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REVIEW ARTICLES OF TOPICS

# Long-term outcomes of carpal tunnel release: a critical review of the literature

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**Abstract**
*Background* Carpal tunnel release (CTR) is widely accepted as an effective surgical treatment method for idiopathic carpal tunnel syndrome. While the short-term literature is well substantiated, the "long-term" literature has rarely exceeded 2 years of follow-up, which may be inadequate for a chronic and potentially recurring disease such as carpal tunnel syndrome.
*Methods* An English language literature search for long-term outcomes research on carpal tunnel release was made. Long-term is defined as 2 years or more after surgery.
*Results* CTR is a highly effective procedure, but important aspects remain poorly understood, including recurrence and existing electromyographic data. Some study design issues exist with the current literature.
*Conclusions* Further high-quality research is needed.

**Keywords** Open carpal tunnel release · Endoscopic carpal tunnel release · Long-term outcomes · Carpal tunnel syndrome

## Background

Carpal tunnel release (CTR) is widely recognized as an effective surgical treatment for idiopathic carpal tunnel syndrome. CTR is performed with a variety of techniques, most commonly open (OCTR) or endoscopic (ECTR). There is yet no consensus on the superiority of any one technique.

Studies have reported that resolution of paresthesias may not occur for 9 months or more [11, 14, 18, 20, 22]. Incomplete release of the transverse carpal ligament, scar tissue formation, infection, polyneuropathy, and psychosocial factors have all been linked to persistent and/or recurrent patient symptoms of carpal tunnel syndrome [6].

Electromyographic (EMG) and nerve conduction velocity (NCV) testing are commonly considered the only true objective measures of CTS [3]. Using EMG/NCV, multiple studies have confirmed that although distal latency scores improve after surgery, they often do not return to normal [9, 13, 19, 21]. These abnormal latencies can be prolonged, lasting for years. Schlagenhauff et al. [21] reported that distal latency scores remained abnormally elevated 36 months after surgery, and Nolan et al. [19] similarly reported that even 66 months after surgery, only 50 % of hands demonstrated normal distal latency. It remains unknown if the presence of these abnormal distal latencies after surgery is connected to clinical results. Finestone et al. [9] found that the results of 100 % of patients remained abnormally elevated 36 months after surgery, yet 78 % felt improvement by at least 75 %. Seventy-eight percent also reported feeling satisfied. These EMG/NCV testing results support the notion that at least some physiologic problems may persist in the long run.

Resolution of symptoms and recovery of function after CTR have not been as thoroughly addressed in the long-term as they have in the short-term. Although studies have generally reported symptom resolution and functional recovery after surgery, few have examined greater than 2 years follow-up [1, 2, 8, 12, 23]. Based on the chronicity of the disease pathology and past findings of prolonged distal latencies after clinically successful surgery, this period

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may not be sufficient to capture the full range of clinical outcomes, including permanent EMG changes. The purpose of this article is to review existing studies on long-term outcomes of carpal tunnel release in order to explore the hypothesis that there still exist important aspects to long-term CTR outcomes which are not well understood.

## Methods

For this paper, we defined long-term as a follow-up period of 2 years or greater. We used the terms "carpal tunnel release," "long-term outcomes," and "recurrence" to search MEDLINE and the ISI Citation Web for recently published articles. The search was conducted in November 2011 and was limited to the English language. Articles were excluded if they focused on only one particular subgroup of patients (e.g., elderly patients only) out of a concern for a bias in results or if the study contained a significant number of cases in which the latest follow-up was less than 2 years (Table 1). We found a total of 13 long-term studies fitting the inclusion criteria (Table 2).

