Subjective Outcomes of Carpal Tunnel Release in Patients with Diabetes and Patients without Diabetes

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Abstract

Introduction This study aims to compare the subjective outcomes of carpal tunnel surgery in the patients with diabetes and patients without diabetes, and it tries to determine the difference between insulin-dependent and noninsulin-dependent patients.

Materials and Methods This retrospective cohort study compares subjective outcomes of 35 patients with type 2 diabetes and 35 patients without diabetes who had a unilateral carpal tunnel release. None of the patients with diabetes had neuropathy. All the patients had surgery by a single surgeon with miniopen incision under local anesthesia. The patients were evaluated before surgery and 6 months after surgery using two Brigham and Women's Carpal Tunnel Questionnaires.

Results Carpal tunnel release was improved based on symptom severity scale (SSS) and functional status scale scores in patients with diabetes and nondiabetic patients. However, the mean SSS scores were higher in patients without diabetes 6 months after the surgery. Comparison between the mean SSS scores of the patients with diabetes showed higher scores in noninsulin-dependent patients. In patients with diabetes, SSS scores were positively correlated with carpal tunnel syndrome and diabetes durations.

Conclusion The outcomes of carpal tunnel release were improved in both patients with diabetes and patients without diabetes suffering from median nerve compression at the wrist. However, the duration of diabetes and its treatment can be related to the severity of the disease symptoms after the carpal tunnel releasing surgeries. In some diabetic patients, the severity of the symptoms was persistent.

Level of Evidence This is a prognostic level IV study.

Keywords
- carpal tunnel syndrome
- diabetes
- symptom severity scale
- functional status scale

Introduction

Carpal tunnel syndrome (CTS) is the most common compression neuropathy with a prevalence rate of 2.7 to 5.8%.[1,2] Although its etiology has been estimated by specific conditions such as metabolic disorders, obesity, collagen vascular diseases, endocrine disorders such as hypothyroidism, diabetes, trauma, heavy repetitive manual work, tumors, amyloidosis, and sarcoidosis may also contribute in its development in certain cases.[1-3]

Type 2 diabetes is one of the most common metabolic diseases. Gül Yurdakul et al investigated 52 patients with different metabolic syndromes and 20 patients with diabetes; they found that CTS was more prevalent among patients with diabetes.[4] Bahrmann et al showed that the prevalence of CTS in the patients with diabetes is 25% higher than patients without diabetes.[5] Perkins et al indicated that the prevalence of CTS in patients with diabetes without neuropathy was 14% higher than the patients without diabetes.[6] Oktayoglu et al investigated 100 patients with metabolic disorders in a case–control study. They found a significant and higher prevalence of CTS among the patients with diabetes.[3-9] The aim of this study is to investigate the subjective outcomes of carpal tunnel surgery in patients with diabetes and nondiabetic patients. Investigation of the effect of diabetes type

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treatments (insulin dependent/oral agents) on the subjective outcomes was the other goal of this study.

Materials and Methods

In this cohort study conducted from June 2014 to October 2016, subjective outcomes of carpal tunnel surgery in 35 patients with type 2 diabetes and CTS and 35 idiopathic CTS patients without any systemic disorders were compared. None of the patients with diabetes had neuropathy. The study was approved by the medical research and ethics committee of the Urmia University of Medical Sciences. All the patients were followed up for 6 months.

The clinical diagnosis of CTS was based on a history of night pain and parenthesis, flick sign, sensory deficit in the three and half radial digits, which were innervated by the median nerve, thenar muscle atrophy, a positive Tinel's sign, a positive Durkan's test, and a positive Phalen's test.

