SCIENTIFIC ARTICLE

The Effect of Carpal Tunnel Release on Typing Performance

Justin W. Zumsteg, MD,*‡ Matthew J. C. Crump, PhD,§ Gordon D. Logan, PhD,†
Douglas R. Weikert, MD,* Donald H. Lee, MD*

Purpose To describe the effect of carpal tunnel release (CTR) on typing performance.

Methods We prospectively studied 27 patients undergoing open CTR. Patient demographics and clinical characteristics including nerve conduction studies, electromyography results, and duration of symptoms were collected. Before surgery and at 8 time points after surgery, ranging from 1 to 12 weeks, typing performance for an approximately 500-character paragraph was assessed via an on-line platform. The Michigan Hand Questionnaire (MHQ) and the Boston Carpal Tunnel Questionnaire functional component (BCTQ-F) and symptom severity component (BCTQ-S) component were completed before surgery and at 1, 3, 6, and 12 weeks after surgery. We used repeated-measures analyses of variance and follow-up dependent-samples *t* tests to analyze change in typing performance across sessions, and linear regressions to assess relationships between typing performance and demographic and outcome measures. We compared typing speed with the MHQ, BCTQ-F, and BCTQ-S using the Pearson correlation test

Results Average typing speed decreased significantly from 49.7 ± 2.7 words per minute (wpm) before surgery to 45.2 ± 3.1 wpm at 8 to 10 days after surgery. Mean typing speed for the group exceeded the preoperative value between weeks 2 and 3, with continued improvement to 53.5 ± 3.5 wpm at 12 weeks after surgery. No clinical or demographic variables were associated with the rate of recovery or the magnitude of improvement after CTR. The MHQ, BCTQ-F, and BCTQ-S each demonstrated significant improvement from preoperative values over the 12-week period. The MHQ and BCTQ-F scores correlated well with typing speed.

Conclusions On average, typing speed returned to preoperative levels between 2 and 3 weeks after CTR and typing speed showed improvement beyond preoperative levels after surgery. The MHQ and BCTQ-F correlate well with typing speed after CTR. *(J Hand Surg Am. 2016;■(■):■−■.*

Type of study/level of evidence Prognostic IV.

Key words Carpal tunnel syndrome, carpal tunnel surgery, typing performance, outcomes, keyboard use.

Additional Material at jhandsurg.org

*From the *Department of Orthopedics and †Department of Psychology, Vanderbilt University Medical Center, Nashville, TN; the ‡Orlando Health Orthopedic Institute, Orlando, FL; and the §Department of Psychology, Brooklyn College of CUNY, Brooklyn, NY.*

Received for publication January 12, 2016; accepted in revised form October 3, 2016.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Justin Zumsteg, MD, Orlando Health Orthopedic Institute, 1222 S. Orange Avenue, 5th Floor, Orlando, FL 32801; e-mail: Justin.Zumsteg@orlandohealth.com.

0363-5023/16/■ ■-0001$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2016.10.005

CARPAL TUNNEL SYNDROME (CTS) IS ONE of the most commonly occurring hand disorders, with an estimated prevalence of 3.7% (range, 0.9% to 4.7%) in the United States.[1] If nonsurgical treatments fail, it is often recommended that patients undergo carpal tunnel release (CTR), in which the transverse carpal ligament is divided surgically.

In an increasingly technological global society, computer use continues to rise and, along with it, the use of keyboard typing. In 2005, 55.5% of households

FLA 5.4.0 DTD ■ YJHSU54979_proof ■ 4 November 2016 ■ 1:41 pm ■ ce

in developed countries had a home computer; this was up to over 80% in 2015.[2] Because keyboard use for both personal and professional pursuits is widespread in modern society, it may be interesting to patients to learn what impact CTR may have on their typing ability, particularly for patients for whom typing comprises a major component of their occupation.

The relationship between CTR and typing performance has not been evaluated. Previous work showed that anesthetizing the index finger leads to a 7- to 9-fold increase in typing errors for that digit.[3] Thus, it is reasonable to expect that there could be an impact on the typing performance of patients with either static or dynamic sensory alterations as a result of CTS. To date, however, this relationship is unknown, and a better understanding of the effect of CTR on typing performance would provide clinicians with more accurate information with which to counsel their patients.

The purpose of this study was to investigate how long it takes for patients' typing proficiency to return to that of their preoperative level when measured as a sustained effort for 1 to 3 minutes, and what factors have an impact on the recovery of peak typing function. We also investigated whether patient-reported outcomes as assessed by the Michigan Hand Questionnaire (MHQ) and the Boston Carpal Tunnel Questionnaire (BCTQ) correlate with typing function.[4–6]

MATERIALS AND METHODS

After we obtained institutional review board approval, we screened patients for inclusion in the study between April 1, 2013, and March 31, 2015.

