Abstract. – Aim: To compare two different mini-incision surgical techniques for carpal tunnel surgery.

Materials and Methods: A total of 45 patients in Group 1 underwent carpal tunnel release through a 2-cm longitudinal incision made distal to the flexor crease, whereas the 45 patients in Group 2 underwent carpal tunnel release through a 2-cm longitudinal incision made proximal to the flexor crease. The self-administered Boston Questionnaire was used to assess the severity of patients’ symptoms and their functional status, both before and after the surgical intervention and at their final follow-up. Patients were also asked, during the final follow-up, about the pain level of their scar tissue.

Results: There was a significant decrease in the Boston Carpal Tunnel Questionnaire scores for the symptom severity scale and the functional status scale of patients in both groups, pre-operatively, post-operatively at one month and at final follow-up (p < 0.001 for both). The mean operative time for Group 2 was significantly shorter than for Group 1 (p < 0.001). At final follow-up, 11 patients in Group 1 stated they had scar tissue pain, compared to three patients in Group 2. The pain in scar tissue among Group 2 was significantly less than for Group 1 (p = 0.02).

Conclusions: Due to shorter operative times, mini-incisions proximal to the flexor crease can be performed. The absence of relapse and good clinical results make both surgical techniques suitable. For this reason, we consider that the selection of the mini-surgical technique used should depend on the experience and skill of the surgeon.

Key Words:
Carpal tunnel syndrome, Mini-invasive surgery, Outcome.
patients, between February 2006 and December 2009. Each patient’s diagnosis was confirmed by physical examination and electromyography. Initially, conservative treatment, including rest, bracing and non-steroidal anti-inflammatory medications, was administered. Patients who had persistent symptoms received surgical treatment, and those with bilateral carpal tunnel syndrome who had undergone bilateral surgical procedures were not included in this study.

Patients were divided into two groups, and received surgical treatment using one of two different mini-incision techniques. The surgical technique each patient received depended on the allocation of consecutive patients to Group 1 (G1) and Group 2 (G2). A total of 45 patients (32 females; 13 males) in G1 underwent carpal tunnel release through a 2-cm longitudinal incision made distal to the flexor crease, whereas the 45 patients (36 females; 9 males) in G2 underwent carpal tunnel release through a 2-cm longitudinal incision made proximal to the flexor crease. In G1, 34 patients had right hand complaints and 11 had left hand complaints; in G2, 31 patients had right hand complaints and 14 had left hand complaints.

All surgery was done under local anesthesia, without a tourniquet, using 2% xylocain 5 cc and isotonic SF 5 cc. A post-operative elastic bandage was applied to all patients, allowing early active motion. The stitches were removed on post-operative day 10.

Outcome Measures
The self-administered Boston Questionnaire was used to assess the severity of patients’ symptoms and their functional status, both before and after the surgical intervention and at their final follow-up. The Boston Questionnaire consists of 11 items for symptom severity scores (SSS) and eight items for functional severity scores (FSS). The result was calculated by adding the scores, from 1 to 5, then dividing this sum by the number of questions. All patients have been monitored by electromyography at final follow-up, and also asked about the pain level of their scar tissue.

Surgical Technique 1 (G1, Distal Approach)
After administering local anesthesia without a tourniquet, a 2-cm vertical incision was made on the ulnar side of the thenar crease, beginning just at the distal wrist crease. The incision was deepened down through the subcutaneous fat layer and palmar aponeurosis, until it reached the transverse ligament. The distal edge of the ligament was cut and, at this point, the superficial branch of the median nerve was identified and preserved. The proximal part of the ligament and the antebrachial fascia were cut with scissors. The median nerve was easily identified and preserved. After doing careful hemostasis, the surgical site was cleaned with normal saline and the skin closed with 4/0 prolene (Figure 1).

Surgical Technique 2 (G2, Proximal Approach)
After administering local anesthesia without a tourniquet, a 2-cm vertical incision was made on the ulnar side of the palmaris longus tendon (PLT), beginning proximal to the wrist crease. After passing through the subcutaneous tissue, PLT and antebrachial fascia were identified, and the median nerve radial to the PLT could be seen. The antebrachial fascia was cut vertically, staying on the ulnar side of the PLT. When the proximal edge of the transverse carpal ligament (TCL) was identified, the PLT was retracted radially and the palmar cutaneous branch of the median nerve preserved. A clamp was placed between the median nerve and the TCL and, using a No. 15 scalpel with the point directed upward, the TCL was cut percutaneously in a proximal-to-distal direction. The TCL was then inspected, using a blunt hook. Finally, the surgical site was cleaned with normal saline and the skin closed with 4/0 prolene (Figure 1).

