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Agreement of CTS-6 and Boston Carpal Tunnel Questionnaire versus Nerve Conduction Study for Diagnosis of Carpal Tunnel Syndrome

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ABSTRACT

Background: Multiple methods are used in diagnosing CTS.NCS is considered as a gold standard method, but it has certain limitation. So, some standardized, affordable and easily available questionnaires are required. CTS-6 tool, and Boston questionnaire are reliable and valid tool for diagnosis of CTS. The purpose of selecting CTS-6 tool and BCTQ was to utilize them in combination to make the diagnosis of CTS with the possibility of achieving results similar to those of NCS.
Objective: To identify the agreement of CTS-6 tool and BCTQ with NCS.
Method: This observational study enrolled 112 CTS patients who visited to NCS unit with either unilateral/bilateral symptoms.CTS-6&BCTQ were administered to determine probability and severity of CTS and then NCS was performed after their written voluntarily consent. Agreement of both scales were compared with NCS for diagnosis of CTS.
Results: Significant agreement was found between NCS and Boston symptoms severity scale as well as functional status scale ($p<0.05$); However, no significant agreement was observed between NCS and CTS-6 tool($p>0.05$)
Conclusion: Significant agreement was found between NCS and both components of BCTQ. However, no agreement was observed between CTS-6 tool and NCS, but CTS-6 tools show high probability towards in the evaluation of CTS. So, both outcomes can be utilized in community where NCS is not available.

***Keywords**:* BCTQ, Carpal tunnel syndrome, CTS-6 TOOL, NCS.

INTRODUCTION

Carpal tunnel syndrome (CTS) is commonest entrapment neuropathy, representing around 90% of all focal entrapment neuropathies.[1] It is more frequent in individuals older than 18years, with incidence rates ranging from 2.7% to 5.8%.[2,3,4] CTS risk factors include age, gender, genetics, body build, DM, RA, overuse, and pregnancy.[5,6,7,8]

Various pathological mechanisms contribute to CTS, including connective tissue

compression, microcirculation, synovial tissue hypertrophy and increased tunnel pressure, which interact with each other. [5,6,9]

Early CTS symptoms commonly include thumb, index, and middle finger- tingling, and numbness in in later stage, symptoms worsen at night, thenar muscle atrophy and difficulty in grasping objects. [10,11]

Multiple tools were utilized to assess the outcomes of CTS. [7,12] The detection of CTS is more likely made through NCS. NCS is standard benchmark for detecting CTS due to its accuracy, nevertheless it is expensive, painful, time-consuming, requires expertise, and is less accessible in community and sometimes it gives false positive results.[13,14,15] On the other side, CTS-6 tool & BCTQ can be utilized as they are cost-effective, easy to administer and community friendly.[16]

CTS-6 tool is reliable and valid for diagnosing probability of CTS.[17] It consists of 6 major signs including: severity, frequency of night and daytime; numbness, tingling and pain. [2,8]

BCTQ is more frequently utilized to evaluate symptoms severity and functional characteristic of CTS patients due to its easy administration.[18,19] Currently, there is no authorized method for identifying severity of symptoms, despite the fact that electro-physiological testing is frequently utilized to diagnose CTS.[2] Easily administered questionnaires, while subjective, are standardized, reproducible, and sensitive to clinical changes, which may lessen bias.[16] so, aim of the study was to identify agreement of CTS- 6 tool and BCTQ with NCS. Purpose of selecting CTS- 6 tool and BCTQ was to utilize them in combination to make the evaluation of CTS with the possibility of achieving results indifferent to those of NCS.

MATERIALS & METHODS

An observational study was conducted in NCS department of rural tertiary care center in western India from April 2023 to May 2025. Written informed consent was obtained from all participants prior to commencement of the trial, following a clear explanation of the study's objectives and procedures. Participants were assured that they would not be subjected to any harm, that the data provided would be used exclusively for research purposes, and that their confidentiality and privacy would be strictly maintained.

Ethical Statement: Ethical approval was obtained from IEC [reference number: IEC/BU/143/Faculty/18/98/2023].

Source of data: Patients who had symptoms of Carpal Tunnel Syndrome and visited to NCS department.

Study Population: Individual who had symptoms of CTS and who matched the inclusive criteria.

Study Duration: 1.5 Years.

