Original Research Article

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RELIABILITY AND VALIDITY OF THE FINNISH VERSION OF THE BOSTON CARPAL TUNNEL QUESTIONNAIRE AMONG SURGICALLY TREATED CARPAL TUNNEL SYNDROME PATIENTS

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ABSTRACT

Background and Aims: **The Boston Carpal Tunnel Questionnaire is the most commonly used outcome measure in the assessment of carpal tunnel syndrome. The purpose of this study was to translate the original Boston Carpal Tunnel Questionnaire into Finnish and validate its psychometric properties.**

Materials and Methods: **We translated and culturally adapted the Boston Carpal Tunnel Questionnaire into Finnish. Subsequently, 193 patients completed the Finnish version of the Boston Carpal Tunnel Questionnaire, 6-Item CTS Symptoms Scale, and EuroQol 5 Dimensions 12 months after carpal tunnel release. The Boston Carpal Tunnel Questionnaire was re-administered after a 2-week interval. We calculated construct validity, internal consistency, test–retest reliability, and coefficient of repeatability. We also examined floor and ceiling effects.**

Results: **The cross-cultural adaptation required only minor modifications to the questions. Both subscales of the Boston Carpal Tunnel Questionnaire (Symptom Severity Scale and Functional Status Scale) correlated significantly with the CTS-6 and EuroQol 5 Dimensions, indicating good construct validity. The Cronbach's alpha was 0.93 for both the Symptom Severity Scale and Functional Status Scale, indicating high internal consistency. Test–retest reliability was excellent, with an intraclass correlation coefficient greater than 0.8 for both scales. The coefficient of repeatability was 0.80 for the Symptom Severity Scale and 0.68 for the Functional Status Scale. We observed a floor effect in the Functional Status Scale in 28% of participants.**

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Conclusion: **Our study shows that the present Finnish version of the Boston Carpal Tunnel Questionnaire is reliable and valid for the evaluation of symptom severity and functional status among surgically treated carpal tunnel syndrome patients. However, owing to the floor effect, the Functional Status Score may have limited ability to detect differences in patients with good post-operative outcomes.**

Key words: Boston Carpal Tunnel Questionnaire; carpal tunnel release; Finnish; validity; reliability; psychometrics

INTRODUCTION

Carpal tunnel syndrome (CTS) is a pathological condition caused by compression of the median nerve in the carpal tunnel at the wrist. CTS is one of the most common upper-extremity disorders causing pain, numbness, and tingling in the hand and arm. Weakness and clumsiness may also occur. Women are more likely to suffer from CTS than men, and its prevalence and severity increase with age (1). According to the Health 2000 study, the prevalence of CTS in the general population in Finland was 2.1% in men and 5.3% in women (2).

Conservative treatments, including splinting, medication, corticosteroid injections, and stretching exercises, are currently recommended for mild to moderate CTS (3). If symptoms are severe or do not respond to conservative treatment, CTS is often treated by surgical release. In the past, clinicians and researchers were confounded by the disparate outcome measures used for the assessment of CTS. Currently, however, studies evaluating the primary outcomes of clinical and post-operative treatment for CTS increasingly use patient-based measures (4). The best of these instruments are validated patient-reported outcome measures (PROMs). Since the 1990s, various standardized PROMs for CTS have been developed. These include the Boston Carpal Tunnel Questionnaire (BCTQ) (5), Michigan Hand Outcome Questionnaire (MHQ) (6), Disability of Arm, Shoulder and Hand (DASH) (7), Upper Extremity Functional Scale (UEFS) (8), and 6-Item CTS Symptoms Scale (9). Some of these questionnaires, like the BCTQ (5) and the 6-Item CTS Scale, are disease-specific (9), while others, such as the DASH (7) and UEFS (8), are region-specific. Some studies have also used generic quality of life measures, such as the SF-36, to assess outcome after carpal tunnel release (10, 11). Overall, the BCTQ is the outcome measure most commonly used in CTS assessment (4).

The BCTQ, also variously referred to as the Levine scale (5), the Brigham and Women's carpal tunnel questionnaire (11), or the Carpal Tunnel Syndrome Instrument (10), assesses symptom severity and functional status. It was introduced in 1993 as the first disease-specific questionnaire for patients with CTS. Both physicians and patients were involved in the item generation process. The BCTQ has since been used as an outcome measure in clinical studies and has undergone extensive testing for validity, reliability, and responsiveness (12). Today, several different language versions of the BCTQ have been developed (10, 13–21).

