Abstract

Background: The Boston Carpal Tunnel Questionnaire (BCTQ) has a symptom severity scale (SSS) with 11 questions and a functional status scale (FSS) with 8 questions. The final score for each scale is the sum divided by the number of questions and ranges between 1 and 5. A score of 1 indicates they have no complaints and 5 indicates high severity and functional loss. Unfortunately, this single digit score does not permit a detailed analysis of the symptoms and functional status. The aim of this study is to conduct an in-depth comparison of preoperative complaints using the BCTQ between patients with severe carpal tunnel syndrome (SCTS) and recurrent carpal tunnel syndrome (RCTS).

Methods: This is a retrospective cohort study on the preoperative status of 37 patients with SCTS and 18 patients with RCTS using the BCTQ. The questions in the SSS and FSS were classified into four groups based on the responses of patients, namely a low complaint (LC) (1–1.99), moderate complaint (MC) (2–2.99), high complaint (HC) (3–3.99), and severe complaint (SC) (4–5) groups. The patients in the SCTS and RCTS groups were compared to find differences in age, gender, hand dominance, and responses to questions in the SSS and FSS.

Results: The age of patients in the SCTS group (76.06 years) was significantly higher compared to the RCTS group (51.11 years). There was no significant difference between the two groups with regard to gender or hand dominance. The top question with SC or HC response in the SCTS group was problems in grasping small objects (SSS) and fastening buttons (FSS) and in the RCTS group was tingling in the hand (SSS) and difficulty with opening a jar (FSS).

Conclusions: An in-depth analysis of the BCTQ allowed us to compare and understand differences in symptoms and function between patients with SCTS and RCTS.

Level of Evidence: Level III (Therapeutic)

Keywords:

- Carpal tunnel syndrome
- Patient reported outcome measures
- Symptom assessment
- Functional status
- Pain

INTRODUCTION

The knowledge of the symptoms of carpal tunnel syndrome (CTS) is important to clinicians because the diagnosis is mainly based on the clinical presentation and provocative tests that reproduce the symptoms.[1] Investigations such as nerve conduction studies and ultrasound can help in the confirmation of the diagnosis and grading severity.[2,3] However, as Chammas stated, “there is no gold standard for the diagnosis of CTS.”[4] The typical symptoms such as pain, paraesthesia, and muscle weakness can evolve over time with change in severity. In some cases, it may be challenging for the clinician to exclude an associated pathology or

other differentials.[4] More information about the symptoms and functional deficits of patients with CTS, especially in different clinical presentations, can help the clinicians with diagnosis and prognostication.

The Boston Carpal Tunnel Questionnaire (BCTQ) is a specific, reliable, and valid questionnaire developed for CTS.[5–7] It has a symptom severity scale (SSS) with 11 questions scored on a Likert scale of 1–5 and the functional status scale (FSS) with 8 questions scored from 1 to 5 with 1 being "no difficulty" and 5 being "cannot perform activity." The final score for each scale is the sum of all the questions divided by the number of questions which ranges between 1 and 5. A score of 1 indicates they have no complaints and 5 indicates high severity and functional loss. Most studies report the total mean score of the BCTQ.[8,9] Unfortunately, this single digit score does not permit a detailed analysis of the symptoms and functional status and fails to identify the most painful and/or disabling activities. We could only find a few articles that analyzed the responses to the questions of SSS and FSS in detail.[10,11] We have previously used the BCTQ in a study comparing severe carpal tunnel syndrome (SCTS) and recurrent carpal tunnel syndrome (RCTS) and found that there were differences in pain, sensibility, and strength between these two presentations of CTS.[15] We feel that additional differences between these two presentations could be identified by an in-depth analysis of the BCTQ.

The aim of this study is to conduct an in-depth comparison of preoperative complaints using the BCTQ between patients with SCTS and RCTS. Our null hypothesis is that there will be no differences between the two presentations with regard to age, sex, gender, symptoms, and function.