Patients with signs and symptoms of either unilateral or bilateral CTS and with positive electrodiagnostic tests were considered for enrollment, although those who elected to undergo either simultaneous or staged bilateral CTR were excluded to maximize consistency in the 3-month postoperative data collection period. Patients with bilateral symptoms but whose contralateral symptoms were deemed by the patient to be mild enough to be amenable to continued nonsurgical treatment were included. Based on work by Salthouse et al showing that age and typing speed were not correlated for subjects aged 20 to 70 years, we included patients in that age range.[7] Study inclusion also required participants to type using both hands on the home row keys at a speed of at least 30 words per minute (wpm), as determined by an in-office screening examination. The examination consisted of typing a paragraph containing approximately 500 characters on a standard desktop computer using a Web-based interface developed by one of the authors (M.J.C.). The in-office screening allowed patients' typing ability to be assessed and offered the opportunity to familiarize them with the software used for the typing test before data acquisition. Exclusion criteria included an inability to read and speak English, those reporting typing less than once per week, a diagnosis of CTS without positive electrodiagnostic studies, a history of previous CTR in the affected extremity, and patients with ipsilateral neuropathies including cubital tunnel syndrome (diagnosed on the basis of history and physical examination) or diabetic neuropathy (diagnosed by the patient's primary care physician, endocrinologist, or neurologist). Patients with coexisting diagnoses of trigger finger, ganglion cyst, or lateral epicondylitis were initially excluded during the first 14 months of the study; however, they were permitted to participate during the final 10 months following a revised study protocol. This resulted in the inclusion of one patient, who had an ipsilateral dorsal carpal ganglion cyst and who did not require operative treatment during the study period, following the revised protocol.

Patient sample

A total of 373 patients were evaluated for CTS during the study period, 64 of whom met all of the inclusion criteria. Reasons for exclusion included nonsurgical management (149 patients), coexisting upper-extremity pathology (132 patients), age outside the limits (49 patients), the patient did not use all fingers to type (49 patients), absent or normal electromyography test (38 patients), previous carpal tunnel surgery (20 patients), the patient did not speak English (6 patients), or the patient did not have access to a computer or the Internet at home (4 patients). Some patients met multiple exclusion criteria. Of the 64 who met eligibility to take the typing screening exam, 15 did not meet the typing requirement and 11 declined participation, which left 38 who ultimately were enrolled in the study. Seven patients either did not end up going through with surgery or did not complete the typing tests and were removed from the study. Four patients underwent staged bilateral CTR and were excluded from the final analysis; this left 27 patients in the study cohort.

Study protocol

Patients completed a preoperative typing examination before surgery via the on-line platform. They were instructed to complete subsequent typing tests on the same computer on which they had performed the original test at 8 to 10 days and 2, 3, 4, 5, 6, 8, and 12 weeks after surgery. Nine different typing tests of similar difficulty were administered at these intervals in random sequence and consisted of approximately 500 characters.[8] Four of these paragraphs had been used in a previous study involving 971 subjects.[7,9] Test-retest reliability was 0.97 in those studies. The additional 6 paragraphs were selected from the same text and had similar readability statistics (Appendix A, available on the *Journal's* Web site at www.jhandsurg.org). Results of the typing test included wpm and accuracy. No letter appeared on-screen for incorrect keystrokes; thus, no backspace was used. Therefore, accuracy was calculated as the number of correct letters on the first attempt divided by the total number of letters in the paragraph.

In addition, before surgery and at 8 to 10 days and 3, 6, and 12 weeks, patients completed the MHQ, BCTQ functional component (BCTQ-F), and BCTQ symptom severity component (BCTQ-S) questionnaires via an on-line data collection service (Research Electronic Data Capture).[10] To maximize data accrual, an automated e-mail was sent to the patients 24 to 48 hours before a typing test or questionnaire was to be completed. If the tests were not completed within 24 hours of the assigned time, a member of the research team called patients to remind them to complete the typing test and/or questionnaires. This resulted in slight variability in the time between surgery and completion of the typing tests and questionnaires. However we analyzed the actual completion time for these assessments versus the desired completion time for each of the 8 post-operative sessions and found that on average, patients completed the assessments for each of the sessions within 24 hours of the specified time.

Surgical protocol

We performed an open CTR in all patients. A sterile soft dressing was applied after surgery and left in place until patients were seen for their first follow-up appointment 8 to 10 days after the procedure, when sutures were removed. No orthoses were employed and finger range of motion was allowed immediately after surgery.