A Finnish version of the BCTQ has not been available thus far. Hence, the purpose of this study was, through a cross-cultural adaptation process (22), to produce a Finnish version of BCTQ and to evaluate its construct validity and reliability in a sample of surgically treated CTS patients.

MATERIALS AND METHODS

CROSS-CULTURAL ADAPTATION

Prior to its implementation, a cross-cultural adaptation of the BCTQ was developed as recommended by Beaton et al. (22). An experienced hand surgeon (T1) and a professional translator (T2), who was blinded to the concepts being investigated and had no medical background, independently translated the questionnaire. A steering group constructed a synthesis from these two translations. A Finnish-speaking native English translator (BT1) then translated the synthesis version back into English blinded to the earlier translations. The BT1 was also unfamiliar with the original questionnaire or concepts used in forming its items. The translations into Finnish and back translation into English were then collated and discussed at a steering group consensus meeting. This Finnish version of the BCTQ was piloted with 10 Finnish volunteers who had undergone carpal tunnel release some years ago. After completion of the questionnaire, these volunteers were cognitively debriefed to reveal any difficult or confusing items or response options.

PARTICIPANTS

We invited all adult patients with primary CTS who had undergone carpal tunnel release surgery (received procedure code ACC51) in the Department of Orthopedics at Central Finland Central Hospital between January 2016 and February 2017 to participate in this study. Prior to surgery, the operating surgeon had established the diagnosis of primary CTS through the patient's medical history and symptoms, a physical examination, and electroneuromyography (ENMG). Most of the patients (75%) had undergone failed conservative treatment.

Traditional open carpal tunnel release was performed under local anesthesia. After surgery, a soft dressing was applied, and patients were given oral and written instructions on post-operative exercises and allowed a gradual return to their normal activities. Supervised therapy was not routinely prescribed.

A total of 528 female and male patients underwent either right-hand or left-hand or bilateral carpal tunnel release surgery between January 2016 and February 2017. We mailed the questionnaires with a cover letter and a blank informed consent form to all patients 1 year after the procedure. Completed questionnaires were returned by 259 patients. For test–retest purposes, we mailed the same participants a second Finnish BCTQ to be completed 2 weeks after the first questionnaire. The second questionnaire was returned by 198 patients, yielding a response rate of 38%. Five patients were excluded owing to an inadequate comprehension of written and spoken Finnish. All other patients met the initial inclusion criteria, that is, age 18 years or older, diagnosed primary idiopathic CTS, carpal tunnel release surgery 1 year earlier, and completion of the BCTQ twice at a 2-week interval 1 year after surgery. These five patients had reported problems in filling out the questionnaires due to language difficulties. Thus, the final study sample comprised 193 participants. No significant differences were observed in the percentage of women between responders to the both BCTQs (67.4%) and the non-responders to the second BCTQ, including those who were excluded owing to problems with the Finnish language (62.1%). However, all responders were older than non-responders (64.2 ± 13.8 vs 55.1 ± 14.8 years, $p < 0.001$). The Ethics Committee of the Central Finland Health Care District approved the study plan (approval number: 15U/2017). All participants gave their written informed consent in accordance with the Helsinki Declaration.

QUESTIONNAIRES

BCTQ

The BCTQ comprises two subscales, a Symptom Severity Scale (SSS) and a Functional Status Scale (FSS) (5). The SSS comprises 11 items assessing pain, paresthesia, numbness, weakness, nocturnal symptoms, and difficulty of grasping. The FSS refers to eight functional daily activities affected by CTS, including writing, buttoning of clothes, holding a book while reading, gripping of a telephone handle, opening of jars, performing household chores, carrying grocery bags, bathing, and dressing. In both subscales, each item is scored on a 5-point response scale, from 1 (no symptoms/difficulties) to 5 (the worst symptoms/cannot perform the activity at all). The overall score for both scales is the mean-item score which ranges between 1 and 5, with a higher score indicating a worse symptom or more impaired function. The BCTQ takes less than 10 min to complete.

