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- *Original Contribution*

ASSOCIATIONS BETWEEN HANDGRIP STRENGTH AND ULTRASOUND-MEASURED MUSCLE THICKNESS OF THE HAND AND FOREARM IN YOUNG MEN AND WOMEN

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Abstract—It is unknown whether muscle size of intrinsic hand muscles is associated with handgrip strength. To investigate the relationships between handgrip strength and flexor muscle size of the hand and forearm, muscle thickness (MT) of 86 young adults (43 men and 43 women) between the ages of 18 and 34 y was measured by ultrasound. Two MTs (forearm radius and forearm ulna MT) in the anterior forearm, two MTs (lumbrical and dorsal interosseous MT) in the anterior hand and handgrip strength were measured on the right side. Linear regression with part (also referred to as semipartial) correlation coefficients revealed that forearm ulna MT positively correlated with handgrip strength in both men (part = 0.379, p = 0.001) and women (part = 0.268, p = 0.002). Dorsal interosseous MT correlated with handgrip strength in women only (part = 0.289, p = 0.001). Our results suggest that the forearm ulna and dorsal interosseous MTs for women and forearm ulna MTs for men are factors contributing to prediction of handgrip strength in young adults. (E-mail: t12abe@gmail.com) © 2015 World Federation for Ultrasound in Medicine & Biology.

Key Words: **B-Mode ultrasound, Maximum-strength hand muscles.**

INTRODUCTION

It has been reported that age-related decline in handgrip strength is associated with several unfavorable health conditions such as increased risk of functional impairment (Hairi et al. 2010; Taekema et al. 2010), morbidity (Rantanen et al. 1998) and mortality (Lauretani et al. 2003; Newman et al. 2006). Handgrip strength is the most useful criterion of age-related change in muscle strength in older adults (Cheung et al. 2012; Cruz-Jentoft et al. 2010). Age-related reduction in muscle size is a major cause of the age-related decline in muscle strength (Akagi et al. 2009). In some cases, however, the decrease in muscle strength with age is greater than what would be expected from the change in muscle mass with age (Manini and Clark 2012). Therefore, alterations in skeletal muscle quantity and quality (relative strength) with age can lead to changes in handgrip strength in older adults.

Handgrip strength is generated from a combination of the intrinsic and extrinsic hand muscles. The intrinsic hand muscles consist of the thenar, hypothenar and midcarpal muscles. Two major flexor muscles, the dorsal interosseous and lumbricals, are located between the metacarpals. Meanwhile, three major extrinsic flexor muscles (flexor digitorum profundus, flexor digitorum superficialis, flexor pollicis longus) are the prime movers of the digits, which are located in the anterior forearm (Drake et al. 2008). In the upper portion of the anterior forearm, two major extrinsic flexor muscles of the fingers (flexor digitorum profundus, flexor digitorum superficialis) are located near the ulna, whereas the pronator teres and brachioradialis are located near the radius. Only one study has investigated the relationships between ultrasound-measured forearm muscle thickness (MT) and handgrip strength in old men and women (Abe et al. 2014b). In that study, the MT of two muscles (forearm radius and forearm ulna MT) was measured. The authors reported that forearm ulna MT significantly

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correlated with handgrip strength in both men and women. However, forearm radius MT correlated with handgrip strength in women only. The reason for this apparent sex difference is unknown, but it may be related to the location and size of the major flexor muscles in the forearm (Abe et al. 2014b), as well as the contribution of intrinsic hand muscles. As described above, the forearm ulna MT includes mainly two muscles (flexor digitorum profundus, flexor digitorum superficialis), which produce flexion movement for the middle phalanges of the fingers. Interestingly, approximately 50% of handgrip strength decreased after median and ulnar nerve block compared with the pre-block measurement (Kozin et al. 1999). Therefore, it is hypothesized that handgrip strength may be associated with ultrasound-measured MT of the extrinsic as well as intrinsic muscles. The purpose of the present study was to examine the relationships between forearm and hand MT and handgrip strength.

