

**RESEARCH ARTICLE**

# A Comparison of Hand Pain and Hand Function after Z-plasty Reconstruction of the Transverse Carpal Ligament with Traditional Median Neurolysis in Carpal Tunnel Syndrome

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**Abstract**

**Background:** Carpal tunnel syndrome is the most common focal mono-neuropathy. A study was designed to compare the effects of traditional open carpal tunnel release with median neurolysis and Z-plasty reconstruction of the transverse carpal ligament on post-operative hand pain and hand function in patients with idiopathic carpal tunnel syndrome.

**Methods:** Fifty-two patients with idiopathic carpal tunnel syndrome entered the study. The patients were randomly assigned into two groups to undergo simple transverse carpal ligament release or division of the ligament with Z-lengthening reconstruction. Forty-five patients completed the study. Two patients of the simple open surgery group and 5 patients of the Z-plasty reconstruction group did not complete the follow up course. After the procedure, the patients were followed to assess post-operative pain and hand function during a 12-week period.

**Results:** The scores of hand pain on the first day after surgery were not statistically different between the two groups ( $P=0.213$ ). But the score of hand pain was significantly lower in the Z-plasty reconstruction group at week 1, week 3, and week 6 after surgery ( $P<0.001$ ). However, at week 12, no patient complained of hand pain in both groups. Considering hand function, no patient had normal hand grip after the first week, but after three weeks, a significantly higher proportion of patients in the Z-plasty reconstruction group had reached near normal hand grip (76.1% vs. 29.1%;). However, at weeks 6 and 12, the differences were not statistically different between the two groups.

**Conclusion:** We observed significant reduction in hand pain, shorter duration of hand pain and shorter period of time to reach normal hand grip by Z-plasty reconstruction of the TCL.

**Keywords:** Carpal tunnel syndrome, Hand Function, Median Neurolysis, Pillar Pain, Z-plasty

**Introduction**

Carpal tunnel syndrome (CTS) is the most common focal mono-neuropathy (1, 2). The prevalence of CTS is estimated to be 1-5% in general population and is reported to be higher in industrial settings,

leading to a significant proportion of work-place absences (3-7).

Treatment options for CTS depend on predisposing factors, underlying etiologies, and the severity of the disease. However, in moderate to severe cases that

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do not improve by conservative measures, surgical decompression is suggested (8-12). The most common techniques of surgery for CTS are open or endoscopic carpal tunnel release. But a recent study has introduced Z-plasty reconstruction of the transverse carpal ligament (TCL) as a suitable surgical technique for CTS, compared with the traditional open carpal tunnel release (13). One of the most common complications of CTS surgery is hand pain that is probably due to the division of the TCL during surgery. It is mostly originated over the pisotriquetral joint, possibly due to displacement of pisiform (14).

Since no other study has evaluated the effects of Z-plasty reconstruction of the transverse carpal ligament for CTS treatment, we designed a study to compare the effects of simple open carpal tunnel release with median neurolysis and Z-plasty reconstruction of the transverse carpal ligament on hand pain and function of the hand after surgery in patients with idiopathic CTS.

### Materials and Methods

In this randomized clinical trial, 52 patients with idiopathic CTS who referred to Imam Hospital of Sari from October 2013 to January 2015 entered the study. The diagnosis of CTS was confirmed by positive electromyography and nerve conduction velocity (NCV) tests. The latency of more than 4.4 milli-seconds was considered in NCV as the criterion for diagnosing CTS.

The inclusion criteria were: age >18 and the presence of idiopathic CTS that was refractory to conservative treatment for at least 6 months. Accordingly, the exclusion criterion was the presence of any secondary cause for CTS (including diabetes, hypothyroidism, pregnancy, and so forth.). The patients were randomly assigned into two groups to undergo simple TCL release or division of the TCL with Z-lengthening reconstruction using computer generated randomization. The protocol was approved by the ethic committee of the Mazandaran University of Medical Sciences and informed consents were obtained from all patients.

Overall, 45 patients completed the study; two patients of the simple open surgery group and five patients of the Z-plasty reconstruction group did not complete the follow up course. The mean ages of the patients were 51±7.6

**Table 1. Demographic characteristics of the patients before surgery**

	Simple open carpal tunnel release (N= 24)	Z-plasty reconstruction (N=21)	P
Gender			
Male (%)	4 (16.7)	0 (0)	0.111
Female (%)	20 (83.3)	21 (100)	
Age (years)	51 ± 7.6	48 ± 8.5	0.276
Body mass index	26.4 ± 2	26.1 ± 1.3	0.588

years and 48±8.5 years in the two groups, respectively ( $P=0.276$ ). Other demographic characteristics of the patients, including gender and body mass index (BMI) did not show a statistically significant difference between the two groups [Table 1].

