Endoscopic Carpal Tunnel Release: Thirteen Years’ Experience With the Chow Technique

James C.Y. Chow, MD, Michael E. Hantes, MD, Mt. Vernon, IL

The purpose of this single-center study was to evaluate the results of endoscopic carpal tunnel release (ECTR) by using the dual portal Chow technique in a large series of patients. A total of 2,675 procedures in 1,886 patients were performed during a 13-year period. Follow-up evaluation was performed in 2,402 (90%) cases or 1,698 (90%) patients. The success rate was 95% and the recurrence rate was 0.5%. A total of 106 cases (4.5%) were considered failures or had unsatisfactory results. The overall complication rate was 1.1% but no serious complications occurred in this series. The return-to-work status was followed-up in 1,156 patients; 90% of non-worker’s compensation patients and 60% of worker’s compensation patients returned to work within 4 weeks. This study suggests that ECTR for carpal tunnel syndrome (CTR) is a reliable procedure with a high success rate. Based on our 13 years of experience, we believe that the technique is safe and iatrogenic complications can be avoided with meticulous surgical technique. (J Hand Surg 2002;27A:1011-1018. Copyright © 2002 by the American Society for Surgery of the Hand.)

Key words: Carpal tunnel surgery, endoscopic release, safety, complications.

Carpal tunnel syndrome (CTS) is the most common compression neuropathy of the upper extremity. It is now the most frequently performed surgery of the hand in the United States. Open carpal tunnel release (OCTR) was popularized by Phalen et al and has proved an effective method for treating CTS. The most common complications after open procedure are hypertrophic or painful scars and pillar pain (pain in the thenar or hypothenar eminences).

In an effort to decrease these complications, endoscopic carpal tunnel release (ECTR) has been developed in the past decade. According to several studies, ECTR results in a notably more rapid return to work and daily activities and less scar tenderness than OCTR. Skepticism was expressed by some surgeons regarding this technique mainly because major neurovascular complications have been reported. Incomplete release of the carpal ligament is a potential complication of this method as suggested by other studies. Thus it seems that the role of ECTR in the treatment of CTS has not been clearly defined.

This retrospective study was undertaken to evaluate the safety and efficacy of ECTR using the Chow technique in a large series of patients. The time to return to work for non-worker’s compensation and worker’s compensation patients also is analyzed.

Materials and Methods

Between September 1987 and February 2001, 2,675 hands in 1,886 patients underwent ECTR using the Chow technique. The diagnosis of CTS was...
Table 1. Demographics of Study Population

<table>
<thead>
<tr>
<th>No. of</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients/Cases</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>1,075*</td>
</tr>
<tr>
<td>Men</td>
<td>623*</td>
</tr>
<tr>
<td>Bilateral involvement</td>
<td>704*</td>
</tr>
<tr>
<td>Right hands (including bilateral cases)</td>
<td>1,336+</td>
</tr>
<tr>
<td>Left hands (including bilateral cases)</td>
<td>1,066+</td>
</tr>
<tr>
<td>Positive Tinel’s sign</td>
<td>2,168+</td>
</tr>
<tr>
<td>Positive Phalen sign</td>
<td>2,243+</td>
</tr>
<tr>
<td>Positive NCV test</td>
<td>2,294+</td>
</tr>
<tr>
<td>Age (y) Mean, 51</td>
<td>Range, 14–96</td>
</tr>
</tbody>
</table>

*Number of patients (total = 1,698).
†Number of cases (total = 2,402).
NCV, nerve conduction velocity.

based on clinical symptoms (numbness, tingling, weakness, pain in the distribution of the median nerve at wrist, Tinel’s sign, Phalen’s sign) and nerve conduction velocity test. All patients had failed prior treatment with splinting and anti-inflammatory medication for at least 3 months before the procedure.