The 6-Item CTS Symptoms Scale (CTS-6)

The CTS-6 is originally derived from the SSS of the BCTQ by Atroshi et al. (9). The authors used factor analysis and items response theory methodology to develop a short 6-item version of the CTS SSS to reduce respondent burden in answering the multiple-choice questions. The scale comprises six items on the severity and frequency of night and daytime numbness and tingling pain. Each item is scored on a 5-point scale from 1 (no symptom) to 5 (most severe symptom). The overall score for the scale is calculated as the mean of the items answered by the patient, a higher score indicating worse symptoms. The CTS-6 score can be calculated with one missing item. The CTS-6 is reliable, valid, and responsive to change in symptoms after surgical treatment (9, 23). The CTS-6 was translated and cross-culturally adapted into Finnish following the guidelines by Beaton et al. (22) (unpublished data).

EuroQol 5 Dimensions Questionnaire

The EuroQol 5 Dimensions (EQ-5D) is a generic health-related quality of life instrument using an EQ-5D descriptive system and a visual analog scale (EQ VAS). The descriptive system measures health status on the day of administration in five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. We used a version with five response options (EQ-5D-5L) per question: no problems, slight problems, moderate problems, severe problems, and extreme problems (24). The patient's responses in each dimension result in a five-digit number profile. The profile data produce a single EQ-5D index score, ranging from −0.594 to 1.0 (UK value set), with higher scores representing better health. We calculated the index score by weighting each respondent's profile data with the UK scoring algorithm.

The EQ VAS is a vertical 20-cm "thermometer" on which 100 represents the "best imaginable health state" and 0 the "worst imaginable health state." The patient is asked to mark an X on the scale to indicate how his or her health is today and then to write the marked number on the scale in the box. The EQ-5D-5L and EQ VAS are cognitively undemanding and take only a few minutes to complete. The Finnish version of EQ-5D has been validated for use in Finland in patients with chronic pain (25).

Background data

The package of questionnaires sent to the patients 1 year after carpal tunnel release surgery included a medical history query. In addition to sociodemographic characteristics, participants were asked about the duration of wrist and/or hand symptoms before the operation, pain 1 year after the operation using a visual analog scale (VAS, 0–100 mm) format, and current medication used for hand and wrist pain.

STATISTICAL ANALYSIS

We present continuous variables using mean and standard deviation (SD) or median and interquartile range (IQR) values and categorical variables using frequency and percentage of total. We considered less than 5% of missing data to be acceptable for calculating an overall score for the SSS and FSS.

We assessed floor and ceiling effects for SSS and FSS by calculating the proportion of the participants who obtained the lowest or highest scores. Floor and ceiling effects are considered present if more than 15%

(26) or more than 20% (27) of respondents score the lowest or highest possible values.

Construct validity measures the degree to which an instrument measures the construct it is intended to measure. Construct validity can be further divided into convergent and discriminant construct validity. Convergent construct validity is good when the instrument under investigation correlates highly with another instrument reflecting the same or similar constructs. Discriminant (or divergent) construct validity means that instruments that measure different constructs show only slight or no correlations (28).

According to the COSMIN group recommendations (29), we tested a priori predefined hypotheses with the Pearson correlation coefficient (r) using Sidak-adjusted probabilities: (a) the SSS correlates strongly with the CTS-6 score, where $r \geqslant 0.7$; (b) the SSS correlates moderately with arm and wrist pain, where $r \geqslant 0.5$; (c) the SSS correlates weakly with the EQ-5D index score, where $r \geqslant 0.3$ and $r < 0.5$; and (d, e, f) the SSS shows no correlation with the EQ VAS score, age, or body mass index (BMI), where $r < 0.3$. Furthermore, (g) the FSS correlates moderately with the EQ-5D index score; (h, i, j, k) the FSS correlates weakly with the EQ VAS score, the CTS-6 score, arm and wrist pain, and age; and (l) the FSS shows no correlation with BMI. The predefined hypotheses were based on the literature or general assumptions. We defined the construct validity of the BCTQ as good if at least 75% of the hypotheses were supported (26).

Reliability is defined as the degree to which the measurement is free from measurement error. We calculated the test–retest reliability of the questionnaire with 95% confidence intervals (CIs) in stable participants using a one-way random effects model of intraclass correlation coefficient (ICC). An ICC value greater than 0.8 is generally considered excellent. We also calculated the absolute reliability of the BCTQ scores using the coefficient of repeatability (CR). The CR expressed the expected maximum size of 95% of the absolute differences between paired observations. The 95% CI was obtained by bias corrected and accelerated bootstrapping (5000 replications).

