JOURNAL OF PLASTIC SURGERY AND HAND SURGERY
2022, VOL. 56, NO. 3, 167–171
https://doi.org/10.1080/2000656X.2021.1953041

RESEARCH ARTICLE

Pain and numbness one month after carpal tunnel release predict patient-reported outcome measures at sixth months

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ABSTRACT

A number of outcome predictors for carpal tunnel release (CTR) for carpal tunnel syndrome (CTS) have been reported. However, some predictors are controversial, and few studies have referred to the early postoperative outcome prognostic factors after CTR. The aim of this study was to investigate whether pain and numbness at 1 month post-CTR were early postoperative predictors of clinical outcomes 6 months after surgery. Pain and numbness were evaluated using the visual analog scale (VAS) preoperatively and at 1 month post-surgery. Patient-reported outcome measures (PROMs), including the Quick Disabilities of the Arm, Shoulder and Hand (QDASH) measure, the Hand20 questionnaire and the Boston Carpal Tunnel Questionnaire (BCTQ), were recorded for each patient 6 months after surgery. The BCTQ consisted of the Symptom Severity Scale (SSS) and Functional Status Scale (FSS). Multivariable linear regression analysis was performed to investigate the association between the VAS scores and PROMs. We retrospectively identified 93 patients who underwent open carpal tunnel release (OCTR) or endoscopic carpal tunnel release. The mean age of the patients was 67.5 years, and 67 patients (72.0%) were female. Sixty patients were treated by OCTR (65.0%). With multivariable linear regression analysis, we found that pain and numbness, evaluated with VAS 1 month post-surgery had significant correlations with QDASH, Hand20, SSS and FSS 6 months after surgery. In conclusion, pain and numbness 1 month after CTR predict PROMs at 6 months.

ARTICLE HISTORY
Received 28 December 2020
Revised 18 May 2021
Accepted 1 July 2021

KEYWORDS
Carpal tunnel syndrome; carpal tunnel release; predictor

Introduction

Carpal tunnel syndrome (CTS) is a common compression neuropathy and accounts for approximately 90% of all entrapment neuropathies [1]. The most common symptoms of CTS are pain and numbness along the median nerve distribution in the hands. Open carpal tunnel release (OCTR) and endoscopic carpal tunnel release (ECTR) are the main surgical treatments for CTS. A number of preoperative factors and types of surgery have been reported as predictors of postoperative outcomes of carpal tunnel release (CTR) for CTS [2–9]. However, some prognostic factors are controversial. For example, some studies have suggested that outcomes after CTR in elderly patients were unfavorable [7,9], while satisfactory subjective results after CTR have been reported in patients over 70 years of age with advanced stages of CTS in another study [10]. In addition, Tang et al. reviewed long-term outcomes in patients with bilateral CTS who underwent CTR (OCTR or ECTR), and the outcome in men was poorer than that in women [8]. In contrast to that study, sex was not a significant predictor of severity of postoperative pain in another study that followed patients after OCTR [11]. Additionally, the predictive value of electrophysiological assessments also remains controversial [6].

Recently, in the field of joint arthroplasty, the early postoperative predictors for satisfaction after total knee arthroplasty have been identified along with several preoperative factors [12]. In contrast, in the field of hand surgery, few studies have investigated the early postoperative prognostic factors of outcomes after CTR. Early postoperative predictors after CTR would enable surgeons to predict which patients could have poor outcomes and arrange careful follow-up from the early postoperative period. In addition, early postoperative pain and numbness have received little attention as prognostic factors after CTR, although they are the main symptoms of CTS.

Therefore, we hypothesized that symptoms in the early postoperative period would correlate with patient-reported outcome measures (PROMs) after surgery. This study aimed to investigate whether pain and numbness 1 month post-CTR for CTS predict clinical outcomes 6 months post-surgery.

Materials and methods

The study protocol was approved by our institution's ethical review board (number 3855). All patients consented to the use of their clinical information and the medical records.

