Age-related Differences in Forearm Muscle Size and Handgrip Maximal and Rapid Force Characteristics

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ABSTRACT

With handgrip strength being an important predictor of future disability and mortality, it is essential to expand our understanding of the age-related changes in handgrip strength characteristics and their underlying mechanisms. Previous studies have reported that decreases in muscle size of the forearm may contribute to age-related deficits in wrist flexion strength. However, we are aware of no previous studies that have examined the contribution of forearm muscle size to age-related differences in handgrip strength, and more specifically, the age-related differences in handgrip maximal and rapid force characteristics. **PURPOSE**: To determine the effects of age on forearm muscle size [muscle thickness (MT)] and handgrip maximal and rapid force characteristics in young and old females. **METHODS**: Ten young (age = 22 ± 3 years; height = 162 ± 8 cm; mass = 62 ± 9 kg) and 10 old (age = 68 ± 4 years; height = 160 ± 5 cm; mass = 68 ± 5 kg) females underwent two diagnostic ultrasound assessments followed by three isometric handgrip maximal voluntary contractions (MVCs) using an electronic handgrip dynamometer. Forearm MT (cm) was measured on the right arm using a portable B-mode ultrasound imaging device and linear-array probe. For each MVC, participants sat in an upright position and were instructed to squeeze the handgrip dynamometer with their right hand "as hard and fast as possible" for 3-4 seconds. Handgrip MVC peak force (PF; N) was calculated as the highest mean 500 ms epoch during the entire 3-4 second MVC plateau. Rate of force development (RFD; $N \cdot s^{-1}$) was calculated as the linear slope of the force-time curve over the time interval of 0-100 ms. Independent samples *t*-tests were used to compare demographic characteristics, MT, PF, and RFD between age groups. Pearson product-moment correlation coefficients (*r*) were used to examine the relationships between MT and PF and RFD. **RESULTS**: There were no differences between the young and old females for height ($P = 0.521$) or body mass ($P = 0.090$). The old females exhibited lower MT (old = 1.53 ± 0.22 cm; young = 1.76 ± 0.21 cm; $P = 0.026$), PF (old = 152.53 ± 28.37 N; young = 209.67 ± 39.08 N; $P = 0.001$), and RFD (old = 606.96 ± 248.41 $N \cdot s^{-1}$; young = 1154.04 ± 390.55 $N \cdot s^{-1}$; $P = 0.002$) than the young females. Significant positive relationships were observed between MT and PF ($r = 0.470$; $P = 0.036$) and RFD ($r = 0.485$; $P = 0.030$). **CONCLUSION**: These findings demonstrated that forearm muscle size and handgrip PF and RFD decrease in old age. The significant relationships observed between MT and PF and RFD in the young and old females perhaps suggest that these age-related declines in forearm muscle size may play an important role in the lower handgrip maximal and rapid force values observed in older adults. As a result, practitioners may consider implementing training programs aimed at increasing MT of the forearm in the elderly which may be beneficial for improving muscle size as well as handgrip maximal and rapid force production.

INTRODUCTION

With handgrip strength being an important predictor of future disability and mortality, it is essential to expand our understanding of the age-related changes in handgrip strength characteristics and their underlying mechanisms. Previous studies have reported that decreases in muscle size of the forearm may contribute to age-related deficits in wrist flexion strength. However, we are aware of no previous studies that have examined the contribution of forearm muscle size to age-related differences in handgrip strength, and more specifically, the age-related differences in handgrip maximal and rapid force characteristics.

PURPOSE

To determine the effects of age on forearm muscle size [muscle thickness (MT)] and handgrip maximal and rapid force characteristics in young and old females.

METHODS

Ten young (age = 22 ± 3 years; height = 162 ± 8 cm; mass = 62 ± 9 kg) and 10 old (age = 68 ± 4 years; height = 160 ± 5 cm; mass = 68 ± 5 kg) females underwent two diagnostic ultrasound assessments followed by three isometric handgrip maximal voluntary contractions (MVCs) using an electronic handgrip dynamometer. Forearm MT (cm) was measured on the right arm using a portable B-mode ultrasound imaging device and linear-array probe (Figure 1). For each MVC, participants sat in an upright position and were instructed to squeeze the handgrip dynamometer with their right hand "as hard and fast as possible" for 3-4 seconds. Handgrip MVC peak force (PF; N) was calculated as the highest mean 500 ms epoch during the entire 3-4 second MVC plateau. Rate of force development (RFD; $N \cdot s^{-1}$) was calculated as the linear slope of the force-time curve over the time interval of 0-100 ms. Independent samples *t*-tests were used to compare demographic characteristics, MT, PF, and RFD between age groups. Pearson product-moment correlation coefficients (*r*) were used to examine the relationships between MT and PF and RFD.

Figure 1. Transverse ultrasound image of the forearm at 30% proximal between the styloid process and the head of the radius. Forearm muscle thickness (MT) was measured as the perpendicular distance between the subcutaneous fat-muscle interface and muscle-bone interface of the radius.