A total of 188 of 1,886 (10%) patients—or 273 of 2,675 (10.2%) wrists—were lost to follow-up evaluation and were excluded from the study. All patients, including those who were lost to follow-up evaluation, came for at least suture removal 1 week after surgery. Therefore the neurovascular status of the hand during the immediate postoperative period was followed-up in all patients. The lost-to-follow-up category refers to this long-term study and includes those patients who could not be reached either because they were deceased, had moved without a forwarding address, or were unavailable because they were living outside the state or country. Thus 1,698 patients (2,402 cases) constitute the subjects of this report. Demographic data of these patients are shown in Table 1.

All patients were offered ECTR after confirmation of CTS. Patients with limited wrist extension, associated Dupuytren’s contracture, and masses in the carpal canal were treated with the open surgical treatment method and were not included in the study. A prior OCTR was not considered contraindication for ECTR. ECTR was performed at separate settings in patients with bilateral carpal tunnel syndrome. All procedures were done by the senior author (J.C.Y.C.).

Demographic data as well as preoperative, operative, and postoperative objective and subjective data (including duration of symptoms, results of nerve-conduction velocity tests, surgery time, relief of symptoms, return to normal activities) were collected on all patients based on chart review. In addition patients were asked to return to the clinic for a final follow-up visit. Patients who returned to the office underwent a complete clinical examination, including Tinel’s sign and Phalen’s sign, by an independent observer (M.E.H). Patients who were not able to return to the office were interviewed by telephone for the current status of their hands. Patients were asked to report the presence and severity of any symptoms after surgery including numbness, tingling, night pain, and weakness.

Of the 1,698 patients, 932 (55%)—or 1,385 cases (57.6%)—returned to the office for a complete follow-up evaluation. The remaining 766 patients (45%)—or 1,017 cases (42.4%)—were reviewed by telephone. The average follow-up period was 6 years and 10 months (range, 4–161 mo). The average duration of symptoms was 3 years and 4 months (range, 3 mo–42 y). Systemic diseases (rheumatoid arthritis, hypothyroidism, diabetes, and lupus) were noted in 88 (5%) patients. Prior trauma to the involved extremity was reported in 123 of 2,402 (5%) cases. Fourteen patients had recurrent CTS after having an open procedure performed in the past.

The return-to-work status was not followed-up in unemployed patients or homemakers. Patients were told to return to work as soon as symptoms allowed. The date of return to any level of employment while using the operated hand was recorded and used to calculate the return-to-work status. For those patients who underwent sequential bilateral ECTR the time from the second surgery to the patient’s return to work was calculated as the return-to-work time.

Recurrences were defined as patients who initially improved after surgery but subsequently noted a return of symptoms. Failed ECTR procedures were defined as patients whose symptoms did not improve after surgery. Patients with moderate symptoms (occasional pain and tingling but not pain at night) after ECTR were classified as unsatisfactory procedures. Following the surgery, those patients who reported complete relief from their symptoms and return of normal hand function were classified as having complete success from the procedure. If the patient indicated that the majority of his or her complaints were relieved following the surgery but still reported slight residual tingling over the fingers, the patient was
considered to have had satisfactory results from the procedure.

Surgical Technique

The original technique as described by the senior author (J.C.Y.C.) is a transbursal technique and requires penetration of the ulnar bursa.\textsuperscript{7,10} The extrabursal modification of this technique makes the procedure much easier and improves visualization of the proximal carpal ligament.\textsuperscript{20–22} The transbursal technique was used in 603 cases (25\%) whereas 1,799 cases (75\%) were treated with the extrabursal technique. The latter technique is described.

Local anesthesia was used for the procedure. Xylocaine 1\% (Astra, Westboro, MA) was injected at both the entry and exit portals, approximately 1 mL at each portal. The procedure was done without the use of a tourniquet.

The entry portal was created by drawing a line from the proximal tip of the pisiform radially, 15 to 20 mm in length depending on the size of the hand. A second line approximately 5 mm was drawn proximally from the end of the first line, followed by a small dotted line (7–10 mm) that was drawn from the end of the second line to create the entry portal. The exit portal was made in the palm surface (0.5–0.75 cm in length) on the bisect line of the angle formed from the distal border of the fully abducted thumb and the third web space and approximately 1 cm proximal to the junction of these lines.