Electrodiagnostic study was also used to confirm the diagnosis of CTS and rule out the probable underlying polyneuropathy and double crush syndrome. Electrodiagnosis objectively determined the severity of the CTS (severe, moderate, and mild) and confirmed the lack of neuropathy. To confirm the entrapment, all the patients underwent bilateral sensory and motor nerve conduction by two experts. The temperature of the organ was ~32°C. In cases expected to have median nerve entrapment, distal median nerve motor latency and distal median nerve sensory latency were increased. But distal median nerve motor amplitude, distal median sensory amplitude, and distal median nerve sensory conduction velocity were decreased. Proximal median sensory latency, proximal median sensory conduction velocity, and motor conduction velocity might be reduced and the rest of nervous guidance parameters remained normal. Patients were entered into the study if both experts confirmed the median nerve entrapment in carpal tunnel and in the case of any evidence of polyneuropathy, they were excluded. In mild, condition's symptoms were as follows: the slow velocity of sensory nerve conduction on finger/wrist measurement and normal terminal motor latency, while in moderate status, sensory potential preserved motor slowing, distal motor latency to the abductor pollicis brevis (APB) < 6.5 milliseconds. In severe cases, sensory potentials were absent, but motor response was preserved, distal motor latency to APB < 6.5 milliseconds, very severe.[10]

All the patients in the both groups had failed nonsurgical treatments including the course of nonsteroidal anti-inflammatory medications, steroid injection, and night splinting. Conservative treatment was tried for 3 months. Patients with a history of any systemic or metabolic disease (except type 2 diabetes), smoking or neuromuscular disease was excluded. All the patients had surgery by a single surgeon with a mini-incision under local anesthesia. All the patients had surgery only on one (side) hand. Before the surgery, organ circulation and condition of radial and ulnar arteries were investigated by Allen's test. Local anesthesia was administrated in the velar surface of the wrist, and the surgery was performed under pneumatic tourniquet hemostasis, which was inflated to 250 mm Hg. The patients underwent the surgery by the application of minimally incision surgical technique. The average time duration of the surgery was ~30 minutes, and wrist splint was applied to all the patients. Splint was removed after a week and the patients' wrist motions started. No pre- or postoperative antibiotics were used.

►**Table 1** demonstrates the demographic characteristics of the two groups. Both groups were homogenous in terms

Table 1 Characteristics of 35 patients with diabetes and 35 nondiabetic patients with CTS

Variable	Diabetic patients (*N* = 35)	Nondiabetic patients (*N* = 35)	*p*-Value
Male	4 (11.4%)	6 (17.1%)	0.3
Female	31 (88.6%)	29 (82.9%)	0.3
Age (years)	51.8 ± 11.6	44.2 ± 12.1	0.001
Height (cm)	162.8 ± 6.8	163.2 ± 7.06	0.1
Weight (kg)	76.8 ±13.2	73.8 ± 11.4	0.3
BMI	28.5 ± 2.6	27.8 ± 5.3	0.2
Bilateral entrapment	32 (91.4%)	29 (82.9%)	0.1
Operated hand			0.1
Left	12 (34.2%)	14 (40%)	
Right	23 (65.8%)	21 (60%)	
Severe severity of CTS on electrodiagnosis	22 (62.9%)	25 (71.4%)	0.3
Moderate severity of CTS on electrodiagnosis	13 (37%)	10 (28.6%)	0.3
Duration of CTS (year)	2.4 ± 1.1	2 ± 1.1	0.1 (*t*-test)

Abbreviation: BMI, body mass index; CTS: carpal tunnel syndrome.

of gender, height, weight, laterality, operated hand, duration of disease, and severity of the CTS according to the electrodiagnosis findings. However, the mean age of the patients with diabetes was significantly higher than the nondiabetic patients (independent *t*-test, $p = 0.001$). According to the Watchmakers and Watchmakers' study, the patients were divided into two groups: younger than and older than 50 years to analyze the age as a confounding variable.[11]

In the patients with diabetes, duration of CTS, duration of treatment (years), type of treatment (oral antidiabetic medications or insulin dependent), fasting blood sugar, and HbA1c were recorded at the time of surgery.

The patients were evaluated before surgery and 6 months after surgery with the two Brigham Hospital CTS questionnaires (symptom severity scale [SSS] and functional status scale [FSS]). The SSS consisted of 11 questions with multiple choice answers. The scale (consisting pain, nocturnal symptoms, numbness, tingling, and weakness) had 5 ordinal response categories ranging from 1 (no symptom) to 5 (very severe symptom). The SSS score was calculated as the mean of the score for the 11 individual questions. The FSS included eight questions on the daily life activities. Each patient rated these activities according to their level of difficulty from 1 (no difficulty) to 5 (unable). The FSS score was calculated as the mean of the eight different activities.[12] Brigham Hospital CTS questionnaires were translated and validated to the Persian language.