Subjects

In this retrospective study, patients who underwent OCTR or ECTR for CTS between January 2016 and November 2019 were included. Patients with follow-up of <6 months were excluded. Electrophysiological assessments, including distal motor latency of the abductor pollicis brevis (APB), compound muscle action

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Supplemental data for this article is available online at https://doi.org/10.1080/2000656X.2021.1953041

potential (CMAP) (APB-DML) and distal motor latency of the second lumbrical (2L) CMAP (2L-DML) were performed preoperatively. Pain and numbness were evaluated using the visual analog scale (VAS) preoperatively and at 1 month after surgery. PROMs were recorded at 6 months post-surgery.

Measures

Pain and numbness were evaluated using the VAS (range, 0 (no pain or no numbness) to 100 (most severe)). Arm-specific disability was assessed using the Quick Disabilities of the Arm, Shoulder and Hand (QDASH) measure [13] and Hand20 questionnaire [14]. QDASH is an 11-item measure with scores ranging from 0 to 100. Hand20, ranging from 0 to 100, consists of 20 questions, and explanatory illustrations are added to 19 of the 20 questions. Higher scores in QDASH and Hand20 indicate a more severe disability. Symptom severity and daily functions were evaluated using the Boston Carpal Tunnel Questionnaire (BCTQ) [15]. The BCTQ consisted of the Symptom Severity Scale (SSS) and the Functional Status Scale (FSS). The SSS and FSS included 8 and 11 items, respectively. Each question was answered on a five-point scale (1 (no complaint) to 5 (severe complaint)). The results are expressed as the mean values for each scale.

Statistical analysis

We investigated whether pain and numbness 1-month post-CTR correlated with clinical outcomes 6 months after surgery. We also investigated whether preoperative pain and numbness correlated with clinical outcomes 6 months after CTR. Multivariable linear regression analysis was used to assess the associations between symptoms, including pain and numbness (evaluated using VAS) and PROMs, including QDASH, Hand20 and BCTQ 6 months after CTR. The objective variables were QDASH, Hand20, SSS and FSS 6 months after CTR. Their association with the VAS pain score 1 month after CTR was analyzed after the data were adjusted for the preoperative VAS pain score, age, sex, preoperative electrophysiological assessment results (APB-DML and 2L-DML) and type of surgery (OCTR or ECTR). Their association with the VAS numbness score 1 month after CTR was also analyzed after the data were adjusted for preoperative VAS numbness scores, age, sex, preoperative electrophysiological assessment results and type of surgery. In addition, after the data were adjusted for age, sex, preoperative electrophysiological assessment results, and type of surgery, we analyzed the associations between preoperative VAS pain and numbness scores and PROMs 6 months after CTR. A p value of $<.05$ was considered statistically significant.

In multiple linear regression analysis, the number of patients required is at least 15 times the number of explanatory variables [16]. In this study, we selected a maximum of six explanatory variables, which required a minimum of 90 cases.

Results

A total of 93 patients were included in this study. The mean age of the patients was 67.5 (range, 30–86 years), and 67 patients (72.0%) were female. The majority of patients were treated by OCTR (60 patients, 65.0%) (Table 1). Seven patients had a trigger finger and six of them underwent open A1 pulley release along with CTR. The average preoperative VAS pain and numbness scores were 45.8 and 64.7, respectively. The average VAS pain and numbness scores 1 month after surgery were 21.3 and 30.5, respectively. The mean QDASH, Hand20, SSS and FSS scores 6 months post-surgery, were 17.1, 17.2, 1.6 and 1.6, respectively.

Table 1. Demographic characteristics of the study population.

Characteristic	Total ($n = 93$)
Age (years), mean ± SD	67.5 ± 12.4
Sex, *n* (%)	
Female	67 (72.0%)
Male	26 (28.0%)
Operation, *n* (%)	
Open carpal tunnel release	60 (65.0%)
Endoscopic carpal tunnel release	33 (35.0%)
APB-DML (ms), mean ± SD	7.3 ± 2.8
2L-DML (ms), mean ± SD	6.4 ± 2.7

Pain and numbness evaluated using the VAS 1 month after surgery were significantly correlated with QDASH, Hand20, SSS and FSS scores 6 months after surgery (Figures 1 and 2). However, correlations between preoperative pain and numbness, evaluated by the VAS, and PROMs, including QDASH, Hand20, SSS and FSS 6 months after surgery, were not significant. The validity of the model was examined by residual histograms (Appendices 1 and 2) and residuals versus fitted plots (Appendices 3 and 4). The variance inflation factors were less than 5 for all, which indicated that there was no significant collinearity between the variables [17].