A common early mistake was ulnar placement of the entry portal. Based on our experience we established helpful checkpoints for the surgeon to use to estimate correct portal placement and avoid mistakes:

1. Look at the entire width of the wrist to be sure that the entry portal is centrally located;
2. Be sure that the landmarks for the entry and exit portals are aligned along the long axis of the forearm;
3. Palpate the hook of the hamate, marking it on the hand, to be sure that both the entry and exit portals are located radially to the hook of the hamate (Fig. 1);
4. Palpate the ulnar artery to be sure that the pulsations are not just below the incision line before making the entry portal. Obviously, if the tourniquet is used this important guideline is lost.

Through the entry portal a longitudinal incision was made to the fascia. Then the curved dissector-slotted cannula assembly unit was slipped under the carpal ligament. With the tip of this unit touching the hook of hamate the hand was hyperextended and the cannula assembly was gently advanced distally, pointing toward the exit portal. A small transverse incision was made and the cannula assembly exited through the distal portal and the hand stabilized in the hand holder. The trocar was then removed and the scope was inserted proximally into the cannula so that the carpal ligament fibers could be seen clearly. A probe should always be used to palpate the ligament and ensure that no other tissue is present between the trocar and the carpal ligament. Any abnormal sensation in the patient's hand at this point should alert the surgeon to a potential problem. If the surgeon has any doubts the tube should be removed and reinserted.

The transverse carpal ligament was then divided with a sequence of cuts with the use of the probe, triangular, and retrograde knives supplied with the kit. An examination of the hand was performed at the end of the procedure while the surgical field was still sterilized. If intraoperative complications have occurred, open surgical exposure of the carpal tunnel can be performed at this time. After releasing the carpal ligament endoscopically, there is seldom any bleeding and only one suture is required for closing each portal.
Active exercise of the hand begins immediately after surgery. Sutures are usually removed in 1 week. The patient is advised to avoid heavy lifting and direct pressure to the palm for 2 to 3 weeks, or until the discomfort disappears.

**Results**

The average operating time was 8 minutes (range, 5–27 min). The operating time took longer than 20 minutes in 12 cases. In these cases an ulnar transligamental motor branch of the median nerve was noted (Fig. 2). Division of the transverse carpal ligament was carried out very carefully, step by step, to avoid the motor branch of the median nerve. The ratio of this variance in our series was 1 per 200 cases. One case was converted to an open procedure because of a rare anatomic variation of the median nerve. In this case, during the insertion of the cannula assembly, the patient felt extreme pain in the entry portal area. Because of this an open standard procedure was performed. Exploration revealed that the motor branch of the median nerve was extremely proximal (Fig. 3).

At the final follow-up evaluation a total of 2,284 (95%) hands were completely asymptomatic or had very minor problems after ECTR and the patients were completely satisfied with the procedure. Regarding the 932 patients (1,385 cases) who returned to the office for a complete follow-up evaluation, Phalen’s sign was negative in 1,345 cases (97.1%) and Tinel’s sign was negative in 1,281 cases (92.5%).

Ninety-four cases (3.9%) were considered unsatisfactory with minor to moderate complaints. The majority of these complaints involved occasional pain, tingling, numbness, and weakness. All patients reported that their hands improved after ECTR and none of the patients had significant discomfort. No second surgery was undertaken in these patients.

Twelve cases (0.5%) were classified as failed ECTR. Of interest is that 4 of these patients had a prior OCTR. In 9 of these patients the duration of symptoms was more than 1 year. Ten of these patients underwent an OCTR by the senior author. Two patients went elsewhere for further treatment. In 4 cases the carpal ligament was considered incompletely transected. In the remaining 6 cases, including those with a prior OCTR, there was abundant scarring in the previously transected area of the carpal ligament, but no evidence was found of a reformed carpal ligament. Fibrous and scar tissue between the median nerve and carpal ligament was noted in all cases and a neurolysis was performed. Despite this only half of these patients had significant improvement after the surgery. All 4 patients with incomplete release had complete relief of their symptoms.

