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## Original Research

## Endoscopic Carpal Tunnel Release after Prior Distal Radius Fixation: Clinical Outcomes and Intraoperative Findings

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**Purpose:** Open carpal tunnel release (OCTR) after distal radius fractures is well described; however, the use of endoscopic carpal tunnel release (ECTR) in the setting of prior distal radius fixation is less clear. We report clinical outcomes and intraoperative findings of patients with carpal tunnel syndrome following prior ipsilateral distal radius fixation who underwent subsequent ECTR.

**Methods:** A retrospective cohort of patients who had undergone prior ipsilateral distal radius fixation and ECTR for ipsilateral carpal tunnel syndrome (CTS) from 2018–2023 was collected at a single institution. All patients had electrodiagnostic evidence of CTS and scored positive on the CTS-6 Questionnaire. All patients underwent ECTR within 1 year of their initial distal radius fixation. Patients with carpal tunnel release at the time of initial distal radius surgery were excluded. Postoperative outcomes included 5-point Likert scale questionnaires regarding overall satisfaction and improvement in symptoms. Intraoperative findings were noted for all patients. Complications including nerve injury, conversion to OCTR, and need for revision surgery were documented. Patients were followed for 1 year after surgery. **Results:** Twenty-two patients with electrodiagnostic evidence confirmed CTS were identified following prior distal radius fixation. Average time from initial distal radius surgery to carpal tunnel release was 3.2 months. Scarring of the median nerve (MN) to the flexor retinaculum was noted in seven patients and hemosiderin deposition along the MN was noted in four patients. Likert scale questionnaire demonstrated 95% symptom improvement and 95% patient satisfaction. There were no injuries to the palmar cutaneous branch, recurrent motor branch, third common digital nerve, or MN. No patients required conversion to OCTR or revision within the 1-year follow-up.

**Conclusions:** Endoscopic carpal tunnel release provides reliable outcomes for patients with CTS after prior distal radius fixation with low complication rates and high patient satisfaction.

**Level of Evidence:** Prognostic IIIa.

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Carpal tunnel syndrome (CTS) is a common compressive neuropathy caused by entrapment of the median nerve (MN) as it passes through the carpal tunnel at the wrist. Carpal tunnel syndrome may be diagnosed through a combination of clinical symptoms, ultrasound, or electrodiagnostic (EDG) studies. Low or high

energy trauma also can precipitate CTS, such as in the setting of a distal radius fracture.<sup>1–3</sup> Prior studies have shown that a surgically-treated distal radius fracture places patients at a nearly 20% increased risk of CTS developing in the ipsilateral extremity within 6 months of treatment.<sup>1</sup> When CTS occurs after distal radius fracture, the severity ranges from transient symptoms to severe compression requiring urgent carpal tunnel release (CTR).<sup>2,3</sup>

While open or mini-open CTR (OCTR) has been the gold standard treatment for CTS, endoscopic CTR (ECTR) has gained in popularity over the past decade. Endoscopic CTR has shown fewer wound complications, earlier return to work, and superior short-term outcomes in patients undergoing primary CTR.<sup>4,5</sup> The efficacy of ECTR in

This is an IRB-approved retrospective study, all patient information was de-identified and patient consent was not required. Patient data will not be shared with third parties.

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**Figure 1.** Intraoperative photograph demonstrates the incision for endoscopic CTR following prior distal radius fixation (solid line). Prior surgical scar also is outlined (dotted line).

patients with prior ipsilateral distal radius fracture fixation is less established. Theoretically, scarring from prior wrist trauma and surgery can make endoscopic visualization and safe release of the transverse carpal ligament more challenging.

Zemirline et al. examined performing concurrent ECTR and distal radius fracture fixation through the same incision with good short-term results.<sup>6</sup> However, to our knowledge, no studies have assessed stand-alone ECTR following a healed surgically-treated distal radius fracture. In this study, we report the intraoperative findings and patient-reported outcomes of ECTR in patients who previously underwent surgical fixation of a distal radius fracture. We hypothesized that ECTR would provide satisfactory clinical outcomes without increased complications in this cohort of patients.

