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Case Series

Boston carpal tunnel syndrome questionnaire clinical function assessment outcomes of carpal tunnel injection for carpal tunnel syndrome

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ABSTRACT

Carpal tunnel syndrome is the most common compressive neuropathy. Risk factors include hereditary, obesity, pregnancy, hypothyroidism, rheumatoid arthritis, and work related. With treatment ranging from simple lifestyle changes, up until surgery. Studies have shown that local steroid injection improve symptoms by at least one month and up to one year after injection, which allows for the delay of surgical treatment. In this study, BCTQ was chosen as a measuring tool because it can objectively assess functional improvement in functional status and disease severity. An analytical study design with a quasi-experimental pretest post-test one group only design approach was used in this study. Primary data and secondary data were used to measure the symptom severity scale and functional status based on the BCTQ. The research subjects were taken from populations that fulfilled the inclusion and exclusion criteria. Based on the Friedman test analysis of differences in the severity scale of symptoms of clinical function assessment outcome data and functional status on the BCTQ from the action of carpal tunnel injection on carpal tunnel syndrome, the results of the BCTQ value show that there is a significant difference before and after injection at one month and three months assessment post injection with a P-value of 0.00 ($p<0.05$) on both. Carpal tunnel injection with Triamcinolone acetonide 20 mg can provide good clinical outcomes in cases of carpal tunnel syndrome and can reduce the severity of symptoms and provide a good functional status scale of the hand.

Keywords: BCTQ, Carpal tunnel syndrome, Steroid injection, Outcome

INTRODUCTION

Compressive neuropathy of the upper extremity is a frequent problem. Compressive neuropathy is a group of injuries of the peripheral nerves that are caused by both pathophysiological factors or normal variant of an anatomical structure that compress the nerve. Carpal tunnel syndrome followed by elbow ulnar nerve compression is the most frequent compressive neuropathy and is the most well-known entrapment neuropathy. It is caused by compression of the median nerve at the wrist. Diagnosis is mostly clinical based on trifecta of symptom of night pain, paresthesia in the median nerve distribution, and thenar muscle weakness. Only after a failed non-operative treatment trials, surgery is indicated.[1] A normal carpal tunnel contains tendons and the median nerve. Current understanding on the pathophysiology of CTS are based on anatomical factors; the cross-sectional area of the carpal tunnel and anthropometric measurement of the wrist and hand. However, detailed characterization of the boundaries of the tunnel and the median nerve is lacking due to

non-standardized imaging protocols. Advances in high resolution ultrasound technology allows the detailed high resolution cross-sectional views of the median nerve for diagnosis of carpal tunnel syndrome and monitoring treatment efficacy.[1] The median nerve starts from the brachial plexus, this plexus is formed from C5-T1 which forms three trunks (superior, median, and inferior), which becomes the fasciculus. The conjoined medial and lateral fasciculus forms the median nerve. The median nerve innervates the flexor muscles in the forearm. In the palm area, the median nerve innervates the thenar muscles (abductor brevis, flexor pollicis brevis, and opponens pollicis muscle). In the center of the palm, the median nerve innervates lumbrical musculus I and II. For sensory on the volar part. The median nerve takes care of up to three and a half fingers while the dorsal part takes care of the medial finger of the thumb, the tip of the index finger, the middle finger, and the lateral part of the tip of the ring finger.[2]