We determined the internal consistency (degree of inter-relatedness among the items) of the first-administered BCTQ by calculating Cronbach's α coefficient. An α value equal to, or greater than, 0.70 is generally regarded as acceptable for internal consistency (30).

Finally, we used the Bradley–Blackwood procedure to obtain the CIs for the mean changes between the two measurements and reproducibility. Statistical analyses were performed using the STATA 14.1 statistical software package (StataCorp, College Station, TX).

RESULTS

TRANSLATION PROCESS

We modified two items of the SSS to better match the Finnish culture and language. In items 6 and 9, the additional information "Loss of sensation" given in brackets was omitted, as in Finnish this refers more to the medical condition of hypoesthesia than numbness per se. We also modified two items in the FSS. In item 4, on the ability to grip a telephone handle, the word "handle" was omitted, because there is no phone handle in Finnish; instead, the phone is gripped. In addition, in item 8, the word "bathing" was changed to "showering," because in Finnish bathing refers to either taking a tub bath or going to sauna. The participants did not report misunderstanding any of the items. The translation into Finnish is available in the supplementary file (see Supplementary file "BCTQ in Finnish").

TABLE 1
Demographic and clinical characteristics of the 193 patients.

Variable	Value
Female, *n* (%)	130 (68)
Age, mean (SD)	64 (14)
Body mass index, kg/m^2, mean (SD)	28.0 (4.7)
Employment status, *n* (%)	
Employed	84 (44)
Unemployed	6 (3)
Retired/pensioner	103 (53)
Current smokers, *n* (%)	20 (10)
Operated side, *n* (%)	
Right	76 (39)
Left	34 (18)
Bilateral	83 (43)
Duration of symptoms before operation, months, median (IQR)	24 (12,48)
Pain, range 0–100, mean (SD)	17.3 (25.6)
Pain medication, *n* (%)	28 (15)

SD: standard deviation; IQR: interquartile range.

PARTICIPANT CHARACTERISTICS

A total of 193 subjects were included in the validity, internal consistency, test–retest, and floor/ceiling effects assessment. Participants were mostly female (68%), and more than half (53%) of all subjects were retired. Mean (SD) self-reported arm and wrist pain during the past week of completing the questionnaire was 16 (23) mm for women and 19 (22) mm for men on a 100-mm VAS scale. Participant characteristics are shown in Table 1.

DESCRIPTIVE STATISTICS

Table 2 represents the mean with SD, response rates, and proportion of participants scoring at the floor and the ceiling levels on the 1–5 scale for the SSS and the FSS.

In total, 42 of the 2123 SSS values (2%) and 31 of the 1544 FSS values (2%) were missing. Since none of the participants had more than one missing value, we calculated both scores for all 193 patients, and thus no participants were excluded.

TABLE 2

Mean scores, response rates and floor and ceiling percentages for the individual items in the Symptom Severity and Functional Status subscales of the Boston Carpal Tunnel Questionnaire.

	Mean (SD)	Response rate (%)	Floor (%) value 1	Ceiling (%) value 5
Symptom Severity Scale				
1. Severity of nocturnal pain	1.57 (0.8)	96	59	1
2. Frequency of nocturnal awakening due to pain	1.48 (0.8)	96	69	1
3. Severity of daytime pain	1.81 (0.82)	96	42	0
4. Frequency of daytime pain	1.85 (1.12)	94	50	6
5. Duration of daytime pain	2.07 (1.27)	93	44	9
6. Severity of numbness	1.80 (0.89)	97	45	1
7. Severity of weakness	2.00 (0.95)	96	33	3
8. Severity of tingling	1.69 (0.87)	97	51	1
9. Severity of nocturnal numbness/tingling	1.69 (0.91)	94	55	1
10. Frequency of nocturnal awakening due to numbness/tingling	1.49 (0.81)	95	68	1
11. Difficulty in grasping small objects	1.69 (0.90)	96	53	1
Total	1.74 (0.74)	98	18	0
Functional Status Scale				
1. Writing	1.47 (0.81)	92	71	2
2. Buttoning clothes	1.59 (0.79)	94	57	1
3. Holding a book	1.70 (0.96)	93	58	2
4. Gripping the telephone	1.35 (0.7)	90	72	2
5. Opening jars	1.95 (1.02)	95	45	4
6. Performing household chores	1.58 (0.82)	93	61	1
7. Carrying a grocery bag	1.75 (1.01)	93	56	1
8. Bathing and dressing	1.41 (0.73)	93	72	1
Total	1.62 (0.75)	98	28	1

SD: standard deviation.

