TEST-RETEST RELIABILITY OF ULTRASONOGRAPHY-DERIVED QUADRICEPS MUSCLE VOLUME IN YOUNG MEN AND WOMEN

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INTRODUCTION

- Measurements of muscle volume (MV) are commonly used to assess the impact of training, disease, and rehabilitation on skeletal muscle size and to determine physiological cross-sectional area (CSA)[1,2].
- Ultrasonography may offer a portable, low-cost, and safer alternative to measure MV than traditional imaging modalities[3].

PURPOSE

- The purpose of this study was to quantify the test-retest reliability of ultrasonography-derived quadriceps MV.

METHODS

- Twenty-nine healthy participants (14 female; mean ± SD age= 22.0 ± 3.4 yr, BMI= 23.4 ± 2.2 kg/m^2) enrolled in the study and reported to the laboratory on two separate occasions (separated by 3-10 days).
- Prior to both sessions, participants were required to abstain from strenuous exercise (48 hours), alcohol (24 hours), and caffeine (12 hours), and fast (4 hours) prior to testing.
- Panoramic ultrasound images were taken at 25%, 50%, and 75% of muscle length for the vastus lateralis (VL), vastus intermedius (VI) and rectus femoris (RF), whereas the vastus medialis (VM) were taken at 33%, 50%, and 66% of muscle length.
- Images were analyzed in an open-source image program, and the straight-line function was used to convert pixels to cm.
- Each muscle (VL, VI, RF, and VM) was outlined with the polygon function to include the most amount of muscle tissue as possible and least amount of surrounding fascia to determine muscle CSA.
- Skeletal MV (cm^3) was calculated for each of the individual muscles using the Cavalieri formula, which assumes a cylinder shape of the muscle between slices[4].
- Total quadriceps femoris (QF) MV was calculated by summing the four individual muscles (VL, VI, RF, and VM) volumes for each participant.

STATISTICAL ANALYSIS

- A one-way repeated measures analysis of variance was used to determine if there was systematic error between days.
- The intraclass correlation coefficient ($ICC_{2,1}$) and standard error of the measurement (SEM) were calculated to assess relative and absolute consistency, respectively[5].
- Minimum difference (MD) values (i.e., amount of change needed to be considered real) were also calculated[5].
- The SEM and MD values were also expressed as a percentage of the grand mean.

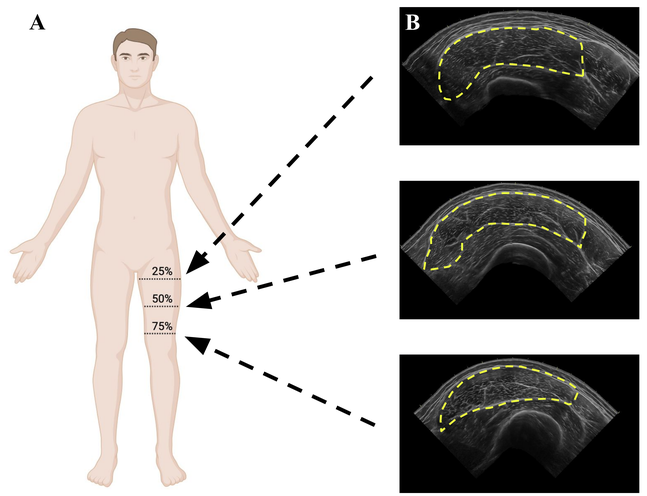

Figure 1. An example of A) leg marked for scanning and B) outlined VL ultrasound scans

RESULTS

- There was no systematic error between days for each muscle and QF volume ($P \geq 0.185$). Test-retest reliability statistics and muscle volume values are reported in Table 1.

Table 1. Test-retest reliability statistics and day 1 and 2 mean ± standard deviation values for ultrasonography-derived quadriceps muscle volume.

	VL	VI	RF	VM	QF
$ICC_{2,1}$	0.980	0.958	0.935	0.971	0.989
SEM (cm^3)	20.7	23.7	13.4	11.1	35.9
SEM (%)	4.1	4.7	6.7	6.0	2.6
MD (cm^3)	57.5	65.8	37.1	30.8	99.5
MD (%)	11.2	13.0	18.7	16.7	7.1
Day 1 (cm^3)	510.0 ± 147.5	504.6 ± 110.2	197.0 ± 49.9	183.4 ± 63.7	1395.0 ± 343.8
Day 2 (cm^3)	513.4 ± 141.5	509.1 ± 120.5	200.0 ± 54.5	185.3 ± 65.7	1407.8 ± 347.2

CONCLUSION

- Results from this study indicated that ultrasonography has acceptable absolute and relative consistency values when examining quadriceps MV in young men and women.

PRACTICAL APPLICATION

- Researchers and strength and conditioning practitioners could consider using ultrasonography to reliably examine changes in quadriceps MV following various interventions, injury, and/or chronic disease.
- The MD values could give practitioners specific criteria to determine the effectiveness of a training or rehabilitation protocol on quadriceps MV.

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