The exact cause of Carpal tunnel syndrome is unknown, but is associated with the compression of the median nerve in the carpal tunnel, under the transversum flexorum ligament. Known intrinsic risk factors includes heredity, obesity, pregnancy, diseases such as diabetes mellitus, hypothyroidism, and rheumatoid arthritis, while extrinsic factors include benign tumors (such as ganglion, lipoma), vascular abnormalities, and work with vibrating tools. In normal people the pressure in the carpal tunnel is 2 mmHg and increases during flexion and extension of the wrist. A pressure of 20-30 mmHg can slow the blood flow of the nerve epineurium. Axonal transport is impaired at a pressure of 30 mmHg. Neurophysiological changes in the form of motor and sensory dysfunction will appear at a pressure of 40 mmHg. At 60-80 mmHg there is a cessation of intraneural blood flow which causes ischemia resulting in nerve cell damage. Although peripheral nerve lesions are more resistant to ischemia, prolonged tension and compression can cause the ischemia process to occur.[3] The prevalence and incidence of carpal tunnel syndrome (CTS) vary widely, influenced by the diagnostic criteria applied. Roughly 10% of individuals may experience CTS at some point, with diagnosis more accurately predicted by clinical criteria than electrophysiological ones. Using either broad (e.g., history or Phalen test) or strict (e.g., sensory or motor deficits) criteria alters reported prevalence rates. CTS primarily affects women, with an average diagnosis age of 50, though this is based on data from patients seeking treatment, which may be biased. OSHA (2014) data shows that CTS affects about 900,000 workers annually in the U.S., costing over $20 billion in compensation. The American Academy of Orthopaedic Surgeons notes an incidence rate of 1-3 cases per 1,000 people annually, with a general prevalence of 50 per 1,000, which can rise to 150 per 1,000 among high-risk groups. Women are more affected than men, with a ratio between 3:1 and 10:1, especially prevalent in the 45-60 age group. Factory workers have a prevalence rate of 5-21%, compared to 1-5% in the wider population. In Washington State, the annual incidence rate ranges from 0.8 to 14.8 per 1,000 people. In Indonesia, specific prevalence rates are unclear due to limited research. However, a study at H. Adam Malik Medan Hospital in 2015 involving 200 CTS patients found a majority were women, with the most affected age group being 46-55 years, predominantly affecting the right hand, and nearly half of the cases were severe.[7]

The definitive treatment for carpal tunnel syndrome is surgical decompression, which are performed on CTS with functional deficits and severe pain. Conservative therapies include oral analgesics, physiotherapy, splints, oral steroids, injection steroid, and the use of modality therapy. Prolonged use of analgesics and oral steroids risks gastrointestinal disorders, while physiotherapy and splints require long term use before its effect is seen. Steroid injection has advantages for carpal tunnel syndrome therapy because of its rapid effect. Other therapies such as exercise, yoga, acupuncture, laser, magnetism are still unclear about their benefits in patients with carpal tunnel syndrome.[8] The Cochrane review and other studies showed that local steroid injection for carpal tunnel syndrome can reduce carpal tunnel syndrome symptoms up to 1 month to 1 year. Delaying the need of surgical treatment. Cartwright et al showed that the effects of steroid injection began to be seen within one week after injection. Steroid injection inhibits the production of pro-inflammatory cytokines. In recent years the effects of steroids on nerve proteins like myelin, glycoprotein, and peripheral myelin protein 22 (PMP22), have been analyzed. The results suggests that steroid hormones can modulate the mRNA of myelin proteins to repair damaged peripheral nerve myelin.[1] Symptoms of carpal tunnel syndrome can be measured using the Boston carpal tunnel syndrome questionnaire (BCTQ). This questionnaire assesses disease severity scale and functional scale. The severity scale includes pain intensity, sleep disturbance due to pain, pain frequency, numbness, numbness intensity at night, tingling, hand weakness, and decreased grip ability in patients with carpal tunnel syndrome. While the functional scale includes difficulty writing, buttoning clothes, holding a book while reading, holding a telephone receiver, opening jars, doing household chores, carrying shopping bags, bathing, and wearing clothes.[9] Recent study showed a significant decrease ($p<0.05$) in the evaluation for 6 and 12 weeks after injection of Triamcinolone acetonide 10 mg and 40 mg with measurements using VAS and BCTQ questionnaires. After a 12-month follow-up, there was a better clinical outcome with Triamcinolone acetonide 10 mg/ml injection than 1 ml NaCl injection as placebo using BCTQ questionnaire ($p<0.01$)[10] The author is interested in conducting research on the outcome of the clinical function assessment of the Boston carpal tunnel syndrome questionnaire (BCTQ) of carpal tunnel injection in carpal tunnel syndrome. In this study, BCTQ was chosen as a measuring tool because it can objectively assess functional improvement in functional status and disease severity.

