

27 The Distal Single Incision Scope-Assisted Carpal Tunnel Release – Thirteen-Year Follow-Up Results

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Introduction

Carpal tunnel syndrome (CTS) was first recognized by Sir James Paget in 1854 and continues to attract considerable attention in contemporary orthopedics [18]. Learmonth first described surgical decompression of peripheral nerves in the 1930s while Phalen's contributions to the clinical evaluation of CTS began in the 1950s [9, 20, 21]. Known both as the most researched and most common peripheral nerve entrapment neuropathy, the incidence of CTS continues to increase [6]. According to data reported by the National Institute for Occupational Safety and Health (NIOSH), roughly 60% of all work-related illnesses are "disorders associated with repeated trauma" [16]. In addition, with about 50% of all CTS cases being work related, return to work can reflect significant costs to industries [22]. Postoperative scar/pillar tenderness and/or weakness of pinch and grip strength are often variables that delay the return to work [1].

When conservative management including the use of nonsteroidal anti-inflammatory drugs (NSAIDs), splinting, and/or cortisone injection fail to alleviate CTS, surgical decompression of the median nerve may be indicated. The most widely accepted surgical approach is to make a curved incision in the palm, which is extended into the distal forearm. Such an open technique has resulted in a median return to work of 46.5 days [1]. Endoscopic techniques for carpal tunnel release (CTR) include two-portal procedures, proximal uniportal incision techniques, and the single distal incision technique [1, 2, 4, 12, 14, 15, 17, 19, 23,]. Overall, these techniques have resulted in a faster return to work, less scar tenderness, and an earlier return of grip strength.

The distal, single incision, scope-assisted carpal tunnel release was first described in 1993 [13]. Its technique, evolution, and early postoperative results have been previously reported [13–15].

Study Protocol

Subjective symptoms of pain, tingling, numbness, burning, and swelling were recorded for each patient by using preoperative and postoperative questionnaires. Patients rated their symptoms as: none; mild, not interfering with normal activities or job function; moderate, occasionally curtailing normal activity or job function; or severe, significantly interfering with normal activity or job function. Two-point discrimination and single-trial grip, lateral, and precision pinch strengths were recorded by using the Jamar hand dynamometer and Jamar hydraulic pinch gauge.

Postoperative measurements are scheduled at 10-day, 4-week, 8-week, 6-month, and 1-year intervals. Four-year follow-up data were available in some patients who were also analyzed. The subjective symptoms, grip, and lateral and precision pinch strengths were recorded at the times noted above. Palpated scar, radial pillar, and ulnar pillar tenderness levels were recorded as none, slight, moderate, or severe. The return-to-work date was documented. The insurance type was classified as "Workman's Compensation" or "Other," and the employment type was classified into "white collar" or "other." Housewives were classified as "other" and retired patients were classified as "white collar" with respect to their employment status.

Operative Technique

Surgery is performed on an outpatient basis by using intravenous regional anesthesia (Bier block) and a forearm tourniquet. The hand is first placed on the AM Surgical arm support table. Two lines are then drawn in the palm (Fig. 27.1), one in a transverse orientation along the distal border of the abducted thumb and one in a longitudinal orientation from the third web space; both lines should intersect as illustrated. Two additional longitudinal lines, each about 2.5 cm in length, are then drawn on the distal forearm, one along the flexor carpi ulnaris tendon and the other along the palmaris longus tendon. If the palmaris longus tendon is absent, the midline of the wrist is used. An "X" is drawn mid-

