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Assessment of quadriceps muscle mass with ultrasound in critically ill patients: intra- and inter-observer agreement and sensitivity

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Dear Editor,
 Loss of muscle mass and muscle weakness are common in critically ill

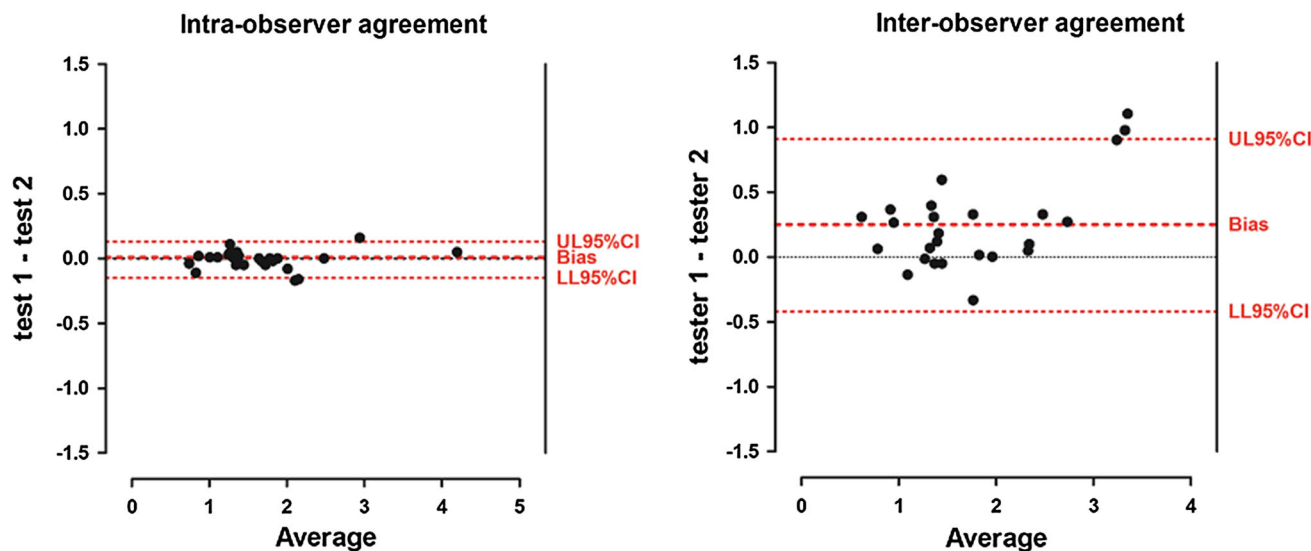
patients [1, 2] and have important clinical implications [3]. Most of the muscle atrophy takes place in the first 2 weeks of ICU stay [1, 2]. Evaluation of the prevention of muscle atrophy requires reliable tools for its assessment. Since critically ill patients are often sedated, voluntary muscle strength tests cannot be performed because of impaired patient cooperation [4]. Measuring of the quadriceps mass by ultrasound has gained interest, because of its non-invasive nature and bedside application [1]. In addition, this measurement correlates well with CT scan assessment, without radiation and a technically difficult procedure for critically ill patients, and the results are immediately available [5]. We studied the intra- and interobserver agreement of ultrasound measurement in the assessment of the quadriceps muscle mass in critically ill patients. In addition, we investigated the sensitivity to detect muscle loss over 1 week with repeated ultrasound measurements at day 3 or 4 and day 10 or 11.

Ultrasound measurements (Vivid 7, GE Healthcare, Herentals,

Belgium) of muscle thickness were performed on the medical and surgical ICU of the University Hospitals, Leuven, Belgium. Patients were eligible for inclusion irrespective of the reason for admission. Patients with different lengths of ICU stay were selected at random. Some patients were on the ICU for only a few days, while others were already in the ICU for several days or even weeks.

The ultrasound images were used to investigate the thickness of the right rectus femoris and vastus intermedius together. The methodology was similar to that used by Seymour et al. [5] (see details in online supplement S1). Data collection and statistical analysis are explained in online supplement S2. All patients were included in an ongoing randomized controlled trial examining the effect of neuromuscular electrical stimulation in critically ill patients. (ClinicalTrials.gov: NCT02133300).

For all three parts of this study, measurements of the quadriceps muscle layer thickness were performed in 25 patients. Patient characteristics are shown in online supplement table S1. Intraobserver



UL95%CI: upper limit 95% confidence interval; LL95%CI: lower limit 95% confidence interval

Fig. 1 Bland–Altman plot of the intra- and inter-observer agreement results

agreement showed an ICC of 0.995 (95 % CI 0.989–0.998). For the interobserver agreement, the ICC was 0.951 (95 % CI 0.890–0.979). The differences between the two measurements of intraobserver agreement were not statistically significant and below 0.2 cm (1.66 vs 1.67 cm, $p = 0.528$). For the interobserver agreement, the differences between the two observers were statistically significant (1.88 vs 1.63 cm, $p = 0.002$). Analysis of muscle thickness showed a significant decrease of 11 % from 2.18 ± 0.83 to 1.95 ± 0.76 cm ($p = 0.012$). The individual measurements of all patients are shown in online supplement figure S3. The Bland–Altman plots of the intra- and interobserver agreement are shown in Fig. 1.

Our results show that muscle thickness as measured by ultrasound can be reliably assessed within observers, but not between observers. In addition, the method is sensitive to detect muscle wasting in critically ill patients provided that the same investigator performs the repeated measurements. Furthermore, this method is unrelated to patient cooperation and can easily be performed at the bedside in all critically ill patients.

Conflicts of interest The authors declare that they have no conflict of interest.

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