Comparison of Partial Excision with Simple Section of the Transverse Carpal Ligament in the Treatment of Carpal Tunnel Syndrome

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In the surgical treatment of carpal tunnel syndrome, debate has commonly focused on whether decompression should be performed by open or blind techniques. Contrarily, the goal of the present study was to determine whether instead of simple section, partial excision of the transverse carpal ligament has contributed to better results. Because complete healing of the transverse carpal ligament observed during reoperations has been reported elsewhere, the charts of 75 carpal tunnel syndrome patients who had been treated with open technique at Dokuz Eylül University were reviewed. Statistical analysis was performed using the Fisher’s exact test and Student’s t test when appropriate. Thirty-five patients had been treated with simple section of the transverse carpal ligament, whereas 40 had been treated with partial excision. Internal neurolysis was also performed in 19 of the patients, 11 of whom were treated with partial excision. The average follow-up time was 3.8 years. The comparisons regarding the overall operative outcomes did not show any significant difference between the two different techniques of releasing the transverse carpal ligament. In patients treated without neurolysis, results of partial excision of the transverse carpal ligament improved when compared with those of simple section, but this superiority was not statistically significant. There seemed to be statistically higher reoperation rates and worse outcomes after neurolysis (p < 0.05). Reoperation was required in eight patients (11 percent). Five of the patients who underwent reoperation had initially been treated with partial excision and neurolysis, whereas two had been treated with simple section and neurolysis. Another patient who had undergone reoperation had initially undergone only simple section. The mean time to return to work or daily activities did not differ between the types of applied technique for releasing the transverse carpal ligament. However, neurolysis lengthened these periods significantly when performed (p < 0.05). In the present study, partial excision of the transverse carpal ligament without adding neurolysis offered relatively better results than simple section. Verification of this finding endoscopically, if applicable, may improve the success rate of surgical therapy in patients with carpal tunnel syndrome.

Carpal tunnel syndrome is the most frequently seen peripheral entrapment neuropathy and affects 1 percent of the general population and 5 percent of the working population. Typically, patients suffer from pain and paresthesia in the first three fingers and radial half of the ring finger, most often at night. Late middle-aged women and workers of both sexes, often young, whose symptoms are aggravated during the course of repetitive manual labor are prone to this entity. In patients with advanced carpal tunnel syndrome, weakness in thumb opposition and thenar atrophy may also be encountered. Surgical release through either an open or endoscopic procedure produces high success rates when the diagnosis of carpal tunnel syndrome is unequivocally defined by history, physical findings that include the provocative and sensory tests and the Tinel sign, and electrophysiology. However, persistence or recurrence of the symptomatology because of unsatisfactory decompression is one of the main sources of debate regarding the best surgical technique. Besides, complete healing of the transverse carpal ligament has also been found during reinterventions. In the present study, we aimed to assess whether performing partial excision in addition to simple section of the transverse carpal ligament had improved the outcome.

PATIENTS AND METHODS

During the years 1986 to 2000, carpal tunnel release was performed in 165 patients. To evaluate the effects of the type of surgical release of...
the transverse carpal ligament (simple section or partial excision) on outcome in a more homogenous population of patients, exclusion criteria were assessed. These criteria were wrist deformity, peripheral neuropathy, systemic diseases, previous operation for median nerve, features of double-crush syndrome, and bilateral operation.

Therefore, 75 patients who had been followed at least 1 year postoperatively could be included in this retrospective study. They were evaluated clinically and electrophysiologically before surgery, and all had typical symptoms and varying degrees of sensory and motor deficits with electrophysiologically proven diagnosis of carpal tunnel syndrome. Worker’s compensation status was also noted in all patients. At the follow-up appointments, residual symptoms and physical examination results were recorded and a questionnaire regarding satisfaction, daily activities, and work was administered. Patients were allowed to indicate, on a five-point scale, their satisfaction with the results of the operation. Improved or resolved results were defined by patient-reported lack of or mild symptoms more than 80 percent of the time. In addition, these patients had to be able to perform the routine daily activities with little or no difficulty more than 80 percent of the time. Finally, patients indicating overall satisfaction with the procedure greater than 80 percent were accepted as completely satisfied. Besides, postoperative outcome was assessed according to the degree of postoperative improvement in neural function (Table I), using the system modified by Steiner et al.8 Postoperative evaluations were all performed by one of the authors (S.E.).