METHODS

Subjects

Forty-three men and 43 women between the ages of 18 and 34 y were recruited through printed advertisement and by word of mouth from the university campus. All subjects were right-handed and free of overt chronic disease (*e.g.*, angina, myocardial infarction, arthritic and neuromuscular disorders) and were not taking any medications known to affect muscle as assessed by self-report. The study was conducted according to the World Medical Association Declaration of Helsinki (http://www.wma.net/en/30publications/10policies/b3/index.html) and was approved by the university's institutional review board. Written informed consent was obtained from all subjects before participation.

Muscle thickness measurement

Muscle thickness was measured using B-mode ultrasound (Aloka SSD-500, Tokyo, Japan) at two sites on the right side of the body: anterior forearm (at 30% proximal between the styloid process and the head of the radius) and anterior hand (at 55% distal between palmar digital crease and flexion crease of wrist) (Fig. 1b). After limb length measurements using anatomic landmarks described earlier, all measurement sites were marked with a marker pen and then limb girth was measured. The measurements for forearm MT were made while subjects stood quietly with the elbow extended and relaxed and the forearm supinated. Additional measurements of the right hand were made while the subjects were seated on a chair with the right hand on a table at an elbow joint angle of approximately 90°. A linear transducer with a 7.5-MHz scanning head was coated with water-soluble transmission gel to provide acoustic contact and reduce pressure by the scanning head to achieve a clear image. The scanning head was placed on the skin surface of the measurement site using the minimum pressure required, and cross sections of each muscle were imaged. Two images from each site were printed (Sony UP-897 MD, Tokyo, Japan), and mean values of each site were used for data analysis. In the lateral forearm, two MTs were measured as the perpendicular distance between the subcutaneous adipose tissue–muscle interface and muscle–bone interface of the radius (forearm radius MT) and ulna (forearm ulna MT)

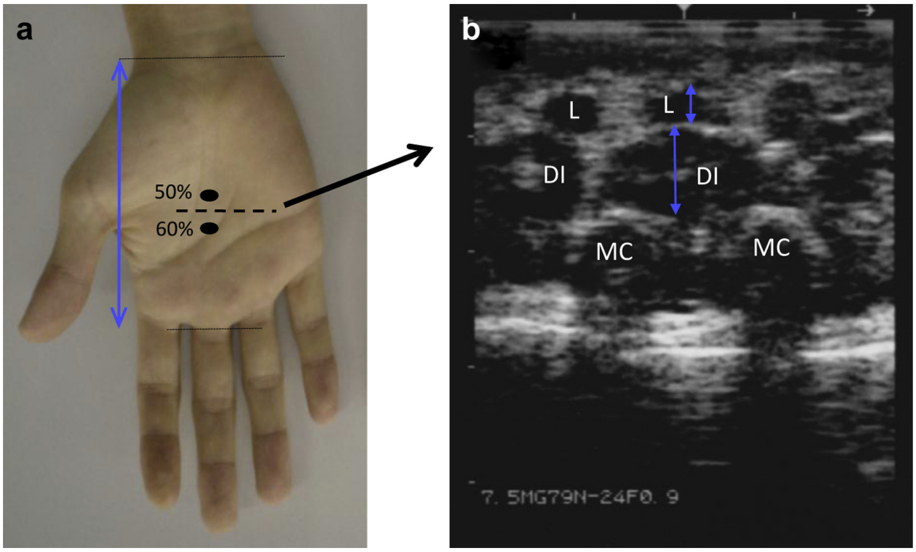

Fig. 1. (a) The distance between the palmar digital crease and flexion crease of the wrist was measured to determine the measurement site. (b) Typical ultrasound image (young woman, 21 y) revealing transverse scan on the palm at 55% distal between two anatomic landmarks. DI = dorsal interosseous; L = lumbrical; MC = metacarpal bones.

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