## Evidence on Open Carpal Tunnel Release

In 1969, Semple et al. [22] reported that 75 % of 150 hands had no symptoms after an average follow-up period of 3.3 years. In 1986, Kulick et al. [17] found that 81 % of patients had resolution of paresthesias 4 years after surgery. Of those which failed, six hands (4.6 %) had suffered recurrence and the remainder had persistent symptoms, including pain, median nerve paresthesia, and APB muscle involvement (atrophy and weakness). All hands had received a trial course of injected steroids prior to surgery. In 1993, Haupt et al. [11] assessed 86 hands a median of 5.5 years after surgery. Using EMG testing, they found that 86 % of cases demonstrated symptom resolution, but only 26 % had complete electrodiagnostic improvement. Seven percent had worsened from their baseline preoperative state.

**Table 1** Inclusion and exclusion criteria

| |
|---|
| Inclusion: |
| 1. Outcomes study on carpal tunnel release (either OCTR or ECTR or related techniques) |
| 2. Latest postoperative visit 2 years or more after surgery |
| Exclusion: |
| 1. Review article |
| 2. Study population restricted to a certain demographic, such as the elderly |
| 3. Latest postoperative visit less than 2 years after surgery. This includes studies which had average follow-up times of 2 years or more, but still included large numbers of patients with less than 2 years of follow-up. |

In 1995, Nancollas et al. [18] conducted a longitudinal study of 60 hands over a period of 5.5 years. At latest follow-up, 87 % reported a "good" or "excellent" result. Forty-two percent, however, reported ongoing pain, 32 % had digital numbness, and 35 % had tingling. Fifty-seven percent reported a return of at least some preoperative symptoms, beginning on average 2 years after surgery. The average time to maximum improvement of symptoms was 9.8 months.

Katz et al. (1998) [15] conducted a prospective population-based study of carpal tunnel syndrome patients in Maine. This study was one of the first long-term investigations to use a validated instrument: the Levine–Katz Carpal Tunnel Questionnaire. They found that CTR patients had score improvements of 23–45 % by 6 months, and maintained these improvements throughout the study's 30-month duration. No incidences of recurrence were reported.

More recently, Kouyoumdjian et al. [16] received responses to a retrospective, unvalidated questionnaire from 114 open carpal tunnel release patients. The average follow-up time was 71 months, and the response rate was 34.8 %. Patients self-ranked their own outcomes as follows: 77.6 % cured, 13.6 % much better, 5.4 % little improvement, 2.7 % unchanged, and 0.7 % worsened.

However, a recent paper by Pensy et al. [20] presented evidence suggesting that the high success rates of OCTR are a result of the natural history of the disease, rather than the procedure itself. Using 24 matched pairs of surgical and non-surgical cases, the authors found significant improvements in both groups' Levine–Katz scores after an average of 6 years follow-up. While the surgical group did improve more, the differences in scores between the two groups were reportedly modest. Pensy et al. postulated that these results are indicative of CTR being less effective than we currently estimate.

In summary, existing long-term outcomes research generally indicates that OCTR is an effective long-term treatment method. Clinical success is shown to occur at a rate of 75–90 %, while recurrence is reported in 4–57 % of cases. Both recurrence and success are variously defined in the literature, perhaps accounting for some of the variation seen.

## Evidence on Endoscopic Carpal Tunnel Release and Other Techniques

A prospective 4-year follow-up on the Agee technique by Erhard et al. [7] revealed that out of 95 hands, 72 % were free of symptoms and 94 % were described by patients as functionally normal. The recurrence rate was reported to be 8.4 %, but of the 27 hands with symptoms at final follow-