Statistical analysis

Repeated-measures analyses of variance and planned comparison paired samples *t* tests were used to analyze changes in typing speed and accuracy across sessions. A threshold of $P < .05$ was adopted for all statistical tests. A major question of interest assessed within-subject changes in typing speed across sessions. We performed a post hoc analysis to estimate the power to detect within-subject changes by computing average within-subject SDs in typing speed from a published data set of 800 typists who performed typing tests similar to those used in the current design.[9] The analysis showed that within-subject differences in typing speed as small as 2.2 wpm could be detected with adequate power ($\beta = .8$) with 27 subjects.

In addition, we conducted bivariate linear regressions relating the recovery rate of postoperative typing performance with the following patient characteristics as predictor variables: age, duration of symptoms, preoperative motor nerve conduction velocity and sensory nerve peak latency, and the presence of abductor pollicis brevis fibrillations on preoperative electromyography. Workers' compensation claims and tobacco use were considered relevant analyses; however, because of low numbers in the experimental group (2 patients with workers' compensation claims and 1 with tobacco use), these analyses were not pursued. Patients with missing data on outcome measures were eliminated from the correlational analyses. This resulted in 26, 25, and 24 patients in the bivariate analyses of motor nerve conduction latency, sensory nerve conduction peak latency, and presence of abductor pollicis brevis fibrillations, respectively, as shown in Table 1. For each set of regressions, we used the following 4 dependent variables to estimate the rate of recovery in typing performance across postoperative sessions. First, recovery rate was estimated by the slope of a linear regression line of best fit for each patient's performance across all sessions. Second, we estimated the recovery rate using the slope of a linear regression line of best fit with the first postoperative session excluded, because this session showed the most variability. Third, recovery rate was estimated using the difference in typing speed between the first and second postoperative sessions, which was the interval during which the greatest improvement between sessions was observed. Finally, recovery rate was estimated as the number of days to recover to baseline typing speed and was determined for each subject as the session in which each subject met or surpassed the preoperative typing speed. Subjects who did not meet this criterion were excluded from this portion of the analysis. We also conducted a separate set of regressions using a normalized measure of total improvement in typing performance as the dependent measure. The overall normalized

FLA 5.4.0 DTD ■ YJHSU54979_proof ■ 4 November 2016 ■ 1:41 pm ■ ce

TABLE 1. Demographic Data

Demographics		Baseline Average wpm (SD)
Age, y (SD)	55 ± 8	50 (3)
Sex, n (%)		
Female	24 (89)	50 (14)
Male	3 (11)	47 (18)
Tobacco use, n (%)		
No	26 (96)	50 (14)
Yes	1 (4)	52 (NA)
Workers' compensation, n (%)		
No	25 (93)	50 (15)
Yes	2 (7)	52 (1)
Hand dominance, n (%)		
Right	26 (96)	50 (14)
Left	1 (4)	37 (NA)
Operative side, n (%)		
Dominant hand	18 (67)	47 (15)
Nondominant hand	9 (33)	55 (11)
Duration of symptoms, mo, n (%)		
<3	1 (4)	41 (NA)
3–6	3 (11)	46 (12)
6–12	5 (18)	56 (24)
>12	18 (67)	49 (12)
Daily computer use, h, n (%)		
<4	9 (33)	41 (11)
4–6	7 (26)	58 (18)
>6	11 (41)	51 (11)
Sensory nerve peak latency, n (%)		
Obtainable	20 (74)	52 (11)
Unobtainable	5 (19)	37 (3)
Missing data	2 (7)	NA
Motor nerve conduction latency (n = 26), n (%)		50 (3)
Fibrillations in abductor pollicis brevis, n (%)		156
Yes	7 (26)	52 (10)
No	17 (63)	46 (12)
Missing data	3 (11)	NA

NA, not available.

change in typing performance for each subject was defined as the difference in wpm between the final postoperative typing test and the first preoperative typing test, divided by the wpm for the preoperative test as a baseline measure. We conducted a separate analysis to compare patient-reported outcomes of MHQ, BCTQ-F, and BCTQ-S with typing speed by session using the Pearson correlation test.