PATIENTS AND METHODS

This is a retrospective cohort study of patients scheduled for carpal tunnel surgery (surgeon was an experienced specialist). The study was approved by our institutional review board and all patients agreed to participate in this study. All patients had a clinical diagnosis of CTS that was confirmed by nerve conduction studies.[2] Patients with cervical spine problems and/or diminished mental capacity were excluded. Patients were divided into two groups: SCTS and RCTS.

SCTS group included patients who did not have any previous surgery for CTS and were graded stage 6 on the Bland neurophysiological scale.[12] The sensory and motor potentials were unrecordable and the amplitude of the abductor pollicis brevis was below 0.2 mV. This group included 37 patients (40 hands) with an average age of 76.05 years. RCTS included patients who previously had an open carpal tunnel release, but needed revision surgery after a pain-free period of at least 1 year.[4] This group included 18 patients (18 hands) with an average age of 51.11 years. The details regarding both groups of patients are summarized in Table 1.

Table 1. Details of the Study Population

Patient characteristics	SCTS	RCTS	*p*-Value
Total number of patients	37	18	–
Total number of hands	40	18	–
Symptomatic on dominant hand	23 (57.5%)	13 (72.22%)	0.285

Table 1. Details of the Study Population			
Patient characteristics	**SCTS**	**RCTS**	***p*-Value**
Age (SD)	**76.05 years (8.43)**	**51.11 years (15.45)**	**<0.001***
Number of male patients	**19 (47.50%)**	**6 (33.33%)**	**0.313**

*significant $p < 0.05$

Patients completed the BCTQ 1–7 days before surgery. We used a Dutch translation, which has been validated for its responsiveness.[13,14] The questions in the SSS and FSS were classified into four groups based on the responses of patients (1–5), namely low complaint (LC) (1–1.99), moderate complaint (MC) (2–2.99), high complaint (HC) (3–3.99), and severe complaint (SC) (4–5) groups. This classification we developed is comparable with the severity scale of the BCTQ. The average score was calculated for every question and then sorted into our classification (Tables 2 and 3). The data were analyzed to look at differences between the two groups in relation to age, sex, hand dominance, and responses to the questions in the SSS and FSS based on the severity of the response as categorized earlier.

Table 2. Summary of Severity of Responses to Questions in SSS and FSS					
Severity of complaints	**BCTQ score**	**Number of responses based on severity (%)**			
		SSS		**FSS**	
		SCTS	**RCTS**	**SCTS**	**RCTS**
LC	**1–1.99**	**3 (27.27%)**	**0**	**4 (50%)**	**0**
MC	**2–2.99**	**6 (54.54%)**	**3 (27.27%)**	**2 (25%)**	**6 (75%)**
HC	**3–3.99**	**2 (18.15%)**	**8 (72.72%)**	**1 (12.5%)**	**2 (25%)**
SC	**4–5.00**	**0**	**0**	**1 (12.5%)**	**0**

Table 3. In-Depth Analysis of the Questions of SSS of the BCTQ								
SSS (11 questions)		**SCTS**	**Rank**	**Response severity**	**RCTS**	**Rank**	**Response severity**	***p*-Value**
Q1	**How severe is the hand or wrist pain that you have at night?**	**2.10 (1.18)**	**7**	**MC**	**2.78 (1.06)**	**10**	**MC**	**0.43**
Q2	**How often did hand or wrist pain wake you**	**1.85 (1.09)**	**9**	**LC**	**3.06 (1.30)**	**6**	**HC**	**0.001***

Table 2. Summary of Severity of Responses to Questions in SSS and FSS									
Severity of complaints	BCTQ score	Number of responses based on severity (%)							
		SSS				FSS			
		SCTS		RCTS		SCTS		RCTS	
	up during a typical night in the past 2 weeks?								
Q3	Do you typically have pain in your hand or wrist during the daytime?	1.63 (0.80)	11	LC		2.72 (1.02)	11	MC	<0.001*
Q4	How often do you have hand or wrist pain during daytime?	2.15 (1.53)	6	MC		3.50 (1.47)	2	HC	0.003*
Q5	How long on average does an episode of pain last during the daytime?	2.00 (1.41)	8	MC		3.11 (1.49)	4	HC	0.003*
Q6	Do you have numbness in your hand?	3.50 (0.67)	2	HC		3.50 (0.79)	3	HC	0.883
Q7	Do you have weakness in your hand or wrist?	2.33 (1.29)	5	MC		3.00 (0.91)	8	HC	0.61
Q8	Do you have tingling sensations	2.70 (0.98)	3	MC		3.67 (0.59)	1	HC	0.001*

