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RELIABILITY OF MIDDLE TRAPEZIUS MUSCLE THICKNESS MEASURED BY ULTRASOUND IMAGING

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SUMMARY
The aim of this study was to propose a technique and assess the intra-rater within- and between-images reliability of thickness of the middle portion of trapezius muscle by ultrasound imaging. Two ultrasound images were acquired on the same day in thirty one healthy male subjects from the Brazilian Naval Academy. The transducer was positioned at the midpoint between the T1 spinous process and the posterolateral border of the acromion. Three thickness measurements were made for each image, whose average values were 12.4 ± 1.9 and 12.5 ± 1.9 mm. No significant difference was observed among repeated measures. The first image showed high intra-rater within-image reliability, with intraclass correlation coefficient 0.90 and low typical error equal to 0.57 mm. The coefficient of variation was less than 3%. The reliability was also high between-images. The present study showed good reliability and low typical error in thickness measurement by ultrasound imaging for the middle portion of the trapezius muscle.

INTRODUCTION
The trapezius muscle plays an important role in stabilizing and moving the shoulder joint [1]. Based on cadaver studies, this muscle is divided into three parts: upper, middle, and lower [1]. During the shoulder lifting motion, the upper and lower trapezius along with the serratus anterior muscle produce the rotation and elevation of the scapula, whilst the middle portion acts as a stabilizer [1,2].

Several authors showed that the cross-sectional area of some muscles have good correlation with the power output [3]. Studies about imaging validation showed good agreement for muscle thickness obtained by ultrasound when compared with magnetic resonance imaging, which is considered as the “gold standard” [4].

O’Sullivan et al. [4] showed a good agreement between thickness of the trapezius muscle by magnetic resonance imaging and ultrasonography at the lower portion (level T8), moderate agreement at level T5 and poor agreement at the middle (T1), and upper (C6) portions [4]. However, further studies showed good and moderate reliability for the thickness of the lower and middle trapezius, respectively [5,6]. This indicates that different methodologies for reliability studies should be tested before establishing the single technique to analysis.

The aim of this study was to propose a technique and assess the intra-rater within- and between-images reliability of thickness of the middle portion of trapezius muscle by ultrasound imaging.

METHODS
Thirty one healthy male subjects from the Brazilian Naval Academy volunteered to participate in this study, with age 23.08 ± 6.52 years (mean ± SD), body mass 75.88 ± 8.06 kg, and height 174.78 ± 6.23 cm. Exclusion criteria were: musculoskeletal or neuromuscular disorders, history of pain in the neck, shoulders and upper limbs. All volunteers signed an informed consent form.

The subjects were positioned lying prone, with the head and neck in neutral alignment, upper limbs along the trunk, and the palms facing upwards. The T1 spinous process and the posterolateral edge of the acromion were identified by palpation and marked with a dermographic pen.

Two ultrasound images was acquired on the same day with a system EUB-405 PLUS (Hitachi Medical, Japan) using the linear 7.5 MHz EUP L33 (Hitachi Medical, Japan) transducer. An Ultrex gel (Farmativa, Brazil) was used for acoustic coupling to the skin surface. The transducer was positioned at the midpoint between the T1 spinous process and the posterolateral border of the acromion. Exploratory pilot work showed that this site provided the best visualization of the muscle belly. The right side of trapezius was chosen for measurements, which were performed by the same investigator. Previously, the investigator was trained for two months in all procedures used in this study.

Ultrasound images were processed off-line using NIH ImageJ software version 1.42 (National Institute of Health, USA). Initially, the images were encoded and shuffled so that the subjects were not identified by the investigator. The belly of the muscle and with greatest thickness was chosen for measurement, where the muscle borders were parallel. A vertical line was drawn from the inner border of the

superficial aponeurosis to the deep aponeurosis [4]. Three measurements were made randomly for each image by the same evaluator (Figure 1).