Discussion

Pain and numbness 1 month after CTR correlated with PROMs 6 months after CTR, but preoperative pain and numbness did not. Considering these results, regardless of the degree of preoperative pain and numbness, better clinical outcomes could be expected in patients with less pain and numbness in the early postoperative period. Therefore, it would be important for surgeons to assess pain and numbness carefully after CTR, and surgeons could inform their patients of expected outcomes at 6 months post-CTR by evaluating their symptoms in the early postoperative period. We identified the early postoperative predictors of the clinical outcomes after CTR by multivariable linear regression analysis, while most previous studies investigated preoperative prognostic factors including sex, age and preoperative electrophysiological assessment results.

Several factors such as age, sex, electrophysiological assessment results and type of surgery have been reported as factors that influence outcomes after CTR. However, some factors remain controversial. For example, increasing age has been reported to lead to poorer results in some studies but not others. Porter et al. prospectively studied 87 patients who underwent OCTR and found that improvement in symptoms and function decreased with increasing age, especially in patients over the age of 60 years [9], while Townshend et al. reported high levels of satisfaction after OCTR in 70 elderly patients over 70 years of age [6]. The same might be true for sex, electrophysiological assessment results and type of surgery. Tang et al. reviewed long-term outcomes in 40 patients with bilateral CTS who underwent CTR [8]. The outcomes of the study were numbness resolution, BCTQ score and patient satisfaction. The mean follow-up was 9.3 years, and men had poorer outcomes than women. However, in another study that followed 447 patients with CTS who underwent OCTR [11], sex was not a significant predictor of severity of postoperative pain. In addition, Kamiya et al. investigated the prognostic factors of patients who lacked a preoperative CMAP of the APB [4]. They retrospectively reviewed 22 CTS patients who underwent CTR and used postoperative APB amplitude at 12 months as the