## Materials and Methods

### Study group

This was a single center retrospective cohort study of patients who were treated with ECTR from 2018–2023 after prior ipsilateral distal radius fracture fixation with volar plating. All patients completed a preoperative CTS-6 evaluation questionnaire and had EDG studies confirming diagnosis of CTS. The CTS-6 evaluation tool grades the presences of symptoms/findings on a 26-point scale.<sup>7</sup> Patients with scores  $\geq 12$  were included.<sup>8</sup> Patients with prior ipsilateral OCTR or ECTR were excluded. Patients who underwent immediate CTR at the time of distal radius fixation were excluded.

Patient demographic data were recorded, including age, biologic sex, smoking status, and time from initial distal radius fixation to ECTR. Initial distal radius Association of Osteosynthesis fracture pattern types were recorded. Intraoperative findings were documented for all patients, as well as complications including nerve injury, conversion to OCTR, and need for revision surgery.

### Surgical technique

All CTRs were performed endoscopically. A transverse incision was made 1 cm proximal to the wrist crease (Fig. 1). Blunt dissection was performed down to the antebrachial fascia, which then was incised and elevated. The MN was identified, and a Freer elevator was used to clear synovium from the transverse carpal ligament (TCL). The TCL was visualized using an antegrade endoscopic release system (AM Surgical, Stratos), taking care to protect the MN. An antegrade release then was performed. Surgical wounds were closed

**Table 1**

Demographic Data for Patients Undergoing Endoscopic CTR After Prior Distal Radius Fracture Fixation

| Demographic                           | Mean                |
|---------------------------------------|---------------------|
| Age                                   | 52                  |
| CTS-6 score                           | 16.6                |
|                                       | Percentage (N = 22) |
| F                                     | 64% (14)            |
| Smoker                                | 32% (7)             |
| Distal radius fracture classification |                     |
| AO Type A                             | 4% (1)              |
| AO Type B                             | 14% (3)             |
| AO Type C                             | 82% (18)            |
| Electrodiagnostic findings            |                     |
| Mild                                  | 9% (2)              |
| Moderate                              | 68% (15)            |
| Severe                                | 23% (5)             |

AO, Association of Osteosynthesis; CTS, carpal tunnel syndrome.

**Table 2**

Intraoperative findings during endoscopic CTR following prior distal radius fracture fixation

| Intraoperative finding                  | Percentage (N = 22) |
|-----------------------------------------|---------------------|
| Median nerve adhesions                  | 32% (7)             |
| Hemosiderin deposition                  | 18% (4)             |
| Distal forearm median nerve compression | 100% (22)           |
| Nerve injury                            | 0% (0)              |
| Conversion to open CTR                  | 0% (0)              |
| Revision CTR at 1 year                  | 0% (0)              |

CTR, carpal tunnel release.

with absorbable suture and skin glue. Intraoperative findings took note of scarring of the MN to the flexor retinaculum and presence of hemosiderin deposition. Patients were allowed to weightbear immediately after surgery without range of motion restriction.