CASE SERIES

This study analyzes the results of the Boston carpal tunnel syndrome questionnaire clinical function assessment of carpal tunnel injection in carpal tunnel syndrome with an analytical study design with a quasi-experimental pretest-posttest group-only design approach. Primary data and secondary data were used to measure symptom severity scale and functional status based on the Boston carpal tunnel syndrome questionnaire. The target population of this study was patients who underwent carpal tunnel injection for carpal tunnel syndrome at H. Adam Malik Hospital. The inclusion criteria in this study were participants who were willing to participate in the study, after receiving an explanation by signing an informed consent on a voluntary basis. Patients who have undergone injection for 1 and 3 months and are over 18 years of age. In contrast, the exclusion criteria included patients who've had carpal tunnel release surgery, complications of spinal cord injury surgery, patients with distal radius fracture, and cervical myelopathy, central nervous system disorders, and peripheral nervous system diseases involving the upper extremities (polyneuropathy, brachialgia, cervical radiculopathy, malignancy either without or with chemotherapy). Research and sample selection were carried out at the Haji Adam Malik General Hospital Medan. The research started from August to November 2021. The sampling method in the study was carried out by non-probability sampling, namely by consecutive sampling technique, where subjects were taken sequentially according to the inclusion and exclusion criteria until the minimum size was met. Patients who met the inclusion criteria had their demographics recorded and were obtained from the medical records. Then the subjects were interviewed, and the BCTQ was calculated. In the implementation of this study, any information that will be asked of patients and patient's families is done after providing information and consent by patients and patient's families.

Characteristics of patients

The cases were collected from September 2021 to April 2022 in patients with carpal tunnel syndrome who sought treatment at the Orthopaedic and Traumatology clinic of H. Adam Malik Hospital, 14 cases were obtained who met the inclusion criteria.

The patients are middle aged female that presents with a clinical complain of carpal tunnel syndrome, which are diagnosed clinically and is treated with an injection of triamcinolone acetonide 20 mg. The patients were followed up at the 1 month and 3 months mark after the injection, with most patients having a reduction of severity on follow up. Distribution of patients were noted in Table 1. And from the total sample of BCTQ clinical function assessment of carpal tunnel, injection in carpal tunnel syndrome were presented as a case of 14 female. With age varying from 35 years to 58 years.

Right hand involvement was noted in 9 subjects (64.28%) (Table 2).

Table 1. demographic characteristic.

Demographic characteristic	N	%
Gender		
Male	0	0
female	14	100
Age (years)		
<50	7	50
≥50	7	50
Education level		
Grade school	1	7.14
Middle school	2	14.28
High school	6	42.85
Associate degree (D3)	1	7.14
University graduate (S1)	2	14.28
Master's degree (S2)	2	14.28
Occupation		
Housewife	7	50
Civil servant	3	21.42
Merchant	2	14.28
Private business	1	7.14
Teacher	1	7.14
Farmer	1	3.57

Table 2: Characteristics of carpal tunnel syndrome.

Clinical	N	%
Affected wrist		
Right	9	64.28
Left	5	35.72
Symptoms		
Pain	5	35.53
Numbness	3	21.43
Paresthesia	2	14.29
Thenar atrophy	4	28.75
Provocation test		
Tinel	14	100
Phalen	7	50
Durkan's	14	100

The most common primary complain is pain, where it was complained on 5 cases (35.71%) followed by thenar muscle atrophy on 4 cases (28.57%). All patients (14 cases) were diagnosed clinically based on compression test. Symptom severity scale before triamcinolone acetonide 20 mg injection is shown in Table 3. Moderate symptoms according to the symptom severity scale was found in 8 subjects (57.14%) followed by severe symptoms as in 4 cases (28.57%) and mild symptoms was reported in 2 cases (14.29%). After one month of Triamcinolone acetonide 20 mg injection, the mild symptoms were noted in 7 cases (50%) followed by moderate symptoms in 5 cases (35.71%). Resolvement of symptoms was noted on 2 case (14.29%). Severe and very severe symptoms were no longer present on any of the cases after injection. After three months of

Triamcinolone acetonide 20 mg injection mild symptoms was found in 9 cases (64.28%) followed by no symptoms on 3 cases (21.43%) and moderate symptoms on 2 cases (14.29%). Severe and very severe symptoms were no longer present after 3 months of injection.

Table 3: Degree of BCTQ on patient undergoing injection.

