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Original Article

Clinical and laboratory efficacy of repetitive triamcinolone injections in carpal tunnel syndrome

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Abstract

Aim: Carpal tunnel syndrome (CTS) is the most common compressive neuropathy affecting the upper extremity. There are many surgical and non-surgical treatment options and it is not clear which approach is more effective. Corticosteroid injections are known to be effective on both CTS symptoms and electrophysiological parameters. Many different techniques are used for injection. It is recommended to use a maximum of 3 injections at intervals of 2-3 months. In our study, we aimed to examine the clinical and electrophysiological efficacy of triamcinolone injection performed in the cases with a rarely used technique.

Material and Methods: This is a retrospective study.Patients who were diagnosed with mild to moderate CTS between December 2012 and June 2018 treated with 40 mg triamcinolone injection were evaluated. Ages of patients were between 18 to 65 years. The changes in the electrophysiological parameters, clinical and examination findings, and visual analog scale (VAS) of 121 patients were examined before and after the injections.

Results: Clinical and examination findings were consistent with previous studies. The second injection was applied to 43.9% and the third injection to 16.4% of the cases. After the third injection, mild to moderate CTS was detected in 6.9% of the cases. The statistically significant changes were observed in the clinical, examination findings and VAS values of the cases before and after the injection. Besides, a significant statistical difference was determined in all parameters of the sensory conductions and in the distal latency of the motor conduction, before and after the injection.

Conclusion: It was determined that 40 mg of triamcinolone caused a significant change in VAS values, and the clinical and examination findings of CTS. There were no complications associated with injection. Consequently, 40 mg of triamcinolone, applied approximately 3 cm distal to the carpal tunnel, is as effective as the more frequently applied techniques.

Keywords: Carpal Tunnel Syndrome; Entrapment Neuropathy; Pain severity; Steroid Injection; Triamcinolone Injection; Nerve conduction study.

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common compressive neuropathy affecting the upper extremity (1). Many surgical and non-surgical approaches have been reported to be effective in treatment, but there is no approach accepted to be more superior (2). The main purpose of these methods is to relieve the median nerve compressed in the carpal tunnel. Local steroid injections are widely used for diagnosis and treatment in the management of CTS (3,4).

In some studies, the initial treatment of the disease has been reported to be the steroid injection to the carpal tunnel, unless serious motor function or severe sensory loss occurs (5-9). Short-term benefits have been reported in the literature for corticosteroid injections, but studies on long-term efficacy are scarce. (11,10).

Strong evidences for the use of a steroid injection have been reported in the American Academy of Orthopedic Surgeons guide (12). Corticosteroid injections in the European guideline have been reported to reduce CTS symptoms (13). In addition to the effect on the symptoms, it has been reported to be effective on the median nerve conduction(14). With electrophysiological examination, it can be applied to the patients with a mild or moderate carpal tunnel syndrome. It is recommended to use a maximum of 3 injections and an interval of 2 to 3 months is recommended when > 1 injection is used (13).

Various methods have been used for carpal tunnel

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injections (3,7,15-18), however, studies on the safety of the methods are insufficient. Commonly using classical method is 1 cm or deeper injection after the determination of palmaris longus and musclesof flexor carpi radialis, with ulnar approach, proximal from 0-4 cm according to the first wrist fold, with 10-90° angle (14). However, it has been reported that injection of more distal to the wrist curves has advantages over the classical method, and the efficacy is the same (14,19).

In our study, 40 mg of triamcinolone was administered from the distal wrist, and the evaluation of the clinical features of the patients on whom the injection was repeated according to the results of the 3-months electrophysiological examination and the evaluation of the effectiveness of the treatment were aimed. (This study aimed to evaluate the effectiveness of triamcinolone injection.

MATERIAL and METHODS

Patient Selection and Electrophysiological Examination

The data of 18-65 years old patients who were diagnosed with CTS, G56 code were entered, between December 2012 and June 2018 and treated with only 40 mg of triamcinolone were retrospectively analyzed. Patients with, other than CTS, any polyneuropathy, nerve root disorders, with comorbidities, and patients with a use of pregabalin, gabapentin, venlafaxine, duloxetine or amitriptyline for any reason were excluded from the study. Patients whose clinical features or laboratory data were incomplete or whose electrophysiological examinations were performed on different devices were not included in the study (Figure 1).