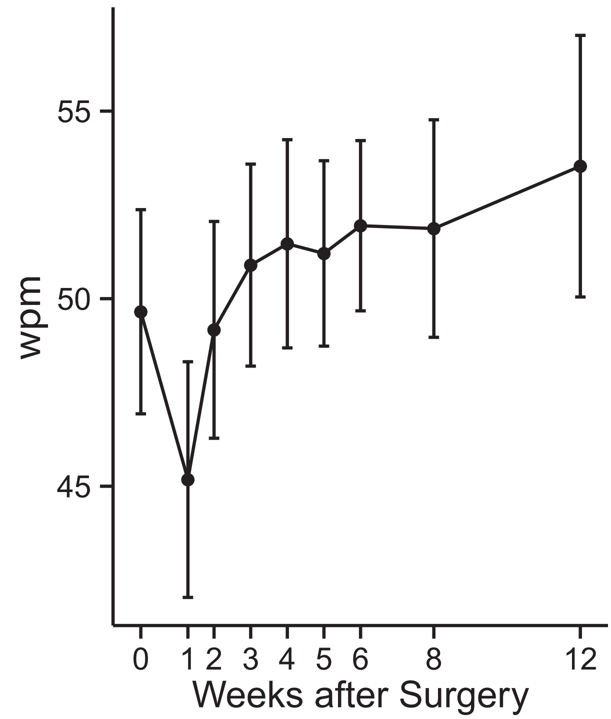

FIGURE 1: Average typing speed for the cohort, by session.

RESULTS

Table 1 lists demographic information and clinical characteristics of the cohort. Patients who reported 4 to 6 hours of computer use per day and those who had measurable values for sensory nerve peak latency had a significantly higher average typing speed before surgery. Otherwise no difference in preoperative typing speed was seen based on patient characteristics.

Overall performance for the group is displayed in Figure 1. Initially, there was a significant decrease in typing speed, from 49.7 ± 2.7 wpm before surgery to 45.2 ± 3.1 wpm at the first postoperative typing test ($P < .05$). However, by 2 weeks, the average typing speed had recovered nearly to the preoperative level (49.2 ± 2.9 wpm) and by the final typing test, typing speed had improved to 53.5 ± 3.5 wpm, although this increased speed was not statistically significant compared with the preoperative typing assessment. Figure 2 shows the proportion of patients surpassing various thresholds of preoperative performance at each session. By 3 weeks, over half of the subjects (15 patients, 56%) had surpassed the baseline performance and 23 patients (85%) and 25 patients

FLA 5.4.0 DTD ■ YJHSU54979_proof ■ 4 November 2016 ■ 1:41 pm ■ ce

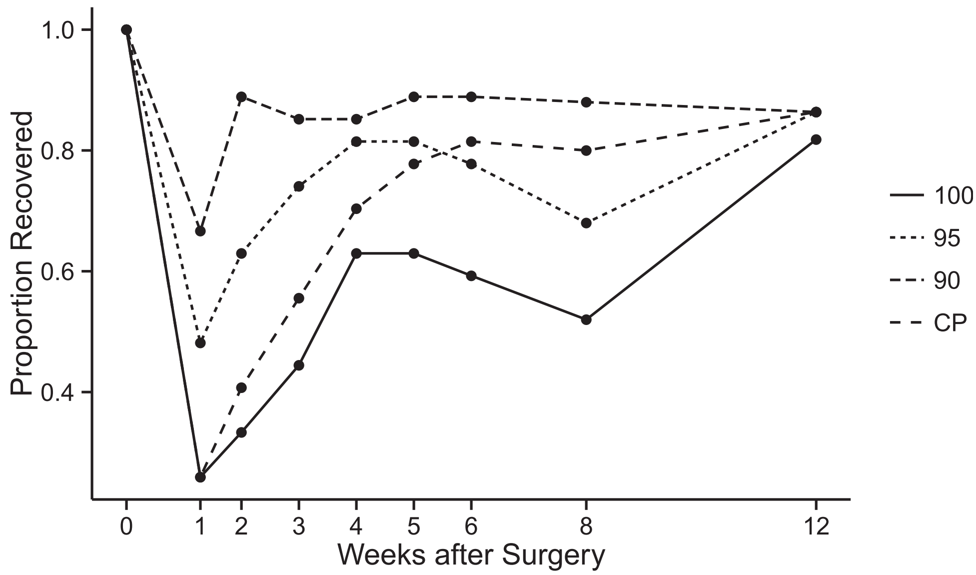

FIGURE 2: CP represents the cumulative proportion of patients who have exceeded their baseline performance at any point since surgery. 100, 95, and 90 represent the proportion of patients exceeding 100%, 95%, and 90%, respectively, of their baseline performance for a given session.

(93%) performed above 95% and 90%, respectively, of the baseline performance. The effect of session on typing accuracy was not statistically significant and mean accuracy ranged between 92% and 94% (Fig. 3).

No significant associations were seen between patient characteristics and the rate of recovery with the use of any of the 4 methods described in the Methods. Likewise, no significant association was seen between patient factors and the overall normalized change in typing speed between the preoperative and final typing tests.

Each of the MHQ, BCTQ-F, and BCTQ-S questionnaire results demonstrated significant improvement from preoperative measurements over the 12-week period. The results are displayed in Figures 4-6. Changes in MHQ (r = 0.90; $P < .05$) and BCTQ-F (r = −0.97; $P < .05$) scores correlated well with postoperative changes in typing speed, whereas BCTQ-S scores did not (r = −0.58; $P = .29$).