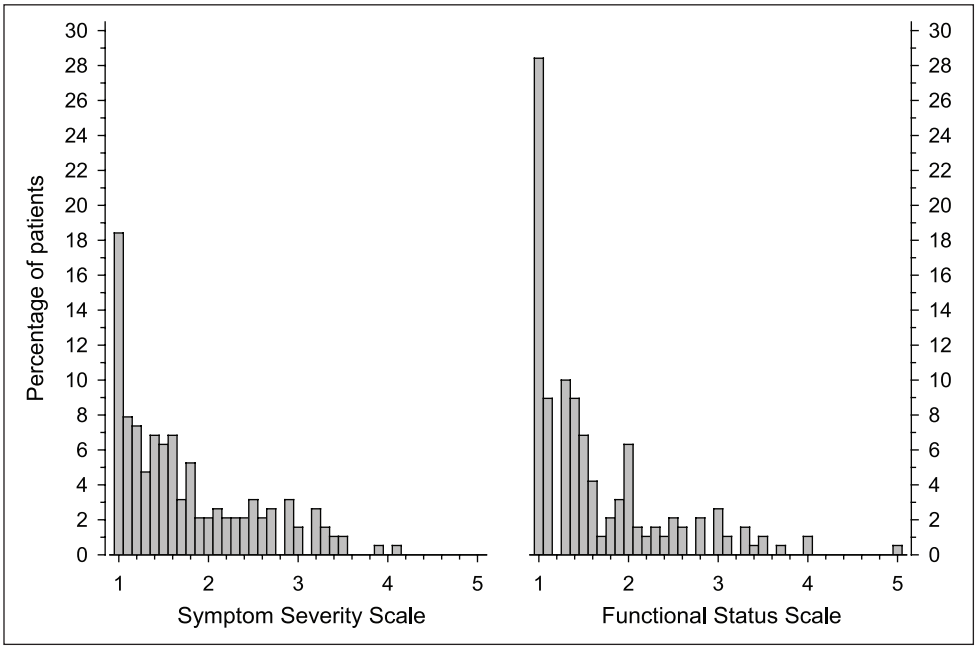

Fig. 1. The percentage distribution of the mean values of the Symptom Severity Scale and Functional Status Scale scores in 193 patients.

For the SSS and the FSS, a floor effect was detected in 35 (18%) and 54 (28%) subjects, respectively. None of the subjects (0%) reached the ceiling effect in the SSS and two subjects (1%) reached the ceiling effect in the FSS. The percentage distribution of the SSS and the FSS scores for all 193 patients is shown in Fig. 1.

CONSTRUCT VALIDITY

The hypotheses on the construct validity of the SSS were supported. The SSS correlated strongly with the CTS-6 score ($r = 0.84$), moderately with arm and wrist pain ($r = 0.64$), weakly with the EQ-5D index score ($r = -0.35$), and showed no correlation with the EQ VAS score, age, or BMI (Table 3).

TABLE 3

Correlations of BCTQ with age, BMI, pain, EQ-5D and CTS-6.

	Symptom severity *r* (95% CI)	Functional status *r* (95% CI)
Age	0.09 (−0.05 to 0.23)	0.31 (0.17 to 0.43)***
BMI	0.16 (0.02 to 0.30)	0.08 (−0.06 to 0.22)
Pain	0.64 (0.55 to 0.72)***	0.50 (0.38 to 0.61)***
EQ-5D index	−0.35 (−0.47 to −0.21)***	−0.54 (−0.63 to −0.43)***
EQ VAS	−0.28 (−0.41 to −0.15)***	−0.41 (−0.52 to −0.28)***
CTS-6	0.84 (0.79 to 0.88)***	0.60 (0.50 to 0.69)***

r: Pearson correlation coefficient; CI: confidence interval; EQ VAS: EuroQol visual analog scale; CTS: carpal tunnel syndrome; BMI: body mass index. Statistical significance calculated using Sidak-adjusted probabilities.
***$p < 0.001$.

TABLE 4

The change between the two measurements and reproducibility of both BCTQ subscales.

