SCIENTIFIC ARTICLE

The Effect of Wrist Position on Grip Endurance and Grip Strength

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Purpose Studies on grip endurance are scant even though it is an important topic with practical implications. This study compares the effect of wrist position, in the flexion-extension plane, on grip endurance and grip strength.

Methods Grip strength and grip endurance were quantified bilaterally at 6 different wrist positions (unrestrained, 45°, 30°, and 15° extension, 0° and 30° flexion) in 38 healthy right-handed individuals.

Results Our results show that wrist orthosis significantly reduced grip strength across all positions and the maximum grip strength in the position with an orthosis occurred at 15° and 30° extension for the dominant hand and 15°, 30°, and 45° extension for the nondominant hand. Hand dominance and sex did not significantly affect grip endurance. Using a wrist orthosis did not significantly reduce grip endurance at 45° and 30° extension.

Conclusions At a position of 30° of wrist extension, maximal grip strength is achieved without significantly compromising grip endurance. This has clinical implications for decisions regarding the optimal position for orthosis and radiocarpal joint arthrodesis.

Clinical relevance This study would aid both surgeons and therapists in facilitating discussion with patients regarding the various therapeutic options in managing wrist pathologies. *(J Hand Surg Am. 2016;■(■):■−■. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Arthrodesis, endurance, grip, orthosis, wrist.

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Grip strength has been widely studied as a predictor of functional performance[1] and is affected by numerous factors including hand dominance, anthropometric indices,[2] and positioning of the elbow,[3] shoulder,[4] and forearm.[5] In particular, the effect of wrist position on grip strength has been widely studied in both the radioulnar and flexion-extension planes.[6–9]

Grip endurance is also an important and relevant measure. An individual is more likely to use a sustained grip than maximum grip effort in daily activities. There are fewer studies exploring grip endurance as a clinical indicator than studies of grip strength[10] and even fewer studies addressing the anthropometric[11–13] and postural factors[14] that impact grip endurance, including wrist position. This could largely be due to the lack of a standardized method of measuring grip endurance.

Various therapeutic interventions such as wrist arthrodesis and the application of orthotic devices are important in the management of certain wrist conditions. Establishing the wrist position at which both grip endurance and grip strength are maximized

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is important in optimizing function. The aim of our study was to assess the effect of wrist position in the flexion-extension plane on grip endurance and grip strength using a hand-held hydraulic dynamometer.

METHODS

Participants

On the basis of the sample size used in other similar studies, 38 healthy individuals (20 males, 18 females) aged 21−24 years were recruited to participate. While not part of the inclusion criteria, all individuals were right-handed. The participants had no upper limb pathology of any description or systemic rheumatologic conditions. Informed consent was obtained from all participants.

Materials and instruments

A Jamar hydraulic hand dynamometer (Baseline, White Plains, NY), set at the second handle position, was used to quantify both grip endurance and grip strength. By using preformed dorsally based thermoplastic orthoses, we measured grip strength and endurance at a fixed wrist angle in the flexion-extension plane.

Experimental protocol

Participants were seated and positioned with their shoulder in 0° abduction and neutral rotation, elbow at 90° flexion, and forearm in a neutral position (Fig. 1). They were also instructed to actively maintain this position throughout the gripping process. One investigator conducted the experiments for all 38 participants to ensure uniformity in the measurements. Both grip strength and grip endurance were measured at 6 different wrist positions in the same sequence for all participants: unrestrained position, 45° extension (45°E), 30° extension (30°E), 15° extension (15°E), 0°, 30° flexion (30°F).

Grip strength measurement

Participants were instructed to perform 3 submaximal contractions bilaterally to get accustomed to using the dynamometer. With standardized verbal encouragement, they were asked to grip the dynamometer with their best effort. A single reading was taken to be the maximum grip strength (MGS) from both the right and left hands at the unrestrained wrist position and the 5 fixed positions. A rest period of 1 minute was given between each measurement.

Grip endurance measurement

The maximum intermittent grip test method was chosen as the means by which grip endurance was quantified. It involved the participant administering his or her maximum grip effort for a number of repetitions with a predetermined period of rest in between repetitions. The proportional difference between the first and the last repetition was then calculated, and this strength decrement index (SDI)[14-16] was used as an estimate of grip endurance.

FIGURE 1: Posture of participants.

Our maximum intermittent test protocol was modeled after a study by White et al.[13] For each position, 12 isometric maximum effort repetitions were conducted per hand. Each repetition was held for 5 seconds followed by 5 seconds of rest before the next repetition. A 2-minute rest interval was given before repeating the entire set of 12 repetitions for the contralateral hand. The SDI was then calculated accordingly: SDI = (Initial maximum) − (Final maximum)/(Initial maximum) × 100.

The SDI was corrected for fatigue from the previous cycles based on the assumption that if there is no fatigue, the initial maximum will equal that of the MGS for that same angle. Corrected SDI = 1/(MGS_{angleX} − Initial $maximum_{angleX}$) × (Initial $maximum_{angleX}$) × SDI.

Data analysis

The effect of sex on grip strength and endurance was analyzed using independent *t* tests. Paired *t* tests were used to analyze the effect of hand dominance on grip strength and endurance.

A one-way analysis of variance with repeated measures was used to analyze the effect of different wrist positions (unrestrained, 45°E, 30°E, 15°E, 0°, and 30°F) on grip strength and endurance. A Bonferroni post hoc test was applied and all results from the one-way analysis of variance were taken in the