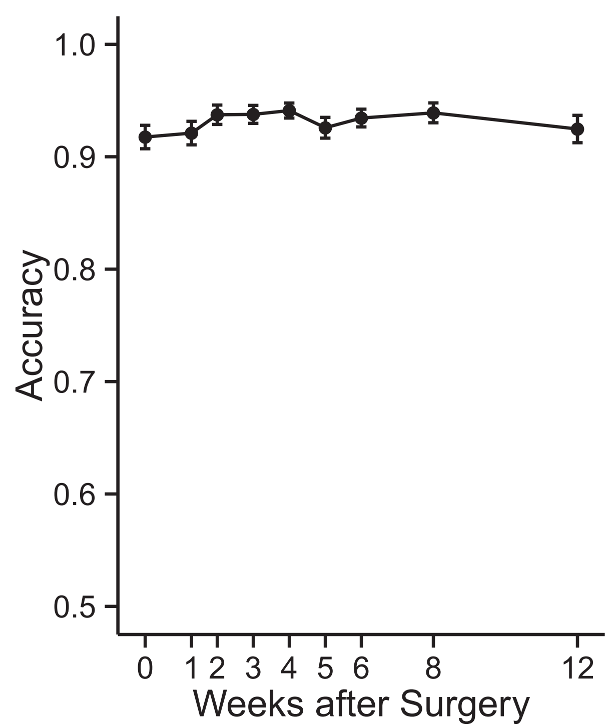

FIGURE 3: Average typing accuracy for the cohort, by session.

DISCUSSION

Keyboard use is widespread today in modern society, with many people engaging in typing for both social and professional reasons.

We found a significant decrease in typing performance 8 to 10 days after surgery; however, recovery from this point back to patients' preoperative typing speed occurred between 2 and 3 weeks after surgery, with a mean typing speed for the group exceeding preoperative performance at week 3. At this point, over half of the participants had exceeded the preoperative performance in a postoperative typing test. From that point forward, there was continued recovery above and beyond patients' preoperative typing performance, which suggests that typing performance was impaired by CTS, although the difference between preoperative and final typing speed was not

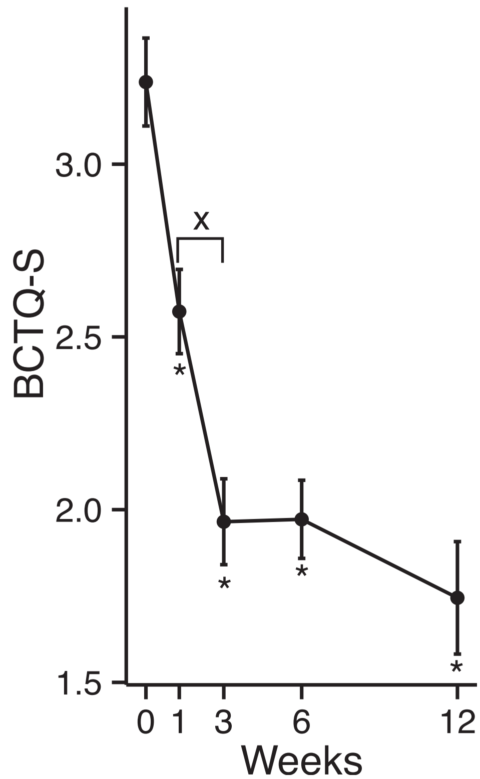

FIGURE 4: Results of the BCTQ-S. Brackets with an *x* indicate statistical significance between consecutive tests. Asterisks indicate statistical significance compared with the baseline value.

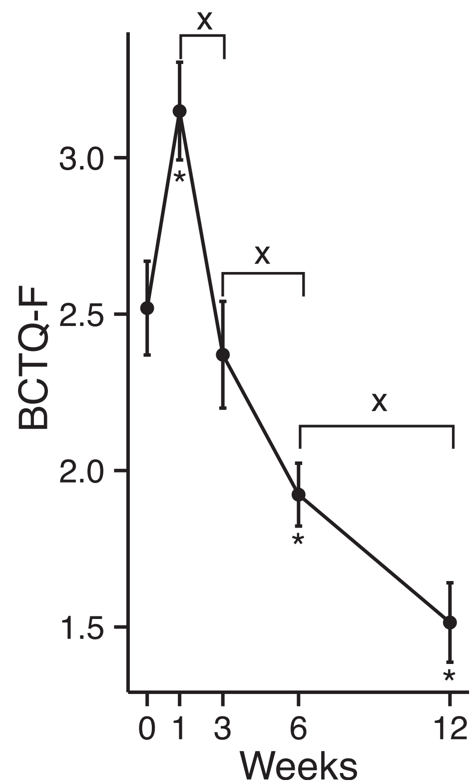

FIGURE 5: Results of the BCTQ-F. Brackets with an *x* indicate statistical significance between consecutive tests. Asterisks indicate statistical significance compared with the baseline value.

statistically significant. Although this may have reflected a learning effect, this seems unlikely because the time spent on the 9 test paragraphs represents a relatively small amount of the overall typing in which the patients engaged, as over 87% of the patients in the study reported normally spending more than 2 hours of computer use per day.