Continuous variables were shown as mean ± standard deviation. Normality of the distribution of each variable was checked using the Kolmogorov–Smirnov's test. The chi-square test was used to study the qualitative variables. Independent *t*-test and Mann–Whitney's *U*-test were used to compare the quantitative data. A paired *t*-test was used to compare the subjective scores before and after the surgery. The Spearman's correlation test was used to find the relationship between the duration of diabetes and duration and severity of CTS symptoms. The Cochran–Mantel–Haenszel's test was used to analyze the age as a confounding variable. A *p*-value of ≤ 0.05 was considered statistically significant.

Results

►**Table 2** lists the mean values of the FSS and SSS scores before and 6 months after the surgery in patients with diabetes and patients without diabetes. Carpal tunnel release was effective in both groups. In both patients with diabetes and patients without diabetes, the difference between the mean SSS and mean FSS scores was statistically significant (paired *t*-test, $p < 0.001$).

Comparison of the mean SSS scores of between patients with diabetes and nondiabetic patients 6 months after the surgery showed statistically significant difference (independent *t*-test, $p = 0.001$). However, comparison between the mean FSS scores of the patients with diabetes and nondiabetic patients 6 months after the surgery exhibited no statistically significant difference (independent *t*-test, $p = 0.07$).

►**Table 3** demonstrates the characteristics and mean of the FSS and SSS scores before and 6 months after the surgery in the insulin-dependent and noninsulin-dependent patients with diabetes. Seven out of 35 patients with diabetes were insulin dependent, while the other 28 patients used oral medications. Comparison between the mean FSS scores of the patients with oral medications and insulin-dependent patients was not statistically significant (Student's *t*-test, $p = 0.02$), while a comparison between the mean SSS scores of the patients with oral medications and insulin-dependent patients showed statistically significant difference in favor of the oral medications (independent *t*-test, $p = 0.01$).

In the patients with diabetes group, 16 (72.7%) out of 22 patients with the age of 50 years or above had a higher SSS score than the rest of the patients. Therefore, the age of 50 years or above was a confounding variable in the patients with diabetes (Cochran–Mantel–Haenszel, 95% confidence interval: 0.3–1.1; $p < 0.001$).

In patients with diabetes, SSS scores were weakly correlated with duration of CTS ($p = 0.02$, $r = 0.3$) (►**Fig. 1**) and positively correlated with duration of the diabetes ($p = 0.01$, $r = 0.5$) (►**Fig. 2**).

Discussion

Similar to previous studies,[3,13,14] this study showed that carpal tunnel release can be useful in both patients with diabetes and nondiabetic patients suffering from CTS. Six months after the surgery, SSS and FSS scores were significantly improved in both groups. However, the difference of postsurgical SSS scores of patients with diabetes and

Table 2 Mean of the FSS and SSS scores before and 6 months after surgery based on Brigham Hospital CTS questionnaires of the 35 patients with diabetes and 35 nondiabetic patients with CTS

Variable	Diabetic patients ($N = 35$)	Nondiabetic patients ($N = 35$)	*p*-Value (statistical test) (independent *t*-test)
FSS score before surgery	28.02 ± 6.6	25.7 ± 6.06	0.05
FSS score 6 months after surgery	11.1 ± 3.6	9.6 ± 3.2	0.07
SSS score before surgery	43.2 ± 5.5	40.5 ± 6.5	0.09
SSS score 6 months after surgery	16.8 ± 6.4	12.1 ± 2.8	0.001

Abbreviations: CTS, carpal tunnel syndrome; FSS, functional status scale; SSS, symptom severity scale.
Note: *p*-Value of less than 0.05 is statistically significant.

