Microsurgical carpal tunnel release

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The author reports on a series of 482 patients who underwent primary carpal tunnel release (CTR) surgery beginning in 1987. Two hundred twenty-five patients underwent CTR in the right hand, 169 patients underwent CTR in the left hand, and 88 patients underwent bilateral CTR surgery, for a total of 570 hands. These surgeries were performed on an outpatient basis. After application of a local anesthetic, a microsurgical technique using a 2-cm longitudinal incision that did not cross the wrist flexion crease was accomplished. In five patients the recurrent thenar branch exited through the middle or ulnar portion of the ligament and this branch was preserved in all five. Perioperative complications included stitch abscesses in nine hands (2%), which were managed on an outpatient basis; deep wound infections occurred in three hands (0.5%) and these patients were admitted for intravenous antibiotic administration and wound care. One steroid-dependent patient suffered wound dehiscence due to a fall and the wound was primarily repaired. One patient required a second minor procedure to remove a retained suture. Two patients developed "trigger finger" 6 months postoperatively. The mean time until return to work for those patients not receiving Workers' Compensation was 3 weeks and for those receiving Workers' Compensation it was 6.5 weeks. Complete disappearance of painful dysesthesias occurred in 431 (89%) of 482 patients. Marked improvement occurred in another 33 (7%) patients, yielding an overall improvement rate of 96%. Motor improvement was noted in 438 (96%) of 454 patients with preoperative motor weakness. Bilateral symptoms resolved on the contralateral side following unilateral surgery in seven patients. Fifteen patients (12 of whom were receiving Workers' Compensation) experienced persistent dysesthesias and/or incision pain and did not return to work. An additional eight procedures were performed in patients who had previously undergone surgery at another institution; four showed no evidence of their transverse carpal ligament being sectioned. Five of the eight patients undergoing reexploration noted postoperative improvement in their symptoms. Finally, 14 (3%) patients presented 1 to 5 years postsurgery with thenar/hypothenar pain. These patients have responded to local steroid injections and are being followed by a hand surgeon.

The reimbursement of the surgeon's fee is \$253.00 from Medicaid, \$360.00 from Medicare, and \$560.00 from preferred provider insurance. The mean total time in the outpatient operating room is 35 to 40 minutes. The outcome and time to return to work are equal, if not superior, to those reported for endoscopic CTR surgery. Microsurgical CTR is thought to be safer and probably more cost-effective.

Key Words * carpal tunnel syndrome * carpal tunnel release * median nerve entrapment * transverse carpal ligament

Surgical division of the transverse carpal ligament (TCL) has been performed since 1933 and is usually a

relatively simple procedure.[28] A recent report on a microsurgical carpal tunnel release (CTR) technique, performed on an outpatient basis, documented excellent results that were equal to those obtained by using minimally invasive techniques such as the retinaculotome or the endoscope.[26] The reported advantage of the minimally invasive techniques is a small incision, which allows for a short operating time and an early return to work for the patient. The incision used in microsurgical CTR is 2 cm long and may be shorter in thin patients. An update on this microsurgical approach is reported in a series of 482 patients, with emphasis on duration of the surgical procedure, outcome, complications, and cost.

CLINICAL MATERIAL AND METHODS

Beginning in 1987, 482 consecutive patients underwent CTR surgery at the Indiana University School of Medicine. Preoperative electromyographic and nerve conduction studies were obtained in all but six patients and only eight (2%) showed no evidence for median nerve entrapment at the TCL. Two hundred twenty-five patients underwent CTR surgery in the right hand, 169 in the left hand, and 88 patients underwent bilateral CTR surgery, for a total of 570 hands. Of the 88 patients with bilateral carpal tunnel syndrome (CTS), 18 underwent surgery on both hands during one sitting and 70 underwent surgery on one hand at a time, separated by intervals ranging from 2 to 100 weeks. Many of the patients with bilateral CTS first underwent CTR surgery on the predominantly symptomatic hand and later developed increasing symptoms in the untreated hand. Only in the patients with severe bilateral symptoms did we perform both CTRs at the same time. Motor weakness was determined for the abductor pollicis brevis muscle by direct confrontation testing during the physical examination.

