CONSISTENCY OF MUSCLE SHAPE AND VALIDITY OF SHAPE-BASED VOLUME PREDICTION IN LEG MUSCLES

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Introduction

The assessment of muscle volume by whole-muscle segmentation is a time-consuming procedure. A promising volume prediction method is based on the consistency of muscle shape (Albracht et al., 2008), but its validity needs clarification. The present study investigated the consistency of muscle shape, the validity of the proposed method and the effect of sex.

Methods

Subjects and segmentations | Whole-muscle segmentations were obtained from magnetic resonance images of the following muscles and populations:

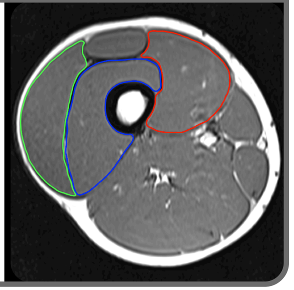
Soleus *SO*, Gastrocnemius lateralis *GL* & medialis *GM*

Untrained individuals: n = 13
Endurance athletes: n = 9
Strength athletes: n = 10

Recreationally active: n = 21

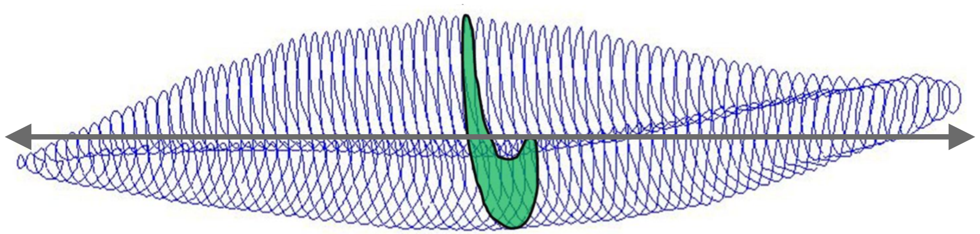
Vastus intermedius *VI*, lateralis *VL* & medialis *VM*

Volleyball athletes
Female: n = 20
Male: n = 17



Methods

Measurement of key parameters | Muscle volume *V*, max. anat. cross-sectional area $ACSA_{max}$, muscle length *L*



Theoretical consideration | The mean ACSA is a fraction of the $ACSA_{max}$ that is defined by the individual shape of the muscle (p_i):

$$p_i = \frac{V}{ACSA_{max} \cdot L}$$

The volume can be predicted (V_p) using the average *p* of a population:

$$V_p = p \cdot ACSA_{max} \cdot L$$

Statistics | Muscle dimensions and muscle shape factors were compared between groups (untrained, endurance & strength trained / male and female athletes) using an ANOVA. We further compared the measured volumes to those predicted using the averaged shape factors by means of a t-test.

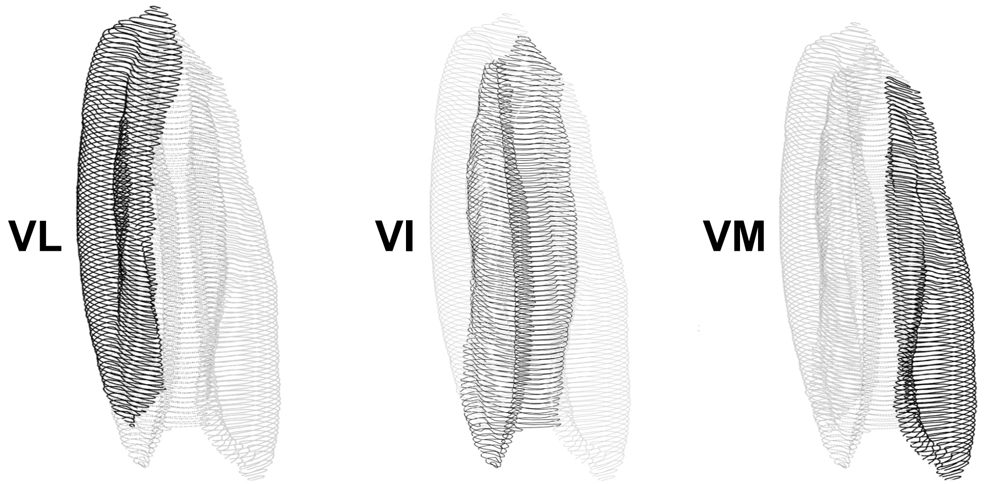


Fig.: Whole-muscle segmentations of vastus lateralis (VL), intermedius (VI) and medialis (VM)

Results | Muscle shape consistency

Sign. group / sex effect	Muscle dimensions: Volume, length, $ACSA_{max}$
No group / sex effect	Shape factors, Position of $ACSA_{max}$

