Rates of Complications and Secondary Surgeries of Mini-Open Carpal Tunnel Release

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Abstract

Background: The purpose of this study was to determine the rates and types of complications and secondary surgeries after mini-open carpal tunnel release. **Methods:** A retrospective cohort study was performed for 1,328 patients who underwent mini-open carpal tunnel release from August 2008 to July 2013. Patients were excluded for acute trauma, the index procedure being revision surgery, neoplasm, age less than 18 years, incomplete records, and postoperative follow-up less than 1 month, which yielded 904 patients who underwent 1,144 surgeries. **Results:** Of 1,144 carpal tunnel releases performed, 14 (1.2%) were noted to have a complication at final follow-up, with no cases of major nerve or vessel injury. Fourteen patients (1.2%) underwent secondary surgery, including 11 cases for persistent or recurrent carpal tunnel syndrome and 3 cases for infection or hematoma. Chronic kidney disease was associated with an increased risk of complication. Diabetes mellitus, chronic kidney disease, and cervical radiculopathy were associated with an increased risk of secondary surgery. **Conclusions:** The short-term complication and secondary surgery rates of mini-open carpal tunnel release are low. Patients with diabetes mellitus, chronic kidney disease, and cervical radiculopathy should be counseled regarding risks of complication and secondary surgery.

Keywords: carpal tunnel syndrome, mini-open carpal tunnel release, complications, secondary surgery, revision

Introduction

Carpal tunnel syndrome is the most prevalent upper extremity compressive neuropathy. The annual incidence of carpal tunnel syndrome is estimated to be 424 per 100 000 people.¹¹ Surgical release of the transverse carpal ligament is a commonly performed and effective treatment of carpal tunnel syndrome.^{12,17,26} Approximately 600 000 cases of carpal tunnel surgery are performed in the United States annually.¹⁰

Rates of complications and secondary surgery after mini-open carpal tunnel release are not well-characterized in the literature. The purpose of this study was to determine the rates and types of complications and secondary surgeries after mini-open carpal tunnel release.

Materials and Methods

Study Design

A retrospective chart review was conducted of all carpal tunnel release procedures performed by 4 surgeons with Subspecialty Certificates in Surgery of the Hand at our institution over a 5-year time period from July 2008 to June

2013. The study was performed with institutional review board approval. The hospital billing records database was queried using Common Procedural Terminology (CPT) codes for all patients who underwent open carpal tunnel release (CPT code 64721: neuroplasty and/or transposition; median nerve at carpal tunnel) within the study period. Exclusion criteria included incomplete records, age less than 18 years, procedures in which the index surgery during the study period was a revision surgery, acute trauma to the anatomic site within 2 weeks prior to the operation, operation for excision of neoplasm, and postoperative follow-up less than 1 month.

We reviewed the electronic medical records of all patients for our response variables, rates of complication and rates of secondary surgery after mini-open carpal tunnel

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Figure 1. (a) A representative mini-open incision is shown. (b) The contents of the carpal tunnel are visualized after sharp incision of the transverse carpal ligament.

release. In addition, those who had revision carpal tunnel surgery were classified as either persistent (symptoms never resolved after index surgery) or recurrent (documented symptom resolution followed by recurrence). The subgroup of patients with at least 3 months of postoperative follow-up was additionally analyzed for rates of midterm complications. When other procedures were performed under the same anesthetic, we focused only on complications and secondary surgeries related to the carpal tunnel release. The following patient-related factors were studied: age, sex, body mass index (BMI), diabetes mellitus, hypertension, hypothyroidism, chronic kidney disease, rheumatoid arthritis, cervical radiculopathy, Dupuytren disease, thumb carpometacarpal arthritis, trigger finger, De Quervain tenosynovitis, current smoking status, past smoking status, prior trauma to the wrist, whether a preoperative electromyography (EMG) was performed, whether the preoperative EMG was positive for carpal tunnel syndrome, and workers' compensation status. Prior trauma to the wrist was defined as a history of a fracture, dislocation, or tendon or ligament injury in the patient's lifetime around the operative wrist, outside the 2 weeks prior to carpal tunnel surgery; cases of acute trauma within 2 weeks of carpal tunnel surgery were excluded. There was greater than 95% completeness for all patient-related explanatory variables in our retrospective review.

Surgical Technique

A modified version of the open carpal tunnel release, using a smaller approximately 1.5- to 2-cm incision, is the standard surgical approach at our institution (Figure 1a). The incision is drawn along an imaginary line from the ulnar aspect of the distal extent of the palmaris longus tendon to the third webspace, just proximal to Kaplan's cardinal line. A tourniquet was routinely used. Sharp dissection was car-

ried down through the transverse carpal ligament (Figure 1b). The distal extent of the transverse carpal ligament was incised under direct vision. The proximal extent of the transverse carpal ligament and distal antebrachial fascia were carefully divided using blunt-tipped scissors in a plane deep to the subcutaneous fat and superficial to the contents of the carpal tunnel. The wound was sutured with 5-0 nylon mattress stitches and a soft dressing was applied.

