Rate of Infection After Carpal Tunnel Release Surgery and Effect of Antibiotic Prophylaxis

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Purpose  To determine the rate of postoperative wound infection and the association with prophylactic antibiotic use in uncomplicated carpal tunnel release surgery.

Methods  We performed a multicenter, retrospective review of all the carpal tunnel release procedures performed between January 1, 2005, and August 30, 2007. Data reviewed included the use of prophylactic antibiotics, diabetic status, and the occurrence of postoperative wound infection. We determined the overall antibiotic usage rate and analyzed the correlation between antibiotic use and the development of postoperative wound infection.

Results  The rate of surgical site infections in the 3003 patients who underwent carpal tunnel release surgery (group A) was 11. Antibiotic usage data were available for 2336 patients (group B). Six patients without prophylactic antibiotics had infection, as did 5 patients with prophylactic antibiotics. This difference was not statistically significant. Of the 11 surgical site infections, 4 were deep (organ/space) and 7 superficial (incisional). The number of patients with diabetes in the overall study population was 546, 3 of whom had infections. This was not statistically different from the nondiabetic population infection rate (8 patients).

Conclusions  The overall infection rate after carpal tunnel release surgery is low. In addition, the deep (organ/space) infection rate is much lower than previously reported. Antibiotic use did not decrease the risk of infection in this study population, including patients with diabetes. The routine use of antibiotic prophylaxis in carpal tunnel release surgery is not indicated. Surgeons should carefully consider the risks and benefits of routinely using prophylactic antibiotics in carpal tunnel release surgery. (J Hand Surg 2010;35A:189–196. © 2010 Published by Elsevier Inc. on behalf of the American Society for Surgery of the Hand.)

Type of study/level of evidence  Therapeutic III.

Key words  Hand, infection, carpal tunnel syndrome, carpal tunnel release, antibiotic.
steroid into the surgical wound was found to be strongly associated with the risk of infection. Because these ancillary procedures are rarely performed in standard primary CTR surgery, the true incidence of infection is called into question. In addition, the indication for preoperative antibiotic prophylaxis is not clear in clean soft tissue procedures of the hand in which the infection rate is low.\textsuperscript{20,21} Whereas the use of antibiotic prophylaxis is beneficial in orthopedic procedures with extensive dissection, with use of an implant, and where there is potential for postoperative hematoma formation,\textsuperscript{22} the regular use of antibiotic prophylaxis in all patients may expose them to the unnecessary risk of antibiotic complications.\textsuperscript{23}

The incidence of surgical site infection after CTR surgery has not been fully examined, by classifying the infections based on Centers for Disease Control (CDC) guidelines, and subsequently determining the relationship with preoperative antibiotic prophylaxis.\textsuperscript{15} The first aim of this study was to determine the incidence of both deep (organ/space) and superficial (incisional) surgical site infections after CTR surgery using CDC guidelines. The second aim was to determine whether prophylactic antibiotic use reduces the risk of infection.

**MATERIALS AND METHODS**

We conducted a multicenter, retrospective review of the CTR procedures performed over a 2.5-year period between January 1, 2005, and August 30, 2007, by 98 surgeons in 11 medical centers. A total of 1400 carpal tunnel release procedures are performed annually among these participating centers. During the study period, 3003 CTR surgeries were performed. After we obtained institutional review board approval, we used medical records, hospital administrative data, and pharmacy records to determine the rate of postoperative surgical site infection, the rate of preoperative antibiotic prophylaxis, patient comorbidities, and methods of treatment of the infections. The 11 participating medical centers all use the same integrated electronic medical record system. This electronic medical record has several modules that contain all inpatient, ambulatory, operating room, and emergency room encounter information as well as comprehensive patient demographic, comorbidity, and pharmacy information.

Using the administrative databases, we identified CTR patients using code 04.43 (Release of Carpal Tunnel) in the *International Classification of Disease, 9th Revision, Clinical Modification* (ICD-9-CM). Patients were excluded from the study group if the principal discharge diagnosis for their procedure was unrelated to carpal tunnel syndrome. All CTR surgeries including revision and those with associated ancillary procedures were reviewed. We did not review the ancillary procedures. CTR procedures performed for acute carpal tunnel syndrome associated with fractures were excluded. Both open and endoscopic carpal tunnel release procedures were included in the study but were not analyzed separately.

**Screening algorithm for infection**

Using an ICD-9 code algorithm, we screened patients’ history using the hospital’s electronic medical records system and administrative databases. Infections were identified by first screening the entire study population for possible inpatient hospital stays, procedures, emergency room encounters, urgent care encounters, outpatient visits indicating a postoperative surgical site infection, and any antibiotic use during the 30-day postoperative period, followed by a chart review to confirm and classify infections according to CDC guidelines.\textsuperscript{24} In accordance with the CDC recommended guidelines, all inpatient hospital activity was screened for up to 1 year postoperatively and all outpatient activity was screened up to 4 months postoperatively. A 30-day period was employed to screen antibiotic use owing to the high likelihood that infection would occur within this time frame for a soft tissue procedure such as a CTR, and because 30 days is the time frame used to define a wound infection after a soft tissue procedure without use of implants under the CDC guidelines (http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/SSI.pdf).\textsuperscript{24}

**CDC guidelines for surgical site infection**

For the purposes of this study, both superficial and deep incisional infections were grouped together as incisional infections. The CDC definition employs a distinction between an infection confined to the skin and superficial subcutaneous tissues of an incision and the deeper subcutaneous tissues without deep, organ space involvement. This distinction could not be easily distinguished for a carpal tunnel surgical site infection, either clinically or based on review of the medical record. The major distinction that is clinically relevant for a carpal tunnel postoperative surgical site infection is between those that are minor, superficial incisional infections and those that are deeper, involving the carpal canal (organ/ space). The CDC guidelines were employed to group the infections into incisional (superficial and deep) and organ/space based on the following definitions.