TABLE 1
DEMOGRAPHICS AND RESULTS OF RIGHT HAND UNILATERAL CTR SURGERY
IN 225 PATIENTS

work	
	189 (84%) of 225 patients were employed preop
	93 (49%) of 189 were receiving Workers' Compensation
	88 (95%) of 93 returned to work at a mean of 6 weeks (40% by 3 weeks)
	4 (6%) did not return to work because of incision pain or dysesthesias
	96 (51%) of 189 were not receiving Workers' Compensation
	95 (99%) of 96 returned to work at a mean of 3 weeks (44% by 2 weeks)
	1 (1%) did not return to work because of dysesthesias
	36 (16%) of 225 patients were unemployed or retired preop
motor strength	
	preop 209 (93%) of 225 patients had 4/5 weakness &
	16 (7%) had normal strength
	postop 202 (97%) of 209 patients had improved strength &
	7 (3%) were unchanged
sensory disturbance	
	210 (93%) of 225 patients had complete relief of dysesthesias
	9 (4%) had partial relief of dysesthesias
	6 (3%) had no relief of dysesthesias
wound dehiscence	
	1 (0.4%) patient due to fall; wound was primarily repaired & did well
wound infection	
	2 (1%) patients had 4 stitch abscesses & 1 wound infection
severe wound/hand swelling	
	2 (1%) patients
delayed onset thenar/hypothenar pain	
	5 (2%) patients

Each patient was offered the choice of receiving local anesthesia or intravenous sedation. Only two patients required a general anesthetic, because they did not comply with constraints surrounding the use of local anesthesia. The local anesthetic was composed of 0.5% lidocaine in a ration of 1:200,000 with epinephrine. No tourniquet was used. The incision was marked on the ulnar aspect of the thenar crease, just distal to the wrist flexion crease, and extended 2 to 3 cm. Surgery was performed with the aid of either a microscope or surgical loupes. Retraction was maintained by means of mastoid retractors, and hemostasis was attained with bipolar cautery. Blunt and sharp dissection were used to expose the TCL. Because the skin incision was short, hand-held retractors (Senn; Codman, Randolph, MA) were used to increase visualization. The TCL was opened sharply with a 15-blade knife and transected completely with iris scissors. A fine dissector and the iris scissors were used to open the thin translucent ventral epineurium longitudinally over the compressed portion of the nerve. The wound was irrigated with bacitracin and sutured closed with 4-0 ethilon, interrupted, vertical mattress sutures.

TABLE 2
DEMOGRAPHICS AND RESULTS OF LEFT HAND UNILATERAL CTR SURGERY
IN 169 PATIENTS

work
148 (88%) of 169 patients were employed preop
59 (40%) of 148 were receiving Workers' Compensation
56 (95%) of 59 returned to work at a mean of 5.5 weeks (33% by 2 weeks)
2 (3%) did not return to work because of incision pain or dysesthesias
89 (60%) of 148 were not receiving Workers' Compensation
88 (99%) of 89 returned to work at a mean of 3.5 weeks (45% by 2 weeks)
1 (1%) did not return to work because of incision pain or dysesthesias
21 (12%) of 169 patients were unemployed or retired preop
motor strength
preop 157 (93%) of 169 patients had 4/5 weakness & 12 (7%) had normal strength
postop 153 (97%) of 157 patients had improved strength & 4 (3%) were unchanged
sensory disturbance
157 (93%) of 169 patients had complete relief of dysesthesias
9 (5%) had partial relief of dysesthesias
3 (2%) had no relief of dysesthesias
wound infection
2 (1%) patients had stitch abscess
severe wound swelling
1 (0.6%) patient
delayed onset thenar pain
3 (2%) patients

RESULTS

Tables 1, 2, and 3 show the outcome results for the unilateral and bilateral surgery groups. The only difference observed was a lesser chance of complete relief of dysesthesias in the group in whom bilateral CTR was performed. Fourteen patients (3%) presented again 1 to 5 years postsurgery suffering from thenar/hypothenar pain. These patients responded to local steroid injection and are being followed by a hand surgeon. Table 4 shows the results of reoperations performed in eight patients in whom symptoms persisted. These patients had previously undergone surgery for CTS at other institutions. Table 5 shows the mean duration and cost of surgery.