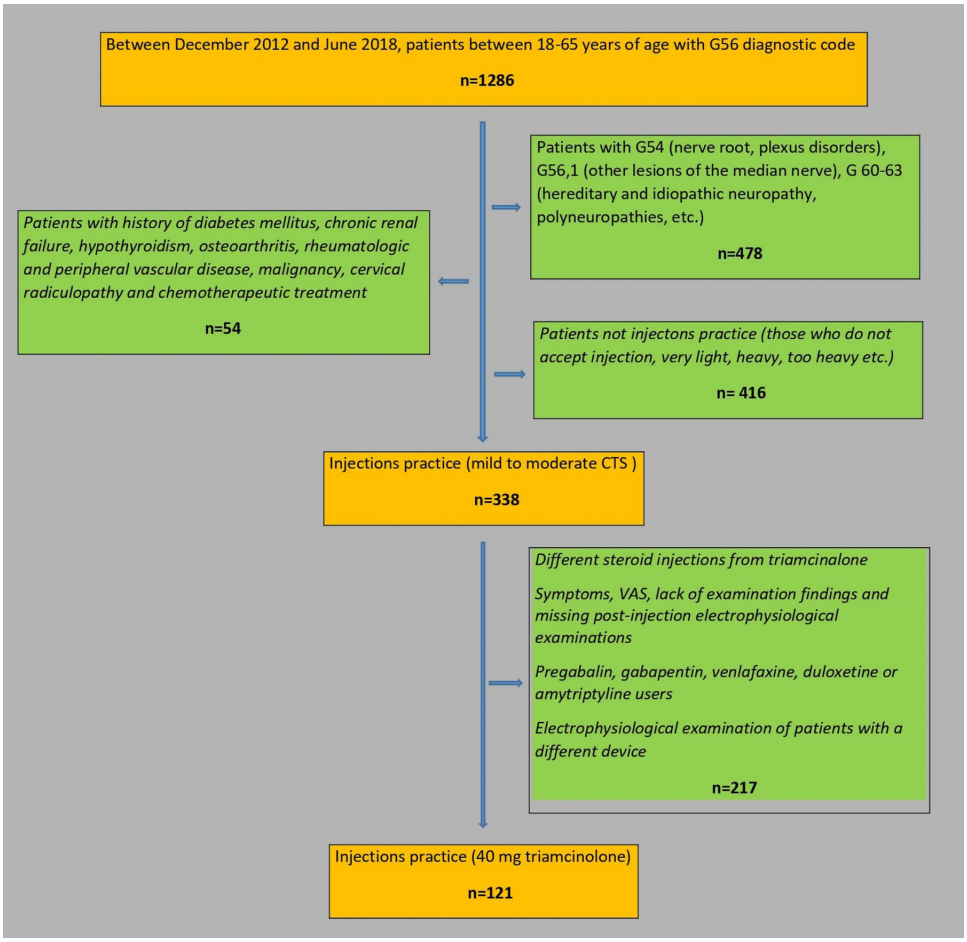

Figure 1. Inclusion and exclusion flow chart

All the electrophysiological examinations had been performed on the same device (Nihon Kohden Neuropack JB-904 BK). Surface electrodes were used for recording. The filter settings in the electroneurography (ENG) records were as follows: frequency filter for sensory nerve conduction 20Hz-2 kHz, sweep/analysis 2 ms / division, sensitivity 20 μV, frequency filter for motor conduction 10Hz-5kHz, sweep/analysis 2ms / division, sensitivity 5mV. During routine ENG examinations, room temperature was maintained at 24-25°C and skin temperature was maintained at 31-34°C. The median nerve from the second finger and the ulnar nerve sensory parameters (distal latency, sensory nerve action potential (DSAP) and conduction velocity) from the fifth finger were recorded with anti-dromic stimulation. The motor parameters (distal latency, combined muscle action potential (CMAP) and conduction velocity) were recorded from the abductor pollicis brevis for median nerve and from the abductor

digiti minimi muscles for ulnar nerve by orthodromic stimulation. The diagnosis of CTS was made according to the recommendations of the American Association of Electrodiagnostic Medicinein 2002 (20). Bland scale (21) was used to determine the CTS severity, which was as follows: Mild CTS: Sensory nerve conduction velocity measured from finger/wrist is slowed, motor conduction distal latency is normal. Moderate CTS; Slowed sensory conduction velocity with motor distal latency between 4.5-6.5 ms.

Injection Technique

The injection was made by using a 1 ml insulin injector with a needle size 27 G x ½ inches, by applying 40 mg of triamcinolone to the middle of the wrist fold between the tenar and hypotenar muscles, with an inlet angle of about 20-25 degrees and about 3 cm distal to the carpal tunnel (Figure 2). Second or third injections were applied to the patient who had mild or moderate CTS (21) in control ENGs 3 months after injection. The injection was repeated maximum three times at 3-month intervals.