In the current study, no patient demographic or clinical factor was associated with either the rate or magnitude of improvement in typing speed after surgery. It is possible that these associations exist and would be demonstrated in a larger sample, although the magnitude of the impact of these factors would be expected to be relatively small, because the current study was powered to detect a within-subject difference of greater than 2.2 wpm. Furthermore, the period of most rapid change in the study was within the first 2 weeks after surgery, during which only 2 typing assessments were conducted. It is also possible that patterns in postoperative typing speed may be affected by patient factors during this time of rapid change that were not able to be detected with the sample owing to the study design.

The MHQ and BCTQ-F scores correlated well with typing speed; they showed initial worsening at the 8- to 10-day postoperative point and then exceeding preoperative values at the 3-week point with continued improvement thereafter. The BCTQ-S showed improvement throughout the study, including at the 8- to 10-day postoperative point. These findings were expected because the MHQ and BCTQ-F, and typing performance are all functional measures, whereas the BCTQ-S is a measure of symptom severity, which recovers relatively rapidly after surgery.[4,11–13] This suggests that a postoperative typing assessment may not be required and either the MHQ or BCTQ-F may be used as surrogates for typing performance.

This study had a number of limitations. First, the patient population represented less than 10% of those initially screened. This was due in large part to patients not meeting study inclusion criteria, the largest proportion of which resulted from nonsurgical management. Thus, the results may not be generalizable to patients with CTS who were outside the inclusion criteria of the study. This includes patients diagnosed with CTS based on clinical findings who have negative electrodiagnostic studies. The resulting sample was sufficiently small that we would not expect to be able to detect subtle differences in

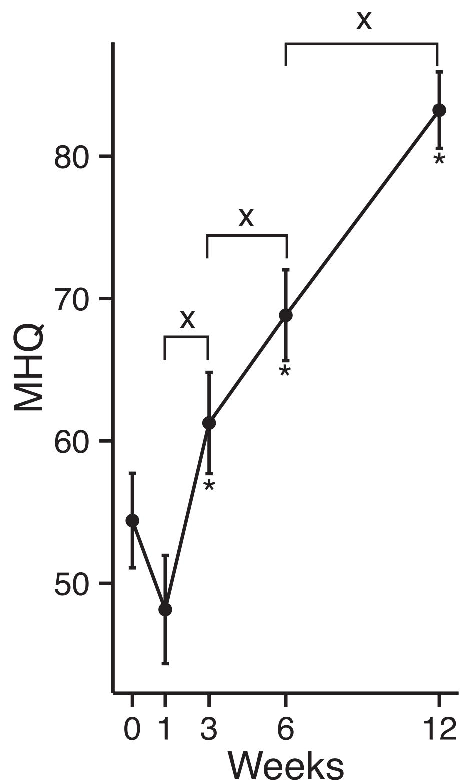

FIGURE 6: Results of the MHQ. Brackets with an *x* indicate statistical significance between consecutive tests. Asterisks indicate statistical significance compared with the baseline value.

postoperative typing performance attributable to patient factors. However, as discussed previously, if these associations in fact exist, we would expect them to be relatively small in magnitude. Although no patients underwent staged bilateral CTR during the study period, some had bilateral CTS symptoms but decided that only one side was symptomatic enough to warrant operative treatment. It is therefore possible that differences existed between the preoperative and postoperative states of the nonsurgical hand, which might have had an impact on our observations. Furthermore, whereas the study addressed maximal typing performance for less than 4 minutes, it did not assess typing endurance or subjective symptoms including pain experienced during typing activities, and therefore may not correspond with a patient's ability to return to work, particularly if the work involves sustained typing for a substantial part of the day. The focus of our study, however, was on peak typing performance, not return to work. Typing speed was the metric as the primary outcome measure because we felt that measuring typing speed at maximal effort for a roughly 500-character paragraph would best allow us to isolate the processes associated with typing. Also, although patterns were present when the data were analyzed for the group as a whole, variability existed when individual patients were examined, and thus when counseling patients before surgery, it is not possible to make exact predictions regarding postoperative typing performance for an individual. Finally, although our on-line data accrual system allowed us to gather more data points than would have been practical with only in-office testing, we acknowledge that it is not possible to confirm whether the patients themselves were actually the ones completing the typing tests or whether testing conditions were standardized for patients across sessions.