**Patients**

Patients were between 26 and 70 years old, with a mean age of 50.4, and history ranged from 6 to 150 months, with an average length of 40 months. The median nerve was affected unilaterally on the right side in 27 patients, whereas it was affected bilaterally in 32. The most common symptom was paresthesia in 71 patients (95 percent), followed by pain and weakness in 64 (85 percent) and 22 (29 percent), respectively (Table II). The Tinel sign was positive in 62 patients (83 percent) and provocative tests also indicated a carpal tunnel syndrome in 55 (73 percent). Sensory deficit, elicited in 66 patients (88 percent), was the most frequent neurologic deficit. Motor deficit and muscle atrophy were also present in 30 patients (40 percent) and 18 patients (24 percent), respectively (Table III).

Preoperatively, median nerve distal sensory and motor latency and conduction velocity studies had been performed to confirm the diagnosis of carpal tunnel syndrome. All patients had varying increases in latencies and decreases in conduction velocities across the wrist.

The groups were also matched relatively well by severity of both clinical and electrophysiologic features. Patients were operated on with one of the simple section or partial excision techniques with which the senior authors (U.D.A. and E.M.G., respectively) were accustomed to performing. Postoperative electrophysiologic studies were performed in only 15 patients with residual symptoms and still indicated varying degrees of median nerve compression at the wrist level.

**Surgical Technique**

All patients were treated on an outpatient basis and operations were performed under local anesthesia. A curvilinear palmar incision that was entirely distal to the wrist crease was used in all patients. After identification of the transverse carpal ligament beneath the palmar aponeurosis, it was gradually opened until the median nerve could be seen. Once the median nerve was identified, the transverse carpal ligament, fibers of the palmar aponeurosis, and thenar or hypothenar muscles that might have crossed midline of the palm were sectioned adequately. In addition, a 3- to 4-mm longitudinal segment of the transverse carpal ligament was excised in a group of patients. Internal neurolysis was also performed in a group of patients with intraoperative findings of a severely compressed median nerve. The flexor retinaculum was not reconstructed in any pa-
tient. During reinterventions, rerelease of the median nerve with excision of either the transverse carpal ligament or fibrotic tissue and repeat internal neurolysis were performed. However, no composite graft was used for restoring a sliding pathway. The wound was closed in a single superficial layer of interrupted mattress sutures, and a light bandage on the elevated arm was applied.

**Statistical Analysis**

Chi-square analysis was applied during comparisons of the groups, and the Fisher’s exact test was used when appropriate. Dichotomy 1 (very good + good versus fair + unsatisfactory) was designed for comparing postoperative surgical outcome, whereas dichotomy 2 (complete versus partial + unchanged) was designed for comparing patient satisfaction. For statistical analysis of data in the descriptive study, the means, standard deviations, and ranges were calculated for the quantitative variables. Comparisons for the quantitative variables and changes in the neurologic findings were also performed with the Student’s t test and the McNemar test, respectively. In all cases, \( p < 0.05 \) was considered to be significant.

**RESULTS**

A total of 75 hands underwent open carpal tunnel release. Sixty-one of the patients were women, indicating a possible gender bias in this condition toward women \( (p < 0.05) \). Nine (12 percent) of the patients were worker’s compensation patients. The mean follow-up time was 3.8 years (range, 12 months to 8 years). During late follow-up, the majority of patients \( [n = 62 (83\%)\] had a good recovery (including very good and good outcomes), with improved neurologic deficits and resolution of subjective findings. Pain and paresthesia disappeared in 88 percent and 85 percent of the affected patients, respectively, whereas motor weakness disappeared in 68 percent (Table III). Neurologic examination revealed the rate of persisting preoperative sensory deficits as 30 percent (20 of 66 patients), motor deficits as 27 percent (eight of 30 patients), and muscle atrophy as 67 percent

