J Shoulder Elbow Surg (2017) ■■, ■■–■■

ELSEVIER

Journal of Shoulder and Elbow Surgery

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ORIGINAL ARTICLE

Elbow flexion and forearm supination strength in a healthy population

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Background and Hypothesis: Despite the lack of representative data of a healthy population, many clinical trials concerning the measurement of postoperative elbow flexion or forearm supination strength use the contralateral side as a control. We hypothesized that there are no differences in elbow flexion and supination strength between the dominant and nondominant sides in healthy volunteers.

Methods: The study was performed on a cross-sectional cohort of healthy subjects without any prior injuries or surgical interventions of the upper extremities. Isometric elbow flexion strength and supination strength were measured on both the dominant and nondominant sides. The results were analyzed for the entire group and subanalyzed for female vs. male, for different age groups, and according to handedness and regular practice of overhead sports.

Results: A total of 150 subjects (75 female and 75 male subjects; mean age, 44 ± 15 years [range, 18-72 years]) were included in this study. Within the entire collective, no significant differences concerning the elbow flexion strength between the dominant and nondominant sides could be detected, whereas the supination strength was 7% higher on the dominant side ($P = .010$). Women, right-hand–dominant subjects, and subjects who do not regularly practice overhead sports have a significant 8% higher supination strength on the dominant side compared with the nondominant side ($P < .05$). Left-hand–dominant subjects have an 8% higher elbow flexion strength on the nondominant right side ($P < .05$).

Conclusion: Elbow flexion strength and forearm supination strength differ between the dominant and nondominant sides. The contralateral upper extremity cannot be used as a matched control without some adjustments.

Level of evidence: Descriptive Epidemiology Study

Keywords: Biceps muscle; biceps tendon; elbow flexion strength; forearm supination strength; isometric muscle strength; biceps tenotomy; biceps tenodesis

Impairments of elbow flexion and forearm supination strength in patients with pathologic processes of the long or distal biceps tendon or after surgical interventions are an important clinical issue as well as interesting in clinical research. Most of the studies concerning these impairments after long or distal biceps tendon surgery compared their results with the nonsurgical contralateral side without any adjustments to the operated side, handedness, age, sex, or activity level of the patients.[2-4,6-8,11,12]

Previous investigations on this topic using healthy subjects are contradictory.[1,9,10,13] These investigations did not analyze the influence of age, handedness, or activity level of the subjects between the dominant and nondominant sides.

The Ethics Committee of Charité-Universitätsmedizin Berlin approved this study: EA4/094/16.

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1058-2746/$ - see front matter © 2017 Journal of Shoulder and Elbow Surgery Board of Trustees. All rights reserved.
http://dx.doi.org/10.1016/j.jse.2017.05.031

The purpose of this study was to determine differences in isometric muscle strength for both elbow flexion and supination between dominant and nondominant upper extremities in a representative cross-sectional cohort of healthy subjects. We hypothesized that there are no differences between dominant and nondominant upper extremities concerning elbow flexion and supination strength regardless of sex, age, handedness, or activity level.

Materials and methods

To receive a representative cross section through all age groups, 5 age groups were defined: 18-29 years, 30-39 years, 40-49 years, 50-59 years, and >60 years. In each age group, 15 women and 15 men were recruited and tested. Subjects were excluded if they had a history of injury or prior operations as well as any symptoms concerning the upper extremities. In addition to age, the Disabilities of the Arm, Shoulder, and Hand score was obtained to verify the state of health of the upper extremity.[5] Furthermore, handedness and regular practice (>2 times a week) of overhead sports were documented. Both elbow flexion strength and forearm supination strength were tested on both sides of each subject. Before testing, each participant received detailed instructions. Elbow flexion strength was measured using an isometric dynamometer (IsoBex dynamometer; MDS AG, Burgdorf, Switzerland). The measurement was performed in 90° of elbow flexion and repeated 3 times (Fig. 1). Elbow flexion strength was measured in newtons.