Eleven cases (0.45%) were classified as recurrent cases. Data from these patients are listed in Table 2. The mean time of recurrence for these patients was 21 months (range, 7–63 mo). The survey also showed that 8 patients engaged in heavy work that...
Table 2. Recurrent Cases

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Gender</th>
<th>Hand</th>
<th>Duration of Symptoms in Months</th>
<th>Date of First Surgery</th>
<th>Time of Recurrence in Months</th>
<th>Type of Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>64</td>
<td>F</td>
<td>R</td>
<td>15</td>
<td>11/23/87</td>
<td>63</td>
<td>ECTR</td>
</tr>
<tr>
<td>2</td>
<td>63</td>
<td>F</td>
<td>R</td>
<td>26</td>
<td>5/7/90</td>
<td>37</td>
<td>ECTR</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>F</td>
<td>R</td>
<td>7</td>
<td>6/22/90</td>
<td>16</td>
<td>None*</td>
</tr>
<tr>
<td>4</td>
<td>36</td>
<td>F</td>
<td>R</td>
<td>4</td>
<td>1/30/91</td>
<td>18</td>
<td>None*</td>
</tr>
<tr>
<td>5</td>
<td>45</td>
<td>F</td>
<td>L</td>
<td>15</td>
<td>2/12/92</td>
<td>12</td>
<td>Open</td>
</tr>
<tr>
<td>6</td>
<td>49</td>
<td>F</td>
<td>R</td>
<td>7</td>
<td>4/13/92</td>
<td>7</td>
<td>ECTR</td>
</tr>
<tr>
<td>7</td>
<td>52</td>
<td>M</td>
<td>R</td>
<td>24</td>
<td>8/5/92</td>
<td>16</td>
<td>ECTR</td>
</tr>
<tr>
<td>8</td>
<td>57</td>
<td>F</td>
<td>R</td>
<td>14</td>
<td>3/22/96</td>
<td>19</td>
<td>Open</td>
</tr>
<tr>
<td>9</td>
<td>41</td>
<td>F</td>
<td>R</td>
<td>5</td>
<td>10/15/97</td>
<td>9</td>
<td>ECTR</td>
</tr>
<tr>
<td>10</td>
<td>55</td>
<td>F</td>
<td>R</td>
<td>26</td>
<td>12/10/97</td>
<td>15</td>
<td>None*</td>
</tr>
<tr>
<td>11</td>
<td>76</td>
<td>F</td>
<td>L</td>
<td>50</td>
<td>12/4/98</td>
<td>20</td>
<td>ECTR</td>
</tr>
</tbody>
</table>

F, female; R, right; L, left; M, male.
*These patients refused or went elsewhere for further treatment.

required repetitive motion of their hands. Further endoscopic or standard open surgery was offered to this group. Six patients chose ECTR again and 2 patients chose the open exploration. The remaining 3 patients refused to have another procedure or went elsewhere for further treatment. In the open revision group one patient had complete relief of her symptoms whereas the other remained the same. In the ECTR revision group the symptoms in 5 of the 6 hands were improved or completely resolved after the procedure. An additional open exploration and extensive neurolysis for the patient who remained the same after the second ECTR was carried out. Eventually the patient improved but she is not without symptoms.

In the ECTR revision group the appearance of the ligament was not that of a normal carpal ligament and a thickened scarlike tissue was noted between the transverse fibers of the ligament. In these cases it was not possible to determine whether the restoration of the ceiling of the carpal canal was the result of scarring or if the ligament had not been completely released.

There were 2 patients who had transient ulnar nerve palsy. The first patient had slightly diminished sensation in the ulnar nerve distribution with tingling, a numb sensation of the ring and small fingers, and an inability to fully abduct the fifth digit. The patient recovered spontaneously in 4 weeks. The second patient developed a loss of interosseous muscles after surgery although the sensation appeared to be intact. It took 5 months before the patient fully recovered and she now has full use of her hand with no residual problems. In both of these cases the transbursal approach was used. Another patient developed a superficial infection in the proximal wound (entry portal). This was treated with oral antibiotics and local wound care.