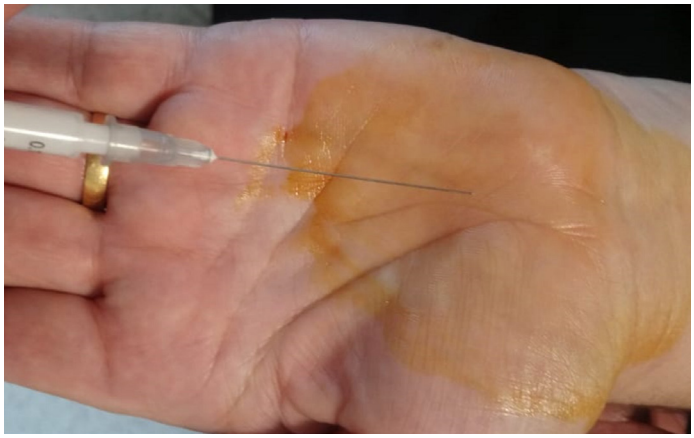

Figure 2. Corticosteroid injection using distal approach in the treatment of carpal tunnel syndrome

Before and 3 months after the injection, the clinical findings such as VAS (Visual Analog Scale) (22), night pain, paresthesia, morning stiffness, and examination findings such as Phalen sign, Tinel sign and other such findings of the patients included in the study were recorded.

The study was approved by our local ethics committee (07/33/29.11.2018).

Statistical Analysis

The D'Agostino-Pearson test was used to determine whether the data were within normal distribution. For more than two groups, normal distribution variables were compared with repetitive ANOVA and non-normal distribution variables were compared with Friedman test. Nominal variables were compared with chi-square test. Two-way p value was considered significant for <0.05. Statistical analysis was performed using the Medcalc program (MedCalc, version 12.2.1.0, Ostend, Belgium).

RESULTS

In our study, we evaluated the clinical and electrophysiological findings on 189 hands of 121 cases. There were 83 female and 38 male in the patient group. CTS was bilateral in 68 (56.2%) cases and unilateral in 53 cases. The presence of CTS only in the right hand was determined as 79.2%. Of the CTS symptoms and findings, night pain was present in 85.7%, Phalen sign in 60.8%, Tinel sign in 65.8%, paresthesia in 80.2% and morning stiffness in 68.8%. The percentage of patients having second injection was 43.9% and third injection was 16.4%. Mild to moderate CTS findings was enduring only in 6.9% of cases after the third injection (Table 1).

Table 1. Summary of the demographic and study data of the patient group

Age ± SD	48.7 ± 9.1
Gender n (%)	
Male	38 (31.4)
Female	83 (68.6)
Side n (%)	
Bilateral	68 (56.2)
Unilateral	53 (43.8)
-Right	42 (79.2)
-Left	11 (20.8)
Neurological examination n (%)	
Paresthesia	150 (80.2)
Night pain	
Morning stiffness	162 (85.7)
130 (68.8)	
Phalen Sign	115 (60.8)
Tinel Sign	123 (65.8)
Number of injection n (%)	
First Injection	189 (100)
Second Injection	83 (43,9)
Third Injection	31 (16,4)
Mild to moderate Carpal Tunnel Syndrome after the third injection n (%)	13 (6.9)

Electrophysiological data before and after each injection were compared. A significant statistical difference was found between the sensory conduction distal latencies, in pre-injection and between repetitive injections (p <0.001); however, there was no statistical difference between sensory distal latencies after repeated injections. Significant statistical differences were found between the arrival sensory action potentials (DSAP) and repetitive injections, and between the first injection and other injections (p <0.001), but there was no statistical difference between the 2nd and 3rd injections (p> 0.05). When the conduction velocities of arrival and repetitive injections were compared, there was a statistically significant difference (<0.017); however, there was no statistically significant difference between the 2nd and 3rd injections (p> 0.05). Significant statistical difference was found between motor conduction distal latencies of the arrival and repetitive injections (<0.001), but, no significant difference was found between the 2nd and 3rd injections (p> 0.05). There was no significant statistical difference

between arrival combined muscle action potential and repetitive injections (p:0.083).