Table 3 Characteristics and mean of the FSS and SSS scores before and 6 months postsurgery in the 35 insulin-dependent/oral diabetes medication patients with diabetes and CTS

Variable	Oral diabetes medications (*N* = 28)	Insulin-dependent (*N* = 7)	*p*-Value (statistical test) (Mann–Whitney's *U*-test)
Age (years)	53.8 ± 8.5	43.7 ± 18.5	0.7
CTS duration (year)	2.4 ± 0.6	2.6 ± 2	0.3
Duration of diabetes	5.9 ± 4.4	6.2 ± 2.4	0.05
FBS mg/dL	161.6 ± 42.9	172.8 ± 30.3	0.1
HbA1c (mmol/mol)	7.7 ± 1.8	7.08 ± 1.1	0.9
FSS score before surgery	28.7 ± 63	25.2 ± 7.8	0.4
FSS score 6 months after surgery	11.2 ± 3.9	10.5 ± 2.2	0.6
SSS score before surgery	43.6 ± 4.9	40.7 ± 7.4	0.2
SSS score 6 months after surgery	13.2 ± 6.9	17.7 ± 2.5	0.01[a]

Abbreviations: CTS, carpal tunnel syndrome; FBS, fasting blood sugar; FSS, functional status scale; SSS, symptom severity scale.
[a]*p*-Value of less than 0.05 is statistically significant.

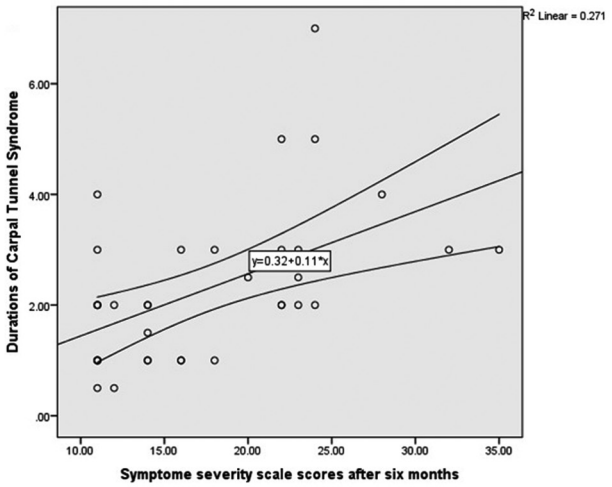

Fig. 1 A positive correlation between the duration of carpal tunnel syndrome and symptom severity scale scores 6 months after the surgery in patients with diabetes (Spearman's test, $p = 0.02$, $r = 0.3$).

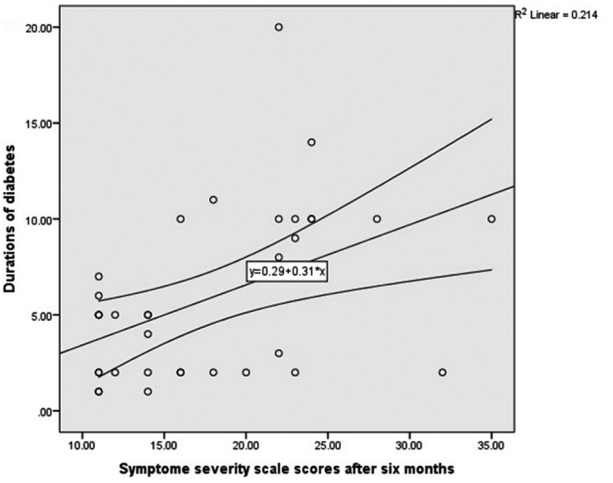

Fig. 2 A positive significant correlation between the duration of diabetes and symptom severity scale scores 6 months after the surgery (Spearman's test, $p = 0.01$, $r = 0.5$).

patients without diabetes were statistically significant in favor of the patients without diabetes.