In order to perform simple open TCL release, a 2 - 2.5 cm incision was made distal to the wrist flexion crease, extending down toward the third inter-digital web. Also, a 2 - 2.5 cm incision was made proximal to the wrist flexion crease in a curvilinear manner toward the ulnar side to avoid trauma to the palmar cutaneous nerve branches. The incision was then deepened through the palmar fascia to the TCL. Afterwards, the TCL was divided longitudinally and the median nerve and its branches were released. After complete neurolysis, hemostasis was achieved and the skin edges were approximated and sutured in a simple, interrupted manner.

In order to perform Z-lengthening reconstruction, the median nerve and its branches were retracted, but were protected during the whole procedure. At first, a proximally base TCL flap was made by releasing its radial attachment to the carpus. Then a distally based flap was developed by releasing the ulnar leaf of the TCL, but preserving its attachment to the hook of the hamate and keeping the recurrent ulnar motor branch. Subsequently, the flaps were rotated and approximated by a 4.0 absorbable suture. At the end, skin edges were sutured in the same fashion as mentioned above.

After surgery, the patients were followed for 12 weeks. All patients were advised to begin range of motion exercises of the digits and wrist immediately after the procedure without any splinting. Soft compression dressing was used during the first four days and the sutures were removed after 7-10 days.

During the follow up period, the patients were evaluated for post operation hand pain on the first day after the procedure and then at 1, 3, 6 and 12 weeks. The pain was scored based on a visual analog scale of 0 to 10

**Table 2. A comparison between the two groups according to post-operative pain score and hand grip status**

	Simple open carpal tunnel release (N= 24)	Z-plasty reconstruction (N=21)	P
Duration of surgery (min)	13.8 ± 2.2	27.4 ± 3.6	<0.001
Hand pain score on:			
- 1 <sup>st</sup> day	7.8 ± 1.1	7.4 ± 0.8	0.213
- 1 <sup>st</sup> week	5.2 ± 1.2	4.5 ± 1.0	0.048
- 3 <sup>rd</sup> week	2.7 ± 1.2	1.1 ± 0.4	<0.001
- 6 <sup>th</sup> week	0.7 ± 0.3	0	<0.001
- 12 <sup>th</sup> week	0	0	1
Normal hand grip (%)			
- 1 <sup>st</sup> week	0	0	1
- 3 <sup>rd</sup> week	7 (29.1)	16 (76.1)	<0.001
- 6 <sup>th</sup> week	20 (83.3)	21 (100)	0.111
- 12 <sup>th</sup> week	24 (100)	21 (100)	1

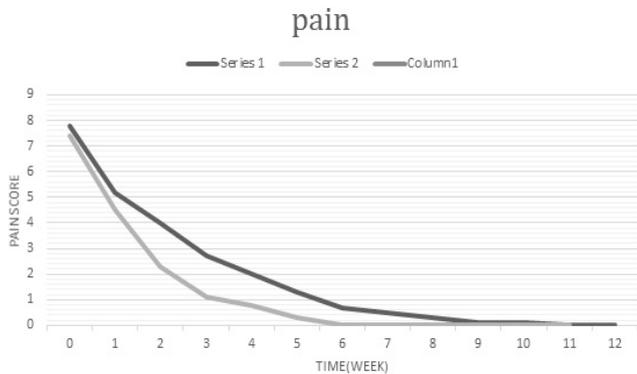


Figure 1. Comparison of pain scores between the two groups.

by each patient during each follow up visit. Zero score indicated having no pain and 10 indicated the worst possible pain. Also, grip strength was evaluated at 1, 3, 6 and 12 weeks by a hand-held dynamometer. In order to perform the evaluation, all patients performed three repeated maximal strength contractions by a hand-held dynamometer before the surgery and data were recorded. After surgery, maximal strength contractions were tested again at 1, 3, 6 and 12 weeks by the same hand-held dynamometer and were compared with the results recorded before surgery.

Data were analyzed using SPSS software for Windows (version 16, SPSS Inc. Chicago, IL, USA). Also, t-test and Chi-square tests were used to compare quantitative and qualitative variables, respectively. P-values less than 0.05 were considered statistically significant.