### Clinical evaluation

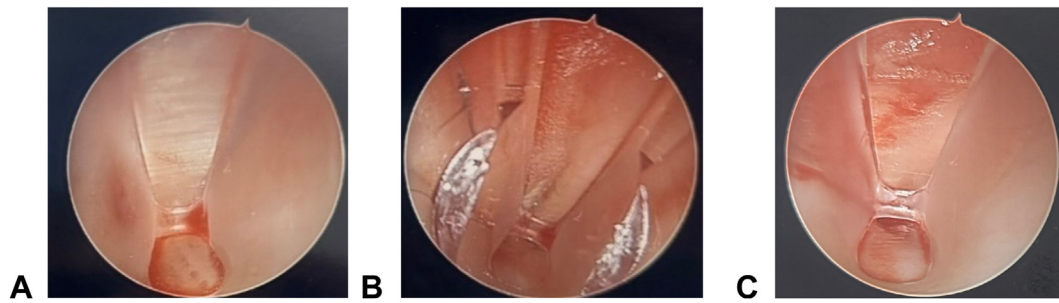
Patients were seen at 2 weeks, 12 weeks, and 1 year after surgery. Visual analog scale (VAS) pain scores on a were collected before surgery and after surgery at each follow-up. Additionally, postoperative outcome measures included patient-reported 5-point Likert scale questionnaires regarding overall satisfaction with the procedure (1: very dissatisfied, 2: somewhat dissatisfied, 3: neutral satisfaction, 4: satisfied, 5: very satisfied) and improvement in symptoms (1: symptoms are worse, 2 no improvement in symptoms, 3: little improvement, 4: some improvement, 5: significant improvement).

### Statistical analysis

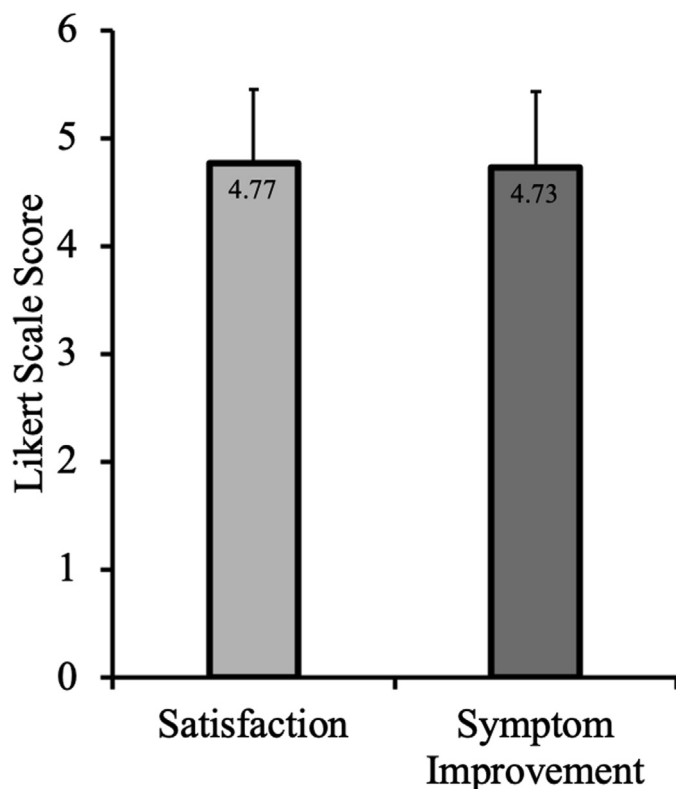
Statistical analysis was performed with SPSS software (version 28.0; SPSS, Chicago, Illinois). Quantitative variables were compared using the paired Student *t*-test. Values of  $P < .05$  were considered significant.

## Results

A total of 22 patients were identified having undergone ECTR after a previously operatively-treated ipsilateral distal radius fracture. Of the patients, 65% were women, with an average age of 52 years (range 24–64). The most common distal radius fracture pattern was Association of Osteosynthesis Type C (82%), with a single patient sustaining a prior open fracture. Electrodiagnostic findings demonstrated mild CTS in 10%, moderate in 70%, and



**Figure 2.** Intraoperative endoscopic photographs depicting **A** normal transverse carpal ligament, **B** scarring of the median nerve, and **C** hemosiderin deposition along the flexor retinaculum.



**Figure 3.** Average postoperative 5-point Likert scale scores for satisfaction and symptomatic improvement.

severe in 20% (Table 1). No patient had a history of prior clinically or EDG diagnosed CTS. Average time from initial fracture fixation to subsequent ECTR was 3.2 months.