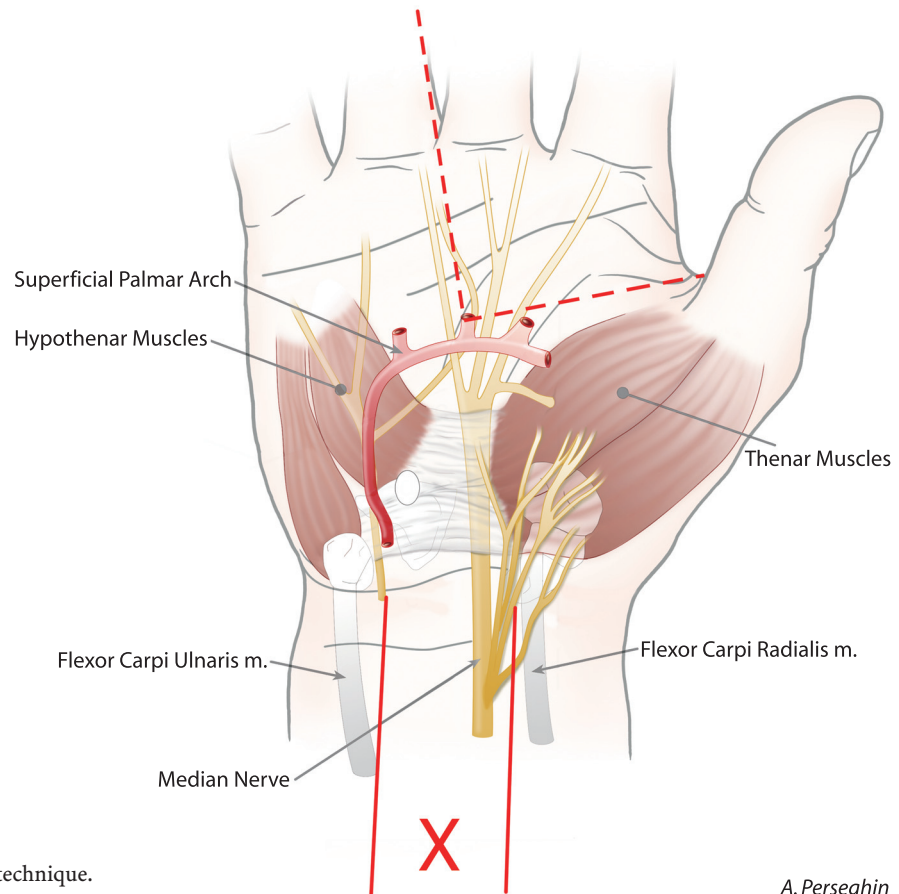


Fig. 27.1. Distal single incision technique.
(Courtesy of AM Surgical)

A. Perseghin

way between those two lines. At 0.5 cm proximal to the intersecting palm lines, a 1.5-cm longitudinal incision is made, usually in or along the thenar crease (Fig. 27.1). The incision is subsequently deepened to expose the palmar fascia, which is then divided longitudinally. Once the incision is complete, the very distal edge of the transverse carpal ligament (TCL) as well as the fat pad that is present at the distal edge of the TCL is exposed. The palmar arch should now be identified. At this point in the procedure it is imperative to identify the median nerve branch to the third web space, otherwise, look for the median nerve itself if the nerve has not divided. At this time, a special effort should be made to identify the communicating branch of the ulnar nerve, and any aberrant motor branch variants, if present. Blunt dissection with a curved clamp is then undertaken to create a pathway underneath the TCL, staying ulnar to the median nerve.

By using a specially designed hand table,¹ the hand is then elevated and the wrist is extended to facilitate the dissection of the extrabursal subligamentous path (Fig. 27.2). This is accomplished by introducing a

curved dissector into the carpal canal, palmar to the ulnar bursa, while hugging the under surface of the TCL. The dissector is then advanced to the “X” mark at the wrist – one should not feel undue obstruction. The dissector is then removed. The obturator-cannula-dissector assembly is now introduced into the pathway created by the dissector. The assembly is then guided midway between the two longitudinal lines on the forearm so as not to damage the median or ulnar neurovascular structures. At this point, the obturator is removed from the slotted cannula and a 4-mm, 30° standard scope is introduced. This standard arthroscope is now used as an endoscope for this technique. Once in place, the endoscope permits thorough visualization of the transverse fibers of the flexor retinaculum. It is of paramount importance to identify these transversely oriented fibers. If fluid or fat globules obstruct the visualization, withdraw the endoscope and introduce a sterile cotton-tipped applicator to clear the obstruction(s) and enhance visualization. If there is any synovial membrane obstructing the visualization of the transverse fibers, repeat the process by reintroducing the clamp and spreading to allow for the reintroduction of the dissector. Reintroduce the obturator-cannula-dis-

¹ Hand Table 9500, A.M. Surgical.