Table 2. Summary of Severity of Responses to Questions in SSS and FSS									
Severity of complaints	BCTQ score	Number of responses based on severity (%)							
		SSS				FSS			
		SCTS		RCTS		SCTS		RCTS	
	in your hand?								
Q9	How severe is numbness or tingling at night?	2.45 (1.32)	4	MC		3.11 (1.23)	5	HC	0.082
Q10	How often did hand numbness or tingling wake you up during a typical night during the past 2 weeks?	1.85 (1.04)	10	LC		3.06 (1.26)	7	HC	0.001*
Q11	Do you have difficulty with the grasping and use of small objects such as keys or pens?	3.71 (1.02)	1	HC		2.89 (1.37)	9	MC	0.023*
Total score		2.39 (0.70)		MC		3.13 (0.84)		HC	0.001*

*significant $p < 0.05$

The assessment of normality was done by the Shapiro–Wilk test. An independent *t*-test was used to find the differences between age and the total scores of the SSS and FSS. A Chi-squared test was used for sex and hand dominance. The Mann–Whitney test was used for the severity of the responses to the questions in SSS and FSS. Significance level was set at <0.05.

RESULTS

The age of the patients in the SCTS group (76.05 years) was significantly higher compared to the patients in the RCTS group (51.11 years) ($p < 0.001$) (Table 1). There was no significant difference between the two groups with regard to gender ($p = 0.313$) or hand dominance ($p = 0.285$).

SSS: The SCTS group showed two questions with HC, six questions with MC, and three questions with LC (Table 2). The two highest complaints were about *difficulties with grasping and use of small objects* (Q11) and *numbness in the hand* (Q6) (Table 3). The average score of SSS for the SCTS group was 2.39 and was ranked as moderate. The RCTS group showed eight questions with HC and three questions with MCs. There were no severe or LC (Table 2). The three highest complaints were about the *tingling in the hand* (Q8) followed by the *frequency of pain during the day* (Q4) and *numbness in the hand* (Q6) (Table 3). This group had an average total score of 3.13 and was labeled as an HC. The response severity was similar in the two groups for two questions namely Q6 (HC) (*numbness in the hand*) and Q1 (*nocturnal pain*) (MC). These have been underlined in Table 3.

FSS: The SCTS group showed one question with SC, one question with HC, two questions reporting MC, and four questions reporting LC (Table 2). The worst problems were *fastening buttons* (Q2) and *opening a jar* (Q5). The RCTS group had two questions reporting HC and six questions reporting MC (Table 2). *Opening a jar* (Q5) and *carrying a grocery basket* (Q7) were the highest problems (Table 4). The average FSS score for SCTS and RCTS were 2.29 and 2.52, respectively, and both were graded as moderate. The response severity was similar in the two groups for two questions, namely Q5 (HC) (*opening a jar*), Q6 (MC) (*household chores*). These have been underlined in Table 4.