Sample size estimation: Considering the article "Method Comparison (Agreement) Studies: Myths and Rationale" which gave information that; as this is a kind of 'estimation problem', the patients' size should be sufficiently large. Bland recommended a minimum of 100 observations. So, according to this study estimation of patient's size was kept 100.[29]

Inclusion Criteria: Patient having symptoms of unilateral/bilateral CTS.

Exclusion Criteria:

Splinting or surgery used to treat CTS in the past.

Previous history of surgery or a wrist fracture on the affected side.

Patients having symptoms of CTS but having following conditions: Patients with cardiac pacemaker, cervical spine radiculopathy, Thoracic outlet syndrome, kidney, or thyroid disease.

Data collection Procedure: The study included a total of 112 patients. Patients

received comprehensive information about the approach, including its advantages, risks, time commitment, and community results. Following patients' written consent to participate in the current study, one researcher completed the CTS-6 and BCTQ, and another experienced clinical therapist who was not involved in our research completed the NCS. The agreement of the two scales was compared with NCS.

Initially, the CTS-6 tool was used to determine the probability of CTS. A score of more than 5 was associated with a 25% chance of CTS, while a score of more than 12 was associated with an 80% chance.[20,23]

The BCTQ was used to assess the functional status and severity of symptoms following completion of the CTS-6 tool. The two sub-scales that make up the BCTQ are the Boston Symptom Severity Scale (BSS) and the Boston Functional Status Scale (BFS). Each question has a score ranging from 1 to 5, where 1 in BFS indicates complete independence and 5 indicates complete dependence, and 1 in BSS indicates no symptoms and 5 indicates severe symptoms. On the BSS scale, a condition is considered normal if the average of all scores is 1, while on the BFS scale, an average of all scores of 1 indicates no difficulty, mild symptoms are represented by a score of 2, moderate symptoms by a score of 3, severe symptoms by a score of 4, and extremely severe symptoms by a score of 5. A score of two denotes mild difficulty, a score of three denotes considerable difficulty, a score of four denotes acute difficulty, and a score of five denotes an inability to perform an activity. More severe symptoms and a higher level of functional disability are indicated by high scores in both sections. In the current study, the overall scale score was calculated using the mean value of the elements that were answered. With the use of an EMG recorder and RMS EMG Epmk2 system, NCS was completed following the administration of both outcomes (CTS-6 tool and BCTQ). Mild, moderate, and severe forms of CTS were identified and categorized findings suggested CTS if any of the following criteria were positive. [1,20]

Distal median motor latency >4.4ms

Difference between distal motor latency of median and ulnar nerves >1.1ms Difference between distal sensory latency of median and ulnar nerves >0.2ms

Difference between median and ulnar sensory latency on stimulating forth digit and recording from wrist at equal distance > 0.2ms.

NCS categorized CTS into severity groups as follows. [1,21]

Mild: For impaired sensory nerve conduction velocity in the digits/wrist and normal distal motor latency.

Moderate: For abnormalities in digit/wrist sensory nerve conduction velocity and abnormalities in distal motor latency

Severe: For absence of sensory response and abnormal distal motor latency Extreme: No motor and sensory response.[22]

Statistical Analysis

Stata 14.2 software was used to analyses the data at the 5% level of significance. Using a Microsoft Excel sheet, the data was input into the computer, tabulated, and then statistically analyzed. Descriptive statistics were used to summarize the study participants' demographic and clinical characteristics. These included frequencies, percentages, and standard errors, as presented in Tables 1 and 2. The CTS-6 tool and BCTQ were found to be in agreement with NCS using the kappa test are mentioned in Table 3, Table 4 and Table 5. P values were deemed statistically significant if they were less than 0.05.

RESULT

Table 1: Frequency and Percentage based on components of CTS-6 tool

	Total patients	Responses	Frequency	Percentage
Q1.	112	Positive characteristics	111	99.1
		Negative characteristics	1	0.9
Q2.	112	Positive characteristics	105	93.8
		Negative characteristics	7	6.3
Q3.	112	Positive characteristics	60	53.6
		Negative characteristics	52	46.4
Q4.	112	Positive characteristics	85	75.9
		Negative characteristics	27	24.1
Q5.	112	Positive characteristics	31	27.7
		Negative characteristics	81	72.3
Q6.	112	Positive characteristics	29	25.9
		Negative characteristics	83	74.1
Total score	112	High probability	97	86.6
		Less probability	15	13.4

