EDITOR'S CHOICE

Influence of Corticosteroid Injections on Postoperative Infections in Carpal Tunnel Release

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Purpose Corticosteroid injections (CSIs) are commonly used in carpal tunnel syndrome; however, recent literature has demonstrated risk of postoperative infection associated with preoperative CSIs in other orthopedic fields. The aim of this study was to assess the relationship of CSIs and postoperative infection following carpal tunnel release (CTR).

Methods A single-center retrospective review was conducted from 2010 to 2019 to identify patients who underwent CTR with subsequent antibiotic prescription for chart-documented wound infection. A demographically-matched cohort of 100 patients was identified for comparison. Information on patient demographics, comorbidities, injection history, and presence of postoperative infection was collected.

Results Thirty-nine patients (0.67% of all CTR patients) were identified with postoperative infections, 3 of which (0.05% of all CTR patients) were deep infections. In the infection cohort, 16 of 39 (41%) patients received an injection prior to surgery, whereas 16 of 100 (16%) patients in the control cohort received an injection. History of CSI was significantly more common in patients with postoperative infection, and patients in the infection cohort had a significantly shorter average time from injection to surgery by approximately 55 days.

Conclusions Corticosteroid injections in the preoperative period are associated with postoperative infection after CTR. Proximity of injection to time of surgery plays a role, although comorbidities, the corticosteroid dose, and frequency of injection require further study to determine risk contribution. *(J Hand Surg Am. 2021;46(12):1088–1093. Copyright © 2021 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Prognostic III.

Key words Carpal tunnel release, corticosteroid injection, postoperative complication, postoperative infection.

PERIPHERAL NERVE ENTRAPMENT syndromes are among the most prevalent complaints seen by hand surgeons in an office setting. The most common and most studied of these entrapment syndromes is carpal tunnel syndrome (CTS).[1] Treatment for CTS often begins with nonsurgical management, including nonsteroidal anti-inflammatory medications, oral steroids, night splints, activity

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modifications, and corticosteroid injections (CSIs). Research regarding the most effective treatment algorithm for CTS is varied, although previous studies on nonsurgical management have primarily shown support for night splints, CSIs, and oral corticosteroids, which is reflected by the 2016 American Academy of Orthopaedic Surgeons Clinical Practice Guideline.[2–6] A recent prospective study comparing CSIs to night orthosis even found that CSIs were superior in terms of relief of nocturnal paresthesia at 1, 3, and 6 months, with 80.3% of patients finding relief at 6 months.[6] The rationale for the use of CSIs is the ability to reduce edema and thus increase the effective area inside the carpal tunnel for the median nerve. CSIs have been shown to be significantly more effective than placebo injection and oral steroids.[7] Evers et al[8] found that in patients with CTS treated with CSIs, 32% did not require subsequent treatment for their symptoms.

Although CSIs are used ubiquitously throughout the field of orthopedics, they may pose certain risks, specifically the postoperative risk of infection. Many studies from multiple subspecialties (hip, knee, and shoulder arthroplasty and arthroscopy) have investigated this relationship with similar findings—CSIs significantly increase the risk of postoperative surgical site infections (SSIs).[9–17] In the hand surgery literature, Ng et al[18] showed that CSIs and their timing relative to trigger finger release increased risk for postoperative infections. Additionally, Matzon et al[19] showed that preoperative CSIs were associated with a small but significant increase in the rate of deep infection following trigger finger release. Many of these studies also concluded that the increased risk of SSIs was most apparent if the CSI was performed within 3 months of surgery, with a smaller risk of infection if the injection was made further from the time of surgery.[11,13,15]

Considering these findings, the purpose of this study was to determine if an association exists between preoperative CSIs for CTS and the rate of postoperative infection in patients undergoing open carpal tunnel release (CTR). We hypothesized that patients who received a CSI prior to surgery were at a greater risk for developing a postoperative infection, and this level of risk would be affected by the timing and dosage of the CSI.