BCTQ symptom severity					
BCTQ levels	**Normal N (%)**	**Mild N (%)**	**Moderate N (%)**	**Severe N (%)**	**Very severe N (%)**
Injection status (with 20 mg of triamcinolone acetonide)					
Before injection	-	2 (14.29)	8 (57.14)	4 (28.57)	-
1 months after injection	2 (14.29)	7 (50)	5 (35.72)	-	-
3 months after injection	3 (21.43)	9 (64.28)	2 (14.29)	-	-
BCTQ level functional severity					
Injection status (with 20 mg of triamcinolone acetonide)	**No difficulty**	**Mild difficulty**	**Moderate difficulty**		
Before injection	8 (57.14)	4 (28.57)	2 (14.29)		
1 month after injection	4 (28.57)	9 (64.28)	1 (7.15)		
3 months after injection	4 (28.57)	9 (64.28)	1 (7.15)		

Table 4: Abnormality test with Shapiro-wilk test for BCTQ of injection on CTS.

Injection (20 mg)	Boston carpal tunnel syndrome questionnaire	Shapiro-wilk (p value)
Before injection	Symptom severity scale	0.851
	Functional severity scale	0.490
1 month after injection	Symptom severity scale	0.022
	Functional severity scale	0.008
3 months after injection	Symptom severity scale	0.534
	Functional severity scale	0.004

Functional status scale before triamcinolone acetonide 20 mg injection shown in Table 4 where mild symptoms were found in 8 cases (57.14%) followed by moderate symptoms on 4 cases (28.57%) and severe symptoms on 2 cases (14.29%). There were no cases where very severe symptoms were noted on the symptom severity scale without additional functional impairment as noted by the functional severity scale symptoms. After one month of Triamcinolone acetonide 20 mg injection, the mild symptoms were most commonly found, where it was found in 9 cases (64.28%) followed by no symptoms on 4 cases (28.57%) and moderate symptoms on 1 subject (7.15%). There were no severe and very severe symptoms on the symptom severity scale. After three months of Triamcinolone acetonide 20 mg injection, the most common functional status were mild symptoms which were found in 9 subjects (64.28%) followed by no symptoms on 4 cases (28.57%) and moderate symptoms on 1 cases (7.15%). Severe and very severe symptoms were not found in all the cases.

Normality test of clinical function assessment outcome data BCTQ of carpal tunnel injection action on carpal tunnel syndrome

Shapiro Wilk test was done to test data normality. This test was carried out because the number of subjects obtained in the study were less than 50 subjects. Because the data obtained were not normally distributed, the Friedman test was used to analyze differences in symptom severity scale and functional status scale before injection, 1 month after injection, and 3 months after injection. Based on the results of the normality test of the BCTQ clinical function assessment outcome data from the carpal tunnel injection action on carpal tunnel syndrome shown in Table 5, the results of the BCTQ values are normally distributed ($p>0.05$) where the symptom severity scale before injection have a p value of 0.851, and the functional status scale before injection is not normally distributed with a p value of 0.490.

Table 5: Friedman test for the symptoms severity scale of the BCTQ.

BCTQ	Friedman p value
Symptoms severity scale	0.00
Functional severity scale	0.001

The symptom severity scale 3 months after injection have p value of 0.534. The results of the BCTQ scores were not normally distributed ($p<0.05$), and the symptom severity scale 1 month after injection with Shapiro-wilk test have a p value of 0.022, functional status scale 1 month after injection have a p value of 0.008, and functional status scale 3 months after injection have p value of 0.004.

Analysis of differences in symptom severity scale of the BCTQ clinical function assessment outcomes

From the results of the data normality test, it was found that the research data were not normally distributed. Because the research data is not normally distributed, the statistical test used to identify the relationship between the outcome of the clinical function assessment of the BCTQ of carpal tunnel injection in carpal tunnel syndrome is to use the Friedman Test. Based on the Friedman test analysis of the difference in the severity of symptoms of the BCTQ clinical function assessment outcome data from the carpal tunnel injection action on carpal tunnel syndrome. The results of the BCTQ value show that there is a significant difference from before action and after action with one month and three months monitoring with a p value of 0.00 ($p<0.05$).

