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The relationship between the Patient-rated Ulnar Nerve Evaluation and the common impairment measures of grip strength, pinch strength, and sensation

Mike Szekeres PhD(c), OT Reg (Ont), CHT[a,*], Joy C. MacDermid PT, PhD[b,c], Graham J.W. King MD, MSc, FRCSC[c,d], Ruby Grewal MD, MSc, FRCSC[c,d]

[a] Health and Rehabilitation Sciences, Western University, London, Ontario, Canada
[b] School of Rehabilitation Science, McMaster University, Hamilton, Ontario, Canada
[c] The Roth McFarlane Hand and Upper Limb Centre, London, Ontario, Canada
[d] Department of Surgery, Western University, London, Ontario, Canada

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ABSTRACT

Study design: Prospective cohort study.
Introduction: Grip strength, pinch strength, and sensory threshold are common evaluations used on a daily basis. Identifying how these variables relate to function for patients allows these assessments to be used for screening to identify who may benefit from surgical intervention, and provides valuable information about what impairments patients think are important with respect to functional use of their upper extremity. Therapists can use this information to focus rehabilitation programs on the most important impairments.
Purpose: To evaluate the relationship between the Patient-rated Ulnar Nerve Evaluation (PRUNE) and impairment measures of grip strength, pinch strength, and one-point sensory threshold.
Methods: Data was prospectively collected from 77 patients before surgery and during regular time points for 2 years following surgery. Patients completed the PRUNE, grip and pinch strength measures, and a one-point sensory threshold evaluation. Correlations between these variables were calculated at baseline, 2 years after surgery, and for change scores during the 2-year follow up. A multiple regression analysis was used to determine the contribution of the impairment variables for determining functional change.
Results: Grip strength showed moderate, statistically significant correlation with PRUNE scores at both baseline ($r = -0.38$) and at two years ($r = -0.29$). There was also a statistically significant correlation between one point sensory threshold for the small finger at two years ($r = 0.36$), but not at baseline. Change in grip strength ($r = -0.28$) and pinch strength ($r = -0.30$) both demonstrated significant correlations with PRUNE change scores. Overall, changes in grip strength, pinch strength, and sensation accounted for 20% of the variance in PRUNE changes.
Conclusion: Since grip strength was most highly correlated with PRUNE scores at baseline and at two years, rehabilitation programs that target grip strengthening is supported. While neither grip nor pinch strength were significant contributors to the regression when used together, each showed significant contributions to PRUNE variability when used in the model independently. Therefore, a combination of grip and pinch strengthening may be important during rehabilitation for improving functional results in patients that undergo surgical intervention for cubital tunnel syndrome.
Level of evidence: 2b

Introduction

Entrapment of the ulnar nerve within the cubital tunnel of the elbow is the second most common peripheral nerve compression in the upper limb.[1] Commonly referred to as cubital tunnel syndrome (CuTS), the mean annual incidence is higher in men than women,

* Corresponding author. 1832 Stackhouse Crescent, London, Ontario N5X 4M6, Canada. Tel.: +1 519 709 4263.
E-mail address: mike.szekeres@gmail.com (M. Szekeres).

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and has been estimated in the range of 25–33 cases per 100,000 person-years for men and 17 to 19 cases per 100,000 person-years for women.[1,2] The higher incidence in men may be due to job related factors and prolonged flexion postures of the elbow during work. This is suggested by the higher incidence in manual jobs, having been reported as high as 57 cases per 100,000 person-years.[2] A recent study reported that smoking was associated with an elevated risk (OR = 4.3) of ulnar neuropathy.[3] Other potential risk factors for CuTS may include education level, work experience, and diabetes.[4,5]

The ulnar nerve is susceptible to entrapment on the medial side of the elbow in several areas. These areas include the arcade of struthers, the medial inter-muscular septum, the medial epicondyle, the cubital tunnel, and under an anomalous muscle called the anconeus epitrochlearis. Ulnar neuropathy at the elbow (UNE) is an umbrella term that includes compression of the nerve at any of these sites, however, compression is still most often referred to as CuTS, regardless of the precise site of compression. The actual cubital tunnel extends from the medial epicondyle for approximately 2 cm distally. The floor is the medial collateral ligament of the elbow. The roof of the tunnel lies between the two heads of the flexor carpi ulnaris muscle under a variably sized band of tissue called the cubital tunnel retinaculum.[6] This retinaculum is drawn taut with flexion of the elbow and can compress the nerve beneath. The nerve can also be stretched or elongated with prolonged elbow flexion.[7] Distal to the aforementioned sites of compression, the ulnar nerve supplies the ulnar heads of the flexor digitorum profundus muscles, the flexor carpi ulnaris, most of the hand intrinsic muscles, and sensation to the small finger, the ulnar half of the ring finger, and the ulnar border of the hand. Based on this anatomical course of the ulnar nerve, the potential physical impairments related to CuTS include decreased grip strength, pinch strength, finger dexterity, and sensibility in the ulnar nerve distribution.