TABLE 3 DEMOGRAPHICS AND RESULTS OF BILATERAL CTR SURGERY IN 88 PATIENTS	
work:	
	80 (91%) of 88 patients were employed preop
	52 (65%) of 80 were receiving Workers' Compensation
	46 (88%) of 52 returned to work at a mean of 7 weeks (32% by 3 weeks)
	6 (12%) did not return to work because of incision pain or dysesthesias
	28 (35%) of 80 were not receiving Workers' Compensation
	27 (96%) of 28 returned to work at a mean of 6 weeks (58% by 3 weeks)
	1 (4%) did not return to work
	8 (9%) of 88 patients were unemployed or retired
motor strength	
	preop 88 patients had 4/5 weakness on at least 1 side
	postop 82 (93%) patients had improved strength & 6 (7%) were unchanged
sensory disturbance	
	64 (73%) of 88 patients had complete relief of dysesthesias
	15 (17%) had partial relief of dysesthesias
	9 (10%) had no relief of dysesthesias
wound infection	
	4 (5%) patients had 3 stitch abscesses & 2 wound infections
severe hand swelling	
	1 (1%) patient
retained suture requiring reop	
	1 (1%) patient
trigger finger	
	1 (1%) patient
delayed onset thenar pain	
	6 (7%) patients

DISCUSSION

Phalen[19,20] stated that the type of incision used in CTR surgery is of little importance provided that it does not cross the distal flexion crease of the wrist at a right angle. Phalen[18] reported a 99% improvement in sensory symptoms in 215 patients treated surgically for CTS. Rengachary[21] believed that the incision should be made from the wrist flexion crease extending curvilinearly to a point in line with the distal border of the fully extended thumb. He also noted that, when possible, the proximal incision should not cross the wrist flexion crease, thus preventing injury to the palmar cutaneous nerve. Our minor modification to the technique was to limit the placement of the incision to just distal of the wrist flexion crease and to shorten it to 2 cm. The subcutaneous dissection is easy and, with retraction, all of the ligament can be visualized. Our results demonstrated complete relief of sensory dysesthesias in 431 (89%) of 482 patients; an additional 33 patients (7%) improved but still experienced some dysesthesias. Motor improvement occurred in 96% of patients, and there was no motor nerve injury. Numerous reports have documented that sectioning of the TCL by any method leads to excellent results in patients with CTS.[1,5,7,8,17,26,27]

TABLE 4
RESULTS OF REOPERATION IN EIGHT PATIENTS UNDERGOING CTR SURGERY*

The TCL had not been sectioned in 4 patients (50%); all improved after surgery & 2 returned to work
The TCL had been sectioned in 4 patients (50%); no Z-plasty was performed; only 1 of 4 improved & 2 of 4 returned to work

*The first surgeries in these patients were performed by surgeons at other institutions.

Previous reports have described endoscopic CTR (ECTR) surgery as a technically demanding procedure with a significant learning curve.[2,6,7,9,15,22,23] The immediate question that arises is: why make a simple surgery more difficult? One reported advantage for ECTR surgery is a shorter operating time. Our mean operating time is 20 minutes. A postgraduate Year 1 to 3 neurosurgery resident assists with every case and learns the surgical technique and its principles. A report on a technique that required a short open incision documented a mean operating time of 7 minutes for CTR.[16] There is no report showing that ECTR surgery can be performed more quickly than open CTR surgery. There is usually a fixed cost for the ambulatory surgery operating room, which is not dependent on the duration of the procedure. The cost of the anesthetic may, at best, be reduced by one unit if CTR surgery can be performed 15 minutes faster than a mean of 20 minutes (Table 5). Thus, a short operating time will lead to minimal cost savings.