<table>
<thead>
<tr>
<th>Simple Section (( n = 35 ))</th>
<th>Partial Excision (( n = 40 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (yr)</strong></td>
<td>53.0 ± 9.7</td>
</tr>
<tr>
<td><strong>Gender (women/men)</strong></td>
<td>28/7</td>
</tr>
<tr>
<td><strong>Side affected (right/left)</strong></td>
<td>12/12</td>
</tr>
<tr>
<td><strong>Worker’s compensation patient</strong></td>
<td>3</td>
</tr>
<tr>
<td><strong>Duration of symptoms (mo)</strong></td>
<td>38.9 ± 35.8</td>
</tr>
<tr>
<td><strong>Mean follow-up time (yr)</strong></td>
<td>4.1 ± 3.0</td>
</tr>
<tr>
<td><strong>Mean time to return to work or daily activities (wk)</strong></td>
<td>6.2 ± 3.1</td>
</tr>
<tr>
<td><strong>Reoperation</strong></td>
<td>5</td>
</tr>
<tr>
<td><strong>Mean time to reoperation (mo)</strong></td>
<td>7.0 ± 2.0</td>
</tr>
<tr>
<td><strong>Patient satisfaction (without neurolysis/with neurolysis)</strong></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>22/6</td>
</tr>
<tr>
<td>Partial</td>
<td>3/1</td>
</tr>
<tr>
<td>Unchanged</td>
<td>1/2</td>
</tr>
</tbody>
</table>

Data were expressed as mean ± standard deviation.

### Table III

Summary of the Symptoms and Signs of the Patients

<table>
<thead>
<tr>
<th></th>
<th>Simple Section</th>
<th>Partial Excision</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symptoms</strong></td>
<td>Preoperatively</td>
<td>Postoperatively</td>
</tr>
<tr>
<td>Paresthesia</td>
<td>32</td>
<td>3*</td>
</tr>
<tr>
<td>Pain</td>
<td>34</td>
<td>3*</td>
</tr>
<tr>
<td>Weakness</td>
<td>9</td>
<td>2*</td>
</tr>
<tr>
<td><strong>Signs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensory deficit</td>
<td>29</td>
<td>12*</td>
</tr>
<tr>
<td>Motor deficit</td>
<td>13</td>
<td>4*</td>
</tr>
<tr>
<td>Atrophy</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>

* Significant difference during intragroup comparisons \( (p < 0.05) \).
The mean time before the patients returned to work or daily activities was 7 weeks (range, 10 days to 18 weeks) and 60 patients (80 percent) were completely satisfied with surgery (Table II). Perioperative complications included two patients with stitch abscess managed on an outpatient basis and one wound infection for which the patient was hospitalized for wound care and antibiotic therapy. Wound dehiscence was also observed in one patient and repaired primarily.

**Analysis of the Initial Operations**

Simple section of the transverse carpal ligament was performed in 35 patients, whereas partial excision was performed in 40. Neurolysis of the median nerve was performed in 19 patients whose transverse carpal ligament had been simply sectioned (in eight patients) or partially excised (in 11 patients). Comparisons regarding both the overall outcome and patient satisfaction demonstrated no significant difference between the two types of surgical release (Table IV). Conversely, in patients who had not been treated with neurolysis, outcome (very good and good) and patient satisfaction (complete) following partial excision (97 percent and 96 percent, respectively) were observed to be relatively better than following simple section (85 percent and 85 percent, respectively). The mean time to return to work or daily activities did not differ between the two procedures. Performing internal neurolysis impaired both the mean time to return to daily activities and outcome (Fig. 1), irrespective of the type of surgical release (p < 0.05). Reoperation was performed in eight patients (11 percent), five of whom had previously been treated with partial excision and three with simple section (Fig. 2). However, in seven of the patients who underwent reoperation, internal neurolysis had also been performed during the initial operations, and internal neurolysis seemed to increase the reoperation rate (p < 0.05).