Table 4. In-Depth Analysis of the Questions of Functional Status Scale of the BCTQ

Functional status scale (eight questions)		SCTS	Rank	Response severity	RCTS	Rank	Response severity	*p*-Value
Q1	Writing	1.90 (1.22)	5	LC	2.00 (1.15)	8	MC	0.487
Q2	Buttoning of clothes	4.00 (1.21)	1	SC	2.19 (1.38)	5	MC	<0.001*
Q3	Holding a book while reading	1.53 (0.87)	7	LC	2.13 (1.06)	7	MC	0.015*
Q4	Gripping of a telephone handle	1.53 (1.06)	8	LC	2.28 (1.36)	4	MC	0.007*
Q5	Opening of jars	3.33 (1.54)	2	HC	3.28 (1.54)	1	HC	0.622
Q6	Household chores	2.15 (0.99)	4	MC	2.75 (1.09)	3	MC	0.050*
Q7	Carrying of grocery basket	2.15 (1.37)	3	MC	3.19 (1.48)	2	HC	0.025*

Table 4. In-Depth Analysis of the Questions of Functional Status Scale of the BCTQ							
Functional status scale (eight questions)	**SCTS**	**Rank**	**Response severity**	**RCTS**	**Rank**	**Response severity**	***p*-Value**
Q8 Bathing and dressing	**1.78 (0.87)**	**6**	**LC**	**2.13 (1.15)**	**6**	**MC**	**0.533**
Total score	**2.29 (0.74)**		**MC**	**2.55 (0.97)**		**MC**	**0.264**

*significant $p < 0.05$

DISCUSSION

The main findings of this study were that each group of CTS (SCTS and RCTS) differ in age, symptoms, and functional status despite similar scores on the BCTQ. Each presentation had a different ranking of the 11 questions of the SSS and the 8 questions of the FSS. Our null hypothesis (no differences between the two presentations) was rejected on several points and will be discussed in detail.

Patients in the SCTS group were significantly older with an average age of 76 years compared to the RCTS group. It is possible that these "elderly" patients ignored the typical symptoms of CTS for a long time resulting in loss of sensation and ability to perform fine motor tasks. In contrast, patients with RCTS were familiar with the symptoms of CTS due to their previous history and surgery and presented earlier.[15] The null hypothesis can be rejected with regard to age. We were unable to find any differences in relation to gender between the two groups and the null hypothesis remained valid for gender. The SCTS group had an almost equal distribution (57.5%) between dominant and nondominant hands, which is consistent with the findings of Lutsky et al.[16] Lee et al. found that hand dominance was not a factor related to CTS.[17] In contrast, 72.22% of the RCTS group in our study had symptoms on their dominant hand, however, this did not impact the outcomes. Zyluk et al. have previously reported that hand dominance has no impact on the outcomes of the BCTQ.[18] For both groups in this study, the null hypothesis remained valid with regard to hand dominance.

The SSS showed that patients with RCTS had a larger number of HCs (72%) compared to patients with SCTS (18%) despite poorer electromyography (EMG) findings in the SCTS group. This may be because these patients were gradually getting accustomed to their symptoms and compensating for them. The SCTS group had more number of MC and LC compared to the RCTS group (Table 2). The analysis of the questions showed that patients with SCTS had a HC about *difficulty in handling small objects* as the first ranked problem followed by *numbness in the hand*. In the RCTS group, the first rank was *tingling* followed by the *frequency of pain during the day* (around five times a day) (Table 3). *Numbness in the hand* and *tingling* are major symptoms of CTS, and these symptoms were highly ranked in both groups of CTS. A study of Ortiz et al. showed that these specific symptoms have a strong correlation with the nerve conduction tests.[19]

Weakness in the hand was only an MC and ranked fifth in the SCTS group. It is likely that patients were adjusting their grip by using more of their fingers while holding tools.[20,21] This group only sought medical attention when they became severely disabled (e.g., opening a jar)

due to the combination of diminished sensibility and decreased strength. The *presence of pain during the day* was ranked as the lowest in both groups. The RCTS group reported that the *frequency of pain* was a greater problem than the *degree of pain*. Nocturnal pain is a characteristic symptom of CTS and also a part of the CTS-6 evaluation tool.[22] *Nocturnal pain* would be expected to be more prominent in RCTS, however, this was not the case. Both groups scored this item as a moderate problem, ranked at the bottom of the list. This confirms that *nocturnal pain* becomes less prominent and may disappear with increasing severity of CTS. In summary, there was a significant difference between the groups in 7 out of 11 questions of the SSS and also between the total mean scores. The null hypothesis can, therefore, be rejected for most of the questions and total score for the SSS component of the BCTQ.