Scale	Measurement		Change	*p*-value[a]	Reproducibility	
	First Mean (SD)	Second Mean (SD)	Mean (95% CI)		ICC (95% CI)	CR (95% CI)[b]
Symptom severity	1.74 (0.74)	1.77 (0.76)	0.04 (−0.02 to 0.10)	0.31	0.85 (0.81 to 0.89)	0.80 (0.67 to 0.93)
Functional status	1.62 (0.75)	1.63 (0.76)	0.01 (−0.04 to 0.06)	0.76	0.89 (0.56 to 0.92)	0.68 (0.57 to 0.81)

SD: standard deviation; CI: confidence interval; ICC: intraclass correlation coefficient; CR: coefficient of repeatability.
[a]Obtained by Bradley–Blackwood procedure.
[b]Expresses the expected maximum size of 95% of the absolute differences between paired observations. 95% CI obtained by bias corrected and accelerated bootstrapping.

As expected, the correlation between the FSS and the EQ-5D index ($r = -0.54$) was moderate. Also as expected, the correlations between the FSS and the EQ VAS score ($r = -0.41$) and between the FSS and age ($r = 0.31$) were weak. Moreover, as hypothesized, no correlation was observed between the FSS and BMI. However, the FSS and the CTS-6 score showed a moderate correlation ($r = 0.60$) instead of the hypothesized weak correlation. Similarly, the FSS and arm and wrist pain showed a moderate correlation ($r = 0.50$) instead of the hypothesized weak correlation (Table 3).

RELIABILITY

The mean time interval between completing the two BCTQs was 18 (SD = 11) days and the median 15 days (range = 6–51). In the Bradley–Blackwood procedure, we found no significant difference in scores between the two measurements ($p = 0.31$ for the SSS and $p = 0.76$ for the FSS). The mean change in the second measurement was 0.04 (95% CI = −0.02 to 0.10) in the SSS and 0.01 (−0.04 to 0.06) in the FSS (Table 4).

Internal consistency

Cronbach's α was 0.93 (95% CI = 0.91 to 0.95) for the SSS and 0.93 (0.91 to 0.95) for the FSS, indicating good internal consistency.

Test–retest reliability

The test–retest reliability results of the SSS and FSS are shown in Table 4. The test–retest reliability of both scales was excellent, with ICCs greater than 0.8. The CR values for the SSS and FSS were 0.80 and 0.68, respectively (Table 4).

DISCUSSION

The results of this study indicate that the Finnish version of the BCTQ has good construct validity and that the questionnaire is a reliable measure of symptom severity and functional status in Finnish patients after carpal tunnel release surgery. Thus, the Finnish version of the BCTQ enables precise assessment of the severity of CTS.

The Finnish BCTQ displayed excellent test–retest reliability, as has also been found for other translations (17, 18, 20). One translation (into Persian), however, has shown unsatisfactory reproducibility (21). The likely reason for the excellent test–retest results in our study is that most of the operated patients were in a stable condition 1 year after surgery.

The test–retest reliability of the BCTQ has been also studied using Pearson's correlation coefficient (5, 13, 14, 19). The results vary, with the Spanish version showing the highest values (0.94 for SSS and 0.99 for FSS) (19) and the Turkish version the lowest (0.60 for SSS and 0.77 for FSS) (14). However, owing to differences in study populations, comparisons between previous results and ours should be made with caution. Whereas the participants in previous studies have mainly had non-operatively treated CTS, our participants were all surgically treated CTS patients.

The CR values representing absolute reliability were 0.80 for the SSS and 0.68 for the FSS. These values indicate that with 95% probability, the absolute score

in stable patients remains within these limits (31). This indicates that both domains have good reliability. In practice, this means that the clinician can be 95% confident that at patient follow-up, a change of 0.80 points or more in the SSS and of 0.68 or more in the FSS represents a true change in the severity of CTS. These CR values are comparable with those (0.64 for SSS and 0.71 for FSS) reported by Atroshi et al. (10) in a test conducted with a small subsample of 22 patients for the Swedish version of the BCTQ.

Some floor effect was found in this study, more in the FSS (28%) than SSS (18%). We assume that the floor effect was linked to a good surgical outcome, as in most cases, symptoms disappear and hand function improves after surgery (1). However, in their study in which some participants received surgery and others conservative treatment, Lue et al. (18) also observed a floor effect for the FSS. This floor effect may indicate that the FSS has limited ability to detect functional problems among subjects with mild symptoms or functional limitations. It remains for future studies to design appropriate items to assess functional problems in milder cases of CTS.