Our findings indicated that in addition to the mechanical compression of the median nerve, other factors probably contribute to the development of CTS in patients with diabetes. It can occur bilaterally in diabetes mellitus patients compared with other metabolic patients.[14] de Krom et al indicated higher frequency of vascular and neurological damages in patients with diabetes in a way that a new term called diabetic hand syndrome has been introduced to include the motion limitations of hand, trigger finger, Dupuytren's disease, and CTS, which may occur alone or collectively in patients with diabetes; it is commonly called diabetic hand.[7] Tekin et al studied biopsy specimens from transverse carpal ligament, tenosynovium adjacent to the median nerve, and epineurium of the median nerves of the patients with diabetes and CTS. They found higher rates of synovial edema, vascular proliferation, and increased vascular wall thickness in patients with diabetes with CTS.[15] Taser et al and Deger et al studied the role of neoangiogenesis and vascular endothelial growth factor (VEGF) in the development of CTS in patients with diabetes. They found that increased ischemia-reperfusion damage, neoangiogenesis, and VEGF expression can lead to significant neovascularization within the subsynovial connective tissue, which can substantially affect the CTS occurrence in patients with diabetes.[16,17]

Mozaffarian et al found postsurgery improvement of electrodiagnostic in patients with diabetes and patients without diabetes; however, the difference between pre- and postoperative nerve conduction velocities was statistically significant in favor of patients without diabetes.[18]

Although numerous articles have compared the outcomes of carpal tunnel surgery in patients with diabetes and patients without diabetes, it was impossible to find a comparison

between the outcomes of carpal tunnel surgery among the insulin-dependent and noninsulin-dependent patients with diabetes.[19] In this study, after 6 months, the difference in the postsurgery SSS scores of insulin-dependent and noninsulin-dependent patients with diabetes was statistically significant in favor of the noninsulin-dependent patients. Insulin increased the neurotrophic factors.[20] Plastino et al showed a relation between insulin resistance and CTS. The prevalence of glucose metabolism abnormalities was significantly higher in 117 patients with moderate to severe CTS.[21]

However, the insulin-dependent patients had diabetes for a longer period of time and a longer duration of CTS. The difference between the duration of CTS and duration of diabetes treatment between the insulin-dependent and noninsulin-dependent patients (►**Table 3**) was statistically significant because of the low number of the insulin-dependent patients.

Although our findings demonstrated the effect of diabetes on the subjective outcomes of carpal tunnel release in 6 months, in a 5-year follow-up study by Thomsen et al, it was revealed that carpal tunnel release had similar consequences in both patients with diabetes and nondiabetic patients, and there was no difference between the two groups in terms of SSS and FSS scores.[22] In another 5-year follow-up study, Thomsen et al indicated that neurophysiological improvement occurs after carpal tunnel release in patients with and without diabetes; however, diabetes had a negative influence on the neurophysiological improvement.[20] In line with Watchmakers and Watchmakers' study, this study demonstrated that the age of 50 years or above is a confounding variable with an adverse effect on the patients' outcomes.[11] Duration of diabetes and treatment with insulin were also among the variables with adverse impact on the patients' outcomes.

This study had several limitations; first, it was a single-center short-term study; second, the number of insulin-dependent patients was low; third, based on Ozer et al, patients with diabetes had less improvement in FSS and SSS scores than patients without diabetes. Ozer et al compared patients' satisfactions with FSS and SSS scores to describe a minimal clinically important difference. They found that patients with diabetes needed a greater improvement in FSS and SSS scores to be satisfied. Patients' satisfaction was not included in the design of our study; therefore, it was not possible to determine the minimal clinically important differences for the changes in SSS and FSS scores that were not statistically significant.[23]

Further prospective multicentric studies with a large number of cases, including more number of insulin-dependent patients, longer follow-up period, added clinical outcome measures, evaluation of minimal clinically important difference, and inclusion of complications will help for better delineation of the prognostic factors about CTS in the patients with diabetes.

Conclusion

According to the findings of this study, the functional improvement in patients with diabetes and CTS is similar to the idiopathic cases, although the symptoms of median nerve entrapment may remain to some extent. Also, the duration of diabetes and its treatment can be related to the severity of the disease symptoms after the carpal tunnel releasing surgeries. In some diabetic patients, the severity of the symptoms was persistent.

Ethical Approval

This study was confirmed by the ethics committee of Urmia University of Medical Sciences.

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Conflict of Interest

None declared.

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