INTRODUCTION

Disorders resulting from traumatic injuries to and various diseases of peripheral nerves are common in clinical practice. Clinical manifestations of hand dysfunction are distinct depending on the nerve involved. The purpose of this study was to investigate the effects of a lower median nerve lesion on thumb motor function. The lesion was simulated by performing median nerve block at the wrist using an anesthetic.

METHODS

Six healthy young male subjects participated in this study. We injected 4 mL of 0.5% bupivacaine hydrochloride (Astra Pharmaceuticals, Westborough, MA, USA) into the carpal tunnel. An experimental apparatus was designed to measure maximum voluntary contraction (MVC) forces of the thumb (Figure 1). A six degree-of-freedom force transducer, together with a thumb ring, was used to measure thumb forces in the transverse plane at the middle of the proximal phalanx of the thumb.

Each subject was tested both before and after median nerve block. Post-block testing started after we verified complete median nerve block, approximately 40 minutes after the injection. Subjects grasped a vertical dowel with the forearm stabilized in a midprone position. Each subject performed 15 circumferential MVC trials with randomized starting directions. The subject was given 15 s to complete each circumferential trial and 60 s of rest between each trial. Data was collected from each subject at 100 samples per second. A force envelope was constructed based on the 15-trials. The area enclosed by the force envelope was divided into extension, abduction, flexion, and adduction quadrants. One- and two-factor Repeated Measures ANOVAs were used to analyze outcome measures.

RESULTS

Force magnitudes were significantly reduced after nerve block (p < 0.001) resulting in significantly smaller force envelopes (Figure 2). The average decrease across all directions was 27.9%. A maximum decrease of 42.4% occurred at 199°, corresponding to a combined direction of abduction and slight flexion, while a minimum decrease of 10.5% occurred at 328° corresponding to a
combined direction of adduction and slight flexion. Relative decreases at 0° (adduction), 90° (extension), 180° (abduction), and 270° (flexion) directions were 17.3%, 21.2%, 41.2% and 33.5%, respectively. Areas enclosed by the post-block envelopes were significantly smaller than the pre-block envelopes (p<0.001). Post-block force envelope area, 10700 ± 4474 N², was 51.9% of pre-block force envelope area, 20628 ± 7747 N². Quadrant area decreased significantly (p < 0.001), with a maximal percentage decrease of 60.9% in the abduction quadrant, followed by a 52.3% area decrease in the flexion quadrant.

**Figure 1.** Average force envelopes produced by the thumb before and after median nerve block. Unit in N.

**DISCUSSION**

Preferential force weakening in the quadrants of abduction and flexion after median nerve block agrees with known anatomical and neuromuscular features of the thumb. The median nerve innervates the abductor pollicis brevis, the opponens pollicis and the superficial head of the flexor pollicis brevis, all of which contribute to the abduction and flexion of the thumb (Smutz et al., 1998); therefore, denervation of these muscles after median nerve block would cause the greatest force deficit related to median nerve function (Kaufman et al., 1999). Additionally, as force application moved towards adduction, the force deficit decreased as neuromuscular control shifted from the median nerve to the ulnar nerve via the first dorsal interosseous and adductor pollicis brevis. Force deficit in extension was also comparably small as extension forces are mainly produced by the extensors pollicis brevis and longus originating in the forearm.

Our reported force decreases following median nerve block (40.9% in abduction, 34.1% in flexion) were smaller than those reported in the literature (Boatright and Kiebzak, 1997; Kozin et al., 1999; Kaufman et al., 1999). The discrepancy may be due to the different testing methods. The methods of strength testing may also help explain the different magnitudes of strength deficit after the nerve block. In addition, all previous results were based on forces obtained in discrete direction(s) and focused exertions. The current study utilized a method of force production in a continuous, circumferential and dynamic manner, which may use different muscle coordination patterns to produce forces in the same directions.

**REFERENCES**


**ACKNOWLEDGEMENTS**

The Aircast Foundation and Whitaker Foundation.