**Table 2** Long-term CTR outcomes literature

| Study | Follow-up (range) | Surgical type | Validated metric | Comments | Measure of success | Recurrence |
|---|---|---|---|---|---|---|
| Atroshi et al. (2009) | 5 years | ECTR and OCTR | Levine–Katz | Prospective randomized | LK symptom score changes: −1.66 (OCTR) and −1.7 (ECTR) | 15 % (19/126) recurrence |
| Cellocco et al. (2005) | 2.5 years (24–42 months) | ECTR and OCTR | Levine–Katz | Prospective randomized | LK symptom score changes: −2.27 (OCTR) and −2.56 (ECTR) | 4 % (8/185) recurrence |
| Cresswell et al. (2008) | 7 years | OCTR and Indiana Tome | Levine–Katz | Prospective randomized | LK symptom score changes: −0.57 (OCTR) and −0.16 (ECTR) | OCTR: 11 % (5 reoperations, 2 ongoing symptoms); ECTR: 30 % (9 reoperations, 7 ongoing symptoms) |
| Erhard et al. (1999) | 4.5 years (32–63 month) | ECTR | No | Prospective | 72 % were symptom-free, 94 % had normal function | 9 % (8/95) recurrence |
| Finestone et al. (1996) | (5–11 years) | OCTR | No | Retrospective with EMG/NCV | 78 % had 75 % relief; 100 % had abnormal postop EMG | Not reported |
| Hankins et al. (2007) | 10 years | ECTR and OCTR | No | Retrospective | Not reported for >10 years group | 3.7 % (81/2,163) reoperation[a] |
| Haupt et al. (1993) | 5.5 years (2–11 years) | OCTR | No | Prospective with EMG/NCV | 86 % positive result; 26 % optimum result | 7 % recurrence (fraction not reported) |
| Katz et al. (1998) | 2.5 years | OCTR | Levine–Katz | Prospective | LK symptom score change: −1.2 to −1.6 | Not reported |
| Kouyoumdjian et al. (2003) | 5.9 years | OCTR | No | Retrospective | 77.6 % "cured," 13.6 % "much better" | Not reported |
| Kulick et al. (1986) | 4 years (2–6 years) | OCTR | No | Retrospective | 81 % "success rate" | 4.6 % (6/130) recurrence |
| Nancollas et al. (1995) | 5.5 years | OCTR | No | Retrospective | 87 % "good" or "excellent" | 57 % recurrence (fraction not reported) |
| Pensy et al. (2010) | 6 years | OCTR | Levine–Katz | Prospective | LK symptom score change: approximately −1.3 | Not reported |
| Semple et al. (1969) | 3.3 years (2–7 years) | OCTR | No | Retrospective | 75 % were symptom-free | Not reported |

[a] Non-workers compensation group treated with ECTR

up, only 17 were examined, suggesting the actual rate may be higher. Eight of these 17 had experienced a recurrence of symptoms after a mean period of 46 months.

Hankins et al. [10] conducted a retrospective 12-year review of one hand center's ECTR cases. Two thousand one hundred sixty-three patients were evaluated after a 10-year period; however, the authors did not state either the minimum or average follow-up time, or how follow-up was conducted. Ultimately, 81 patients (3.7 %) underwent reoperation, but there was no indication of how many patients chose not to reoperate despite experiencing persistent or recurrent symptoms.

Atroshi et al. [1] conducted a prospective study with a follow-up period of 5 years and a cohort of 126 patients. Patients were randomized to receive either OCTR or ECTR. The results suggested that both procedures were essentially equivalent in their outcomes, as demonstrated by both the significant improvement in the Levine–Katz score for both groups from baseline, and the moderate rate of recurrence (15 %). Recurrence was defined as deterioration in the symptom score by 0.4 points or more. Data collected in the first 3 months showed that ECTR offered an advantage in pain reduction, but later this advantage disappeared. All measures at 5 years were essentially equivalent for the two.

Cellocco et al. [4] compared the outcomes of carpal tunnel release using the Knifelight instrument versus OCTR at 3 months and 30 months postoperation. Data were gathered via the Levine–Katz instrument. For 222 consecutive hands, all scores improved between the two follow-up visits, and no incidences of recurrence were noted. Knifelight patients experienced better outcomes in the first 3 months, but by 30 months, no significant difference could be found between the two techniques. Seven Knifelight cases compared to one OCTR case showed recurrent disease at latest follow-up (4 % of cases overall) ($p<0.01$).