TABLE 5
COST ANALYSIS FOR A REPRESENTATIVE PATIENT UNDERGOING
OPEN CTR SURGERY

mean duration of surgery (skin to skin) was 20 mins (5–40 mins)

anesthesia standby

intravenous sedation cost fixed at \$125

3 base units plus 1 unit/15 mins

anesthesia unit

\$14 from Medicaid

\$35 from preferred provider insurance

ambulatory operating room

\$728 fixed cost regardless of duration of procedure

recovery

\$162 for 1 hr

reimbursed surgeons' fee

Medicaid	\$253.00
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Medicare	\$288.00
Medicare	\$360.00

preferred provider	\$560.00
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It is difficult to quantitate the effect of a smaller incision on return to work. The biportal technique, which allows direct visualization of the TCL has become a widely used endoscopic procedure, with some reports documenting patients being able to return to work earlier.[23,24] The combined length of the two incisions required for the biportal technique is nearly identical to the 2-cm open CTR technique incision. In a report on 666 ECTR surgeries, the mean time to return to work for patients not receiving Workers' Compensation was 23 days and for those receiving Workers' Compensation it was 60 days; these results are quite similar to ours.[7] A prospective study comparing a minimal-incision open CTR technique to the two-portal ECTR technique documented no significant difference in scar length, need for hand therapy, rate of complications, duration of time before the patient resumed routine activities, duration of time before the patient returned to work, or overall outcome.[9] It has also been documented that early

hand therapy is more important than incision length in minimizing the interval to regaining normal function and return to work.[16] In fact, early return to work is less dependent on the technique than it is on the motivation of the patient and the type of job the patient performs. We have returned patients to work as soon as 24 hours postsurgery. Other reports have failed to show a significant benefit of ECTR surgery in early return to work analysis.[22,23]

A disturbing and common theme, both in our experience and in the literature, is symptoms persisting in patients who had previously undergone CTR surgery and the discovery at reoperation that the TCL had not been transected.[3,4,11-14] In our experience, most of these operations were performed by physicians who had no formal training in peripheral nerve surgery. Reports on surgeries by means of the ECTR and retinaculotome techniques documented a 0.4% rate of incomplete TCL transection.[7,17] There is little justification for not sectioning the entire TCL at the first operation.

Although Pagnanelli and Barrer[17] reported no recurrent thenar branch injuries after CTR surgery via a blind technique using the retinaculotome, we remain concerned that the rare aberrant course of the recurrent thenar motor branch can predispose it to be injured in any blind procedure. Median and ulnar nerve transection injuries along with nerve contusion and vascular injuries with both the uniportal and two-portal ECTR techniques have been reported.[3,6,7,15,22,23] One of the problems with the use of an endoscope in CTR procedures is that there is no natural cavity in which the equipment can be inserted, in contrast to its use in cranial and thoracic spine procedures. Thus contusion, stretching, and limited visibility can all contribute to potential neurological complications. The open microsurgical technique effectively diminishes the likelihood of these problems.

Reported infection rates in CTR surgery range from 0.25 to 6%.[1,8] Hanssen and coworkers[10] reviewed 3620 cases in which the CTR procedure was used and found a deep-infection rate of 0.47%. Our deep-infection rate was three (0.5%) of 570 hands. There are no data to support a reduction in the infection rate with ECTR.

The delayed onset of thenar/hypothenar pain that appeared in 3% of our patients may be secondary to altered biomechanics at the wrist following TCL transection. Rarely, additional surgery on the carpal bones is necessary to treat uncommon conditions such as piso-triquetral pain syndrome.[25] There are no data to date to support the contention that the ECTR technique will lessen this problem.

The overall cost of surgical procedures is gaining increased importance. If ECTR surgery does not return patients to work more quickly and the equipment to perform the operation is more costly, then there may be no net cost savings.

In conclusion there appear to be many compelling reasons to resist the use of the endoscope to perform CTR surgery. The concern is that many neurosurgical colleagues may feel compelled to learn this demanding and increased-risk technique to compete for patients with hand surgeons who use this technique as a marketing tool.

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