MATERIALS AND METHODS

This study was an institutional review board-approved retrospective study of all patients who underwent open CTR at a single medical center between August 2010 and August 2019. Inclusion criteria were an open CTR with a minimum of 3 months of follow-up. Carpal tunnel release is a standardized procedure at our institution for which patients do not receive perioperative antibiotics. Exclusion criteria included revision CTR, patients with active infection, or patients on suppressive antibiotics. Additionally, patients who received prior CSIs from outside providers noted in their charts without full information on dosage, date, and location were excluded as well. All patients with chart-documented postoperative infection were included in the infection cohort. Of the remaining patients who had no history of infection, 100 patients were randomly selected for a control cohort that matched the infection cohort in age, sex, and body mass index (BMI) within 5% of each parameter based on the infection cohort. Specifically, out of these remaining infection-free patients, a list was generated that contained only patient age, sex, BMI, unique patient identifier, and a random number between 0 and 1,000,000 generated through a spreadsheet function. Using the random number, 74 women and 26 men were selected. Then, using the BMI as a reference and exchanging 1 man for every 3 women, patients were randomly exchanged between the generated control cohort and general infection-free group until the BMI between the infection and control cohorts matched. Then, again exchanging 1 man for every 3 women and exchanging patients with BMI within 5% of each other, patients were exchanged until the age, sex, and BMI were within 5% between the infection cohort and control cohort. Whether an injection had been administered was not evaluated until both patient cohorts were identified. Patient medical records were then reviewed to obtain additional patient demographics and comorbidities. This study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

Postoperative infections were identified by first evaluating for International Classification of Diseases Ninth Revision and Tenth Revision codes related to postoperative infection (998.12, 998.13, 998.83, 998.3, 998.32, 998.5, 998.59, 681.00, 681.9, 682.3, 682.4, 686.9, M96.840, L76.32, M96.841, L76.34, M96.842, M96.843, T81.30XA, T81.31XA, T81.4XXA, L03.019, L03.113, L03.114, L03.119, and L08.9). Additionally, to select all patients who received antibiotics in the postoperative period, manual chart review was performed and any mention of prescribed antibiotics in the postoperative period was investigated. For these patients to be listed as receiving antibiotics because of concerns for CTR

TABLE 1. Patient Demographics*

Variable	Infection Cohort (N = 39)	Control Cohort (N = 100)
Carpal tunnel injection incidence	16 (41)	16 (16)
Ipsilateral non−carpal tunnel injection	7 (17.9)	13 (13)
Age (y)	62.8 ± 11.1	63.6 ± 16.1
Sex (female)	30 (76.9)	74 (74)
BMI (kg/m^2)	33.1 ± 6.8	33.1 ± 8.6
Current smoker	5 (12.8)	10 (10)
Former smoker	15 (38.5)	35 (35)
Diabetes mellitus	11 (28.2)	24 (24)
PVD	1 (2.6)	0 (0)
Hemoglobin A1C†	6.6 ± 2.3	6.9 ± 2.0
CAD	4 (10.3)	7 (7)
CHF	0 (0)	2 (2)
CKD	1 (2.6)	2 (2)
HTN	23 (59.0)	51 (51)
HLD	17 (43.6)	39 (39)
Liver disease	0 (0)	0 (0)
Thyroid disease	9 (23.2)	23 (23)
Depression	11 (28.2)	14 (14)

CAD, coronary artery disease; CHF, congestive heart failure; CKD, chronic kidney disease; HLD, hyperlipidemia; HTN, hypertension; PVD, peripheral vascular disease.
*Data are shown as mean ± SD or number of patients and percentage.
†Nine infection patients, and 21 control patients.

postoperative infection, there had to be chart-documented concern for infection related to surgery and a prescription associated with that encounter. Further, manual chart review of the selected patients was performed, and the patients who had postoperative infection, as documented by the operating surgeon, were included in the infection cohort. Superficial infection was defined as requiring antibiotics for resolution without return to the operating room; deep infection was defined as requiring irrigation and debridement. The time from surgery to clinical diagnosis of infection was recorded, as well as the type of antibiotics prescribed. For deep infections, number of revision surgeries and infecting organism were recorded.