**Analysis of the Reoperations**

In all patients who underwent reoperation but one, neurolysis was also combined with the release of the transverse carpal ligament. Their symptoms had initially resolved following surgical release but subsequently recurred, requiring surgical rerelease of the carpal tunnel. The mean time between the initial operation and reintervention was 9 months (range, 5 to 18 months). During reoperations, moderate fibrosis enclosing the scarred median nerve in the carpal tunnel was detected and managed with repeat decompression and internal neurolysis of the median nerve. Neither insufficient release of the ligamentous structures nor complete healing of the transverse carpal ligament was encountered as the source of recurrent symptoms in any of the five reoperations after partial excision. However, severe fibrotic changes of the median nerve were visible in four of the patients. In addition, a continuous fibrous tissue from the carpal tunnel throughout the skin was also seen. In the other patient, the two cut edges of the transverse carpal liga-

**TABLE IV**

**Follow-Up Results of Surgical Treatment**

<table>
<thead>
<tr>
<th></th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Unsatisfactory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple section</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without neurolysis</td>
<td>11</td>
<td>12</td>
<td>4</td>
<td>–</td>
</tr>
<tr>
<td>With neurolysis</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Partial excision</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without neurolysis</td>
<td>19</td>
<td>9</td>
<td>1</td>
<td>–</td>
</tr>
<tr>
<td>With neurolysis</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

*Fig. 1. Relationship between neurolysis and reoperation. Neurolysis lengthened the mean time to return to work or daily activities significantly regardless of the technique used for releasing the carpal tunnel (p < 0.05). Data were expressed as mean ± SD. *Significant difference during group comparisons (p < 0.05). Filled bars, simple section; open bars, partial excision.*
ment were separated without finding any healing or scarring. The median nerve was covered only by a thin layer of fascia under the skin without finding any entrapment between the two cut edges of the transverse carpal ligament. Conversely, complete healing of the transverse carpal ligament and entrapment of a severely scarred median nerve between the two cut edges of the transverse carpal ligament were found during reoperations following simple section in two patients and one patient, respectively. None of the patients who underwent reoperation was cured satisfactorily, but we also observed no deterioration of the clinical features. Besides, four of them showed a significant reduction in pain, with improved sensation and strength.

**DISCUSSION**

The most common cause of failed carpal tunnel release continues to be the inadequate release of the ligament either proximally or distally. The main objective of carpal tunnel release should be complete section of the transverse carpal ligament without damage to the median nerve, to its branches, or to the adjacent cutaneous nerves. Therefore, open release of the transverse carpal ligament is the "gold standard" for the surgical treatment of carpal tunnel syndrome. Direct vision of the ligament guarantees complete section and prevents inadvertent damage to the vulnerable structures. More recently, newer methods using the endoscope have evolved, with an advantage being decreased pain in the postoperative period. However, the optimal method for releasing the transverse carpal ligament remains unclear. In the traditional open release, the ligament is left sectioned vertically with or without application of neurolysis. In addition to incomplete release of the transverse carpal ligament, complete healing of the transverse carpal ligament, anterior displacement of the carpal tunnel structures through the gap in the ligament, and fibrous proliferation and scarring in the carpal tunnel that had been observed during reoperations were the source of attempts for seeking alternative ligament incisions. However, it seems difficult to provide an enlarged and an intact transverse carpal ligament that prevents anterior displacement of the contents of the carpal tunnel. For this purpose, resuturing of the sectioned transverse carpal ligament after a linear sliding of the Z-plasty-like incision has been proposed. Likewise, Abdullah et al. introduced a parabolic incision in the transverse carpal ligament that could retain a ligament flap coverage of the tunnel with accomplishment of both the same degree of expansion of the ligament and the same proportionate increase in the volume of the carpal tunnel as would a vertical linear incision. However, these procedures are not widely used because the standard classic open technique provides excellent results, with few troublesome sequelae. Besides, these procedures may not be the best for the relatively inexperienced surgeon or the surgeon who decompresses the carpal tunnel infrequently.