Table 2: Frequency and Percentage distribution based on the different categories of the overall average of the BSS, BFS and NCS findings

	Mild	Moderate	Severe
Symptom severity scale	64(57.1 %)	39(34.8 %)	9(8 %)
Functional status scale	95(84.8 %)	15(13.4 %)	2(1.8 %)
NCS findings	87(77.6%)	20(17.9%)	5(4.5%)

Table 3: Agreement between total score of CTS-6 tool(T-CTSs) and NCS findings (NCS-F)

	NCS-F				
	Mild	Moderate	Severe	B/L Mild	Total
T-CTSs Less probability	13	2	0	0	15
High probability	67	18	5	7	97
Total	80	20	5	7	112

Symmetric Measures

	Value	Asymp. Std Error[3]	Approx. Tb	Approx. Sig.
Measure of Agreement kappa N of valid cases	0.035 112	0.031	1.057	0.291

Table 3 shows that P-value is >0.05. So, there is not statistically significance difference found in both outcomes (CTS-6 tool & NCS).

Table 4: Agreement between Boston symptom severity scale (BSS) and NCS findings (NCS-F)

	NCS-F				
	Mild	Moderate	Severe	B/L Mild	Total
BSS Mild	54	5	1	4	64
Moderate	22	14	1	2	39
Severe	4	1	3	1	9
Total	80	20	5	7	112

Symmetric Measures

	Value	Asymp. Std Error[3]	Approx. T[b]	Approx. Sig.
Measure of Agreement kappa N of valid cases	0.304 112	0.075	4.516	0.000

Table 4 shows that P-value is <0.05. So, there is statistically significance difference found in both outcomes (Boston symptom severity scale & NCS).

Table 5: Agreement between Boston functional status scale (BFS) and NCS findings (NCS-F)

	NCS-F				
	Mild	Moderate	Severe	B/L Mild	Total
BFS Mild	73	15	2	5	95
Moderate	6	5	3	1	15
Severe	1	0	0	1	2
Total	80	20	5	7	112

Symmetric Measures

	Value	Asymp. Std Error[3]	Approx. T[b]	Approx. Sig.
Measure of Agreement kappa N of valid cases	0.178 112	0.078	2.561	0.010

Table 5 demonstrates that P-value is <0.05. So, there is statistically significance difference found in both outcomes (Boston functional status scale & NCS).

DISCUSSION

In the community level, several assessment tools are used to assess carpal tunnel syndrome.[3] CTS diagnosis relies on traditional diagnostic methods, and NCS. Nerve conduction study is more commonly used, but it has some limitations. However, CTS-6 tool and BCTQ are easily administered and include components of clinical history, physical-examination and ADLs which were hampered due to CTS. Therefore, purpose of this study was to identify an agreement of CTS-6 tool and BCTQ with NCS for diagnosis of CTS.

Former studies suggest that CTS-6 tool and BCTQ are reliable and valuable screening methods for determining probability and severity of CTS, respectively. [18,23,24] Previous study conducted in 2020 suggests a triangulation approach for CTS diagnosis, in which provocative tests, sensorimotor testing, symptoms, and clinician-based evaluations were carried out.[17] CTS-6 incorporates all these components. Hence, it

is more reliable, valid and utilized in majority of studies.

In the present study, table 1 demonstrates that most of patients exhibit a high probability of CTS in CTS-6 tools, but the underlying pathophysiology has not been demonstrated in any previous studies so far. This study assumed that patients with a high probability of CTS had grade 2 and 3 injuries, involving both axonal loss and minimal scar tissue in the endoneurium. These injuries may lead to tingling, numbness, positive Tinel's test, loss of two point discrimination, and thenar muscle atrophy, all of which are incorporated in components of CTS-6 tool.[25]

Previous research suggests that BCTQ is reliable screening method for determining CTS severity. BCTQ comprises two main components: Boston functional status scale (BFS); evaluating daily activity performance, and Boston symptoms severity scale (BSS); evaluating severity of symptoms.