This study suggests that typing performance returns to preoperative levels for most patients between 2 and 3 weeks after CTR surgery. It is also possible that patients' CTS imparted a degree of impairment to typing performance, because their performance improved beyond baseline as their symptoms resolved, although further work is required to establish this relationship. Additional studies investigating typing endurance and patient symptoms could be useful to predict more reliably when patients will be able to return to work.

ACKNOWLEDGMENTS

This work was funded by an Orthopedic Research and Education Foundation/Depuy Resident Research Project Grant. This study also received support from ULI TR000445 from the National Center for Advancing Translational Sciences/National Institutes of Health for the use of Research Electronic Data Capture. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the National Center for Advancing Translational Sciences or the National Institutes of Health. The authors would like to express their deep gratitude to Julie Daniels for her hard work and contributions to this project.

REFERENCES

1. Papanicolaou GD, McCabe SJ, Firrell J. The prevalence and characteristics of nerve compression symptoms in the general population. *J Hand Surg Am*. 2001;26(3):460−466.
2. International Telecommunications Union. 2005−2015 ICT Data. *ITU: Statistics*. Available at: http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx. Accessed December 22, 2015.
3. Rabin E, Gordon AM. Tactile feedback contributes to consistency of finger movements during typing. *Exp Brain Res*. 2004;155(3):362−369.
4. Levine DW, Simmons BP, Koris MJ, et al. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. *J Bone Joint Surg Am*. 1993;75(11):1585−1592.

5. Chung KC, Pillsbury MS, Walters MR, Hayward RA. Reliability and validity testing of the Michigan Hand Outcomes Questionnaire. *J Hand Surg Am*. 1998;23(4):575−587.
6. Chung KC, Hamill JB, Walters MR, Hayward RA. The Michigan Hand Outcomes Questionnaire (MHQ): assessment of responsiveness to clinical change. *Ann Plast Surg*. 1999;42(6):619−622.
7. Logan GD, Crump MJC. Hierarchical control of cognitive processes: the case for skilled typewriting. In Ross BH, ed. *The Psychology of Learning and Motivation*. Vol. 54. Burlington, VT: Academic Press; 2011:1−27.
8. Collier M. *Border Collies*. Neptune City, NJ: T.F.H. Publications; 1995.
9. Crump MJC, Logan GD. Prevention and correction in post-error performance: an ounce of prevention, a pound of cure. *J Exp Psychol Gen*. 2013;142(3):692−709.
10. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377−381.
11. Osei DA, Calfee RP, Stepan JG, Boyer MI, Goldfarb CA, Gelberman RH. Simultaneous bilateral or unilateral carpal tunnel release? A prospective cohort study of early outcomes and limitations. *J Bone Joint Surg Am*. 2014;96(11):889−896.
12. Castillo TN, Yao J. Prospective randomized comparison of single-incision and two-incision carpal tunnel release outcomes. *Hand (N Y)*. 2013;9(1):36−42.
13. Atroshi I. Outcomes of endoscopic surgery compared with open surgery for carpal tunnel syndrome among employed patients: randomised controlled trial. *BMJ*. 2006;332(7556):1473.

FLA 5.4.0 DTD ■ YJHSU54979_proof ■ 4 November 2016 ■ 1:41 pm ■ ce

APPENDIX A. Readability Statistics for Paragraphs Used in Typing Tests

Statistic	1	2	3	4	5	6	7	8	9	10	Mean	SD
Words	114	117	113	110	106	113	107	108	114	109	111.1	3.60
Characters	500	525	529	511	471	517	490	463	487	469	496.2	23.97
Sentences	5	6	5	5	5	6	5	5	5	5	5.2	0.42
Words/sentence	22.8	19.5	22.6	22.0	21.2	18.8	21.4	21.6	22.8	21.45	21.45	1.35
Characters/word	4.3	4.4	4.6	4.5	4.4	4.5	4.5	4.2	4.2	4.4	4.2	0.15
Percent passive	0	50	0	0	20	50	20	40	0	40	18.04	21.46
Flesch reading ease	65.6	66.2	60.3	61.4	71.9	67.9	59.3	69.7	76.8	72.1	67.12	5.70
Flesch-Kincaid grade level	9.7	8.8	10.4	10.1	8.4	8.4	10.2	8.8	8.2	8.6	9.16	0.85

All texts are from Collier M. *Border Collies*. Neptune City, NJ: T.F.H. Publications; 1995.