For all patients in the infection and control cohorts, the occurrence of a carpal tunnel injection with a corticosteroid in the year prior to surgery was identified. These patients' medical records were additionally reviewed for any CSIs in the ipsilateral hand outside of the carpal tunnel that occurred in the year prior to surgery. All CSIs for the carpal tunnel of interest were recorded for time prior to surgery, type of steroid, and dose of steroid. Steroid injection amounts were then converted into dexamethasone equivalents.[20]

Statistical analysis

Comparison between groups was performed using *t* test for continuous variables and chi-square test for categorical variables. Differences between groups were significant at a P value of $< .05$.

A *post hoc* analysis of the sample for the outcome of injection incidence between groups with an α of 0.05 found a power of 86.1%.

RESULTS

A total of 5,806 CTR procedures met the initial inclusion criteria. Of these, 39 (0.67%) were identified as having a postoperative infection, with 3 (0.05%) patients requiring irrigation and debridement. The proportion of non−carpal tunnel CSIs was 17.9% (7/39) for the infection cohort and 13% (13/100) for the infection cohort, but the sample was underpowered to make any further analysis. Key demographics are outlined in Table 1. The infection cohort had 30 (77%) women, average BMI of 33 ± 7 kg/m^2, and average age of 63 ± 11 years; the control cohort had

TABLE 2. Injection Characteristics*

Variable	Infection (N = 16)	Control (N = 16)	*P* Value
Time prior to surgery (d)			
Mean ± SD	77 ± 52	133 ± 89	.05
Median	61	94.5	-
Range	38−212	45−345	-
Injection within 3 mo of surgery			
No. of patients (%)	13 (87)	8 (50)	-
Steroid dose (mg dexamethasone)			
Mean ± SD	3.4 ± 1.2	3.8 ± 0.9	-

*Data are shown as mean ± SD or number of patients and percentage.

74 (74%) women, average BMI of 33 ± 9 kg/m^2, and average age of 64 ± 16 years. The prevalence of comorbidities is presented in Table 1.

The incidence of CSI was significantly higher in the infection cohort than the control cohort (41% vs 16%, $P < .05$). Additionally, the time from injection to surgery was shorter in the infection cohort (77 ± 52 days) versus the control cohort (133 ± 89 days) by 56 days ($P = .05$). The number of patients injected within 3 months of surgery was higher in the infection cohort, although the sample did not have sufficient power to determine if this was spurious (87% vs 50%, $P = .06$; power 62.5%, $\alpha = 0.05$). The mean steroid dose was 3.4 ± 1.2 mg dexamethasone in the infection cohort and 3.8 ± 0.9 mg in the control cohort (Table 2). There was 1 patient in the infection cohort with multiple carpal tunnel CSIs, and 3 patients in the control cohort.

Of those with a superficial infection, the average time from surgery to diagnosis of infection was 17 ± 9 days, while those with deep infection had a time to diagnosis of 23 ± 10 days. Of the superficial infection cases, cephalexin was most commonly prescribed (26/36 cases, 72%), followed by trimethoprim/sulfamethoxazole (6/36 cases, 17%).

DISCUSSION

Consistent with our hypothesis, the results of this study show that CSIs in the preoperative period are significantly associated with postoperative infection after CTR. These findings are also consistent with the literature on rate of infection following shoulder, hip, and knee CSIs and their subsequent surgeries. For instance, Forsythe et al[10] found that patients who received a CSI within 1 month of their rotator cuff repair had a higher rate of SSIs (1.3%) than the controls (0.8%).[10] Wang et al[11] also concluded that preoperative CSIs within 3 months of hip arthroscopy was associated with higher risk of postoperative infection than the noninjected controls. Finally, Cancienne et al[16] determined that the incidence of infection following knee arthroscopy was greater at both 3 and 6 months in patients who had been given an ipsilateral intra-articular knee steroid injection at the time of surgery. In addition, research in the field of hand surgery has demonstrated similar findings. Ng et al[18] found that CSIs and decreased time between injection and surgery were risk factors for postoperative infection following trigger finger release. Similarly, Matzon et al[19] described an increased risk for deep infection in trigger finger release surgery associated with preoperative CSI. Therefore, regardless of the site of the CSI, there is likely to be an increased risk of postoperative infection in that area. One interesting component that is not fully supported by our data is the notion that injections outside the carpal tunnel, but on the same hand, may also affect infection risk. We investigated this in our study and found that having injections in the same hand in the year prior to surgery was not associated with infection; however, our sample size was underpowered to verify this finding statistically.