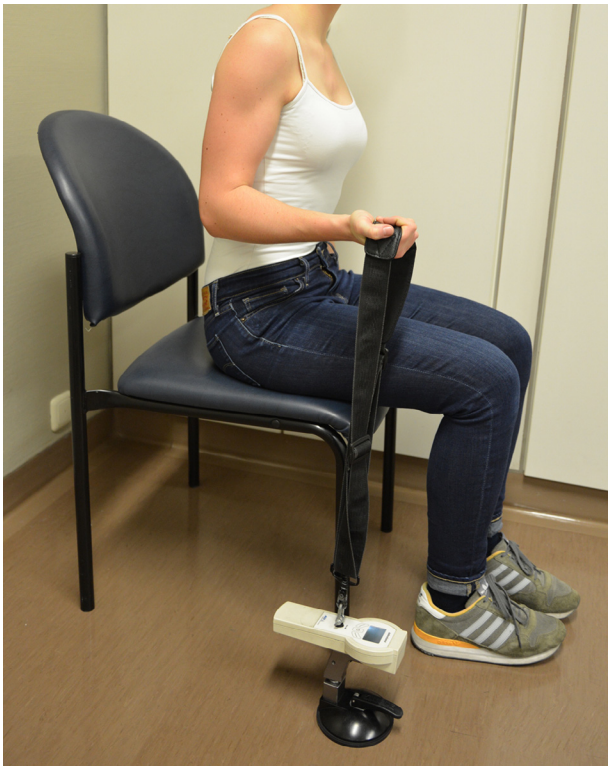

Figure 1 Isometric elbow flexion strength measurement in 90° of elbow flexion.

Figure 2 Forearm supination strength measurement. The participant was seated with shoulder and elbow in approximately 45° of flexion, grasping the T-handle with the forearm in neutral position.

Supination strength was tested using a Baseline hydraulic dynamometer (Fabrication Enterprises Inc., White Plains, NY, USA) and repeated 3 times. The participant was seated with shoulder and elbow in approximately 45° of flexion, grasping the T-handle with the forearm in neutral position. To control the elbow position, the elbow was immobilized through a motion control splint (Fig. 2). Free forearm rotation without any restrictions due to the splint was ensured. Previous investigations have shown that the Baseline hydraulic dynamometer is a valid and reliable tool for measuring forearm supination strength.[14] The forearm supination strength was measured in kilograms. Participants had a minimum of 5 minutes of rest between flexion and forearm supination strength testing. Testing started alternately on the right or left side. Before the first measurement was performed, each subject started with 3 practice trials on the contralateral side. Furthermore, an alternating flexion and supination strength measurement test protocol was used to prevent a systematic bias due to fatigue of the biceps muscle.

A paired Student *t*-test was used to compare dominant and nondominant upper extremities. A P value of $< .05$ was considered significant. The statistical analysis was carried out using SPSS software (IBM, Armonk, NY, USA).

Results

A total of 150 subjects (75 female and 75 male subjects) were included in this study. The mean age was 44 ± 15 years (range, 18-72 years). Female and male subjects showed no significant differences concerning the mean age (female subjects, 45 ± 15 years [range, 18-72 years]; male subjects, 44 ± 15 years [range, 22-72 years]; $P = .828$). The mean body mass index of all participants was 25.6 ± 4.4 (range, 18-41). All subjects showed the lowest point value (0 points) in the Disabilities of the Arm, Shoulder, and Hand score, which indicates no disability of the upper extremities; 133 subjects were right-handed (89%) and 17 were left-handed (11%). Of 150 participants, 16 reported regular practice of overhead sports (11%).

Within the entire collective, no significant difference for elbow flexion strength between the dominant side and the nondominant side was detected ($P = .160$). The mean flexion strength was 135 ± 7 N on the dominant side vs. 132 ± 6 N