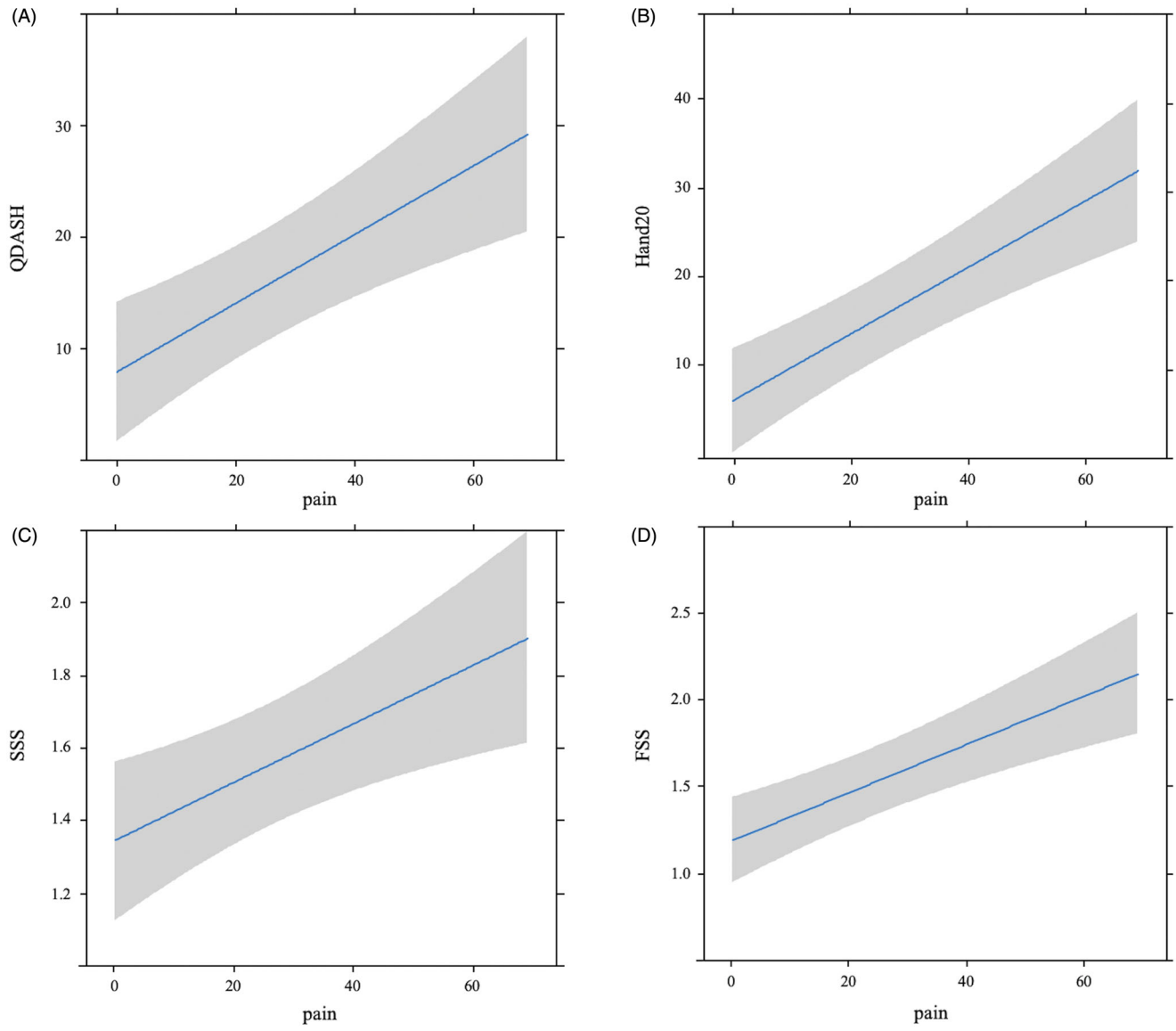

Figure 1. (A) Association between pain evaluated using VAS and QDASH. QDASH increased with pain when adjusted for preoperative VAS of pain, age, sex, preoperative electrophysiological assessments and operation ($p<.05$). The gray zone indicates 95% CIs (confidence intervals). (B) Association between pain evaluated using VAS and Hand20. Hand20 increased with pain when adjusted for preoperative VAS of pain, age, sex, preoperative electrophysiological assessments and operation ($p<.05$). The gray zone indicates 95% CIs. (C) Association between pain evaluated with VAS and SSS. SSS increased with pain when adjusted for preoperative VAS of pain, age, sex, preoperative electrophysiological assessments and operation ($p<.05$). The gray zone indicates 95% CIs. (D) Association between pain evaluated with VAS and FSS. FSS increased with pain when adjusted for preoperative VAS of pain, age, sex, preoperative electrophysiological assessments and operation ($p<.05$). The gray zone indicates 95% CIs.

outcome. They found significant correlations with preoperative 2L-DML and postoperative APB amplitude and reported that patients with preoperative 2L-DML of 8 ms or less had good electrophysiological recovery at 12 months and that absent preoperative 2L CMAP predicted a poor electrophysiological recovery. However, in the study that followed 62 patients who had undergone CTR, a relationship between the preoperative nerve conduction impairment and surgical outcome was not found [18]. Finally, whether OCTR or ECTR is performed has been reported to affect the outcome after CTR. Sayegh and Strauch performed a meta-analysis of randomized controlled trials to review the efficacy and safety of OCTR versus ECTR [2]. They reported that patients who underwent ECTR could return to work earlier than patients treated with OCTR. However, in another meta-analysis study of randomized controlled trials, there was no conclusive evidence favoring ECTR over OCTR with regard to symptom relief and return to work [19]. As some prognostic factors have been controversial and few early postoperative predictors have been reported, we tried to identify the early postoperative factors that could predict the clinical outcomes after CTR and focused on the main symptoms of CTS. In the present study, we evaluated pain and numbness using the VAS scale, which is noninvasive and easy to administer. Therefore, surgeons could easily predict outcomes after CTR by assessing pain and numbness in their early postoperative follow-up, thereby allowing them to arrange closer follow-up and earlier therapeutic intervention for patients expected to have poor outcomes.