Analysis of differences in functional status scale outcomes of clinical function assessment of BCTQ

Friedman test analysis of differences in the functional status scale of the BCTQ clinical function assessment outcome data from the action of carpal tunnel injection on carpal tunnel syndrome. The results of the BCTQ value show that there is a significant difference from before action and after action with one month and three months monitoring with a p value of 0.00 ($p<0.05$).

DISCUSSION

Carpal tunnel syndrome is a common neuropathy, especially in patients aged 30-60 years. Where it is 2-3 times more common in women than men[11] where the ratio of women to men with carpal tunnel syndrome is 3-10:1.[5] The relationship between carpal tunnel syndrome and occupational activities is well documented, but in-depth analysis of the movements involved in work activities that can specifically trigger carpal tunnel syndrome would be time-consuming and costly and therefore are still limited. Activity type that are listed in studies are usually a self-reported activity questionnaire by the study subjects (e.g., bending/straightening the wrist >1 hour/day).[12.]

The results of this study are consistent with a research conducted by Veluthamaningal et al in 2010, where local injection of triamcinolone acetonide showed a significant difference with the measurement of the assessment of the severity scale of clinical function symptoms with the BCTQ with a p value of 0.008 (<0.05).[13] In a study conducted by Rayegani et al in 2019 in Iran, local injection of triamcinolone acetonide in 81 research subjects divided into 3 injection techniques with Ultrasound Guidance (Ulnar In-Plane, Midline In-Plane, and Landmark-Guided) and was evaluated for 6 weeks and 12 weeks, there was no significant difference with the measurement of the clinical function symptom severity scale assessment with the BCTQ. In a study conducted by Santoso et al in 2021 in Malang, Indonesia, local injection of triamcinolone acetonide in 30 research subjects divided into two groups was evaluated for 4 weeks, it was found that there was a significant difference in the assessment of the severity scale of clinical function symptoms with the BCTQ with a p value of 0.001 (<0.05).[14] Veluthamaningal et al in 2010 shows there was a significant difference with injection of corticosteroid for the functional status scale assessment of clinical function with BCTQ with a p value of 0.012.[13] Study by Rayegani et al in 2019 in Iran, local injection of Triamcinolone acetonide in 81 research subjects who were divided into 3 injection techniques with Ultrasound Guidance (Ulnar In-Plane, Midline In-Plane, and Landmark-Guided) was evaluated for 6 weeks and 12 weeks, there was a significant difference with the measurement of the functional status scale assessment of clinical function with the BCTQ with a p value <0.05.[14] In a study conducted by Santoso et al in 2021 in Malang, Indonesia, local injection of Triamcinolone acetonide in 30 research subjects divided into two groups was evaluated for 4 weeks, it was found that there was a significant difference with the measurement of the assessment of the clinical function functional status scale with the BCTQ with a p value of 0.020 (<0.05).[15] Corticosteroid injection has been used for the treatment of carpal tunnel syndrome with varying success reported, randomized controlled trials conducted to evaluate the efficacy of corticosteroid injection compared with nonsteroidal anti-inflammatory drugs and splinting, showed significant improvement with both treatment methods.

A temporary complete resolution of symptoms after carpal tunnel injection is an excellent prognostic factor for successful carpal tunnel syndrome surgery. Complications of steroid injection have been reported in the form of injury to the median nerve. But overall evidence suggests that injections with triamcinolone acetonide inserted into the carpal tunnel can be a therapeutic option because the symptomatic relieve outweigh the risk of complication.[16] The small number of samples was an impediment in this study so a larger study with a more comprehensive examination might be needed, but the 3 months observation and division of degrees in each subject with carpal tunnel syndrome were deemed adequate to evaluate the overall response to treatment.

CONCLUSION

Carpal tunnel injection using triamcinolone acetonide 20 mg can reduce symptom severity and provide a good functional status scale of the hand in cases of CTS. Based on the BCTQ outcomes of this study we suggest that up to 3 months of observation after injection of triamcinolone acetonide in CTS patients is needed to really determine the outcome of the therapy. Larger research, that divides the severity of CTS by way of ECG might be needed in the future to further gather data on the efficacy of corticosteroid injection for CTS.

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