The return-to-work status was followed-up in 1,156 patients. This was not done in the remaining 542 patients who were unemployed or homemakers. There were 374 worker’s compensation patients and 782 non-worker’s compensation patients. Analysis showed that most (65%) of the non-worker’s compensation patients were able to return to work on or before 4 weeks after ECTR. Ninety percent of them were able to return to work on or before 4 weeks after ECTR. In contrast, only 60% of the worker’s compensation patients were able to return to work on or before 4 weeks after ECTR (Table 3).

Discussion

ECTR was introduced in the late 1980s as a new technique for surgical treatment of CTS. Since then

Table 3. Return to Work After ECTR for Worker’s Compensation Patients and Non-Worker’s Compensation Patients

<table>
<thead>
<tr>
<th>Return to Work</th>
<th>Non-Worker’s Compensation (n = 782)</th>
<th>Worker’s Compensation (n = 374)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On or before 1 wk</td>
<td>287 (36.5%)</td>
<td>41 (11%)</td>
</tr>
<tr>
<td>On or before 2 wks</td>
<td>508 (65%)</td>
<td>116 (31%)</td>
</tr>
<tr>
<td>On or before 3 wks</td>
<td>614 (78.5%)</td>
<td>168 (45%)</td>
</tr>
<tr>
<td>On or before 4 wks</td>
<td>701 (89.6%)</td>
<td>224 (60%)</td>
</tr>
<tr>
<td>More than 4 wks</td>
<td>778 (99.5%)</td>
<td>367 (98%)</td>
</tr>
<tr>
<td>Did not return or change work</td>
<td>4 (0.5%)</td>
<td>7 (2%)</td>
</tr>
</tbody>
</table>
many studies have been done that showed a high success rate for the procedure.\textsuperscript{11,12,23-25} Comparative clinical studies showed that ECTR resulted in less postoperative pain, faster recovery of grip and pinch strength, and earlier return to work than open methods.\textsuperscript{2,11,12} Major controversy has ensued in the literature, however, regarding the safety, success, and, most importantly, the complication rate of this procedure. It seems that there are many unanswered questions regarding ECTR. Is ECTR a reproducible and effective method for CTS? When do these patients who have had ECTR return to work? Is ECTR a safe procedure? Are there any guidelines for surgeons to help them avoid complications?

We undertook this study in an effort to answer these questions, based on 13 years of experience with the Chow technique. It is not the intent of this article to answer the question of whether ECTR is better than the standard open method; other studies have tried to address this issue.\textsuperscript{2,11,12,26,27}

Although our study has the limitations of a retrospective study it has the advantage of a consecutive series of patients who had surgery by a single surgeon. Moreover, follow-up evaluation approached a period of almost 7 years and involved the vast majority of patients. The overall success rate in our series was 95%, which is comparable with any success rate reported in the literature for the open procedure.\textsuperscript{4,5,28} Previous studies also have shown that ECTR with the Chow technique provided excellent results.\textsuperscript{2,11,12,20,23,24} These data suggest that endoscopic methods are effective methods and can relieve the patient of CTS symptoms (pain, numbness, tingling). Moreover, the effectiveness of ECTR in reducing notably the interstitial pressures in the carpal canal has been shown by Okutsu et al.\textsuperscript{29}

After surgery the majority of our patients required 0 to 2 pain medication tablets and were able to move the wrist joint immediately. Because the method is minimally invasive it permits early return to normal activities and work. As might be expected non-worker's compensation patients returned to work earlier than did worker's compensation patients. Nearly two thirds of the non-worker's compensation patients returned to work less than 2 weeks and 90% of them less than 4 weeks after ECTR. Similarly, Nagle et al.\textsuperscript{24} reported that 81% of the non-worker's compensation patients returned to work less than 4 weeks after the procedure. Kerr et al.\textsuperscript{12} found that patients treated endoscopically irrespective of insurance class returned to work 10.6 days sooner than did those treated openly and this was statistically significant (p = .001). Other studies have shown that tenderness of the scar is significantly greater in patients who had OCTRs.\textsuperscript{2,11} In our opinion, diminution of postoperative pain, early return to normal activities and work, and less scar tenderness are the major benefits of a successful ECTR.