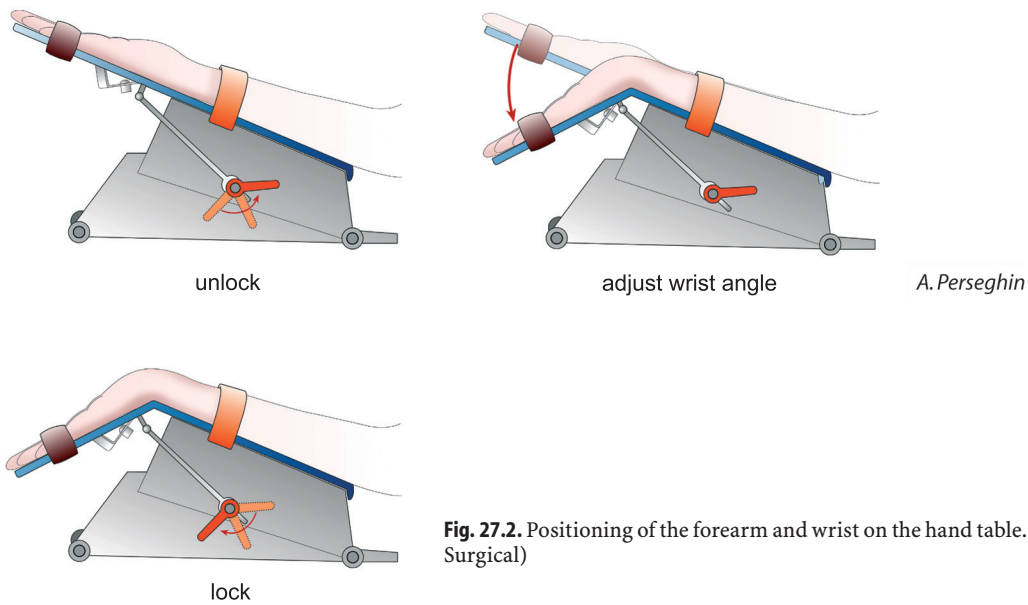
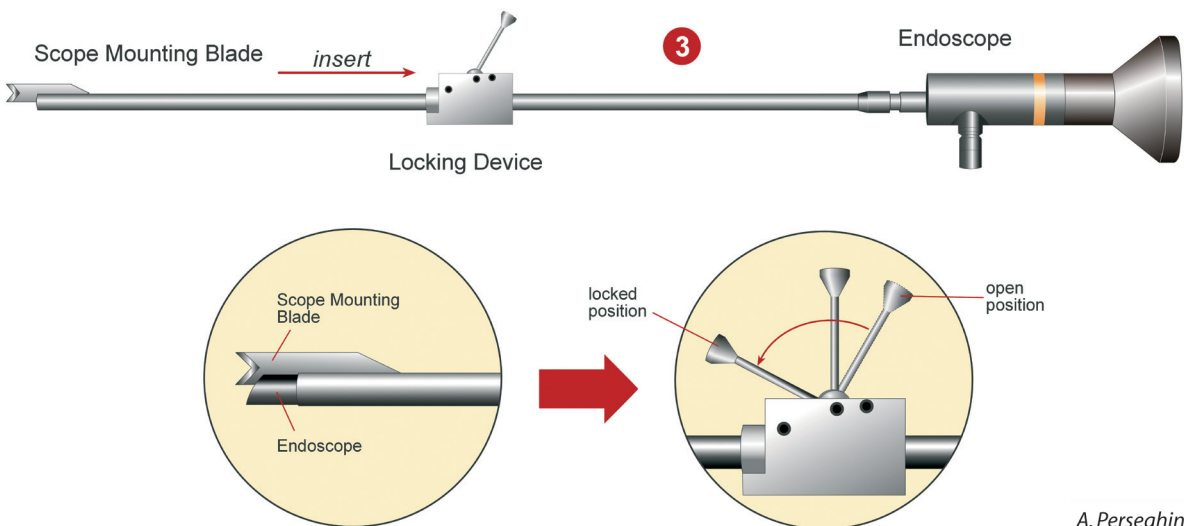