Cresswell et al. [5] examined the 7-year results of the Indiana Tome procedure versus OCTR, also using the Levine–Katz instrument. In a prospective randomized trial of 53 Indiana Tome and 62 OCTR patients, they determined that the Indiana Tome produced more reoperations and complications than OCTR, but the differences were not significant. Both groups improved in symptoms and function, but symptom scores for Indiana Tome were worse by a statistically significant margin.

ECTR generally provides strong outcomes while carrying a low, but undeniable, risk of recurrence. Current literature indicates that long-term results are essentially indistinguishable between ECTR and OCTR, so the choice of procedure is a matter of surgeon preference. Some, but not all, studies suggest a higher incidence of recurrence with techniques other than OCTR, but the numbers to support this are small.

## Discussion

Existing long-term studies report generally positive results for carpal tunnel release, with a clinical success rate between 75 % and 90 %. The lone dissenting study is from Pensy et al. which asserted that the surgical group outcomes were not significantly different from those of the conservative treatment group at long-term follow-up.

Nevertheless, there are shortcomings to the long-term outcome literature, which indicates that further work is necessary in order to bring it up to the current standards of evidence-based medicine. In particular, the long-term risk of recurrence and the clinical impact of persisting abnormal distal latencies after surgery are two questions still to be answered. Outcomes data, and especially long-term outcomes data, are important for evaluating these risks.

There are study design issues with the existing research. Most studies are retrospective and do not have preoperative and/or short-term postoperative data to compare against the long-term results. Furthermore, much of the existing literature does not make use of validated metrics or instruments (Table 2). Validated outcome measures are particularly important for carpal tunnel syndrome as the symptoms can be difficult to evaluate postoperatively [6]. Additionally, the utilization of many different outcome measures makes results between studies difficult to compare. A third shortcoming is inadequate length of follow-up. The average reported follow-up period of the studies we reviewed was 4.7 years. Given that carpal tunnel syndrome is a chronic disease which affects many patients for decades, this means the current literature may monitor only a small percentage of the disease's natural history.

Additionally concerning is the undetermined clinical impact of the persistence of nerve abnormalities after successful surgery, as measured by EMG/NCV. Few explanations for why this occurs have been suggested, and no sufficient answer has been found. We not only recommend that future studies investigate this matter, but also use EMG/NCV as a testing tool more regularly. Despite it being the only commonly accepted objective measure for carpal tunnel syndrome, we found only two long-term CTR studies [9, 11] which used it to evaluate patients both pre- and postoperatively.

Lastly, there is a lack of a clear and consistent definition for recurrence in the literature. Most agree that recurrence constitutes the return of symptoms after a temporary period of resolution. However, while some authors consider the return of any preoperative symptoms to qualify as recurrence [18], others set stricter guidelines, such as the need for reoperation [10] or a certain level of symptom score deterioration [1]. These inconsistencies may help to explain the range of reported recurrence rates from as low as 3.7 % [10] to as high as 57 % [18].

There is currently a need for further long-term studies on the outcomes of carpal tunnel release. EMG/NCV testing, the only objective data available, suggests that there are long-term, persistent abnormalities in a high percentage of patients. It remains unknown if there is a correlation between objectively abnormal nerves and the presence of persistent problems and/or development of recurrent symptoms. Finally, existing studies are of limited quality.

From a design standpoint, longer follow-up periods are indicated. Additionally, longitudinal design prospective studies with at least three data collection time points—preoperative, short-term postoperative, and long-term postoperative—are recommended. In terms of metrics, validated carpal tunnel instruments should be used when possible. We found postoperative EMG/NCV testing, in particular, to be an underinvestigated topic in many aspects. Finally, agreeing upon a basic, standard definition such as: "the return of symptoms based on a worsening of Levine-Katz score of X points after a temporary improvement period of Y duration" is important. This avoids the biases inherent in revision surgery, as the criteria for that procedure is not consistent. The challenge for future research on carpal tunnel release will be to add high-quality long-term studies which address these issues.

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