Paragraph 1 (pp. 20−21)

The natural working ability in border collies makes them most easy to train, yet there are some dogs that have no working instinct whatever, and will never become effective sheep workers however long they are trained. It is not unusual for farmers to buy a fully or partly trained dog, as some have neither the time nor the ability to train the dogs themselves. It also means that they do not waste valuable time on a dog that may not turn out to be a successful worker. Many farmers find that the cost of such a dog is well worth it. Even good trial dogs sometimes change ownership, but the prices are very high.

Paragraph 2 (p. 6)

Dogs have been part of human life since before history was recorded. People started to make use of dogs very early in their relationship. First, they were used as guards for the home, and later as guards for other properties, such as livestock. In early times, they were guards only, and there is no written record of dogs working with livestock in any way until the Book of Job in the Old Testament. Even here they are referred to only briefly, and it would seem that they were guard dogs only, even then. The first modern reference to a dog working sheep in a similar manner to the modern border collie was made in the seventeenth century.

Paragraph 3 (p. 15)

Border collies have become the chief participant in the sport of agility. Their natural athleticism and keenness to please have made them a very suitable subject for this sport, where the main requirements are speed and the ability to clear a variety of jumps, weave through poles, and go through tunnels. If the border collie has a fault in this sport, it is that it can be faster than the handler, and this can lead to errors. It is no coincidence, though, that the top agility dog has been a border collie since they started recording winners. Working trials are yet another canine sphere where border collies have become the dog to beat.

Paragraph 4 (pp. 13−14)

A border collie is never happier than when doing something. Such is their desire to please that they are willing to be trained to do most things, and they usually excel in the field chosen for them by their owner. Although primarily a sheep dog, the border collie is not averse to turning his paw to anything that involves work or pleasure in any sphere. Border collies are the dogs to beat at obedience trials. They relish working hard with their handlers, and seem to find little difficulty in adapting their sheep-working habits to obedience, which, on the face of it, appears to be a totally different set of skills.

FLA 5.4.0 DTD ■ YJHSU54979_proof ■ 4 November 2016 ■ 1:41 pm ■ ce

Paragraph 5 (p. 6)

It is difficult to know how man ever managed large flocks of sheep on the rough and hilly terrain of these areas without the help of these wonderful dogs. The strains that proved most adept at the specialized type of work required were highly prized and selectively bred from. This produced the sort of collie we know today. From looking at very old photographs, it is remarkable how little they have changed in the last hundred years or so. It proves that the early flock-masters knew well the type of dog that was built on the correct lines for the job it was intended to do.

Paragraph 6 (p. 16)

One other sphere where border collies are most successful is in search and rescue. Dog handlers are required to go out and look for missing climbers and walkers. A lot of these people get lost in areas where sheep are grazed. Border collies have to range well ahead of the handlers in order to cover the maximum amount of ground, so they must be tested for their trustworthiness with sheep before training starts. It does show what an adaptable breed the border collie is, in that it can be taught to ignore an animal that it has been specifically bred to herd. Border collies are becoming more and more popular for this purpose.

Paragraph 7 (p. 11)

A border collie from the correct source can be a charming pet. However, dogs bred from a strong working line can become very frustrated and destructive if they find themselves in an environment where there is nothing for them to do. The job is the border collie's main reason for living. The desperate need to work is slightly diluted in certain lines of border collies that are bred for the show ring. It is important to remember that, although a border collie is usually quite happy to be a loving pet, he will need plenty of exercise, and preferably some occupation for his very able brain.

Paragraph 8 (p. 17)

Sheep dog trials are a stylized form of farm work for the border collie. Most dogs that compete in trials do so in addition to their daily work on the farm. It is rare that a dog is kept exclusively for trials, as the border collie is too useful to be kept for a special occasion. Most of the exercises that a working dog performs on the trials field are slight modifications of the jobs they perform every day of their working lives, and most sheep farmers would be lost without their dogs. Most trial winners more than earn their keep when used on the daily farm work.

Paragraph 9 (pp. 17-18)

It is wonderful to watch a sheep dog trial and see how the slightest word or whistle gets an almost instant response from the dog. At most trials, the course is virtually the same, and the rules are easily picked up by watching. The course always starts with an outrun, which takes the dog out in a wide arc behind the sheep. The dog then lifts the sheep by creeping up behind them and moving them towards the handler. When the sheep get to the handler, the idea is to drive them around him, then move them away through a gate and then through a second drive before bringing them back to the handler.

Paragraph 10 (p. 19)

The main variation to the trials is the brace competition, where a handler works two dogs as a pair. When handling two dogs, different whistles or commands must be used for each dog, and the handler works one dog on each side of the sheep. It is a very serious fault if they cross at any time, and great skill is required by the handler to make sure that each dog keeps to its appointed side. Quite often, a dog is tempted to move over if it things that its partner is not doing too well. This is where the handler's skill becomes paramount in anticipating and correcting this.