Ideally, construct validity should be tested against a previously validated generic measure to compare the outcomes of CTS with those of other disorders, a region-specific measure to compare with other conditions in the same region, and a disease-specific measure to compare outcomes of different treatments of the same condition (4). We assessed construct validity by calculating correlations of the translated questionnaire with generic health-related quality of life (EQ-5D instrument), a few anthropometric and clinical measures, and the disease-specific CTS-6 instrument. Both the SSS and FSS displayed good convergent and divergent validity. As expected, we found a strong, moderate, and weak correlation between the symptom severity assessed with the BCTQ and the CTS-6, pain, and EQ-5D index, respectively, when measuring the same or similar constructs. The EQ-5D index was also expected to correlate moderately with the FSS, as both instruments inquire, in part, about the same activities of daily living. Unexpectedly, the FSS correlated moderately instead of weakly with both the CTS-6 and wrist and arm pain. The latter is understandable, given that arm and wrist pain affect people's ability to perform common daily activities. Nevertheless, 10 out of 12 (83%) of our hypotheses were confirmed, which is well within the 75% laid down by the COSMIN group as necessary to demonstrate the validity of a questionnaire (26). The construct validity of the Finnish BCTQ is comparable with that of the Korean BCTQ, which was also validated against the EQ-5D with patients treated by corticosteroid injection therapy (17). Other studies have used the SF-36 as a generic health measure and reported different correlations (14, 18).

The main strength of this study is the large sample size, which can be considered excellent for conducting psychometric analyses (29). In the previous BCTQ validation studies, populations have ranged between 31 (15) and 142 participants (21). This study has also its limitations. First, the surgically treated subjects in this study do not represent the whole spectrum of people suffering from CTS. However, it was important to undertake transcultural adaptation of the BCTQ into Finnish and to validate its psychometric properties. This proved possible with the present sample of post-surgical CTS patients. Second, due to the cross-sectional study design, it was not possible to assess the instrument's ability to detect clinically important changes over time. For this reason, the responsiveness of the Finnish version of the BCTQ should be assessed longitudinally among non-surgically treated CTS patients.

In conclusion, this research effort produced an appropriately translated and culturally adapted version of the BCTQ. The Finnish version of BCTQ is both reliable and valid for measuring symptoms and functioning in surgically treated CTS patients. However, due to the floor effect, the Functional Status Score may have limited ability to detect differences in patients with good outcomes after surgery. The responsiveness of the Finnish version of the BCTQ in groups of non-surgically treated CTS patients remains to be tested.

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AVAILABILITY OF DATA AND MATERIALS

The datasets generated and analyzed during the study are available from the corresponding author on reasonable request.

DECLARATION OF CONFLICTING INTERESTS

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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SUPPLEMENTAL MATERIAL

Supplemental material for this article is available online.

REFERENCES

1. Burton CL, Chen Y, Chesterton LS et al: Trends in the prevalence, incidence and surgical management of carpal tunnel syndrome between 1993 and 2013: An observational analysis of UK primary care records. BMJ Open 2018;8(6):e020166.
2. Shiri R, Miranda H, Heliövaara M et al: Physical work load factors and carpal tunnel syndrome: A population-based study. Occup Environ Med 2009;66(6):368–373.