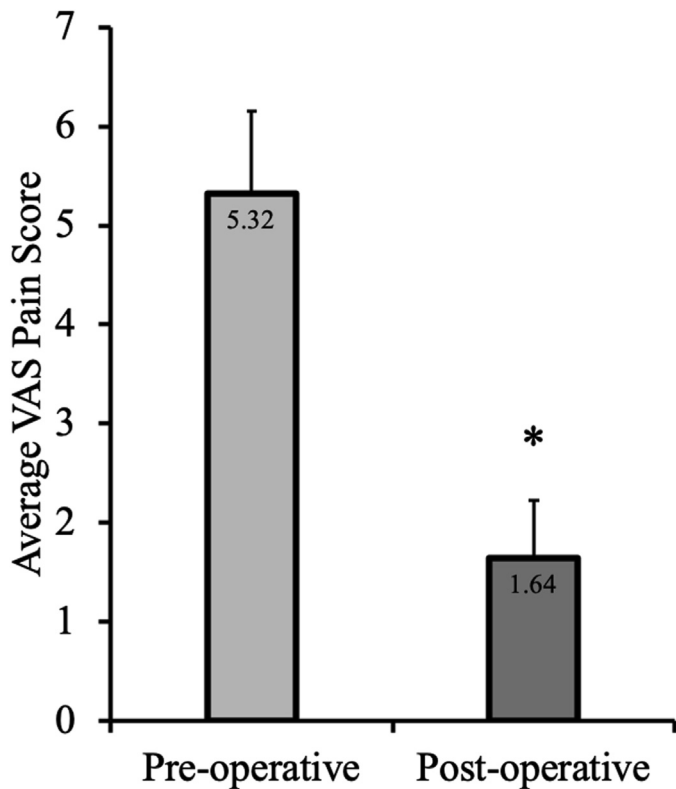
All patients required decompression of the MN in the distal forearm (Table 2). Scarring of the MN to the flexor retinaculum was noted in 7 of 22 patients (32%; Fig. 2). Hemosiderin deposition was observed along the flexor retinaculum and MN in 4 of 22 patients (18%). No patient required conversion to OCTR. There were no patient reports or clinical findings of nerve injury, specifically to the palmar cutaneous branch of the MN, recurrent motor branch of the MN, third common digital nerve, or MN. A total of 95% of patients reported being very satisfied with the procedure and 95% reported “some” or “significant” improvement in their symptoms, with average scores of 4.77 and 4.73, respectively (Fig. 3). Average pre-operative VAS pain scores showed improvement from 5.32 to 1.64 ( $P < .01$ ; Fig. 4). All patients with severe EDG findings demonstrated improvement in VAS pain scores. No patient required revision within the 1-year follow-up.

## Discussion

The development of CTS after operative fixation of distal radius fractures has been well established, with reported incidence rates varying from 10%–20%.<sup>1,2</sup> Following surgical intervention the resulting inflammation, swelling, and scarring around the MN can lead to compressive neuropathy requiring surgical decompression. In a posttraumatic patient cohort, this can be seen as a thickened TCL (posttraumatic or idiopathic) or from cicatrix formation in the distal forearm following distal radius fracture fixation.<sup>3</sup> Median nerve symptoms following trauma can also occur from direct MN injury or MN contusion, both of which are present immediately after injury. Our patient cohort demonstrated symptoms not present at the time of injury, but with delayed onset. The average time of 3.2 months from distal radius fracture fixation to ECTR supports a delayed form of CTS in our patients. The EDG studies, however, may not have the sensitivity to differentiate between MN symptoms produced by cicatrix or compression in the distal forearm versus those from compression within the carpal tunnel.