Statistical Analysis

Descriptive statistics for explanatory variables were calculated for study groups. Student *t* test was used for continuous data and Fisher exact test was used for categorical data for comparisons between the study groups in the bivariate analysis. The standard significance criterion of $\alpha = 0.05$ and standard power criterion of $1 - \beta = 0.80$ were employed for all statistical tests. Our study was underpowered to evaluate the impact of age, sex, BMI, diabetes mellitus, hypertension, hypothyroidism, rheumatoid arthritis, cervical radiculopathy, Dupuytren disease, thumb carpometacarpal arthritis, trigger finger, De Quervain tenosynovitis, current or past smoking status, prior trauma to the wrist, whether a preoperative EMG was performed, whether the preoperative EMG was positive for carpal tunnel syndrome, and workers' compensation status on rates of complication and secondary surgery after mini-open carpal tunnel surgery.

Results

Initial query of our billing records database yielded 1,328 patients. Two hundred eighty-one patients were excluded for postoperative follow-up less than 1 month, 99 patients were excluded for acute trauma, 21 patients were excluded for the index surgery being revision surgery, 16 patients were excluded for incomplete records, and 7 patients were

excluded for excision of neoplasm. There were 288 males and 616 females in the study group compared with 160 males and 264 females in the excluded group. The average age ($\pm$ standard deviation) was 58.4 ± 14.0 in the study group compared with 54.1 ± 15.6 in the excluded group. The average BMI ($\pm$ standard deviation) was 30.9 ± 7.1 in the study group compared with 30.2 ± 7.1 in the excluded group. The final cohort included 904 patients who underwent 1,144 mini-open carpal tunnel release surgeries.

Of 1,144 carpal tunnel releases performed in 904 patients, 14 (1.2%) were noted to have a complication at final follow-up. Of the 14 complications, 13 were cases of postoperative infections, 11 of which were treated with oral antibiotics and wound care and 2 of which underwent surgical irrigation and debridement. There was 1 case of a hematoma requiring reoperation. There were no noted cases of surgical nerve injury or major vessel injury. On average, infections were noted on postoperative day 13 (range, postoperative day 10 to day 19). The hematoma was noted on postoperative day 1. Of the patients who had postoperative infections, 1 was on methotrexate for rheumatoid arthritis. No other patients were taking immunosuppressive medications. The patient who had a hematoma was not on anticoagulation. All complications were noted by the first postoperative clinic visit. Sequelae of these 14 complications included 1 case of chronic pain. Of the 872 (76.2%) carpal tunnel releases that had greater than 3 months of postoperative follow-up, no further complications were noted. Of the 14 total complications seen in the whole cohort, 12 of these patients had follow-up beyond 3 months and 2 had follow-up between 1 and 3 months. A diagnosis of chronic kidney disease was associated with an increased risk of complication after mini-open carpal tunnel release ($P < .05$). The median length of follow-up for patients who underwent mini-open carpal tunnel release was 9 months (interquartile range, 3-25 months). For patients without complications, the median follow-up was 9 months (interquartile range, 3-25 months), and for patients with complications, the median follow-up was 8 months (interquartile range, 3-19 months) (Figure 2).

Of the 281 carpal tunnel release patients excluded from our study for postoperative follow-up less than 1 month, 88 were male and 193 were female. The average age ($\pm$ standard deviation) was 57.5 ± 14.4 and the average BMI ($\pm$ standard deviation) was 30.8 ± 7.3 in this group. One hundred forty-six cases were followed until the first postoperative clinic visit at 1 to 2 weeks in this excluded group, of which there was 1 complication (0.7%) of a contact dermatitis from the postoperative dressing, which did not require further treatment.

Of 1,144 carpal tunnel releases performed, 14 (1.2%) underwent secondary surgery. Three patients (0.3%) underwent irrigation and debridement procedures for hematoma or infection, within 1 month from the index carpal tunnel

Figure 2. The length of follow-up in months is shown for 1,144 cases of mini-open carpal tunnel release.

surgery. Eleven patients (1.0%) underwent secondary surgery for carpal tunnel symptoms, 5 (0.4%) of whom had persistent carpal tunnel syndrome and underwent revision carpal tunnel release on average 7 months after the initial operation, and 6 (0.5%) of whom had recurrent carpal tunnel syndrome and underwent revision carpal tunnel release on average 34 months after the initial operation. At revision carpal tunnel release, an incomplete release of the transverse carpal ligament was found in 1 case of persistent carpal tunnel syndrome; otherwise, idiopathic scarring or reconstitution of the transverse carpal ligament was encountered. The rate of secondary surgery within 1 month of the index carpal tunnel surgery was low (0.3%), and these were all irrigation and debridement procedures. The rate of revision carpal tunnel release was 0.7% within 2 years and 0.3% beyond 2 years in our cohort. Diabetes mellitus, chronic kidney disease, and cervical radiculopathy were associated with an increased risk of secondary surgery after mini-open carpal tunnel release ($P < .05$).