Statistical Analysis
Outcome measures were analyzed using the SPSS package program (SPSS Inc., Chicago, IL).
USA); data was shown as mean plus/minus standard deviation. Student’s t-test was used to compare symptom severity scores and functional severity scores, both before and after surgical intervention and at final follow-up, for both groups. The independent samples t-test was used to compare the mean operation time and the scar tissue pain between the two groups. A p-value less than 0.05 was accepted as statistically significant.

**Results**

The mean follow-up period was 30.4±15.0 months in G1 and 31.0±15.3 months in G2. (Table I) There was a significant decrease in the Boston Carpal Tunnel Questionnaire scores for the symptom severity scale (SSS) and the functional status scale (FSS) of patients in both groups, pre-operatively and post-operatively at one month (p < 0.001). A statistically significant decrease was found in the SSS and FSS scores of patients in both groups, pre-operatively and at final follow-up (p < 0.001) (Table II).

No statistically significant difference was found between the groups in the SSS and FSS scores, pre-operatively, at post-operative one month and during final follow-up (p > 0.05). In both groups, the SSS and FSS scores at final follow-up had increased in comparison to those at post-operative one month, which did not, however, reach statistical significance (p > 0.05).

The mean operative time for G2 was found to be statistically significantly shorter than for G1 (p < 0.001). At final follow-up, 11 patients in G1 said they had scar tissue pain, compared to three patients in G2. The pain in scar tissue among G2 patients was statistically significantly less than for G1 patients (p = 0.02) (Table I).

According to the follow-up electromyographies and physical examinations there was no worsening in either group.

**Discussion**

In carpal tunnel surgery, procedures performed with standard open techniques require a large incision. This can lead to complications such as tension of the flexor tendons, excessive scar tissue formation and increased sensitivity.10-12 For this reason, mini open and endoscopic surgical techniques performed through a smaller incision have been recommended. Mini-incision procedures were performed using a small longitudinal palmar incision or a transverse wrist incision. Few, or no, complications were observed with these techniques.2-8,13-18 Minimally invasive techniques allow early motion and minimize scar tissue pain, thus meeting the post-operative expectations of the patient.

In the present study, we compared the more commonly used mini-incision technique, performed distal to the flexor crease of the wrist, to the less commonly used mini-incision technique, performed proximal to the flexor crease of the wrist. Significant clinical results were observed at post-operative follow-up in both techniques.

When mini-incision and endoscopic surgical techniques were compared, no significant difference was found between the outcomes in the short or long term.15,19-21 The disadvantages of endoscopic techniques include high cost, possible damage to the neighbouring soft tissues and the inability to perform a complete sectioning of the transverse carpal ligament.8,22,23

Broomley et al, in their investigation, used a mini-incision technique and reported less scar

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**Table I. Clinical details of the patients and results.**

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
<th>p value</th>
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<tbody>
<tr>
<td>Sex (F/M) (%)</td>
<td>71.1</td>
<td>80.0</td>
<td>0.332</td>
</tr>
<tr>
<td>Mean age (year)</td>
<td>45.8 ± 8.3</td>
<td>47.7 ± 7.8</td>
<td>0.276</td>
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<tr>
<td>Side (Right/Left) (%)</td>
<td>75.6</td>
<td>68.9</td>
<td>0.486</td>
</tr>
<tr>
<td>Mean operation time (min)</td>
<td>18.6 ± 2.3</td>
<td>10.7 ± 2.0</td>
<td>&lt; 0.001**</td>
</tr>
<tr>
<td>Mean follow-up period (month)</td>
<td>30.4 ± 15.0</td>
<td>31.0 ± 15.3</td>
<td>0.84</td>
</tr>
<tr>
<td>Scar tissue pain (%)</td>
<td>24.4</td>
<td>6.7</td>
<td>0.02**</td>
</tr>
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G1 = Incision distal to the flexor crease; G2 = Incision proximal to the flexor crease; F = Female; M = Male; *Independent sample t test; **P < 0.05.
tissue formation, shorter operative time, less post-operative pain and the possibility for local anesthesia. Avci and Sayli\(^3\) reported good results and fewer complications for the knife-light technique that involves a short longitudinal palmar incision. Paolo et al\(^24\) compared the standard mini-incision technique to the knife-light technique on 185 patients. A tourniquet was applied to all patients. Axillary block was performed in some cases, while local anesthesia was administered for the others. The study found that the operative time was shorter than 20 minutes in patients who received the knife-light technique through a transverse incision at the flexor crease. Short-term outcomes were found to be better among these patients than for patients undergoing standard mini-incision. However, there was no significant difference in the long-term outcomes.

