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## Quantification of weakness caused by distal median nerve lesion by dynamometry

Nikolaus Johannes Wachter MD<sup>a,\*</sup>, Martin Mentzel PhD<sup>b</sup>, Raphaela Hütz MD<sup>b</sup>, Gert D. Krischak PhD<sup>c</sup>, Joachim Gülke MD<sup>b</sup>

<sup>a</sup> Department of Hand, Plastic and Microsurgery, Katharinenhospital, Stuttgart, Germany

<sup>b</sup> Department of Traumatology, Hand, Plastic and Reconstructive Surgery, University of Ulm, Ulm, Germany

<sup>c</sup> Clinic of Orthopedics and Traumatology, Bad Buchau, Germany

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### ABSTRACT

**Introduction:** In the assessment of hand and upper limb function, grip strength is of major importance. Use of the JAMAR dynamometer has been an accepted test of grip strength and routinely part of the physical examination.

**Purpose of the Study:** The aim of this study was to determine by means of a median nerve block simulating a patient group if the measurement of different types of grip force can improve the quantification of impairment of the hand beyond the sole power grip measurements.

**Methods:** In 29 healthy volunteers, grip force measurement was done by the JAMAR dynamometer for power grip and by a pinch grip dynamometer for pincer grip, precision grip, pinch grip, and palmar abduction. At the power grip, the force of digit 2–5 was measured separately by a sensor glove. For each measurement, 3 trials were recorded subsequently.

**Study design:** A within-subject research design was used in this prospective study. Each subject served as the control by preinjection measurements of grip and pinch strength. Subsequent measurements after median nerve block were used to examine within-subject change.

**Results:** In power grip, there was no significant reduction of maximum grip force with median nerve block compared with grip force without block. By measuring the finger forces by a sensor glove, a reduction of force at the individual fingers was found compared with the setting with no block, although significant only at the middle finger ( $P < .017$ ). With median nerve block, average grip force decreased significantly 20% in pincer grip ( $P < .021$ ), 29.5% in pinch grip ( $P < .002$ ), 39.5% in precision grip ( $P < .001$ ), and 70.7% in palmar abduction ( $P < .013$ ).

**Conclusions:** These experiments suggest a minor role of the measurement of the power grip force in the diagnostics of distal median nerve block with the dynamometer, which could not be substantially improved by the digit forces and the force distribution of the individual fingers. The assessment of other grip forms, such as pincer grasp, precision grip, pinch grip, and especially palmar abduction, leads to a relevant improvement in the diagnostics of distal median nerve lesion.

**Level of Evidence:** II.

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\* Corresponding author. Katharinenhospital Stuttgart, Kriegsbergstrasse 60, 70174 Stuttgart, Germany. Tel.: +49 71127833501.n.wachter@klinikum-stuttgart.de

### Introduction

For the diagnosis of a median nerve lesion, there exist various techniques; however, the measurement of grip strength is a standard procedure for the evaluation of the remaining function of the hand after median nerve dysfunction. Carpal tunnel syndrome (CTS) is the most common degenerative reason, whereas the injury of the median nerve at the wrist is one of the most common nerve injuries at the forearm.<sup>1</sup> The reliability of power grip force for median nerve lesion is under discussion. The loss of strength ranges from 20% to 70%, dependent on the measurement method.<sup>2</sup> The commonly used JAMAR dynamometer (Baseline, Fabrication