Our results also show that the proximity of injection to the time of surgery may play a role in the rate of postoperative infection. However, the literature on the temporal relationship of injection and surgery with SSIs is mixed. Our findings are in agreement with those of Schairer et al[13] that there is an increased risk of periprosthetic joint infection if total hip arthroplasty is performed within 3 months of CSI. Ng et al[18] and Matzon et al[19] also described that decreased time between CSI and surgery increased risk for postoperative infection. Kokubun et al[21]

determined that when controlling for confounding variables, CSI within 90 days of total knee arthroplasty was not associated with increased number of complications, higher rates of infection, or poorer functional outcomes. We advise that patients should be informed that the risk of infection following a CTR is exceedingly low, less than 1%. However, injections given 2 to 3 months prior to surgery may increase this risk slightly. Those who do develop an infection will likely respond to a short course of antibiotics.

Finally, our data demonstrated similar corticosteroid dose and injection frequency between groups, although the sample size was too small to allow for a properly powered statistical evaluation. Chambers et al,[12] in evaluating these components, found that multiple steroid injections increase the risk of infection after total hip arthroplasty. In their study, the cohort that had a single injection had an infection rate of 2.0%, whereas the cohort with 2 or more injections had an infection rate of 6.6%. Kokubun et al[21] determined that there is no relationship between number of intra-articular steroid injections with postoperative complications from knee arthroplasty. Future studies are required to determine if dose amount and injection frequency play a role in the associated risk of infection related to carpal tunnel surgery.

The true number of infections identified in this study is likely underestimated. This is due in part to the limited reporting of infection within our own medical records and due to patients seeking care for postoperative infection with physicians outside the capture of our medical records. Additionally, the infections that were identified by-and-large responded to oral antibiotics, which would further support the possibility of an unrecognized postoperative infection if treated by an urgent care center, emergency room, or another outside provider. Therefore, the infection rate we report should be considered a minimum estimate for CTR.

This study possesses notable limitations. Because of the retrospective nature of our study, data collection relied heavily on the coding and documentation by physicians in patient charts, which is subject to individual bias, error, and missing information. There may also be confounding variables outside of those that were controlled for that were not captured in our analysis. Although this study was an attempt at a case-control design, the cohorts in this group were only matched for BMI, sex, and age. During this process, there was no attempt to match for the other comorbidities that may have contributed to postoperative infection. This was intentional because the research team believed that while BMI, sex, and age are well-documented in our EMR, there was less consistency in the way in which the other comorbidities were coded; therefore, a manual review of patient medical records was the best way to ensure accuracy, which could only occur after the cohorts were generated. The other comorbidities, such as diabetes, were not controlled for and could be important confounders that biased the data. Diabetes specifically is a known risk factor for postoperative infection; thus, a cohort that closely matched for the rate of diabetes would have been more ideal. Additionally, there is a loss to follow-up bias, such that patients with postoperative infection may be overrepresented in our results. This is because patients with uncomplicated recoveries may not return for additional follow-up visits or because patients with infections may seek care at another institution. Moreover, the authors of this article agreed upon the definition of superficial infection as any infection requiring treatment with antibiotics. Historically, definitions of superficial infection have been unreliable, particularly for use in a retrospective review. According to Seigerman et al,[22] despite using the criteria put forth by the Centers for Disease Control and Prevention to define the absence or presence of a superficial infection, interobserver and intraobserver reliability was poor.[23] Current definitions of superficial infection demonstrate poor reliability.[18] Thus, our definition of superficial infection may represent a potential limitation in this study.

In general, CTR carries a low risk for postoperative infection, with infections requiring irrigation and debridement being exceedingly rare. Corticosteroid injections in the preoperative period may be associated with an increased risk for postoperative infection. If a patient desires surgery shortly following an injection, they should be warned of the increased risk of infection, and surgeons should use their discretion as to whether surgery should be delayed. Proximity of injection to time of surgery plays a role, although the corticosteroid dose and frequency of injection require further study to determine risk contribution. Larger studies are required to determine how the various comorbidities affect the risk of infection in carpal tunnel release.

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