Fig. 27.2. Positioning of the forearm and wrist on the hand table. (Courtesy of AM Surgical)

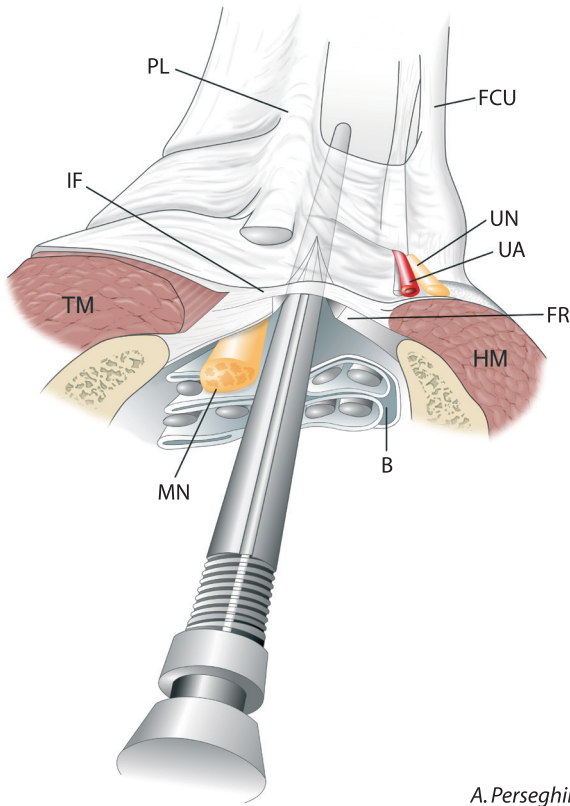


A. Perseghin

Fig. 27.3. Standard arthroscope with sleeve/knife assembly and locking device. (Courtesy of AM Surgical)

sector assembly, then, remove the obturator and insert the scope. The cannula can be rotated toward the radial side to visualize the median nerve, and then rotated toward the ulnar side to visualize the flexor tendon. This maneuver is very important for beginners because it allows the surgeon to ascertain the position of the median nerve and the flexor tendon. No attempt at endoscopic release should be made unless the transverse fibers of the TCL are clearly seen through the endoscope with no other structures obstructing the view. If this cannot be achieved, convert to an open carpal tunnel release procedure at this time.

Once the transverse fibers are identified, the endoscope is withdrawn from the slotted cannula. The sleeve/knife device is then slid over the endoscope and locked into place by depressing the lever on the locking device (Fig. 27.3). Next, the sleeve-knife-scope assembly is introduced into the cannula, dividing the TCL along a distal-to-proximal direction by means of gently pushing the knife/scope assembly proximally under endoscopic visualization (Fig. 27.4). The design of the instrument allows one to continuously visualize the knife and TCL during the division (Fig. 27.5). When the division of the TCL is complete, the knife can be palpated



A. Perseghin

Fig. 27.4. Knife/scope unit dividing the flexor retinaculum (FR) while preserving the interthenar fascia (IF) [15] (reprinted with permission from the Arthroscopy Association of North America)

ed through the skin with the surgeon's opposite hand, at a point proximal to the wrist flexion crease. This will ascertain the proximal-most portion of the division of the TCL, which should be proximal to the wrist crease. The knife/scope assembly is then removed from the cannula and the knife/sleeve device is detached from the endoscope. The scope is reintroduced into the slotted cannula to ascertain the complete division of the TCL. By rotating the cannula, the cut edges of the TCL, as well as the median nerve and flexor tendons, are visualized. The cut edges of the TCL segment are notably thicker when compared with the cut edges of the thinner antebrachial fascia located in the distal forearm. The transverse fibers of the "interthenar fascia" are preserved in some patients and are seen superficial to the divided TCL. These fibers are less densely arranged than those of the TCL and herniation of palmar adipose tissue is often noted proximal to them (Fig. 27.6).