Vladeva E. P. et al., conducted study in 2020 concluded that BCTQ can interchange other non-standard methods for severity assessment.[24] In this study, the findings presented in Table 2 indicate that, on the BSS scale, 57.1% of participants fall into the mild category, 34.8% into the moderate category, and 8% into the severe category. In BFS scale: 84.8% mild, 13.4% moderate, 1.8% falls in severe category. For NCS: 77.6% mild, 17.9% moderate, 4.5% falls in severe category. These findings suggests that majority of patients fall into mild categories which is out- turn of Ahmad Almigdad, et al.[29]

Agreement between components of CTS-6 tool and NCS:

According to Table 3, present study observed slight agreement between CTS-6 tool and NCS based on kappa score, with no previous comparisons of CTS-6 components with NCS in prior studies. In this study, Table 3 illustrates that, 99.1% of patients experienced tingling and numbness. The study revealed that 53.6% of patients exhibited thenar muscle atrophy, aligning closely with Phalen CM's et al., of 41%; however, relatively low evidence was supported by Khalid A.O. AL-Dabbagh et al., of 8%.[26] Sustained pressure on the median nerve primarily affects sensory nerve fibers which leads to numbness followed by atrophy of thenar muscles.[27] The result of our study indicates that Phalen's test positive in 75.9% and Tinel's test positive in 25.9% of patients, which is consistent with prior studies.[26] These findings were equivalent with prior studies conducted in 2013 indicated that Tinel's test is less specific and sensitive than Phalen's test.[26] Earlier research showed a notable correlation between symptoms duration and positive Tinel's test.[28] Phalen's test revealed 67.2% sensitivity, 92.9% specificity while Tinel's test showed 53.4% sensitivity, 95.6% specificity. Additionally, present study represented that 26.8% of patients had loss of 2- point discrimination. Reduced capillary circulation and rising intrafunicular pressure compromise nerve fiber nutrition, particularly affecting large, myelinated fibers. Repeated ischemic attacks damage these fibers, resulting in loss of 2- point discrimination.[28]

Agreement between components of BCTQ and NCS:

Old evidence suggested no agreement between BCTQ components and NCS findings, but the present study observed an agreement between them [30,31,32] Table 4 demonstrates marked agreement between BSS and NCS findings ($p < 0.05$), and Table 5 exhibits significant agreement between BFS and NCS findings ($p < 0.05$). This denotes that BCTQ has biological significance, reflecting median nerve injury. We observed moderate agreement (kappa: 0.304) between BSS and NCS, and lower agreement (kappa: 0.178) between BFS and NCS. In 2022, Ahmad Almigdad et al., found a significant correlation between CTS severity by NCS and clinical manifestation, especially with BSS scale compared to BFS scale.[29] Questions

regarding tingling and numbness provided a more accurate representation of median nerve pathophysiology.[33] Previous research conveyed a lack of correlation between FSS and NCS. [34,35] Our study represented quite similar results to previous studies but as of now exact Pathophysiology was not identified.

The current study reported fair agreement between BSS and NCS, while slight agreement was observed between BFS and NCS, possibly due to various factors. In 2018, Shin et al., concluded a correlation between depression and pain, anxiety with CTS symptom severity, but not with functional disability.[36] Psychological variables have a greater impact on patient's functional impairment and symptom severity than the disease's pathophysiology.[37,38,39] In 2011, Fernando Ortiz- Corredor et al., observed no significant correlation between NCS and Pain.[21] They hypothesized that normal NCS findings could occur despite stronger pain. Results suggest a significant relationship between patient's pain anxiety, depression, perception capacity, and CTS symptom severity.

This study disclosed that, CTS-6 suggests a high probability of carpal tunnel syndrome, and BCTQ shows significant agreement with NCS. Therefore, both tools proved to be effective for identifying probability and severity of CTS, respectively. It is demonstrated that when a NCS is not possible due to lack of feasibility of instruments in the community, CTS-6 tool and BCTQ can be used

CONCLUSION

This study concluded that there was statistically significant agreement found between NCS and both components of BCTQ. This agreement was notably significant more on symptom severity scale compared to functional status scale. NCS and Boston symptoms severity scale demonstrated mild agreement, whereas Boston functional status scale exhibited fair agreement. Conversely, NCS and CTS-6 tool revealed poor agreement. However, CTS-6 tool shows high probability towards the diagnosis of CTS. So, in places where NCS is not available in community, CTS-6 tool and BCTQ can be effectively utilized, however strong agreement with NCS was not exhibited.

Declaration by Authors

Ethical Approval: Ethical approval was obtained from IEC [reference number: IEC/BU/143/Faculty/18/98/2023].

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