In this study, we used multivariable linear regression analysis to adjust for confounders. In most of the previous studies, the multivariable analysis included the significant factors identified by univariate analysis. However, the general statistical guidance of *Annals of Internal Medicine* (https://www.acpjournals.org/journal/aim/authors/statistical-guidance) recommends selecting factors for inclusion in a multivariable model only if factors which are

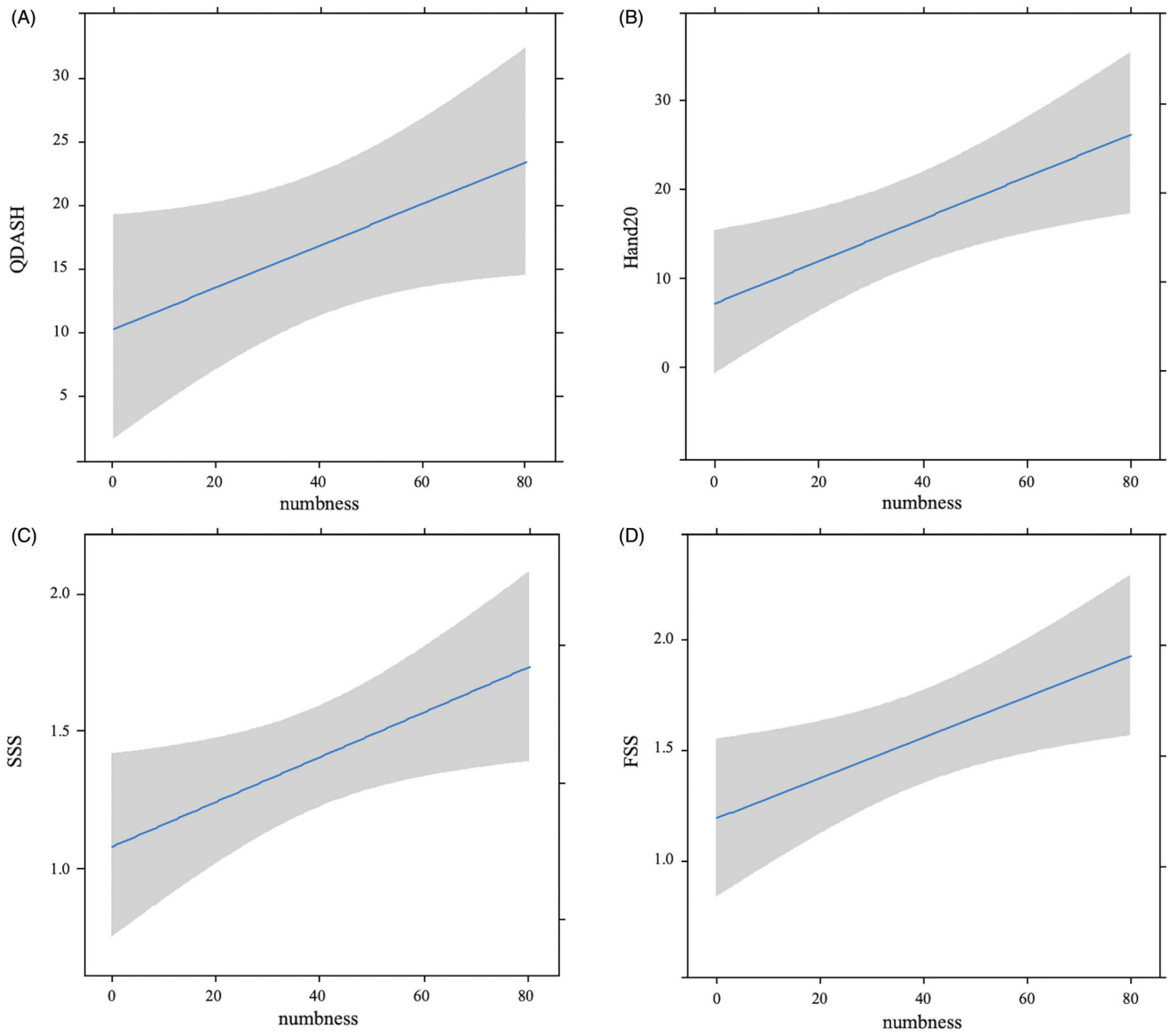

Figure 2. (A) Association between numbness evaluated using VAS and QDASH. QDASH increased with numbness when adjusted for preoperative VAS of numbness, age, sex, preoperative electrophysiological assessments and operation ($p<.05$). The gray zone indicates 95% CIs. (B) Association between numbness evaluated with VAS and Hand20. Hand20 increased with numbness when adjusted for preoperative VAS of numbness, age, sex, preoperative electrophysiological assessments and operation ($p<.05$). The gray zone indicates 95% CIs. (C) Association between numbness evaluated using VAS and SSS. SSS increased with numbness when adjusted for preoperative VAS of numbness, age, sex, preoperative electrophysiological assessments and operation ($p<.05$). The gray zone indicates 95% CIs. (D) Association between numbness evaluated with VAS and FSS. FSS increased with numbness when adjusted for preoperative VAS of numbness, age, sex, preoperative electrophysiological assessments and operation ($p<.05$). The gray zone indicates 95% CIs.

'statistically significant' in the 'bivariate screening' are not optimal. Using only variables that are significant in the univariate analysis means that all variables screened with statistical significance in univariate analyses are automatically entered without manual selection and without considerations for the relevance of those variables [20]. Adjustments for confounders are necessary for observational studies like the present one to account for differences in the background factors in the cohort [21]. We selected the confounders from previous studies [2,7–9,22,23] and adjusted the data for them and the preoperative symptoms, to adjust for the differences in the background factors and the severity of preoperative symptoms.