Upon completion of the surgery, the wound is irrigated and then closed with a running subcuticular closure consisting of 4-0 Prolene sutures. Steristrips are then applied, 5–8 ml of 0.5% bupivacaine is infiltrated subcutaneously, and the hand is wrapped in a soft bulky dressing; the tourniquet is then deflated.

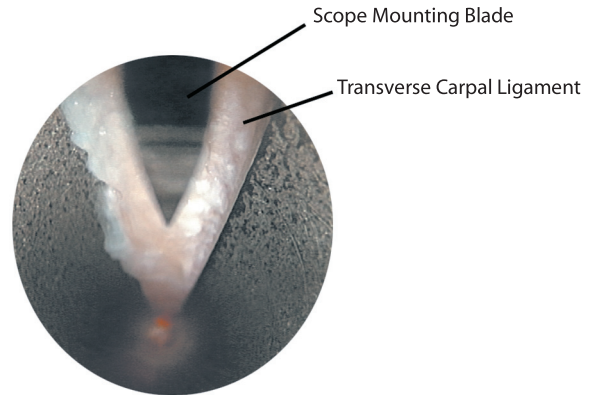


Fig. 27.5. Endoscopic photograph of knife/scope assembly dividing flexor retinaculum. (Courtesy of AM Surgical)

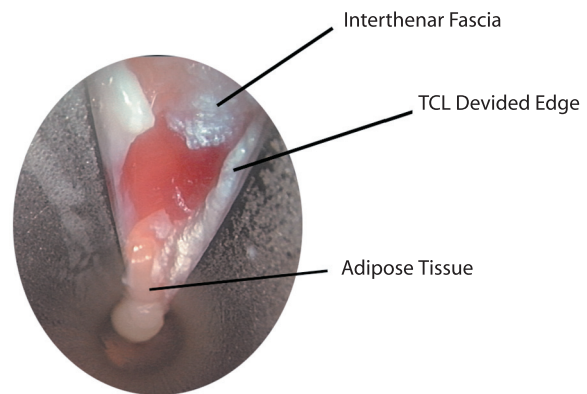


Fig. 27.6. Endoscopic photograph showing division of the TCL with herniation of adipose tissue. (Courtesy of AM Surgical)

Results

Demographics

One thousand eight hundred seventy-seven cases of CTS were evaluated for this study. Electromyographic and nerve conduction studies were performed to confirm the diagnosis in those patients with questionable clinical findings. Five hundred seventy-three cases were excluded from this study. The majority were excluded because the endoscopic carpal tunnel release was accompanied by other procedures or the patient had a history of wrist instability. Additional patients were excluded because the endoscopic procedure was converted to a modified open carpal tunnel release, or because the patient had a prior carpal tunnel release by a different surgeon, and due to continued symptoms, open carpal tunnel release was indicated. Thus, the following results are reported on 1,304 unaccompanied cases, of whom 877 were female and 427 were male. Among the 1,304 patients for whom data were available, the mean age was 52.4 years ($n = 1,279$).

Patient-Reported Symptoms

Table 27.1 demonstrates the relative frequency (%) distribution of the patient-reported symptoms of pain, tingling, numbness, burning, and swelling, over time. These symptoms are reported prior to surgery, 10 days postsurgery, 4 weeks postsurgery, 8 weeks postsurgery, 6 months postsurgery, and 1 year postsurgery. In Table 1 we note that the percentage of patients reporting the absence of the symptoms (the category “None”) increased steadily after surgery. By 1 year, a minimum of 90% of the patients for whom data are reported exhibited no symptoms. This trend is apparent across all reported symptoms.

Hand Strength

Table 27.2 presents the median percent change in grip strength, lateral pinch strength, and precision pinch strength at the indicated time points postsurgery. The median values are reported because the distribution of the data set is asymmetric.