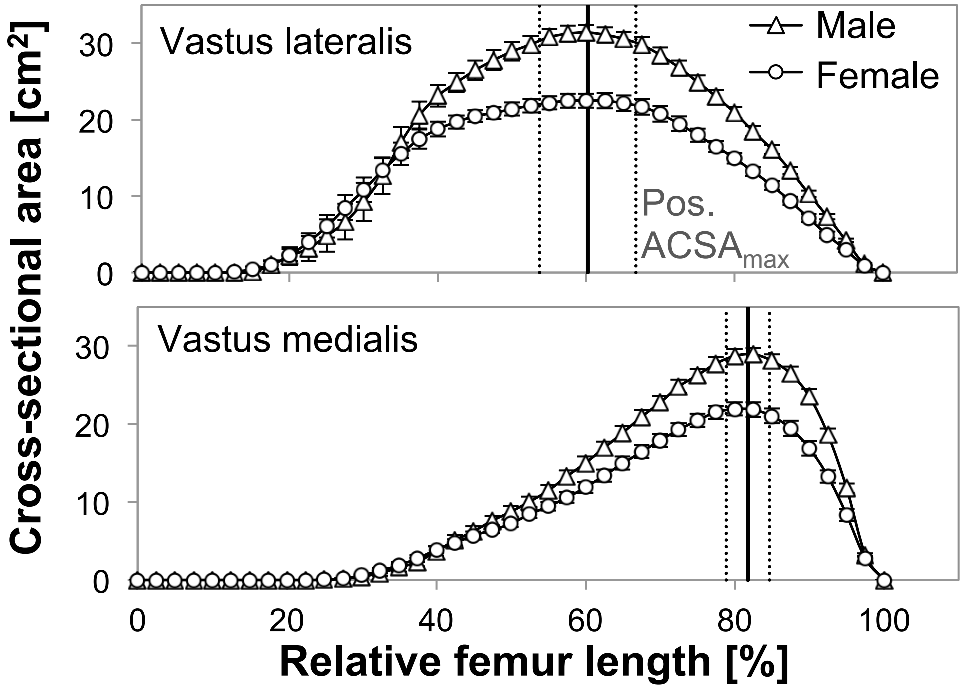


Fig.: Cross-sectional area as a function of relative femur length

Results | Applicability of prediction

➔ No significant difference between measured and predicted muscle volume

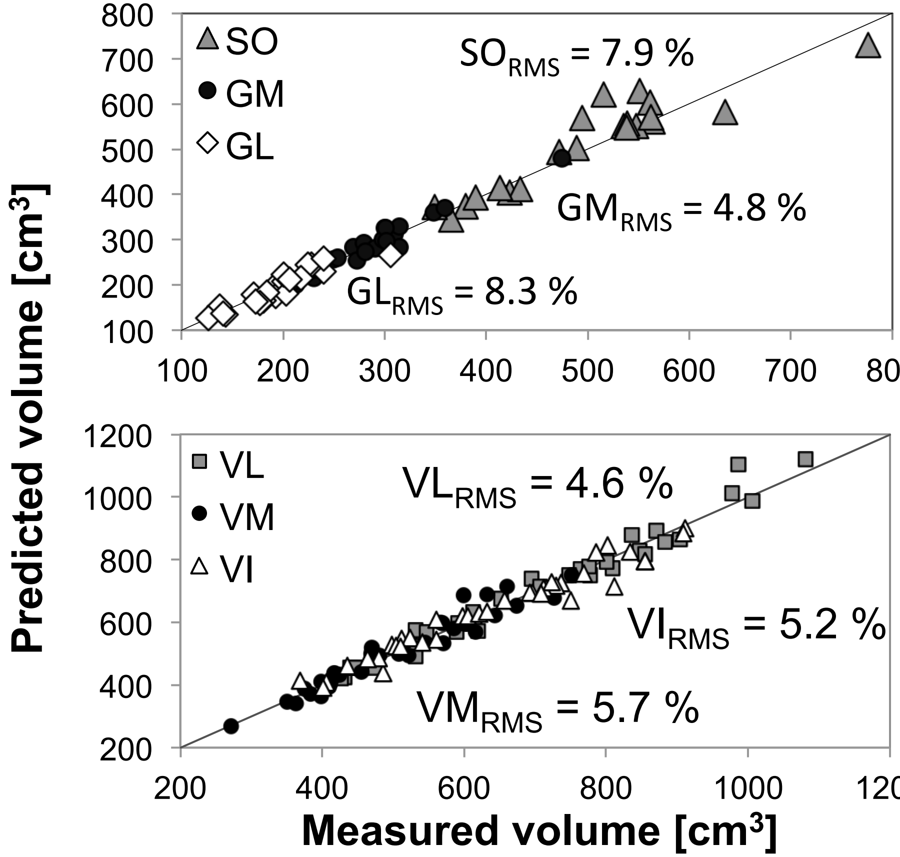


Fig.: Measured and predicted volume and root mean square (RMS) differences for triceps surae (top) and quadriceps femoris vastii (bottom)

Discussion

Consistency of muscle shape | The similar shape factors between groups with significantly different muscle dimensions (i.e. untrained individuals, endurance and strength athletes / male and female volleyball athletes) provide a strong argument for muscle shape consistency.

There was no effect of sex on muscle shape despite reports of differences regarding whole-body muscle mass distribution (Abe et al., 2003) or tissue structure (Toft et al., 2003).

	SO	GM	GL	VI	VL	VM
Shape factor	0.497	0.596	0.556	0.582	0.658	0.543
Position* $ACSA_{max}$	33 %	19 %	16 %	57 %	60 %	81 %

* Relative to shank or femur length from proximal to distal

Applicability of volume prediction | The sensitivity of the proposed method seems sensitive enough to detect volume changes associated with hypertrophy (10 %, VL: Aagaard et al., 2001), sarcopenia (22 %, triceps surae: Morse et al., 2005) or unloading (29 %, triceps surae: Alkner & Tesch, 2004).

References

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