Reliability was determined by the two-way analysis of variance (ANOVA) ($\alpha = 0.05$), intraclass correlation coefficient (ICC), typical error of measurement (TE) and coefficient of variation (CV). Only the first ultrasound image was chosen for the within-image reliability, and the ICC(3,1) was chosen based on three measurements made in the ImageJ [7]. Moreover, ICC(3,3) was selected for testing between-image reliability, taking the average of the three measurements for each image [7]. The 95% confidence interval (CI95%) was also calculated for ICC, and the TE was calculated by the squared root of mean square error obtained by ANOVA.

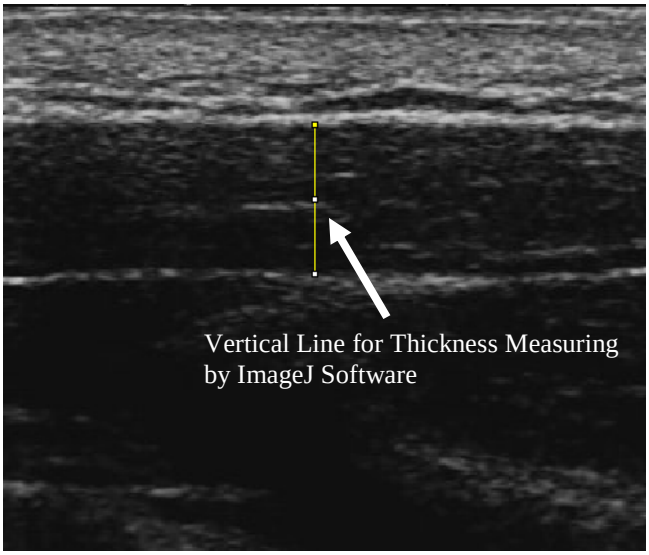

Figure 1: Middle portion of trapezius muscle, and thickness measurement by the ImageJ software.

RESULTS AND DISCUSSION

The average values for the two images were 12.4 ± 1.9 and 12.5 ± 1.9 mm. No significant difference was observed among repeated measures ($p > 0.05$). The first image showed a high intra-rater within-image reliability, with ICC(3,1) equal to 0.90 (Table 1), where the TE (0.57 mm) was low, compared with the average thickness of the muscle, suggesting that the ultrasound technique produces an accurate estimation of muscle thickness. The CV also showed low value, less than 3%. The reliability was also high between-images, as shown in Table 1.

Table 1: Within- and between- ultrasound images reliability of thickness of the middle portion of the trapezius muscle

	CCI (CI95%)*	TE (mm)	CV**
Within-image	0.90 (0.82-0.94)	0.57	2.10%
Between-images	0.93 (0.87-0.96)	0.61	3.71%

*Intraclass correlation coefficient (95% confidence interval).
**Coefficient of variation (CV).

These results confirm that only one thickness measurement performed on one image is enough to obtain sufficient reliability. Similar studies also indicated a high reliability within-image to the lower portion of the trapezius, with ICC(3,1) 0.91 and CI95% 0.98 to 1.00, and between-images, with ICC(3,3) 0.96 and CI95% 0.90 to 0.98 [5].

The present study evaluated only the intra-rater within-day reliability. This limitation does not allow generalizing the results for the inter-rater and between-days reliabilities [6,8].

CONCLUSION

The present study showed good reliability in thickness measurements by ultrasound images for the middle portion of the trapezius muscle, using the proposed protocol. The between-images ICC proved to be slightly larger, presumably reflecting the choice of the model which took into account the average of three measurements from each image.

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REFERENCES

1. Ludewig PM, et al., *J Orthop Sports Phys Ther*. **24**:57-65, 1996.
2. Johnson G, et al., *Clin Biomech*. **9**:44–50, 1994.
3. Bemben MG, *J Strength Cond Res*. **16**:103-108, 2002.
4. O'Sullivan C, et al., *Man Ther*. **14**:572–578, 2009.
5. O'Sullivan C, et al., *J Orthop Sports Phys Ther*. **37**:620-626, 2007.
6. Bentman S, et al., *Clin Physiol Funct Imaging*. **30**:426-431, 2010.
7. McGraw KO, et al., *Psychol Methods*. **1**:30-46, 1996.
8. Martins NSF, et al., *Rev Bras Cineantropom Desempenho Hum*. **14**:212-220, 2012.