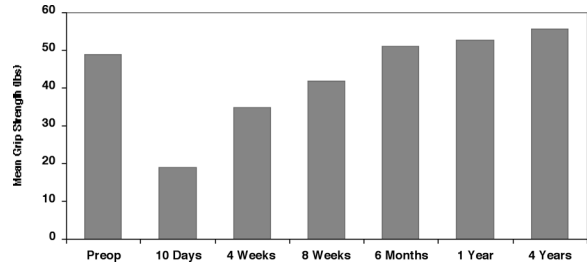


Fig. 27.7. Grip strength

The median grip strength approached a preoperative level after 8 weeks and was greater than the preoperative value by 6 months (Table 27.2). The overall mean grip strength for the reported data is shown in Fig. 27.7. By 8 weeks, median lateral and precision pinch strengths increased 10% and 14%, respectively, over preoperative values (Table 27.2). Figure 27.8 illustrates the overall mean pinch strength findings for the lateral and precision pinch data reported. By 1 year postsurgery, lateral pinch strength was twice that reported at

Symptom		Pre-op	10 days	4 weeks	8 weeks	6 months	1 year
Pain	None	16.5	61.9	78.5	87.9	97.3	97.1
	Slight	13.6	26.6	17.5	9.5	1.6	1.4
	Moderate	33.3	10.3	3.2	2.3	0.5	1.4
	Severe	36.6	1.2	0.7	0.2	0.5	0
	Total (n)	982	929	713	472	188	70
Tingling	None	2.3	54.7	72.4	80.5	88.3	95.7
	Slight	9.2	32.7	23.1	15.8	10.1	4.3
	Moderate	33.5	10.3	4.2	3.6	1.1	0
	Severe	54.9	2.3	0.4	0.2	0.5	0
	Total (n)	990	945	720	476	188	70
Numbness	None	1.4	46.2	61.4	69.6	80.2	90
	Slight	7.8	34.8	30.4	24.1	16	8.6
	Moderate	31.6	14.9	6.8	5.1	2.7	1.4
	Severe	59.2	4	1.4	1.3	1.1	0
	Total (n)	990	945	718	474	187	70
Burning	None	67.5	84	93.7	94.7	98.9	100
	Slight	10	12.1	4.5	4.7	1.1	0
	Moderate	12.1	3	1.7	0.4	0	0
	Severe	10.4	1	0.1	0.2	0	0
	Total (n)	972	935	712	473	185	70
Swelling	None	58.9	79.5	92.4	94.6	96.7	98.6
	Slight	12	15	6.5	4.9	3.3	1.4
	Moderate	18.6	4.8	1	0.2	0	0
	Severe	10.5	0.6	0.1	0.2	0	0
	Total (n)	966	928	711	465	184	70

Table 27.1. Patient-reported symptoms. Relative frequency (%) distribution

Strength measurement	Median percent change from preoperative value				
	10 days	4 weeks	8 weeks	6 months	1 year
	<i>n</i> = 925	<i>n</i> = 1077	<i>n</i> = 913	<i>n</i> = 527	<i>n</i> = 302
Grip	-66.7	-33.3	-15.6	4.4	8.9
Lateral pinch	-40	0	10	20	20
Precision pinch	-28.6	0	14.3	14.3	14.3

