginal}R2$ = 0.03) MV were all statistically non-significant.

For the models examining torque at 90°, the isolated effects of proximal (β [CI95%] = 2.04 $N{\cdot}m/cm^2$ [0.46, 3.62], p = 0.013, $_{Marginal}R2$ = 0.31), medial (β [CI95%] = 1.90 $N{\cdot}m/cm^2$ [0.23, 3.57], p = 0.026, $_{Marginal}R2$ = 0.26), and distal (β [CI95%] = 1.79 $N{\cdot}m/cm^2$ [0.03, 3.54], p = 0.046, $_{Marginal}R2$ = 0.22) MV were all statistically significant.

For the models examining torque at 120°, the isolated effects of proximal (β [CI95%] = 2.58 $N{\cdot}m/cm^2$ [0.81, 4.35], p = 0.005, $_{Marginal}R2$ = 0.36), medial (β [CI95%] = 2.57 $N{\cdot}m/cm^2$ [0.76, 4.39], p = 0.007, $_{Marginal}R2$ = 0.35), and distal (β [CI95%] = 2.56 $N{\cdot}m/cm^2$ [0.69, 4.44], p = 0.009, $_{Marginal}R2$ = 0.34) MV were all statistically significant.

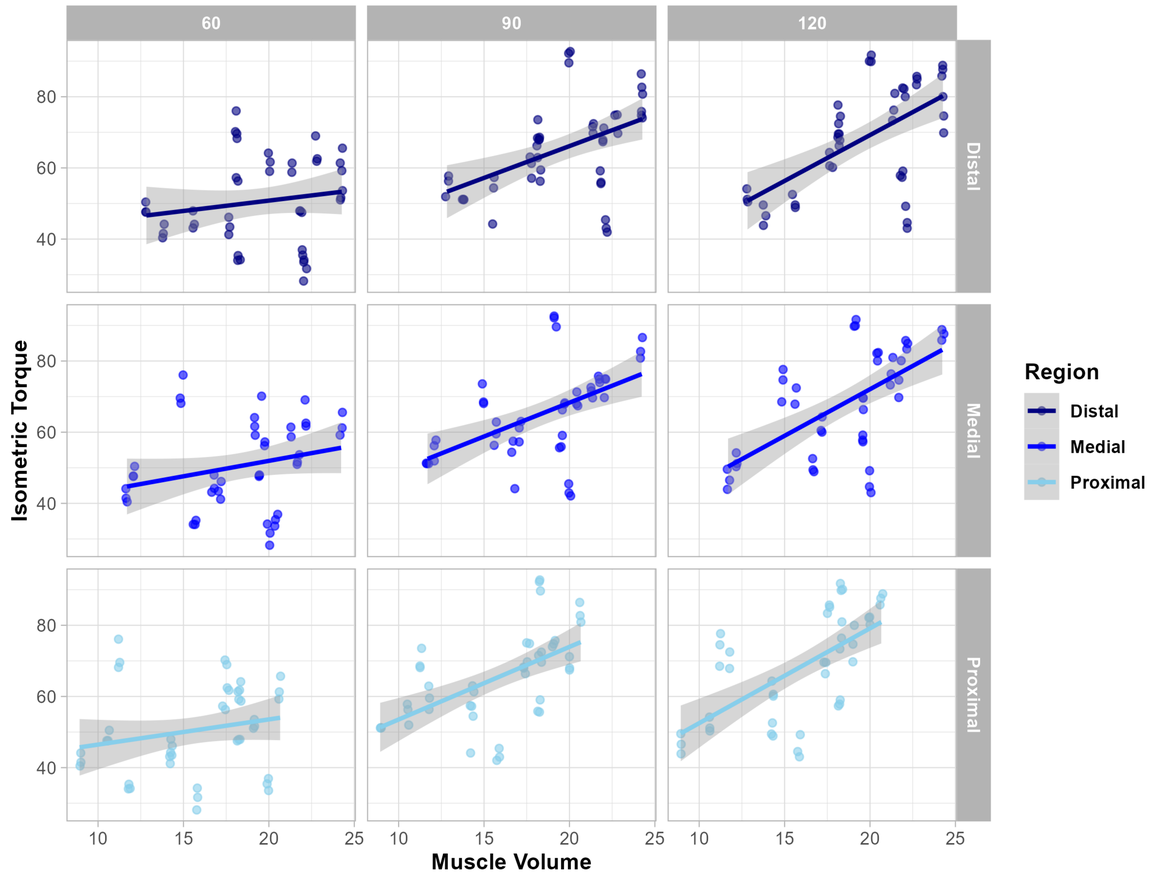

Figure 1. Relationship between muscle volume (cm^2) and isometric torque ($N{\cdot}m$) across angles (60°,90°,120°) and regions (Distal, Medial, Proximal).

CONCLUSION

At 60° of flexion, MV across all regions exhibited trivial ($_{Marginal}R2 < 0.10$) non-significant relationships with torque. Conversely, at 90° and 120° of flexion, MV across all regions exhibited small ($_{Marginal}R2 \geq 0.10$) to moderate ($_{Marginal}R2 \geq 0.30$) significant correlations with torque. The increased strength of this relationship at greater angles might reflect a more favorable biomechanical position for torque production. At greater joint angles (90-120°), the biceps brachii might operate closer to its optimal length for force production, wherein the actin and myosin filaments, theoretically, have an ideal overlap, enhancing the muscle's ability to generate torque.

PRACTICAL APPLICATION

These data indicated MV of the proximal, medial, and distal region of the biceps brachii may play a role in predicting muscle torque when produced at 90° or 120° of forearm flexion, suggesting that these sites may be functionally relevant locations for determining torque capacity for these specific joint angles.

METHODS

15 recreationally trained men (Age = 22.5 yrs ± 3.1; Height = 180.1 cm ± 7.5; Weight = 77.2 kg ± 13.4) were used for the present analysis.

Participants underwent ultrasonographic assessment of the non-dominant bicep for proximal, medial, and distal MV (expressed as cm^2), followed by isometric assessments (expressed as $N{\cdot}m$) at 60°, 90°, 120° of forearm flexion (180° = full extension).

To assess reliability of region-specific MV and angle-specific torque, ICC were produced using a two-way random effects model. To examine the effects of regional MV on torque, 9, separate, linear mixed effect models were fit for angle-specific torque with region-specific MV included as fixed effects and random intercepts per participant. For all statistical analysis significance was set at $p < 0.05$.