No significant difference was detected between the motor conduction velocities of the arrival and repetitive injections (0.091). Significant statistical difference was found between arrival VAS averages and repetitive injections, and between the injections (p <0.001). There was a significant statistical difference between the presence of arrival night pain, Phalen and Tinel signs, paresthesia and morning stiffness and the presence of these symptoms after the injection (p <0.001) (Table 2).

Table 2. Comparison of data obtained at arrival, after the first injection and the repetitive injections

	First arrival	After the 1st Injection	After the 2nd Injection	After the 3rd Injection	p
Electroneurography					
Sensory					
Distal latency	4.1±0.38*	3.3 ± 0.26$^{\&}$	3.2 ± 0.24$^{\&}$	3.1 ± 0.32$^{\&}$	**<0.001**
Amplitude	7.17 ± 2.17^{a}	12.4 ± 3.2^{b}	14.5 ± 1.8^{c}	14.9 ± 1.6^{c}	**<0.001**
Conduction Velocity	41.62 ± 3.67^{+}	47.71 ± 3.83^{X}	48.69 ± 3.74$^{=}$	48.80 ± 3.72$^{=}$	**<0.017**
Motor					
Distal latency	5.3 ± 0.6^{x}	4.3 ± 0.6^{y}	3.9 ± 0.5^{z}	3.6 ± 0.5^{z}	**<0.001**
Amplitude	10.5 ± 2.2	10.6 ± 1.8	10.6 ± 1.5	9.7 ± 1.5	0.083
Conduction Velocity	54.78 ± 3.62	56.84 ± 3.81	54.64 ± 3.78	53.83 ± 3.70	0.091
Median VAS	4^{d}	3^{e}	2^{f}	1^{g}	**<0.001**
Night pain + (%)	162 (85.7)	42 (31.6)	8 (9.6)	3 (9.7)	**<0.001**
Paresthesia + (%)	150 (80.2)	46 (25.4)	8 (9.6)	2 (6.5)	**<0.001**
Morning stiffness + (%)	130 (68.8)	40 (21.2)	8 (9.6)	1 (3.2)	**<0.001**
At least one symptom	97.4	48.1	22.9	4.8	**<0.001**
Phalen + (%)	115 (60.8)	40 (21.2)	1 (1.2)	0 (0)	**<0.001**
Tinel + (%)	123 (65.8)	30 (15.9)	3 (3.6)	0 (0)	**<0.001**

* there is a statistically significant difference, ^{and} there was no statistically significant difference (p> 0.05)
$^{a, b, c}$ There is a statistically significant difference
$^{+, X}$ There is a statistically significant difference, $^{=}$ There was no statistically significant difference (p>0.05)
$^{x, y}$ there is a statistically significant difference, ^{z} there was no statistically significant difference (p>0.05)
$^{d, e, f, g}$ There is a statistically significant difference

DISCUSSION

The average age of the patients was determined as 48.7 years, and the influences of female gender, bilateral CTS and right wrist were more frequent. The presence of symptoms such as night pain, paresthesia and morning stiffness, and the positivity of examination findings such as Phalen and Tinel signs were consistent with the literature (3.11.23).

CTS is one of the most expensive upper extremity musculoskeletal disorders in terms of the maintenance cost and was reported between 1-16% (24.25). There are different recommendations regarding the treatment of this syndrome, which is common and has a high cost of treatment. Non-surgical and surgical approaches such as analgesics, night splints, physiotherapy, and local steroid injections are used in the treatment of CTS. Although surgical intervention in the treatment of CTS provides good results, complications such as pain and weakness after surgery are the limiting aspects of this treatment approach (26). Therefore, surgical treatment is usually recommended for patients with severe CTS, and for mild to moderate CTS patients that do not get any satisfactory results with other treatment modalities (27). The aim of the treatment is the decompression of the median nerve. Local steroid injection also provides a kind of decompression by reducing perineural inflammation and swelling of the surrounding soft tissue (28). For injection, triamcinolone, hydrocortisone and methyl-prednisolone may be used.

