EFFECT OF FOREARM ROTATION ON GRIP STRENGTH

L. DE SMET[1], B. TIREZ[2], K. STAPPAERTS[2]

Forearm rotation affects grip strength. In a study with 40 volunteers, an overall decrease in grip strength was observed when the forearm rotated from pronation to supination. In males grip strength in pronation was significantly lower compared to the neutral and supinated position, with the wrist free as well as in an immobilized wrist position. In females this was only observed with a free wrist position, but with the wrist immobilized, the grip strength was higher in supination compared to neutral and pronation.

Keywords : wrist ; forearm ; pronation ; supination ; grip strength.
Mots-clés : poignet ; avant-bras ; pronation ; supination ; force de préhension.

INTRODUCTION

Several studies have demonstrated that wrist and body position affect grip strength. Rotation of the forearm has only been studied by Agresti and Finlay (1), La Stayo *et al.* (6) and Richards *et al.* (9). The purpose of this study was to evaluate whether grip strength varied with pronation and supination.

MATERIAL AND METHODS

Subjects : 40 healthy volunteers, students in the department of physical therapy, 20 male and 20 female, all right-handed, between 19 and 30 years of age (mean age 22.8 years) were tested. Name, age, gender, health status, profession and sports activities were recorded. Length, weight, hand length and hand width were measured (table I).

Table I. — Subject characteristics

	Males	Females
Age (years)	22.75	22.90
Length (cm)	183.75 (SD : 5.9)	166.30 (SD : 7.1)
Weight (kg)	74.8 (SD : 9.8)	60.43 (SD : 8.6)
Hand length (cm)	20.7 (SD : 1.0)	19.97 (SD : 0.7)
Hand width (cm)	9.54 (SD : 0.5)	8.42 (SD : 0.4)

Instrument : A calibrated Jamar dynamometer was used to test the grip strength. The adjustable handle was set at position 2, 3 or 4 according to the hand length and the subject's comfort.

Procedure : Only the dominant right hand was tested first. Three trials for each position were recorded, with 1 minute of rest between each. The mean value of each test was taken into consideration.

The volunteer was sitting comfortably on a chair without arm rests, the shoulder the body, the elbow flexed 90°. In a first testing procedure the forearm was positioned neutrally, in full pronation and in full supination, with the position of the wrist free. In a second testing procedure a cast was applied with the wrist fixed in 10° extension (the position most often used in wrist arthrodesis), and the grip strength was measured consecutively in neutral rotation, full pronation and full supination.

[1] Department of Orthopedic Surgery, U.Z. Pellenberg, Weligerveld 1, B-3212 Pellenberg, Belgium.
[2] Department of Physical Therapy, Catholic University, Leuven, Belgium.
Correspondence and reprints : L. De Smet, Universitair Ziekenhuis, Weligerveld 1, B-3212 Pellenberg, Belgium.

Statistics : Unpaired and paired Student's t-tests were used for analysis ; the level of significance was set at $p < 0.01$.

RESULTS

In the free position (set-up 1) grip strength was significantly lower in pronation, in women as well as in men (table II). In the free position the differences between neutral rotation and supination were not significant. In the casted position (set-up 2), grip strength was significantly higher in supination, compared with neutral rotation. Here too grip strength was lower in pronation in males, but not significantly in females (table III). No significant correlations were found between grip strength and body length, body weight and hand sizes (Pearson correlation coefficient > 0.05).

DISCUSSION

The effect of wrist, elbow and shoulder position on grip strength has been studied by several authors (2, 3, 5, 7, 10) ; the forearm rotation received only minimal attention. This study confirms a previous one by Agresti and Finlay (1) and indicates that the static grip strength decreases from supination to pronation. Dynamic testing demonstrated no differences in grip strength when the forearm rotated between 70° supination and 70° pronation (6).

During pronation the radius finishes over the ulna, and a relative shortening occurs (4, 8). The flexor muscles, originating on the ulnar epicondyle follow this shortening. Probably this is the responsible phenomenon to explain the decreased grip strength in full pronation. Muscles require an ideal

Table II. — Grip strength (in pounds) in different positions

Position	Males		Females	
	mean	SD	mean	SD
set-up 1 "free"				
neutral	112.35	15.5	79.78	11.7
pronation	104.98	15.5	71.73	10.04
supination	111.48	15.5	81.83	13.1
set-up 2 "casted"				
neutral	91.73	16.7	62.50	7.7
supination	96.75	16.0	66.42	7.8
pronation	86.40	15.6	61.22	6.7

Table III. — Significant differences between different forearm positions

Males	free		Females	free	
	pronation	supination		pronation	supination
neutral	**	NS	neutral	***	NS
pronation		**	pronation		***
	casted			casted	
	pronation	supination		pronation	supination
neutral	*	*	neutral	NS	*
pronation		***	pronation		*

* = $p < 0.01$, ** = $p < 0.001$, *** = $p < 0.0001$.

length to develop a maximal contraction power, depending on the actin-myosin interaction.

The grip strength reduction in the immobilized position probably results from the mere presence of the cast, since in the "free" position most volunteers spontaneously choose a slightly extended wrist position.

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SAMENVATTING

L. DE SMET, B. TIREZ, K. STAPPAERTS. Effect van onderarm rotatie op de grijpkracht.

De grijpkracht werd bij 40 vrijwilligers gemeten in verschillende rotatiestanden van de onderarm, éénmaal met vrije pols en éénmaal met de pols ingegipst. Er is een significante vermindering van de grijpkracht in pronatie t.o.v. neutrale stand en supinatie bij mannen en bij vrouwen met een vrije polspositie. Bij vrouwen met een ingegipste pols is er tevens een significante verhoging van de grijpkracht in supinatie t.o.v. de neutrale en pronatie stand.

RÉSUMÉ

L. DE SMET, B. TIREZ, K. STAPPAERTS. Influence de la rotation de l'avant-bras sur la force de préhension.

La force de préhension a été mesurée chez 40 sujets normaux, dans différentes positions de l'avant-bras, tout d'abord avec le poignet libre, puis avec le poignet plâtré. Dans l'ensemble la force était nettement moindre en pronation qu'en supination. Chez les sujets masculins, cette différence se retrouvait aussi bien lorsque le poignet était libre que lorsqu'il était immobilisé dans un plâtre. Chez les sujets feminins, cette différence n'était relevée qu'avec le poignet libre.