Volumetric magnetic resonance imaging studies have shown that healing leaves the transverse carpal ligament in an expanded position, because there is a volumetric increase in the carpal canal with simple section. However, as far as we know, there have been no data published concerning the effects of performing partial excision of the transverse carpal ligament to decompress the carpal tunnel. Despite speculative results regarding the persistent pain and tenderness at the operation site caused by anterior displacement of the median nerve and other contents of the carpal tunnel, long-lasting decompression of the median nerve may be achieved better with partial excision of the transverse carpal ligament.
In addition, the possibility of recurrent nerve compression may be reduced with the formation of a wider reparative tissue bridging the two edges of the sectioned ligament. However, this explanation seems to be speculative because postoperative magnetic resonance imaging evaluations of the patients from the two groups to localize the median nerve and to identify whether the transverse carpal ligament has healed have not been performed in our patients. Concannon et al. found that the transverse carpal ligament had completely healed in five of their six patients who underwent reoperation after endoscopic release. In the present study, similar findings were also observed during reinterventions after simple section in two of the three patients who underwent reoperation. However, partial removal of the sectioned ligament covering the median nerve seemed promising, because we did not observe spontaneous closure of the transverse carpal ligament in any of the patients who underwent reoperation who had initially been treated with partial excision. In the patient showing no healing of the transverse carpal ligament, or scarring, the median nerve was covered by a thin layer of fascia under the skin. Decreased protection of the transverse carpal ligament against even microtraumas might have led to recurrence of the symptoms. In this group of patients who underwent reoperation, internal neurolysis had also been performed during the initial operations and might have been one of the main causes for reinterventions, because interfascicular neurolysis was found to impair microvascular circulation of the median nerve resulting from induction of fibrosis. Although internal neurolysis has initially been proposed by many investigators, it has recently been reserved for reoperations rather than initial operations. Therefore, apart from the partial excision of the transverse carpal ligament, neurolysis might have been the leading cause for the high reoperation rate and worse outcome in this group of patients. Fibrotic changes of the median nerves observed during reoperations have also supported this conclusion. However, internal neurolysis should not be accused of causing poor results alone, because it is not widely accepted that it always worsens outcome. Intraoperative findings of a severely affected median nerve requiring neurolysis may also partially explain these poor results in our patients. Conversely, complete healing of the transverse carpal liga-

ment was observed in two of the three patients who underwent reoperation who had previously been treated with simple section of the transverse carpal ligament. Neurolysis had also been performed in these two patients. In the other patient, the median nerve was not only entrapped between the two cut edges of the ligament but also compressed by a continuous fibrous tissue from the carpal tunnel through the skin.

Because the results of the standard open technique are excellent and its complications are quite low, it is difficult to prove an advantage of a newer technique for surgical release of the transverse carpal ligament. The improvement rate after open section of the transverse carpal ligament ranges from 91 to 98 percent. In patients we treated with only simple section of the transverse carpal ligament, we found the improvement rate was 85 percent. Conversely, the improvement rate following partial excision was 97 percent, which was comparable to those of the previously reported series. The mean time to return to daily activities or work did not differ according to the type of surgical release used, but the results of partial excision were found to be superior to those of simple section. Although significant correlation between improvement in the nerve conduction velocities and clinical improvement could not be consistently demonstrated at follow-up in the previous studies, our results could probably be more objective if we were able to perform electrophysiologic tests in all patients postoperatively.

The structures at risk of injury during carpal tunnel release are the motor and the palmar cutaneous branches of the median nerve, the superficial palmar arch, the ulnar nerve and artery, and the communicating branch of the ulnar nerve. Because the open method affords the advantage of direct visualization, the complication rate is relatively low, ranging from 1 to 2 percent. The fact that we did not encounter any injury of the vulnerable structures might have been because of the availability of adequate visualization with the skin incision used. Therefore, performing partial excision of a vertically sectioned transverse carpal ligament is not a sophisticated technique as compared with other advocated alternatives. However, the complication rate of endoscopic carpal tunnel release varies between 1 and 10 percent, and attempts at excising the transverse carpal ligament endoscopically may
increase the complication rate because of the limited visualization.

CONCLUSIONS

Partial excision of the transverse carpal liga-
ment offered better results than simple section
in patients with carpal tunnel syndrome. How-
ever, further evaluations for both the complica-
tion rate of this procedure and the availabil-
ity of its endoscopic application are needed.

REFERENCES

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