HMSC
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THE INFLUENCE OF VASTUS LATERALIS MUSCLE SIZE, ARCHITECTURE, AND PATELLAR TENDON MOMENT ARM LENGTH ON COUNTERMOVEMENT JUMP PERFORMANCE

Nicholas A. Buoncristiani[1], Luke R. Arieta[2], Hayden K. Giuliani-Dewig[3], Jacob A. Mota[4], Eric D. Ryan[1]

[1]The University of North Carolina at Chapel Hill, Chapel Hill, NC; [2]University of Massachusetts Amherst; [3]West Virginia University, Morgantown, WV; [4]Texas Tech University

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INTRODUCTION

- The countermovement jump (CMJ) is a common assessment performed by strength and conditioning coaches and sports scientists to assess lower-body performance.[1]
- Identifying the role of quadriceps muscle size, architecture, and patellar tendon moment arm length (MA_{PT}) on CMJ performance could help inform future training strategies.

PURPOSE

- The purpose of this study was to examine the relationship and influence of vastus lateralis (VL) muscle size, architecture, and MA_{PT} length on CMJ performance.

METHODS

- Thirty-one recreationally active young adults (18 females; age: 21.77±3.30 years, stature: 173.63±9.46 cm, body mass: 70.92±11.84 kg) enrolled in the study.
- Participants reported to the laboratory on two separate occasions to perform a CMJ assessment (visit 1) and determine VL muscle size and architecture, and MA_{PT} using ultrasonography and dual-energy x-ray absorptiometry, respectively (visit 2).
- All muscle size and architecture variables were taken from the VL of the dominant limb. Muscle size was defined as total muscle volume (cm^3) using the Cavalieri formula that utilized VL cross-sectional area (Figure 1.A.) at 25%, 50%, and 75% of muscle length. Fascicle length (FL; cm) was taken from two clearly visible fascicles from the middle of the muscle and averaged (Figure 1.A.).[2]
- Pennation angle (PA;°) was taken from the same fascicles at the angle between the fascicle and deep aponeurosis and was averaged (Figure 1.B.)[2,3]
- The MA_{PT} was defined as the perpendicular distance between the tibiofemoral contact point (i.e. the midpoint of the shortest distance between the femoral condyles and tibial plateau) and the patellar tendon action line (Figure 1.C.).[4] Fascicle length, PA, and MA_{PT} were assessed via an open-source image program.
- A CMJ was performed on a jump mat with to measure jump height (cm). Participants performed three CMJs, with the highest jump height used for analysis.

STATISTICAL ANALYSIS

- Pearson product moment correlations (*r*) were used to determine the association between VL muscle size, PA, FL, and MA_{PT} and CMJ performance.
- A stepwise regression analysis was used to determine the relative contribution of VL muscle size, PA, FL, and MA_{PT} to CMJ performance. An alpha level of 0.05 was set a priori to determine statistical significance.

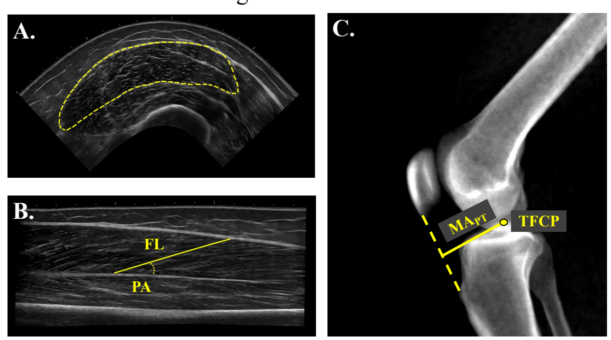

Figure 1. An example image of the cross-sectional area (A), fascicle length and pennation angle (B), and patellar tendon moment arm length (C). FL – fascicle length; PA – pennation angle; MA_{PT} – patellar tendon moment arm; TFCP – tibiofemoral contact point.

RESULTS

Table 1. Mean ± standard deviation (SD) values for muscle size, architecture, patellar tendon moment arm, and countermovement jump.

CMJ Height (cm)	40.52 ± 8.42
Muscle Volume (cm^3)	501.46 ± 162.75
Fascicle length (cm)	9.59 ± 1.62
Pennation Angle (°)	12.95 ± 3.18
MA_{PT} Length (cm)	4.55 ± 0.39

- CMJ height was significantly associated ($P \leq 0.0018$) with VL muscle size (r=0.791), PA (r=0.461), and MA_{PT} (r=0.557).
- The stepwise regression analysis suggested that VL muscle volume and FL contributed to CMJ height (R^2=0.665; P<0.001).

CONCLUSION

- Higher CMJ heights were associated with VL muscle volume, PA, and MA_{PT}. Further, it appears that FL is an important "cofactor" for CMJ performance which becomes increasingly important for those with greater muscle volumes that collectively explains 67% of CMJ height.

PRACTICAL APPLICATIONS

- VL muscle volume and FL are important predictors of CMJ performance, which are factors that can be modified with resistance training programs. This may be important for coaches and sport scientists as these measures can be reliably assessed using ultrasonography.

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