We did not investigate whether age, sex, electrophysiological assessment results and type of surgery were prognostic factors for the clinical outcomes after CTR. By adjusting the data for these, we performed multivariable linear regression analysis to clarify the relationship between the early postoperative symptoms and clinical outcomes 6 months post-CTR. In addition, we analyzed two different types of surgeries (OCTR and ECTR) together. However, the underlying principle of releasing the transverse carpal ligament is the same in both types of surgeries, and Tang et al. also analyzed CTR, including both OCTR and ECTR, to evaluate their outcomes [8]. Additionally, we used multivariable linear regression analysis to account for the difference between OCTR and ECTR.

We used QDASH and Hand20 for patients having a wide range of generations as domain-specific measures and used BCTQ as a disease-specific outcome in the present study. In a recent systematic review, 834 studies were reviewed to appraise the use of hand-relevant PROMs [24]. Three basic types of health-related quality of life instruments are available, namely, generic, domain-specific and disease-specific [25]. The QDASH and Hand20 were

categorized as domain-specific measures, and BCTQ was categorized as a disease-specific measure. From the review [24], the authors reported that BCTQ was the most commonly used PROM and that the most common domain-specific outcome measures in CTS were DASH and QDASH [24]. DASH and QDASH were recommended for patients between 18 and 65 years of age [26], although they are widely used in other age groups as well. Therefore, Hand20 was developed to expand the age range [14].

There were several limitations to this study. These included the retrospective design, small sample size and relatively short-term follow-up. Another limitation was that we used QDASH, Hand20 and BCTQ as outcomes. If we had used other PROMs, such as the Michigan Hand Outcomes Questionnaire and Short Form 36, we might have obtained different results. However, we believe that our data are valid because the PROMs used in the present study are widely used in CTS.

In conclusion, symptoms including numbness and pain in the early postoperative period correlated with PROMs post-surgery. We found that pain and numbness 1 month after CTR predicted PROMs at 6 months.

Acknowledgements

The authors thank Editage (www.editage.com) for English language editing.