In studies in which corticosteroids have been reported to be effective, patients were asked whether they felt better or worse compared to pre-injection, and by using CTS functionality scales, the rate of patients with partial or complete relief were evaluated together. In a study with different doses of hydrocortisone and 20 mg of triamcinolone, 6-weeks activity rates were reported to be 63-72% and 6-months activity rates were 50-66% (28). In a different study, 12 mg of methylprednisolone was used and the rates of cases with complete or partial improvement were 71% at the 6th week and 57% in the 3rd month (14). In a study in which 20 mg of methylprednisolone was used and long-term efficacy was evaluated, surgery was required in 15% of the cases in the first year and in 33% of the cases in 5 years of follow-up, and in the carefully selected CTSs in this study, corticosteroid injection was reported to be effective in the long term (11). In a different study with an average follow-up of more than 7 years, 32% of the patients did not need repetitive treatment after the

first injection and corticosteroid injection was reported to have therapeutic efficacy (29). In addition, changes in sensory and motor nerve distal latencies and changes in DSAP amplitudes have been reported in different studies with corticosteroid injection (14,19). In our study, changes in the symptoms, examination findings, visual pain scale and electrophysiological parameters of patients with CTS were examined. Injections were repeated in patients with mild or moderate CTS after the injection. The second injection was applied to 43.9% of the patients with CTS and the third was applied to 16.4%. In 56.1% of the patients with CTS, there was no need for re-injection because of full recovery or very mild CTS in the electrophysiological examination after the initial injection. In addition, in our study, the rate of at least one symptom presence after the first injection decreased from 97.4% to 48.1%. The presence of at least one symptom was reduced by repetitive injections and decreased to 4.8% after the third injection, there was a statistically significant difference between before the injection and after repetitive injections. After the third injection, the rate of patients with mild to moderate CTS was 6.9%, according to the Bland classification (21), in other words, 92.1% of cases were normal or had very mild CTS with 1-3 injections. Also, there was also a statistically significant decrease in mean VAS, night pain, paresthesia, morning stiffness, Phalen and Tinel signs with repeated injections. In addition, a significant statistical difference was found between sensory and motor conduction distal latencies, sensory nerve action potential amplitudes and sensory conduction velocities between the first electrophysiological examinations and the post-injection examinations; there was no significant difference in these parameters with repetitive injections; after the first injection, the distal latency times were decreased, the DSAP amplitudes were increased and the conduction velocities were increased. Although the methodology and efficacy assessment parameters in our study were different from the mentioned studies, the rate of decrease in the rates or symptoms of patients who did not need second injections were consistent with the rates of efficacy in the literature. However, despite the need for surgery in 15% of the patients in the first year of the study in which the long-term efficacy was evaluated by a single injection, 6.9% of our cases were mild to moderate CTS with a third injection and according to the 9th month evaluation. Although when this group was considered to be a candidate group for surgical treatment, the rate was lower than the rates in the literature, our follow-up period was shorter than the literature. Again, we do not know the clinical and electrophysiological results in the 9th month of the patients that do not need another injection after the first or the second injections. These cases are very likely to be diagnosed with CTS or the cases of very mild CTS had a change in their stages. In addition, no electrophysiological changes were observed after the 2nd and 3rd injections, and we assert that this could be explained by the higher rate of patients who do not need to be injected.

Carpal tunnel injection can be made by many different methods (15-17). The most severe complications for injection are median and ulnar nerve injury (30). With the increase in the volume of the median nerve at the entrance of the carpal tunnel, the risk of median nerve injury increased during injection and permanent sensory defect was reported in approximately 10% of the patients (8). Recommendations such as injection to the medial of the palmaris longus tendon (PL), to the fourth finger alignment, injection between the PL and the flexor carpi radialis (FCR) tendons were reported to minimize injury (8.30-33). There are studies reporting that USG-guided injection is safer and more effective (29,34). However, the USG guided procedure is likely to take more time than conventional methods. For this reason, the classical method is still preferred. In the cadaveric study comparing different methods, it has been reported that the median nerve can be injured intraneurally at the rate of 6.7-26.7% (35). However, these complications belong to the injections made via different techniques from the techniques that we applied. In the study where a similar technique was used, it was reported that the injection time was shorter and safer (14). In this study in which the number of cases was low, no complication was reported. In the literature, studies that are sufficient and that consisted of more cases related to the technique we have applied have not been reported. In our study, injection was applied from the distal of the carpal tunnel. The number of cases was higher than that performed with similar technique, and no injection-related complications were reported in these cases. Surgical treatment has been reported to be more costly and to cause complications such as inability to work for weeks in cases (1). Compared to the surgical method, steroid injection is easier to administer and less costly. In addition, no complication was observed in repetitive injections with the method we applied.

CONCLUSION

Local steroid injection is highly effective and cost-effective, and the injection method that we applied is very safe and simple. We think that in patients with mild to moderate CTS according to the Bland classification, local steroid injection should be considered primarily in the treatment due to its efficacy, easy application, low complication risk and cost.

Competing interests: The authors declare that they have no competing interest.
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Ethical approval: The study was approved by our local ethics committee (07/33/29.11.2018).

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