Discussion

Release of the transverse carpal ligament is a commonly performed and effective surgical treatment for carpal tunnel syndrome.^{10,12,18,26} Carpal tunnel release is routinely performed via the traditional open approach, mini-open approach, or endoscopic approach with high rates of success.^{5,6,23,25,30,32,35} There is controversy between the relative merits of the three surgical approaches. The traditional open approach, although safe from a structural standpoint,^{24,35} is associated with scar tenderness, pillar pain, burning discomfort, and a longer time to return to

work.^{1,6,35} Endoscopic carpal tunnel release has generally shown earlier recovery of strength and earlier return to work; however, some studies have shown that the endoscopic approach carries a higher risk of nerve injury, mostly transient neurapraxias.^{9,31} Advocates of the mini-open approach report its safety from a structural standpoint and a more rapid return to work than the traditional open approach, although scar tenderness and pillar pain can still be seen.^{1,35} A randomized comparison of the traditional open and mini-open approaches showed lower rates of recurrent disease with the mini-open approach, but in a small sample size with limited follow-up.³⁵ Comparative operative time using the mini-open and endoscopic techniques is controversial and may be surgeon dependent.^{25,31} Improvements in disability are equivalent between the open and endoscopic approaches at 3-month, 5-year, and 12-year follow-up.^{2,4}

Review of the American Board of Orthopaedic Surgery database from 2003 to 2013 found the complication rate of open and endoscopic carpal tunnel release to be 3.6%.³⁴ The reported rate of complications of the mini-open approach is 2.6% at 18-month follow-up.²² Our study addresses the rate and types of complications following mini-open carpal tunnel release at a single institution over a 5-year time period. Our reported rate of complication of 1.2% at median 9-month follow-up is comparable to the reported rates in the literature. We report a secondary surgery rate of 1.2% in our cohort. Patients with recurrent symptoms underwent secondary surgery on average over 2.5 years after the index operation in our cohort; it is therefore important to be aware of the possibility of late symptom recurrence in a small subset of patients who may benefit from reoperation.

Chronic kidney disease is well-established as a risk factor for complications after surgical procedures.^{8,27} Patients with chronic kidney disease are predisposed to infection due to immunologic abnormalities from neutrophil dysfunction as a result of uremia. These immunodeficiencies are compounded by immunosuppressive agents often used to treat underlying disorders, concomitant nutritional deficiencies, and hemodialysis.²⁹ Hemodialysis-associated carpal tunnel syndrome has been described as a separate entity.^{15,21,33,39} Symptom relief following carpal tunnel release in patients on hemodialysis are comparable to the general population in the short-term, but not well-described in the long-term.^{19,20} Amyloid deposition has been found on histology from a small case series of hemodialysis patients undergoing carpal tunnel release, leading to the hypothesis that amyloid deposition in the transverse carpal ligament may lead to thickening of the transverse carpal ligament over time and subsequently carpal tunnel syndrome.²¹ Revision carpal tunnel release for persistent or recurrent symptoms may be reflective of underlying or concomitant neuropathy. Diabetes mellitus is thought to

compound compressive neuropathy by the accumulation of abnormal stable end products of nonenzymatic collagen glycosylation leading to stiffer collagen and worse nerve entrapment as well as relative neural ischemia through diabetic microangiopathy.^{13,28} Both diabetes mellitus^{14,17,36,37} and cervical radiculopathy³⁸ are concomitant insults to the median nerve that may lower the threshold for experiencing symptoms leading to revision surgery.

Our study has some limitations. The surgeries were performed at a single institution, and our results may not be generalizable to another population. Moreover, our study could not adequately evaluate a number of explanatory variables, which may or may not be risk factors for complications after carpal tunnel surgery. In addition, our study was retrospective in nature with variable lengths of follow-up. While median length of follow-up was 9 months, 14% of patients in our study were followed for only 1 month postoperatively. Brevity of follow-up may limit detection of later complications; however, we expect common complications of carpal tunnel release, including infection and wound complications as well as major nerve or vessel damage, to manifest by the first postoperative visit. Subgroup analysis of patients followed up to 3 months postoperatively did not detect any additional complications. Finally, we were unable to account for minor variations in technique between participating surgeons in the study, nor were we able to stratify complication and secondary surgery rates by surgeon in our study.

Our study has demonstrated that the short-term rate of complications after mini-open carpal tunnel release is low. The most common reasons for secondary surgery are persistent or recurrent carpal tunnel syndrome and postoperative infection. There were no noted cases of surgical nerve injury or major vessel injury in our study cohort. Prior studies have shown that age, sex, and a number of medical comorbidities including diabetes mellitus does not influence outcomes after carpal tunnel release.^{7,16} We have found that patients with chronic kidney disease are at higher risk for complications after mini-open carpal tunnel release; moreover, patients with diabetes mellitus, chronic kidney disease, and cervical radiculopathy are at higher risk for secondary surgery after mini-open carpal tunnel release. Informed preoperative discussions and careful patient selection may ameliorate the risk of postoperative complication and secondary surgery.

Ethical Approval

The study was performed with institutional review board approval.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent

Informed consent was waived in this retrospective study.

Declaration of Conflicting Interests

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