RESULTS

There were no differences between the young and old females for height ($P = 0.521$) or body mass ($P = 0.090$). The old females exhibited lower MT (old = 1.53 ± 0.22 cm; young = 1.76 ± 0.21 cm; $P = 0.026$), PF (old = 152.53 ± 28.37 N; young = 209.67 ± 39.08 N; $P = 0.001$), and RFD (old = 606.96 ± 248.41 $N \cdot s^{-1}$; young = 1154.04 ± 390.55 $N \cdot s^{-1}$; $P = 0.002$) than the young females (Figure 2). Significant positive relationships were observed between MT and PF ($r = 0.470$; $P = 0.036$) and RFD ($r = 0.485$; $P = 0.030$).

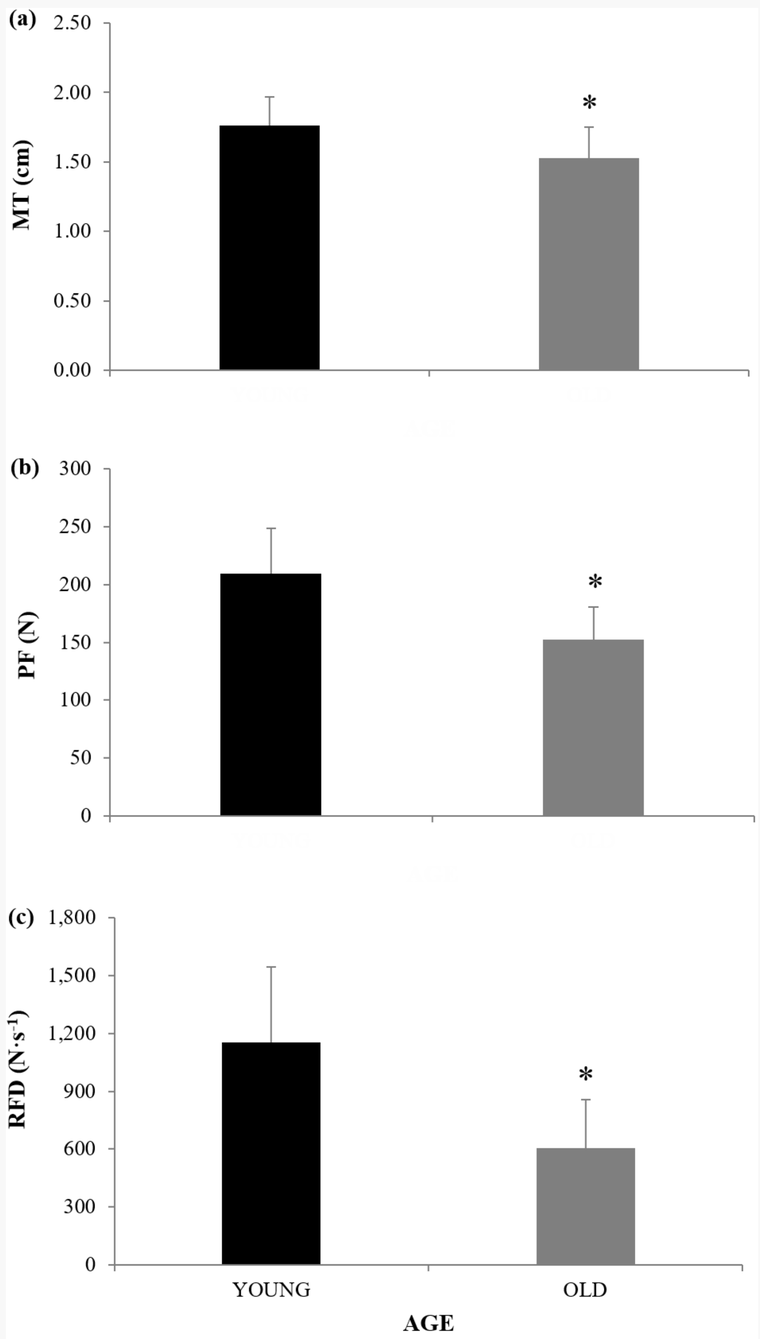

Figure 2. (a) Forearm muscle thickness (MT) and isometric handgrip (b) peak force (PF) and (c) rate of force development (RFD) for the young and old females. Values are mean ± SD. *Significantly lower for the old ($P < 0.05$).

CONCLUSION

These findings demonstrated that forearm muscle size and handgrip PF and RFD decrease in old age. The significant relationships observed between MT and PF and RFD in the young and old females perhaps suggest that these age-related declines in forearm muscle size may play an important role in the lower handgrip maximal and rapid force values observed in older adults. As a result, practitioners may consider implementing training programs aimed at increasing MT of the forearm in the elderly which may be beneficial for improving muscle size as well as handgrip maximal and rapid force production.

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