Table 27.2. Strength by time since surgery

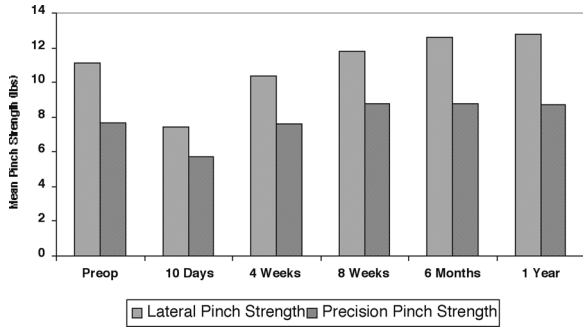


Fig. 27.8. Pinch strength

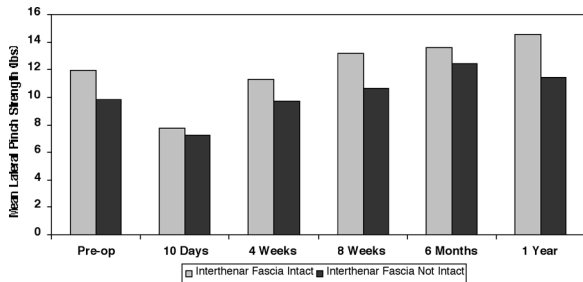


Fig. 27.9. Lateral pinch strength related to interthenar fascia integrity

8 weeks, with the precision pinch strength level remaining at the 8-week level (Table 2). Lateral pinch strengths were significantly higher at 8 weeks in patients whose interthenar fascia was left intact, and remained so through the 1-year time point (Fig. 27.9, $p = .009$).

Tenderness Postsurgery

At 8 weeks, tenderness to palpation along the postoperative scar, as well as the radial pillar and ulnar pillar was minimal. At 10 days postsurgery, all but 4 patients of the 903 reporting incisional tenderness exhibited, at

Table 27.3. Resolution of tenderness to palpation

		10 days	4 weeks	8 weeks	6 months	1 year
Incision	None	557	528	466	223	78
	Slight	257	154	56	5	0
	Moderate	85	38	14	0	0
	Severe	4	3	2	0	0
	Total (n)	903	723	538	228	78
Radial pillar	None	645	516	426	218	77
	Slight	200	167	84	9	1
	Moderate	55	39	24	0	0
	Severe	6	3	0	0	0
	Total (n)	906	725	534	227	78
Ulnar pillar	None	622	460	412	216	78
	Slight	216	200	96	9	0
	Moderate	61	55	26	2	0
	Severe	6	5	2	0	0
	Total (n)	905	720	536	288	78

most, moderate symptoms. By 6 months, all reporting patients exhibited either slight or no tenderness at the incision. Symptom changes were similar for those who reported radial pillar and/or ulnar pillar tenderness as well (Table 27.3).

Return to Work and Normal Function

Table 27.4 presents the mean and median time to return to work or normal activity as a function of insurance type. For this analysis insurance is either workman’s compensation or some other insurance type (including no insurance). The results of applying a *t*-test (equal variances not assumed) indicate that the difference in the mean values of 14.5 days is statistically significant ($t = 7.9$, $df = 261.3$, $p < .001$).

Where available, the patient’s occupation was classified as “White Collar” or “Other.” Table 27.5 presents the mean time to return to work or normal activity as a function of occupation. The results of applying a *t*-test indicate that the difference in the mean values of 15 days is statistically significant as well ($t = 8.5$, $p < .0001$).

Table 27.4. Return to work and normal function. comparison of workman’s compensation to other types of payment

Workman’s compensation	Mean (days)	Median (days)	Standard deviation (days)	n
Yes	30.0	28	20.47	164
No	15.5	12	14.07	256
Difference	14.5	16	24.84	

Table 27.5. Return to work and function – by occupation. comparison of white collar workers to other types of workers

Occupation	Mean (days)	Standard deviation (days)	n
White collar	11.3	9.8	118
Other	26.1	19.1	165
Difference	14.8		

The overall mean time for return to work and full function was 21 days. Patients not on worker's compensation returned to work sooner than the worker's compensation patients (Table 27.4).

Statistical Analyses

The database used for the analyses in this report contains 1,304 cases. Data for a number of the symptoms and findings are missing on many of these cases. No attempt to impute values for missing data was made. The number of cases containing values for each variable is reported in each table as appropriate. These numbers change from table to table because of missing values. Data collected from the patient questionnaires were converted to an SPSS for Windows file (SPSS, Inc., Chicago, IL) by using DBMSCOPY V7.05 (Conceptual Software Inc.). Differences between data sets were evaluated by performing a t-test. A level of $p < .05$ was accepted as statistically significant.

Complications

Data on pain management were available for 785 of the 1,304 patients studied. Among these 785 individuals, 27% required no analgesic therapy. For those requiring analgesia, the majority (60%) required the use of an analgesic, such as hydrocodone. The remaining patients (13%) alleviated their surgical discomfort with acetaminophen or NSAIDs.