Treatment for CuTS often starts with conservative approaches and progresses to surgical management if nerve dysfunction and associated symptoms and disability do not resolve. A recent trial of extension splinting has shown that conservative management can be a successful management option, with 21 of 24 patients successfully avoiding surgical intervention with the use of a night-time thermoplastic extension orthosis.[8] Operation rates for patients that report to general medical practices with CuTS have been reported at 30%, and this is likely higher for patients referred to specialty surgical centers.[1] The surgical procedure for treatment of CuTS may include either simple decompression or anterior ulnar nerve transposition, with good evidence supporting both interventions.[9–12] With both decompression and nerve transposition, sensory and motor recovery is expected if the nerve compression is not too severe or prolonged. The outcome measures used across clinical trials for measuring this recovery are variable, making it more difficult to compare outcomes across studies.

Several patient-reported and clinician-based outcome measures have been used to evaluate the functional limitations for patients with elbow pathology. These include the Patient-rated Ulnar Nerve Evaluation (PRUNE)[13] which is specific to CuTS, and measures that focus on the upper limb disability like the Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) which has been validated for CuTS.[14,15] There are also measures that focus on elbow-related pain and disability such as the Patient Rated Elbow Evaluation (PREE).[16,17] A clinician-based ulnar nerve outcome measure, the Bishop Rating Scale has also been used as an outcome measure but has yet to be reported.

The PRUNE is an open access, self-reported measure that consists of 20-items that focus on ulnar-nerve related sensory/motor deficits and associated functional disability. The PRUNE has recently been shown to have excellent reliability and responsiveness for individuals with CuTS, with an intra-class coefficient for total score of 0.98 and a standardized response mean of 1.55.[13] A minimal detectable change of 7.1 points discriminates between clinically important subgroups based on work status, residual symptoms, motor recovery, and sensory recovery.

As mentioned, CuTS may lead to impairment of grip strength, pinch strength, dexterity, and sensibility. The relationship between these impairment-based changes and overall functional limitation remains unclear. Measures of grip strength, pinch strength, and sensation are often measured clinically and can be used to inform decisions about treatment, functional status, or ability to return to work. Therefore, the knowledge of how these measures are related to function is important. Understanding the relative contribution of grip strength, pinch strength, and sensation to function can guide the design of rehabilitation programs and outcome measurement strategies.

A recent systematic review of potential factors that predict outcomes following ulnar nerve transposition reported that “we were unable to conclude which predictor(s) affect surgical outcomes after anterior transposition of the ulnar nerve.”[18] The purpose of this study was to estimate, in patients evaluated preoperatively and two years following ulnar nerve transposition, the extent to which 1) baseline and follow-up grip strength, pinch strength, and sensory scores are associated with functional outcomes as measured by the PRUNE and 2) changes in these impairment measures explain changes in function (PRUNE scores) in the two years following nerve transposition.

Methods

Subjects

The data for this prospective cohort study was collected as part of a two year study of patients undergoing ulnar nerve transposition at the Roth McFarlane Hand & Upper Limb Centre.[19] Patients were included in the study if they were over 18 years of age, had a CuTS diagnosis confirmed electrically and clinically by a fellowship trained upper extremity surgeon, and underwent surgical intervention. Surgical intervention was either a submuscular or a subcutaneous anterior transposition of the ulnar nerve. Surgery was performed by one of seven experienced upper limb surgeons. Exclusion criteria included previous surgical intervention for CuTS, age less than 18 years, inability to complete self-report outcome measures, or inability to return for follow up that was identified a priori.

Outcome measures

All patients were evaluated at the Roth McFarlane Hand & Upper Limb Centre Clinical Research Laboratory by a researcher not involved in the clinical care of the patient. The study was approved by the Western University Research Ethics Board. All patients provided written consent for participation. Impairments were measured using standardized procedures. Outcome measures included grip strength, lateral pinch strength, one-point sensory threshold using the Pressure Specified Sensory Device (PSSD), and the PRUNE before surgery and then at regular time points for two years following surgery. Lateral pinch was chosen rather than tripod pinch since this would most likely be affected during CuTS. All grip and pinch strength measures were recorded using an NK Biotechnical Corporation Hand Assessment System DIGIT-grip Device (Model DGR 001) using standardized positioning. Three trials of each measurement were recorded and then averaged by the device to record a score for each time point. This method has been