No permanent nerve or vessel damage was found in our series. In total we had 26 complications, including perioperative (neurapraxias) and late complications (failed cases, recurrences, infections). This translates to a complication rate of 1.1%. This low rate of complication compares favorably with large published series of OCTRs.\textsuperscript{4,5,28} We had only 2 patients with transient ulnar nerve palsy in whom the transbursal technique was used. This was in accordance with other researchers who reported that the extrabursal approach was associated with fewer complications.\textsuperscript{24} A low complication rate without serious complications also has been reported by many surgeons after ECTR.\textsuperscript{2,12,24,27,28,30} This means that ECTR is a safe method when properly executed. We have to consider, however, that the senior author (J.C.Y.C.) has 13 years of experience with this type of surgery and performs it on a regular basis.

It is true that serious neurovascular complications can occur with ECTR. The actual incidence of complications after ECTR is unknown. There have been several reports in the recent literature of major neurovascular injuries associated with ECTR although most of them are case reports or include small series.\textsuperscript{13-16} We believe that the major reason for this is lack of experience. As we have mentioned a common mistake is placement of the entry portal in a position that is too ulnar. The checkpoints we described in the Surgical Technique section are useful guidelines to estimate proper portal placement. Another critical point for the procedure in our opinion is the use of local anesthesia. A patient who is awake can help the surgeon during the procedure. Any abnormal sensation in the patient's hand should alert the surgeon to a potential problem. For example, in our case that was converted to an open release, the patient's discomfort was the critical sign for our decision to proceed with the open method. It was revealed afterward that there was a rare nerve variance and the cannula assembly probably impinged against the nerve. In the earlier-mentioned studies\textsuperscript{13-16} in which major complications (ulnar nerve transection) occurred, general or regional anesthesia was used for the procedure. We believe that if local anesthesia had been used these complications could have been avoided.
Visualization is of paramount importance when performing endoscopic procedures. Adequate visualization allows the surgeon to identify the transverse fibers of carpal ligament and any other structures before any cuts are made. We were able to observe an extremely ulnar transligamental motor branch of the median nerve 12 times and save it.

In 12 cases ECTR did not help at all; therefore, an open exploration was performed. In 4 cases the ligament was incompletely released and, as would be expected, revision carpal tunnel release was helpful. Extensive fibrosis was noted in the rest of the cases. Other reported causes such as irreversible damage to the median nerve or psychological illness probably are responsible for the continued symptoms in these patients after the second surgery. Because 4 of these patients had a prior OCTR and the overall failure rate in these patients was unacceptably high (28.5%), we have discontinued performing ECTR in patients with a previous OCTR.

Eleven patients in our study were found to have recurrence of their symptoms. All these patients had immediate relief after ECTR. As Hulsizer et al stated, “If the carpal ligament is incompletely released, patients would not be expected to have any resolution of symptoms.” Therefore we do not believe that an incomplete division of the ligament was performed in these cases, although there is no way to prove it. The number of patients treated by revision ECTR in this group does not permit a conclusion on the effectiveness of the endoscopic technique after recurrent CTS.

There were no injuries to the palmar cutaneous branch of the median nerve, which is the most frequent serious complication of the open technique. This, in conjunction with preservation of the normal anatomic structures above the carpal ligament, should be credited for the fact that we have not had a single case of reflex sympathetic dystrophy with the ECTR technique in over 2,400 cases.

Our results suggest that ECTR with the Chow technique is a reliable alternative treatment for CTS and can be done safely. However, it does have its limitations. The surgeon who is interested in this technique should become familiar with endoscopic anatomy and anatomic relationships within the carpal tunnel. Surgeons unfamiliar with endoscopes and arthroscopic techniques may find the procedure technically demanding. We strongly recommend that the surgeon perform the procedure in cadaver specimens until a sense of comfort, understanding, and consistency as to the surgical technique is obtained.

References

18. Rowland EB, Kleinert JM. Endoscopic carpal-tunnel release in cadaveria. An investigation of the results of twelve
1018  Chow and Hantes / Chow Technique