In our study all surgery was done under local anesthesia, without using a tourniquet. The mean operative time was 18.6 minutes for G1 and 10.7 minutes for G2. The shorter operative time in G2 patients resulted from the absence of dense soft tissue mass that needs to be excluded. The median nerve was reached easily and the proximal edge of the transverse carpal ligament could be seen. However, for G1 patients, the need to pass through the subcutaneous dense fat tissue to reach the transverse carpal ligament resulted in a loss of time.

A bloodless surgical field is important in hand surgery; using a tourniquet produces a bloodless surgical field. However, no tourniquet was used in either group and no surgical difficulty was observed in our study. Tzarnas and Darby\(^25\) reported good results, with no complications, in surgeries performed under local anesthetic containing adrenaline without a tourniquet.

After testing the reliability of the surgical procedure on cadavers, Dayican et al\(^26\) performed carpal tunnel surgery on 96 patients, through a vertical incision proximal to the flexor crease of the wrist. No neurological complications were reported. The procedure was performed under local anesthesia, without a tourniquet. The mean operative time was found to be nine minutes, with no bleeding noted. Significant clinical results were observed at post-operative follow-up.

No neurological symptoms were observed in G2 patients who were treated with the latter technique, which is less frequently used and believed to involve an increased risk of neurological damage. Radial retraction of the palmaris longus tendon and incision of the transverse carpal ligament on the ulnar side reduce the risk of neurological damage. G2 patients had shorter operative time and less hypertrophic scar tissue pain at final follow-up. The results from the symptomatic and functional scales revealed an improvement in both groups. Given shorter operative time and reduced

<table>
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<th>Table II. Patients’ results of Boston carpal tunnel questionnaire scores.</th>
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<tr>
<td>Preop</td>
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<tr>
<td>SSS</td>
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<tr>
<td>Results of symptomatic severity score (SSS) for G1 patients</td>
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<td>p value*</td>
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<tr>
<td>Results of functional status scale (FSS) for G1 patients</td>
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<tr>
<td>p value*</td>
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<tr>
<td>Results of symptomatic severity score (SSS) for G2 patients</td>
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<td>p value*</td>
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<tr>
<td>Results of functional status scale (FSS) for G2 patients</td>
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<td>p value*</td>
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*Student t test.
hypertrophic scar tissue formation, the mini-longitudinal incision technique performed proximal to the flexor crease of the wrist can be used.

Klein et al.\textsuperscript{27} reported successful results with open surgical techniques performed through a 1 cm incision. The mini-incision technique yielded satisfactory results. Our surgical techniques were performed through a 2 cm incision, but the incision can be reduced.

**Conclusions**

The surgical procedures performed in this study are low-cost techniques that require no hospitalization and yield successful clinical results. No statistically significant difference was found between the results of the surgeries performed using either of the two techniques. The decrease in the operative time and the reduction in hypertrophic scar tissue formation reached statistical significance in G2 patients. A small incision and decreased tissue damage clearly reduce tension of the flexor tendons and scar tissue formation, and mini open techniques are superior to standard open surgical technique. However, mini open surgical procedures were the same in terms of short- and long-term clinical outcomes. Through a mini-incision made proximal to the flexor crease of the wrist, the identification of the proximal TCL and the incision of the TCL from the proximal to the distal can be easily performed, as in G2 cases. Due to shorter operative time, mini-incision made proximal to the flexor crease can be performed. Finally, the absence of relapse and good clinical results make both surgical techniques used in this study suitable. For this reason, we consider that the selection of the mini-surgical technique used should depend on the experience and skill of the surgeon.

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