

injuries. The rates of at least one overuse condition were 57.8% in Service Members with below elbow amputations and 47.2% in above elbow amputations while only 21.2% in the minor injury group. The incidence of overuse upper limb conditions was 36.3% in the below elbow group, 20.0% in the above elbow group, and 9.4% in the minor injury group. The incidence of overuse lower limb conditions was 35.6% in the below elbow group, 28.3% in the above elbow group, and 11.8% in the minor injury group. The incidence of low back pain was 19.8% in the below elbow group, 24.1% in the above elbow group, and 7.3% in the minor injury group. After controlling for age, the odds of developing an upper limb overuse condition in the first year after injury was two times greater [Odds ratio (OR): 2.39; 95% confidence interval (CI): 1.13 – 5.05;  $p < 0.05$ ] in above elbow amputation and five times greater [OR: 5.45; 95% CI: 3.13 – 9.49;  $p < 0.001$ ] in below elbow amputations as compared to the minor injury group. The odds of developing a lower limb overuse condition in the first year after injury was nearly three times greater [OR: 2.93; 95% CI: 1.48 – 5.79;  $p < 0.01$ ] in above elbow amputation and four times greater [OR: 4.07; 95% CI: 2.35 – 7.04;  $p < 0.001$ ] in below elbow amputations as compared to the minor injury group. The odds of developing low back pain in the first year after injury was nearly four times greater [OR: 3.95; 95% CI: 1.87– 8.32;  $p < 0.01$ ] in above elbow amputation and three times greater [OR: 3.07; 95% CI: 1.59 – 5.92;  $p < 0.01$ ] in below elbow amputations as compared to the minor injury group. Overlap in confidence intervals for the above and below elbow amputations groups suggests no difference in the odds of developing an overuse musculoskeletal condition in the first year after injury between the upper limb amputation levels.

**Conclusion:** The findings of this study suggest that Service Members who have sustained upper limb traumatic amputation are at an elevated risk for developing overuse upper limb, lower limb, and low back conditions within the first year after amputation. The findings from study this suggest there is a need to develop preventative and rehabilitative strategies for overuse upper limb, lower limb, and spine conditions in patients who have sustained upper limb amputation.

**Disclosure:** The view(s) expressed herein are those of the author(s) and do not reflect the official policy or position of Brooke Army Medical Center, the U.S. Army Medical Department, the U.S. Army Office of the Surgeon General, the Department of the Air Force, the Department of the Army, Department of the Navy, or the Department of Defense or the U.S. Government.

30

### Cubital Tunnel Control Orthosis (CTCO) for the Non-Operative Management of Cubital Tunnel Syndrome

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**Purpose:** Cubital tunnel syndrome (CuTS), ulnar nerve entrapment about the elbow, is the second most common neuropathy of the upper extremity. Symptoms most commonly reported include paresthesia of the small finger and ulnar half of ring finger, difficulty maintaining grasp on objects and difficulty

sleeping. These symptoms may be worsened by repetitive flexion of the elbow or external pressure at the ulnar aspect of the elbow. Conservative treatment is most often utilized for management of mild and moderate CuTS symptoms and include a combination of patient education, activity modification, non-steroidal medication use, ulnar nerve glides, and nocturnal extension splinting. It was observed that traditional static elbow extension orthoses, while effective, presented barriers to positive patient outcomes in terms of comfort and compliance at an outpatient hand clinic. This article describes a novel orthosis design for the non-operative treatment of cubital tunnel syndrome.

**Methods:** The two cases described followed standard non-operative management of cubital tunnel syndrome rehabilitation with the use of a dynamic cubital tunnel control orthosis (CTCO) as an alternative to the static elbow extension orthosis. The CTCO orthosis differs from the traditional static extension orthosis in that it allows for active flexion of the elbow while promoting passive extension when the joint is at rest (Fig1). Due to the design of the thermoplastic dynamic bars that allow active movement at the elbow joint and the position of the straps, there is no pressure over the cubital tunnel (Fig 2). Patients were instructed to wear the orthosis at every night and during the day as needed to manage symptoms. Patient progress was evaluated through use of the QuickDASH, an 11-point numerical pain rating scale, and grip strength assessed with a dynamometer.