While a mini or open CTR traditionally is the gold standard treatment, ECTR offers several advantages, including smaller incisions, less soft tissue disruption, and faster recovery times.<sup>5</sup> A recent systematic review of 28 studies comparing ECTR to traditional OCTR found higher satisfaction rates, greater key pinch strengths, earlier return to work, and a lower incidence of scar-related complications in the ECTR approach. Though transient nerve injury rates were higher in the ECTR group than the OCTR group, there was no significant difference in rates of permanent nerve injury.<sup>9</sup> In another systemic review comparing ECTR to OCTR in bilateral CTR, ECTR yielded significantly higher Boston Carpal Tunnel Questionnaire Functional Status scores, without a difference in symptom severity scores, hand grip strength, digital sensibility or 2-point discrimination. Endoscopic CTR required longer operative times but no difference in complication rates were found.<sup>4</sup> These studies demonstrate that ECTR offers a safe and effective approach to CTR, with overall higher patient satisfaction rates and no significant increase in complications.

The effectiveness and potential advantages of ECTR have been less studied following prior wrist trauma. Specifically, the use of ECTR in patients with prior ipsilateral distal radius fracture fixation has not been well established. Zemirline et al<sup>6</sup> first outlined the feasibility of concurrent single incision ECTR at the time of distal radius fracture fixation. In their series of 10 patients, all 10 found symptomatic improvement at 6 months of follow-up. However, there were five reported complications, including two cases of temporary MN dysesthesia, and a case with temporary hypoesthesia in the palmar branch of the MN (all of which resolved). More recently, Bhashyam et al<sup>10</sup> reported on 17 patients who underwent concomitant ECTR with their operatively-treated distal



**Figure 4.** Average pre- and postoperative VAS pain scores ( $P < .01$ ). VAS, visual analog score.

radius fractures. All patients had a return of light touch sensibility by 12 weeks after surgery, and no need for revision CTR release at 2-year follow-up. They found no palmar cutaneous branch, recurrent motor branch, or the third common digital nerve injuries. Both studies demonstrated feasibility of ECTR at the time of concurrent distal radius fixation.

Our present study offers the first investigation to our knowledge into the feasibility and outcomes of ECTR for treatment of CTS in patients with a history of surgically-treated distal radius fractures on the ipsilateral side. The anatomic distortion and scarring from prior trauma and surgical approach can pose technical challenges for achieving adequate endoscopic visualization and safe release of the TCL. Our findings indicate that, despite these challenges, the endoscopic approach allows for successful decompression of the MN without need to transition to OCTR or increased complications after surgery. Intraoperatively, scarring of the MN to the flexor retinaculum and hemosiderin deposition were identified in a subset of patients, reflecting the effects of the previous trauma or the surgical approach. Notably, however, these intraoperative findings did not prompt conversion to an open procedure. We did not observe any nerve injuries in our cohort, and recognize that the findings of nerve injury may limit the use of ECTR and prompt consideration for conversion to an open approach. Future studies comparing the outcomes of ECTR to OCTR after distal radius fractures will better determine the best course of action in the setting of MN injury.

This study has several limitations. Inherent biases are present because of its retrospective, single-surgeon design. Although our cohort was limited to only 22 patients, to our knowledge this is the largest study evaluating outcomes of ECTR following prior distal radius fixation. Larger prospective and comparative studies are needed to evaluate the outcomes of ECTR versus OCTR. This study only provided short-term outcomes at 1 year, and longer-term follow-up is needed to evaluate the recurrence of ECTR in this cohort. Finally, future studies using validated PROs and objective measures (standardized 2-point discrimination and monofilament testing) may add insight in this cohort of patients.

Overall, this study demonstrated that ECTR is a safe and effective minimally-invasive alternative to the traditional mini-OCTR in patients with a history of prior volar plate fixation of distal radius fractures. Despite anatomic distortion and scarring from the previous trauma and surgical intervention, our series suggests that endoscopic technique allows for adequate visualization and decompression of the MN without reported complications or need for conversion to open release. Given the observed excellent symptom relief and reported high satisfaction rates, ECTR can be considered a viable surgical option for treatment of CTS in this specific patient population. Future studies are warranted to further explore long-term function and outcomes of ECTR following prior surgical trauma, with larger cohorts to allow for comparison to OCTR.

#### Conflict of Interest

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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