## Results

According to the analyses, the mean duration of the surgical procedure was significantly longer in the Z-plasty reconstruction group ( $27.4 \pm 3.6$  vs.  $13.8 \pm 2.2$  minutes,  $P < 0.001$ ).

The scores of hand pain at the first day after surgery were not statistically different between the two groups ( $P = 0.213$ ). But the score of hand pain was significantly lower in the Z-plasty reconstruction group at week 1, 3, and 6 after surgery ( $P < 0.001$ ). However, in both groups at week 12, no patient complained of hand pain [Figure 1; Table 2].

Considering hand function, no patient had normal hand grip after the first week, but after three weeks, a significantly higher proportion of patients in the Z-plasty reconstruction group had reached near normal hand grip ( $76.1\%$  vs.  $29.1\%$ ;  $P = 0.003$ ). However, at week 6 and 12, the differences were not statistically different between the two groups [Figure 2; Table 2].

## Discussion

According to the results of this study, although both groups had no pain and had reached normal hand grip at week 12, a significant reduction in hand pain, shorter duration of hand pain, and shorter period of time to reach normal hand grip was observed after Z-plasty reconstruction surgery.

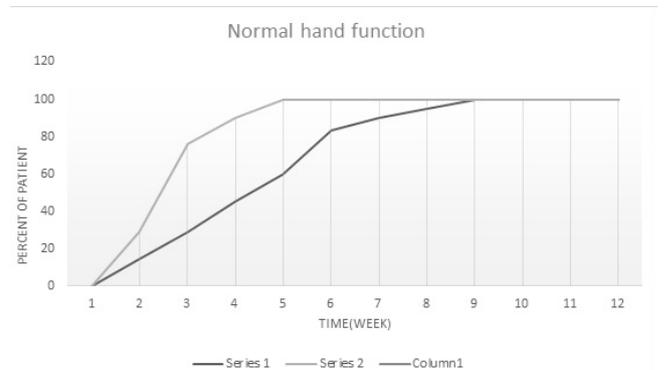


Figure 2. Comparison of normal hand function between the two groups during 12 weeks of follow up.

There are several modalities for CTS surgery and the most common approaches are endoscopic carpal tunnel release and open carpal tunnel release through a standard or limited incision. Although the endoscopic approach has been developed to eliminate post-operative pain, earlier return to work, and better cosmesis, some studies have reported significant complications (15). Pagnanelli et al. have reported 5.4% recurrence rate after endoscopic carpal tunnel release (ECTR) (16). There are also some risks associated by ECTR, including inability to examine the contents of the carpal canal, inadequate exposure of the structures, increasing the risk of injuries and the probability of incomplete TCL release. Furthermore, the success of the ECTR is closely related to the experience of the surgeon (17, 18).

On the other hand, although some trials have reported a sooner post-operative recovery and return to work by ECTR, other studies have not shown significant differences between ECTR and open carpal tunnel release (15, 19-23). Furthermore, although ECTR may lead to less post-operative pain and local tenderness, the degree of this advantage seems to be modest (23).

Z-plasty reconstruction surgery is a novel approach for open carpal tunnel release. In 2013, Seitz and Lall performed a study comparing open carpal tunnel release and median neurolysis with Z-plasty reconstruction of the TCL on 120 patients. Sixty-four patients underwent simple decompression surgery, while 56 patients underwent Z-lengthening reconstructive elongation of the retinacular ligament. The results of the study showed significant reduction in hand pain and earlier return to normal hand function by Z-plasty reconstruction surgery (13). We found no other study evaluating the effects of Z-plasty reconstruction on CTS. Therefore, the strong point of our study is offering the mentioned approach as a novel and suitable option for CTS surgery.

Regarding the results of previous studies, the incidence of hand pain after simple open TCL release during the first three months has been reported to be 6% - 20% (24, 25). In our study, no patient complained of hand pain at week 12 after surgery. The difference might be due to the exclusion of non-idiopathic CTS patients from the study.

The only previous study that has evaluated Z-plasty reconstruction of the TCL has reported 0% and 7%

post-operative hand pain at week 6 and 12 after surgery, respectively (25). The results are almost similar to the results of our study.

The major limitation of the present study was the small number of patients in each group, mainly due to performing the study on idiopathic CTS patients and performing the study in a single center.

In conclusion, we observed a significant reduction in hand pain, shorter duration of hand pain, and shorter period of time to reach normal hand grip by Z-plasty reconstruction of the TCL. We suggest further studies with a larger number of patients and to compare this approach with ECTR in the future.

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