**Results:** Case 1 was a 33 year old right hand dominant male with a five-year history of ulnar nerve compression to the left upper extremity with no co-morbidities noted. He underwent bilateral ulnar nerve transposition surgery five years prior with resolution of symptoms to his right upper extremity, but persistent ulnar nerve compression symptoms to the left remained. He was unable to tolerate a traditional static orthosis due to pain caused by pressure over the ulnar aspect of his elbow. After 14 weeks of conservative treatment with a home program including nightly use of the CTCO, the patient demonstrated an 18.18% decrease in his QuickDASH score, a 6-point decrease in pain with activity (0/10 pain at discharge), and an increase of 24 pounds in grip strength. Case 2 was a 56 year old right hand dominant female with a two month history of ulnar nerve compression at the left elbow. Her job involved desk work and she often experience severe symptoms while at work. After 8 weeks of conservative treatment with a home going program including use of the CTCO, the patient demonstrated a 15.91% decrease in the QuickDASH, a 4-point decrease in pain with activity (0/10 pain at discharge), and a 25 pound increase in grip strength. The patient reported that due to the dynamic nature of the CTCO she was able to wear the orthosis at work in addition to nocturnal wear to help manage her symptoms. Of note, neither patient required orthosis modification during their course of wear. Both patients were able to wean themselves from their orthoses and reported independent function with daily tasks three months after initial evaluation.

**Conclusion:** Utilizing this new orthosis may increase patient orthosis wear compliance in comparison to traditional methods. Both cases show meaningful change in the QuickDASH, reduction in pain, increase in grip strength, and were able to return to functional independence within a three month timeframe. Further evaluation of CTCO orthosis in comparison to traditional orthosis methods are warranted.

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**Figure 1.** Active elbow flexion with passive elbow extension at rest while wearing the CTCO.



**Figure 2.** Use of thermoplastic dynamic bars and location of strapping prevents pressure over the cubital tunnel.

### 31

#### Normative Data for the 5 Position Baseline Hydraulic Pinch Meter and the Relationship Between Lateral Pinch Strength And Pinch Span

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**Purpose:** The primary aim of this study was to collect normative data for the Baseline® 5 Position Hydraulic Pinch Meter using health adult subjects. The secondary aims were to evaluate interrater reliability using the Baseline® 5 Position Hydraulic Pinch Meter as well as to identify at which pinch span the greatest force was produced.

**Methods:** Ten occupational therapy student raters were used to examine interrater reliability. An average intraclass correlation (ICC) was calculated. Subjects for normative data collection were recruited of various socioeconomic status levels across several locations in West Michigan. Testing procedures recommended by the American Society of Hand Therapists were followed and lateral pinch strength was assessed with three trials in each of the 5 positions measured at (2cm, 3cm, 4cm, 5cm, & 6cm) in pinch span bilaterally with rest (15 sec) between each trial. Data were analyzed by age categories and sex to develop normative standards. A one-way repeated measures ANOVA was used to determine if there was a significant difference between mean force produced at the 5 different pinch spans and a three-way mixed ANOVA was used to determine if there was an interaction between pinch span, age, and sex.

**Results:** The Baseline 5 Position Hydraulic Pinch meter showed excellent interrater reliability (ICC=.98). Normative data were

calculated using descriptive statistics for a sample of 605 subjects (292 males and 313 females) with a minimum of 38 men and women per age category. The greatest pinch force was produced at the 3<sup>rd</sup> level (4cm span) with males using their left hand and females bilaterally, and at the 4<sup>th</sup> level (5cm span) with males using their right hand. One-way repeated measures ANOVA demonstrated significant differences between means between of the 5 different spans ( $p < .001$ ), but a small effect size was noted. A non-significant three-way interaction between age category, pinch spans, and sex was noted ( $p = .552$  right hand,  $p = .551$  left hand). A significant two-way interaction was noted between pinch spans and sex ( $p < .001$ ) bilaterally.

**Conclusion:** The pinch span that produced the greatest amount of force was not consistent with previous literature. However, previous literature examining pinch force and pinch span all created various pulleys attached to fabricated frames which may explain the mixed conclusions. Although there was a statistically significant difference in pinch force produced at the difference pinch spans using the Baseline 5 Position Hydraulic Pinch Meter, a small effect size was noted, and a mean difference in pinch strength of 1 to 2 pounds of force was noted between the different pinch spans. The clinical environment is becoming increasingly demanding for both assessments and interventions to be provided in a timely fashion to reduce cost. Assessing lateral pinch strength at 5 different pinch spans bilaterally is time consuming and not likely worth this increased time given the limited difference produced between the various pinch spans.