3. Huisstede BM, Friden J, Coert JH et al: Carpal tunnel syndrome: Hand surgeons, hand therapists, and physical medicine and rehabilitation physicians agree on a multidisciplinary treatment guideline-results from the European HANDGUIDE Study. Arch Phys Med Rehabil 2014;95(12):2253–2263.
4. Sambandam SN, Priyanka P, Gul A et al: Critical analysis of outcome measures used in the assessment of carpal tunnel syndrome. Int Orthop 2008;32(4):497–504.
5. 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.
6. Chung KC, Pillsbury MS, Walters MR et al: Reliability and validity testing of the Michigan Hand Outcomes Questionnaire. J Hand Surg Am 1998;23(4):575–587.
7. Hudak PL, Amadio PC, Bombardier C: Development of an upper extremity outcome measure: The DASH (disabilities of the arm, shoulder and hand) [corrected]. Am J Ind Med 1996;29(6):602–608.
8. Pransky G, Feuerstein M, Himmelstein J et al: Measuring functional outcomes in work-related upper extremity disorders. J Occup Environ Med 1997;39(12):1195–1202.
9. Atroshi I, Lyren PE, Gummesson C:The 6-item CTS symptoms scale: A brief outcomes measure for carpal tunnel syndrome. Qual Life Res 2009;18(3):347–358.
10. Atroshi I, Johnsson R, Sprinchorn A: Self-administered outcome instrument in carpal tunnel syndrome. Acta Orthop Scand 1998;69(1):82–88.
11. Gay RE, Amadio PC, Johnson JC: Comparative responsiveness of the disabilities of the arm, shoulder, and hand, the carpal tunnel questionnaire, and the SF-36 to clinical change after carpal tunnel release. J Hand Surg Am 2003;28(2): 250–254.
12. Leite JC, Jerosch-Herold C, Song F: A systematic review of the psychometric properties of the Boston Carpal Tunnel Questionnaire. BMC Musculoskelet Disord 2006;7:78.
13. de Campos CC, Manzano GM, de Andrade LB et al: Translation and validation of an instrument for evaluation of severity of symptoms and the functional status in carpal tunnel syndrome. Arq Neuropsiquiatr 2003;61:51–55.
14. Sezgin M, Incel NA, Serhan S et al: Assessment of symptom severity and functional status in patients with carpal tunnel syndrome: Reliability and functionality of the Turkish version of the Boston Questionnaire. Disabil Rehabil 2006;28(20):1281–1285.
15. Upatham S, Kumnerddee W: Reliability of Thai version Boston questionnaire. J Med Assoc Thai 2008;91(8):1250–1256.
16. Mody GN, Anderson GA, Thomas BP et al: Carpal tunnel syndrome in Indian patients: Use of modified questionnaires for assessment. J Hand Surg Eur Vol 2009;34(5):671–678.
17. Park DJ, Kang JH, Lee JW et al: Cross-cultural adaptation of the Korean version of the Boston carpal tunnel questionnaire: Its clinical evaluation in patients with carpal tunnel syndrome following local corticosteroid injection. J Korean Med Sci 2013;28(7):1095–1099.
18. Lue YJ, Lu YM, Lin GT et al: Validation of the Chinese version of the Boston Carpal Tunnel Questionnaire. J Occup Rehabil 2014;24(1):139–145.
19. Oteo-Alvaro A, Marin MT, Matas JA et al: Spanish validation of the Boston Carpal Tunnel Questionnaire. Med Clin 2016;146(6):247–253.
20. Bougea A, Zambelis T, Voskou P et al: Reliability and validation of the Greek version of the Boston Carpal Tunnel Questionnaire. Hand 2018;13(5):593–599.
21. Hassankhani GG, Moradi A, Birjandinejad A et al: Translation and validation of the Persian version the Boston Carpal Tunnel Syndrome Questionnaire. Arch Bone Jt Surg 2018;6(1):71–77.
22. Beaton DE, Bombardier C, Guillemin F et al: Guidelines for the process of cross-cultural adaptation of self-report measures. Spine 2000;25(24):3186–3191.
23. Atroshi I, Lyren 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.
24. Herdman M, Gudex C, Lloyd A et al: Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). Qual Life Res 2011;20(10):1727–1736.
25. Vartiainen P, Mäntyselkä P, Heiskanen T et al: Validation of EQ-5D and 15D in the assessment of health-related quality of life in chronic pain. Pain 2017;158(8):1577–1585.
26. Terwee CB, Bot SD, deBoer MR et al: Quality criteria were proposed for measurement properties of health status questionnaires. J Clin Epidemiol 2007;60(1):34–42.
27. Andresen EM, Rothenberg BM, Panzer R et al: Selecting a generic measure of health-related quality of life for use among older adults. Eval Health Prof 1998;21(2):244–264.
28. Trochim WMK, Donnelly JP: The Research Methods Knowledge Base, 3rd ed. Cengage Learning, Mason, OH, 2008.
29. Mokkink LB, Terwee CB, Patrick DL et al: The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: An international Delphi study. Qual Life Res 2010;19(4):539–549.
30. Fayers PM, Machin D: Quality of Life: Assessment, Analysis and Interpretation. John Wiley & Sons, Chichester, 2000.
31. Bland JM: An Introduction into Medical Statistics. Oxford University Press, Oxford, 2000.

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