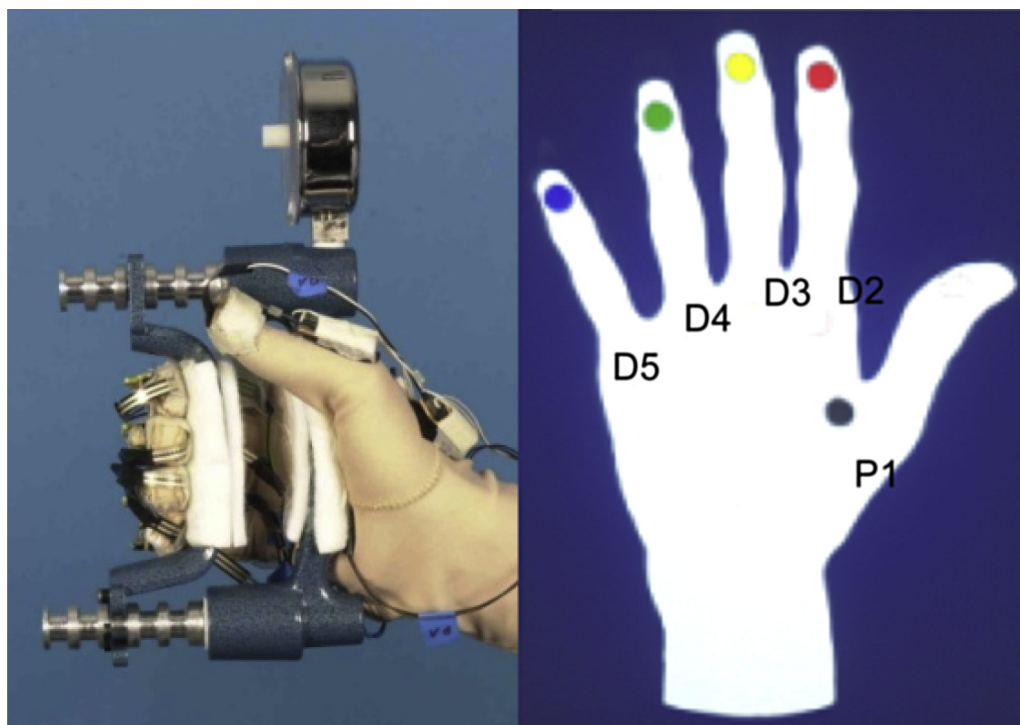


Fig. 1. JAMAR dynamometer, position of the pressure sensors at the sensor glove.

Enterprises, Inc, Irvington, NY) provides the grip force during a power grip of the whole hand. Further studies included the force distribution of the single fingers to increase the reliability.<sup>3,4</sup> For the examination of the force distribution of the fingers during power grip, a special sensor glove has been developed<sup>5</sup> and tested in recent studies.<sup>6</sup> Some authors reported that the measurement of the grip force of pincer grasp, precision grip, and pinch grip can substantially increase the reliability of the diagnostics of median nerve dysfunction.<sup>3,7,8</sup> For the measurement of pinch grip, pincer grip, and key grip, there are used special pinch dynamometers.<sup>9</sup> Most studies on this issue compared healthy subjects with patients, implicating the problem of a certain bias due to interindividual differences within the patient groups.<sup>10,11</sup> To avoid these effects, we performed the measurements in a combined setting simulating a median nerve injury by setting a median nerve block at the wrist according to Kozin et al,<sup>3</sup> minimizing the bias resulting from interindividual differences.

The aim of this study was to evaluate the ability of the power grip force measured by a JAMAR dynamometer (Baseline, Fabrication Enterprises, Inc) for the detection of a median nerve block in healthy volunteers in a combined setting. The force distribution of the fingers was taken into account in power grip. In addition, the ability of other grip forms, such as pincer grip, precision grip, pinch grip, and palmar abduction for the discrimination between a median nerve block and healthy subjects, was examined. The study should evaluate which dynamometric measurements lead to an improvement of the quantification of weakness caused by distal median nerve lesion.

## Methods

About 29 healthy subjects participated in this study with an average age of 32.6 years (23–43). Included were only male subjects with the right hand dominant. The hand length over the middle finger was 18.4 cm ( $\pm 1.2$  cm), and the distance from the tip of

thumb and small finger 21.9 ( $\pm 1.8$  cm). A clinical examination by a hand surgeon revealed no pathologic findings. The power grip force was measured using a hydraulic hand dynamometer (JAMAR dynamometer Baseline, set to middle position Fabrication Enterprises, Inc, Irvington, NY; Fig. 1). For the measurement of other grip forms, a pinch dynamometer was used (Pinch gauge dynamometer, model no. PG-30; B&L Engineering, Tuscin, CA). For the pincer grip, it was held between the tips of thumb and index (Fig. 2), and for precision grip, it was held between index and middle fingers on one side and thumb on the other side (Fig. 3). For the pinch grip, the pinch dynamometer was held between the radial side of the proximal phalanx of the index and the tip of the thumb (Fig. 4).

For the palmar abduction, the force was measured with the sensor glove by a pressure sensor at the radial tip of the thumb against a perpendicular surface (Fig. 5). The force of the individual fingers was measured by a sensor glove as well by 5 pressure sensors located on the palmar surface of the glove (FSR 151 NS; International Electronics and Engineering, Luxembourg; Fig. 1).

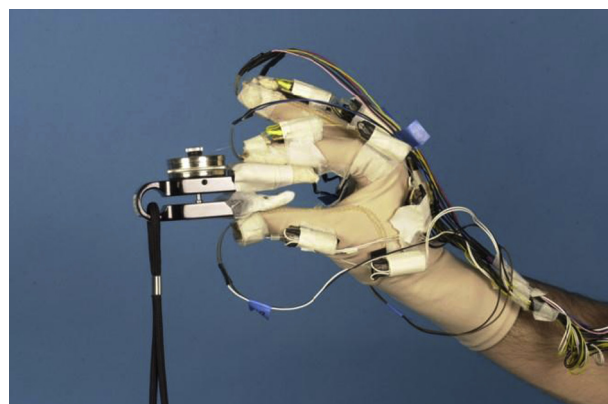


Fig. 2. Pincer grip measured with the pinch dynamometer.

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