VASTUS LATERALIS MUSCLE ARCHITECTURE EXHIBITS NON-HOMOGENEOUS ADAPTATION TO RESISTANCE TRAINING


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ABSTRACT

Changes in strength can be attributed in part to adaptation of a number of architectural parameters within muscle. Adaptation may also be specific to certain regions of the muscle. PURPOSE: To compare changes in strength with changes in vastus lateralis (VL) muscle architecture at two transverse landmarks (VL0 and VL5) during on-season and off-season training in male athletes (19.7 ± 1.0 yrs; 71.1 ± 0.9 m; body mass: 64.6 ± 8.9 kg) participating in a 15-week off-season training program. Testing was conducted at the beginning (PRE) and end (POST) of training. Each visit consisted of maximal strength testing (1-RM barbell squat test) and muscle architecture measures. Cross-sectional area (CSA), pennation angle (PA), and fascicle length (FL) of the VL were measured via ultrasonography of the athlete’s self-reported dominant leg. VL0 was defined as the point of intersection between the VL and 50% of the straight line distance between the greater trochanter and the lateral epicondyle of the femur, while VL5 was sampled at a point 5cm medially of VL0. Comparisons between VL0 and VL5 were made using an independent t-test. Changes in muscle architecture and strength measures were analyzed using magnitude-based inferences derived from the p-value of dependent t-tests. Relationships between changes in VL architecture and strength were examined using Pearson correlation coefficients, which were further analyzed to determine the magnitude of effect. RESULTS: Significant increases in 1RM squat strength (3.7 ± 2.4 kg, p ≤ 0.004) were observed from PRE to POST. A likely greater FL at VL0 (99.4%) and a possibly greater FL at VL5 (81.2%), and a very likely greater MT at VL5 (99.4%) were observed from PRE to POST. Changes in 1-RM squat strength showed likely positive correlations with MT and FL at VL0 at the 0.3 threshold (85.9% and 79.1% respectively). All participants were engaged in a 15-week periodized resistance training program consisting of a weekly 4-day split per week, split routine.

INTRODUCTION

Muscle architecture varies across both individual muscles and muscle groups according to the tissue’s functional role with distinct architectural structures conferring specific contractile properties. In addition, muscle demonstrates a high degree of plasticity in regards to its configuration, resulting from both contractile and metabolic functional demands. Changes in strength may be attributed in part to the simultaneous adaptation of a number of interrelated architectural parameters. Further, adaptations may also be specific to certain regions of the muscle. Variations in transverse point of measure landmarks may have a significant effect on both the expression of the structure-function relationship and observed adaptation.

METHODS

To compare changes in the magnitude of two commonly utilized point measure landmarks occurring transversely within the vastus laterals (VL0), in order to assess whether architectural adaptation occurs homogeneously across the VL, to correlate changes in muscle architecture of VL at each anatomical landmark, to examine concurrent changes in muscle architecture and strength were made using an independent t-test. Changes in muscle architecture and strength measures were examined using Pearson correlation coefficients, which were further analyzed to determine the magnitude of effect. RESULTS: Significant increases in 1RM squat strength (3.7 ± 2.4 kg, p ≤ 0.004) were observed from PRE to POST. A likely greater FL at VL0 (99.4%) and a possibly greater FL at VL5 (81.2%), and a very likely greater MT at VL5 (99.4%) were observed from PRE to POST. Changes in 1-RM squat strength showed likely positive correlations with MT and FL at VL0 at the 0.3 threshold (85.9% and 79.1% respectively).

RESULTS

All correlations were calculated from 90% confidence intervals. To determine the magnitude of effect, the smallest non-trivial change, or smallest worthwhile change, was set at 20% of the smallest of the observed difference in magnitude, with likely being assumed when the smallest non-trivial change was ≤ 0.037. Analysis of the magnitude of correlation coefficient relationships revealed a number of significant positive correlations with changes in muscle architecture at VL0 only.

TABLE 1.

Methods continued...

Statistical Analysis

All differences and relationships were assessed using magnitude-based inferences, calculated from 90% confidence intervals. Comparisons between VL0 and VL5 were analyzed using the p value from independent t-test, while changes in muscle architectural and performance measures from PRE to POST were analyzed using the p value from dependent t-test to determine a mechanistic inference. Qualitative inferences were based upon the chances that the true magnitude of the effect at POST- off season was substantially greater or smaller than baseline values (PRE), and were assessed as: ≤ -1% almost certainly smaller, -1% to 5% likely very smaller, 5-25% likely smaller, 25-75% possibly greater, 75-95% likely greater, and ≥ 95% almost certainly greater. If there was a greater than 5% chance that the true value was both greater and smaller, the result was considered unclear (unclear). Statistical Software

All statistical analyses were performed using statistical software (JMP 13.0.0, SAS Institute Inc., Cary, NC. 2015). Figure 1: Differences in muscle architecture (area of rectangles). Figure 2: Magnitude based inferences for architectural change (mean (POST-PRE) ± 90% confidence limits) at VL0 and VL5 relative to the smallest worthwhile change (SWC). The SWC (Critical zone) was set at 20% of the grand standard deviation for all PRE-values. For figure clarity, changes were represented as a factor of the SWC in order to compare values with differing units and were determined by dividing the mean and 90% confidence limits of each parameter by its corresponding SWC value.

REFERENCES


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