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RELIABILITY STUDY

Ultrasound imaging of the diagonal dimension of the deep cervical flexor muscles: A reliability study on healthy subjects

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Summary The purpose of this study is to assess the reliability of a new ultrasound imaging (USI) parameter and procedure for the evaluation of the size of the deep cervical flexor (DCF) muscles. Thirty-one healthy male subjects (21.6 ± 2.5 years old) participated in this study. Two images of the diagonal dimension (DD) of the DCF of the subjects, at 1.5 finger-breadths below the laryngeal prominence of the thyroid cartilage in a relaxed state, were taken on separate days with a 1-week interval. The intraclass correlation coefficient between the days was 0.82 (95% confidence interval, 0.65–0.91). The standard error of measurement and minimal detectable change were 0.8 mm and 2.1 mm, respectively. The results indicated that the DD may be used as a reliable USI parameter to measure the DCF thickness in healthy subjects.

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Introduction

The stability of the cervical spine is provided by the surrounding musculature (Panjabi et al., 1998). Altered patterns of neck flexor synergy are known to be present in persons with neck pain (Jull et al., 2004; Falla et al., 2004). Studies of the coordination of the deep cervical flexor (DCF) and superficial cervical flexor muscles in craniocervical flexion tests have demonstrated increased electromyographic amplitude of the sternocleidomastoid muscle in persons with neck pain (Jull et al., 2004; Falla et al., 2004). This was associated with reduced activation of the DCF muscles (Falla et al., 2004), longus capitis and longus colli (LC), the primary muscles involved in the support and control of the cervical curve, compared with asymptomatic subjects (Mayoux-Benhamou et al., 1994). Additionally, muscle atrophy of the DCF due to neck pain has been demonstrated by using ultrasound imaging (USI) (Javanshir et al., 2011a, b). Muscle size may provide an indirect measure of force-generating capacity, as demonstrated by various muscles (Kanehisa et al., 1994; Maughan et al., 1983; Mayoux-Benhamou et al., 1989). Therefore, the measurement of the DCF size with USI needs to be a reliable method that provides accurate assessment of muscle changes, such as those occurring during atrophy or hypertrophy.

The number of studies assessing the DCF with USI is limited (Javanshir et al., 2011a; Javanshir et al. 2011b, 2010; Cagnie et al., 2009). The reliability of USI in the measurement of the cross-sectional area (CSA) of the LC was assessed by Cagnie et al. (2009). Javanshir et al. (2011a) who investigated the reliability of USI of the LC in measuring CSA, anterior posterior dimension (APD), and lateral dimension (LD). However, it is not easy to clearly image the whole muscular fasciae of the DCF because of the acoustic shadow of the trachea, which causes the medial boundary of the LC to appear insufficiently clear on USI (Javanshir et al., 2011b). Therefore, we propose a new USI parameter and procedure for the evaluation of the DCF size. The DCF muscles are located diagonally forward of the vertebral body, and the carotid arteries are located diagonally forward of the DCF. We define DCF thickness as a diagonal dimension (DD) a length between the anterolateral boundary (muscular fasciae of the DCF) and the posteromedial boundary (the vertebral body) in the extension line from the carotid artery to the nearest muscular fasciae of the DCF (Figure 1). Previous studies measured the USI of LC at 2 cm below the top of the thyroid cartilage (Javanshir et al., 2011a,b). In this study, the measurement level of the DD was defined at 1.5 fingerbreadths below the laryngeal prominence of the thyroid cartilage to adjust the relative position on the basis of the build of the subjects (Figure 2). The purpose of this study is to demonstrate the reliability of the measurement the DD of the DCF in a relaxed state by using USI in healthy subjects.

Methods

Subjects

Thirty-one male volunteers participated in this study. The exclusion criterion was a history of neck injury. The subjects' age, height, and weight (mean ± standard deviation [SD]) were 21.6 ± 2.5 years, 170.9 ± 5.8 cm, and 62.4 ± 10.1 kg, respectively. The protocol for this study was approved by the Ethics Committee of the Kawasaki University of Medical Welfare. Each subject provided his written informed consent prior to participation.

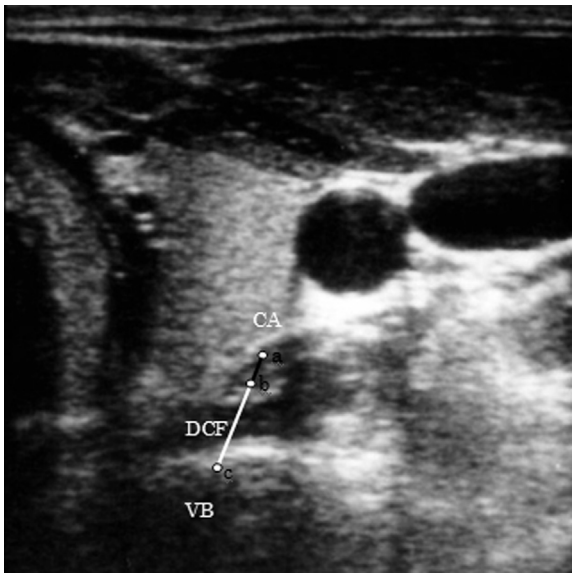

Figure 1 Ultrasound imaging of the deep cervical flexor muscles CA: Carotid artery DCF: Deep cervical flexor muscles VB: Vertebral body ab: Line from the carotid artery to the nearest muscular fasciae of the deep cervical flexor muscles b: Anterolateral boundary (muscular fasciae of the deep cervical flexor muscles) on the extension line of the ab c: Posteromedial boundary (the vertebral body) on the extension line of the ab bc: Diagonal dimension of the deep cervical flexor muscles.

Procedure

B-mode USI measurements of the DCF were captured, stored, and measured by using an Aloka SSD-3500SX

Figure 2 Position of transducer for imaging of the deep cervical flexor muscles. The center of the index finger middle phalanx was placed at the laryngeal prominence with the index and middle fingers of the left hand together, and then the measurement level was defined at 1.5 fingerbreadths below the laryngeal prominence of the thyroid cartilage of the subjects.