Due to continued complaints of numbness and tingling, five patients underwent a second procedure. Median nerve compression was found in one of these five patients. An open release was performed in this case, and improvement was noted in two-point discrimination as well as all other reported symptoms. Other complications consisted of two cases of mild reflex sympathetic dystrophy (RSD), one common digital nerve injury, and three cases of persistent numbness to the middle and ring fingers. The RSD improved with conservative management in one patient and one patient was lost to follow-up. These three cases of persistent numbness were previously reported as injury to the communicating branch of the ulnar nerve, which we characterized as neurapraxia [14]. This condition resolved in the affected patients. We now conclude that this was likely due to neurapraxia of the median nerve and not injury to the communicating branch. No injuries occurred to the median nerve or its motor branch, or the palmar arch.

Discussion

The identification of key anatomic structures in the midpalm is important when performing a CTR [3]. The small, longitudinal incision in the palm described with the distal, single incision, scope-assisted carpal tunnel release provides identification of the palmar arch, the median nerve and its branches, as well as the distal edge of the TCL. This exposure has been shown to minimize complications previously reported, such as the inadvertent release of Guyon's canal, injury to the palmar arch, or injury to the median nerve or its motor branches [7, 8, 10, 11, 25].

The knife was designed to accomplish transection of the flexor retinaculum simply, in one pass, while providing good endoscopic visualization and control. The knife mounts on a standard 4-mm arthroscope, avoiding the purchase of costly new equipment. The endoscopic release described here divides the TCL as well as the most distal portion of the anterior brachial fascia.

Since Rotman and Manske [24] further clarified the anatomic relationships surrounding the carpal canal, we now have a better understanding of the superficial fascia, which is palmar to the TCL. We refer to this layer as the "interthenar fascia" because it receives most of its contribution from the thenar muscle fascia and lesser contributions from the hypothenar and palmaris brevis muscle fascia [5, 24]. The interthenar fascia is usually left intact in some patients after dividing the flexor retinaculum with one pass of the knife/scope assembly. It appears as intact transverse fibers not as densely arranged as the fibers of the divided TCL (Fig. 27.6). Less widening of the transverse carpal arch has been seen when comparing ECTR with open CTR [26]. Keeping the interthenar fascia intact may contribute to less pillar migration, with an associated decrease in postsurgical loss of strength and pillar tenderness, resulting in an early return to work. We, as well as many others, elect to leave the fascial layer superficial to the TCL intact. If one chooses to divide it, a second pass of the knife/scope assembly will accomplish this. Preserving the interthenar fascia appears to significantly increase the return of strength postoperatively.

The incision is small, usually concealed in the thenar crease, resulting in a cosmetically appealing scar. The one palmar incision avoids the transverse incision at the wrist. Thus, using the single distal incision technique may account for the absence of ulnar nerve neurapraxia, compared with a 10%–13% incidence of transient postoperative ulnar nerve neurapraxia reported with other techniques that use a transverse skin incision at the wrist with retraction near the ulnar neurovascular structures [19].

Overall, we observed good postoperative relief of symptoms and an early return of strength with little use of pain medication. Of the 1,304 patients analyzed

in our study, 1.7% (22 cases) were converted to a modified open CTR because of inadequate visualization, usually due to excessive tenosynovitis. Most of these conversions were done earlier in the series and such conversions became less frequent as proficiency with the endoscopic technique increased. Conversion to the open technique is simply accomplished by extending the incision proximally in the usual fashion [20, 21].

This report summarizes findings gathered over a 13-year period of clinical practice. Data collection and analysis methods begun at the outset of the study have been refined over time and although we have attempted to present our findings as clearly as possible, gaps in the patient-reported symptoms exist. Regardless of this shortcoming, we have observed that the trends in the data remained consistent throughout our study.

Conclusion

Our 13-year experience with this technique has demonstrated good short-term as well as consistent long-term results. The safety of the technique is ascribed to the ability of the surgeon to see the pertinent anatomy with both direct and endoscopic vision. The authors feel this technique combines the safety of the open CTR with the rapid recovery and patient satisfaction of the endoscopic CTR.

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