Unlike the results for SSS, the FSS in both groups scored 25% of the responses as severe or HCs. In the SCTS group, *fastening buttons* and *opening jars* ranked 1 and 2, respectively. In the RCTS group, *opening jars* and *carrying grocery* ranked 1 and 2, respectively. Several studies have shown that CTS results in deterioration of pinching and grasping tasks.[23,24] According to Kozin et al., a total median nerve block decreases pinch strength by 60%.[25] The median innervated thenar muscles also play an important role in palmar abduction, opposition, and circumduction movement of the thumb.[26,27] This loss of strength and motion has a negative impact on the total hand function as the thumb contributes to 40–50% of the total hand function.[26] In the FSS part of the BCTQ, the mean score for both groups were an MC and not significantly different. However, there were significant differences between the two groups in five out of eight questions emphasizing the need for a detailed analysis of the BCTQ. In summary, for the FSS component of the BCTQ, the null hypothesis remained in effect for the total score but can be rejected for various questions.

In the original, BCTQ mean values were used to analyze the data.[5] Storey et al.[28] recommended grouped totals to avoid statistical skewing and suggested an adapted category based on the grouped total. The grouped totals for SSS and FSS for the SCTS group in our study are 26.3 (standard deviation [SD] 7.75) and 20.74 (SD 0.74), respectively. These scores would be labeled as moderate, and would correspond to our results (Tables 3 and 4).The grouped totals for SSS and FSS for the RCTS group are 34.39 (SD 9.41) and 23.57 (SD 0.95), respectively. These scores would be labeled as severe (SSS) and moderate (FSS), which is also consistent with our results (Tables 3 and 4).

We do not have preoperative BCTQ data for patients who underwent carpal tunnel release at an earlier stage of their disease to compare against the SCTS and RCTS groups. Chen at al. have reported BCTQ data in this group of patients.[10] Their results for the SSS are different compared to the results in our two groups. They reported one question with SC, five questions with HC, four questions with MC, and one question with LC. The top three complaints were about *nocturnal awaking due to pain*, *numbness at night*, and *awaking due to the numbness at night*. *Tingling*, *fine motor skills*, and *strength* were ranked lower. The total SSS score was ranked as severe, while our groups had a moderate total result. The preoperative FSS reported by Chen et al. showed seven questions with MC and one question with LC. The total FSS was moderate, which is close to our results. They found *fastening buttons* and *opening jars* were problematic, like our results.

Despite the reliability and the wide use of the BCTQ, we were unable to find any large-scale in-depth analyses of this questionnaire in literature. Jansen et al. showed that it was possible to reduce the number of questions of the BCTQ from 19 to 6, while maintaining the interclass

correlation coefficient of the original article.[29] A shorter BCTQ will help save time in daily clinical practice. However, more details, as demonstrated by this study, are needed to study the issue further. We were able to extract valuable information from this analysis. An in-depth analysis of the BCTQ may provide better insights into patients' perception of their preoperative symptoms and functional status. This way we can learn more about the condition and the information could be useful for clinicians in the diagnosis and treatment of CTS.[30]

This research has some limitations. In addition to a relatively smaller sample size than is ideal, our groups demonstrated very specific presentations of CTS with different patient behavior and response. The SCTS group is "severity" dependent while the RCTS group is based on "duration" since last surgery. A comparison of two groups that were similar would be more accurate. In the future, we plan to perform preoperative BCTQ for all patients who undergo carpal tunnel release. In summary, *tingling* and *numbness* of the hand were symptoms common to both the SCTS and RCTS groups, whereas *difficulty in opening a jar* was the common functional deficit in both groups. This study showed that when only the total score is reported, interesting information may be unnoticed and that a detailed analysis of the BCTQ can increase our knowledge and insights into different presentations of CTS.

DECLARATIONS

Conflict of Interest:

The authors do not have any potential conflicts of interest with respect to this manuscript.

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No information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript can be used to identify patients.

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