Disclosure statement

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

References

[1] Aroori S, Spence RA. Carpal tunnel syndrome. Ulster Med J. 2008;77(1):6–17.
[2] Sayegh ET, Strauch RJ. Open versus endoscopic carpal tunnel release: a meta-analysis of randomized controlled trials. Clin Orthop Relat Res. 2015;473(3):1120–1132.
[3] Kanatani T, Nagura I, Kurosaka M, et al. Electrophysiological assessment of carpal tunnel syndrome in elderly patients: one-year follow-up study. J Hand Surg Am. 2014;39(11):2188–2191.
[4] Kamiya H, Kimura M, Hoshino S, et al. Prognosis of severe carpal tunnel syndrome with absent compound muscle action potential. Muscle Nerve. 2016;54(3):427–431.
[5] Kronlage SC, Menendez ME. The benefit of carpal tunnel release in patients with electrophysiologically moderate and severe disease. J Hand Surg Am. 2015;40(3):438–444.e1.
[6] Townshend DN, Taylor PK, Gwynne-Jones DP. The outcome of carpal tunnel decompression in elderly patients. J Hand Surg Am. 2005;30(3):500–505.
[7] Hansen TB, Larsen K. Age is an important predictor of short-term outcome in endoscopic carpal tunnel release. J Hand Surg Eur Vol. 2009;34(5):660–664.
[8] Tang CQY, Lai SWH, Tay SC. Long-term outcome of carpal tunnel release surgery in patients with severe carpal tunnel syndrome. Bone Joint J. 2017;99-B(10):1348–1353.
[9] Porter P, Venkateswaran B, Stephenson H, et al. The influence of age on outcome after operation for the carpal tunnel syndrome. A prospective study. J Bone Joint Surg Br. 2002;84(5):688–691.
[10] Tomaino MM, Weiser RW. Carpal tunnel release for advanced disease in patients 70 years and older: does outcome from the patient's perspective justify surgery? J Hand Surg Br. 2001;26(5):481–483.
[11] Atroshi I, Lyrén PE, Ornstein E, et al. The six-item CTS symptoms scale and palmar pain scale in carpal tunnel syndrome. J Hand Surg Am. 2011;36(5):788–794.
[12] Williams DP, O'Brien S, Doran E, et al. Early postoperative predictors of satisfaction following total knee arthroplasty. Knee. 2013;20(6):442–446.
[13] Imaeda T, Toh S, Wada T, et al. Validation of the Japanese Society for Surgery of the Hand Version of the Quick Disability of the Arm, Shoulder, and Hand (QuickDASH-JSSH) Questionnaire. J Orthop Sci. 2006;11(3):248–253.
[14] Suzuki M, Kurimoto S, Shinohara T, et al. Development and validation of an illustrated questionnaire to evaluate disabilities of the upper limb. J Bone Joint Surg Br. 2010;92(7):963–969.
[15] 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.
[16] Harrell FE. Regression modeling strategies. 2nd ed. New York: Springer; 2015. p. 72–74.
[17] Zheng X, Zhang R, Liu X, et al. Association between cumulative exposure to ideal cardiovascular health and arterial stiffness. Atherosclerosis. 2017;260:56–62.
[18] Longstaff L, Milner RH, O'Sullivan S, et al. Carpal tunnel syndrome: the correlation between outcome, symptoms and nerve conduction study findings. J Hand Surg Br. 2001;26(5):475–480.
[19] Thoma A, Veltri K, Haines T, et al. A systematic review of reviews comparing the effectiveness of endoscopic and open carpal tunnel decompression. Plast Reconstr Surg. 2004;113(4):1184–1191.
[20] Nojima M, Tokunaga M, Nagamura F. Quantitative investigation of inappropriate regression model construction and the importance of medical statistics experts in observational medical research: a cross-sectional study. BMJ Open. 2018;8(5):e021129.
[21] Gum PA, Thamilarasan M, Watanabe J, et al. Aspirin use and all-cause mortality among patients being evaluated for known or suspected coronary artery disease: a propensity analysis. JAMA. 2001;286(10):1187–1194.
[22] Hobby JL, Venkatesh R, Motkur P. The effect of age and gender upon symptoms and surgical outcomes in carpal tunnel syndrome. J Hand Surg Br. 2005;30(6):599–604.
[23] Bae JY, Kim JK, Yoon JO, et al. Preoperative predictors of patient satisfaction after carpal tunnel release. Orthop Traumatol Surg Res. 2018;104(6):907–909.
[24] Lloyd-Hughes H, Geoghegan L, Rodrigues J, et al. Systematic review of the use of patient reported outcome measures in studies of electively-managed hand conditions. J Hand Surg Asian Pac Vol. 2019;24(3):329–341.
[25] Szabo RM. Outcomes assessment in hand surgery: when are they meaningful? J Hand Surg Am. 2001;26(6):993–1002.
[26] The Disabilities of the Arm, Shoulder and Hand (DASH) outcome measure: frequently asked questions; 2020; [cited 2020 Dec 23]. Available from: https://www.dash.iwh.on.ca/faq