A superficial incisional infection was defined as an infection that occurred within 30 days after the surgery and involved only the skin or subcutaneous tissues of
the incision and at least 1 of the following: (1) purulent drainage; (2) growth of organisms from tissue or fluid obtained aseptically from the wound; (3) 1 of the following symptoms or signs: pain or tenderness, localized swelling, redness, or heat, when the superficial incision was deliberately opened by the surgeon, unless the incision was culture negative; and (4) diagnosis of superficial infection by the surgeon or attending physician.

A deep incisional surgical site infection was defined as an infection that occurred within 30 days after the surgery and was associated with at least 1 of the following: (1) purulent drainage from the deep incision but not from the organ/space component of the surgical site; (2) a deep incision that spontaneously dehisced or was deliberately opened by a surgeon when the patient had at least 1 of the following signs or symptoms: fever (>38°C), localized pain, or tenderness unless the site was culture negative; (3) an abscess or other evidence of infection involving the deep incision found on direct examination, during reoperation, or by histopathology or radiologic examination; and (4) diagnosis of a deep incisional surgical site infection by a surgeon or attending physician.

An organ/space surgical site infection was defined as an infection that occurred within 30 days after the surgery if no implant was left in place, or within 1 year if an implant was left in place and the infection appeared to be related to the surgery and infection involved any part of the anatomy (e.g., organ and spaces) other than the incision that was opened or manipulated during an surgery, and at least 1 of the following: (1) purulent drainage from a drain that was placed through a stab wound into the organ/space; (2) organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space; (3) an abscess or other evidence of infection involving the organ/space that was found on direct examination, during reoperation, or by histopathologic or radiologic examination; and (4) diagnosis of organ/space surgical site infection by a surgeon or attending physician.

**Prophylactic antibiotic usage**

Surgical prophylactic antibiotic use was extracted from hospital pharmacy records at locations where this information was available, and from direct contact with the surgeons involved in the care of the study population. Cases that lacked adequate pharmacy or medical record data to determine antibiotic use were excluded from data analysis of antibiotic prophylaxis. The antibiotics were delivered to each patient based on the clinical judgment of each surgeon without a specific protocol.

<table>
<thead>
<tr>
<th>Table 1. Study Groups A and B Demographics and Diabetes Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A (Overall Population, n = 3,003)</strong></td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>IQR</td>
</tr>
<tr>
<td>Diabetes</td>
</tr>
</tbody>
</table>

IQR, interquartile range.

The type of antibiotic and timing of delivery were not extracted from the chart.

**Study population**

We used the hospital administrative database to obtain demographic data including patient gender, age, surgical setting (inpatient vs outpatient), and medical center location. Diabetic status was extracted from the medical record. The study population (3003 cases) consisted of 2067 women and 936 men. We studied this population of patients (group A) to determine the rate of infection after CTR surgery. The median age was 56 years (range, 48–66 years). There were 546 cases of diabetes in group A (Table 1). In group A, there were 2974 cases performed in the outpatient setting, whereas 29 cases were performed in the inpatient setting.

The patients in group A were reviewed for the use of antibiotic prophylaxis. The rate of antibiotic prophylaxis varied between the 11 medical centers with a low of 12.3% to a high of 89.4%, as well as between surgeons with a low of 0% to a high of 100%. In 667 of 3003 cases, the administration of antibiotics could not be confirmed either through review of patient charts or contact with the surgeon. The resulting 2336 cases (group B) were studied to determine the effect of antibiotic prophylaxis (Table 1). The demographic data of study groups A and B were similar. There were no differences in gender, diagnosis, and outcomes between groups A and B (all p > .05); however, patients in group B were older (mean, 58 vs 55 years of age) (p < .001).

We analyzed patients who developed a postoperative surgical site infection to determine whether they received antibiotic prophylaxis, if cultures were taken and whether they grew any microorganisms, and what type
of treatment was rendered for the infection (antibiotics with or without surgical debridement). This information was not collected for the remainder of the study population.

**Statistical analysis**

We used the chi-square test to compare infection rates between demographic categories, diabetic status, and antibiotic usage in groups A and B. Age was treated as a continuous variable and compared among prophylactic usage status using a Mann-Whitney test. All reported p values were 2-sided and were considered to indicate statistical significance if the p value was less than .05. The study tested the null hypothesis that the proportion of infections would be identical between the population of patients who received antibiotic prophylaxis and those who did not. Given the existing sample size, we determined that the study would have a power of 78% to yield a statistically significant result when the effect size (difference between the proportions) was 1.1%. This effect was selected as the smallest effect that would be important to detect, in the sense that any smaller effect would not be of clinical or substantive significance. It was also assumed that this effect size was reasonable, in the sense that an effect of this magnitude could be anticipated in this field of research. We employed univariate analyses to examine the rate of infection in patients given prophylactic antibiotics versus patients without prophylaxis in group B. All analyses were performed using the statistical software (SPSS for Windows Release 14.0.0; SPSS Inc., Chicago, IL).

**RESULTS**

**Group A**

The overall rate of surgical site infection was 11 of 3003 in group A. Of the 11 surgical site infections, 4 were organ/space and 7 incisional (superficial/deep), based on the CDC definition of infection (Table 2). There were 2974 cases performed in the outpatient setting, whereas 29 cases were performed in the inpatient setting. All of the cases in which patients developed a postoperative wound infection were performed in the outpatient setting. The mean number of CTR surgeries performed by the 98 surgeons who participated in the study was 37 per year (median, 29 per year; range, 16–103 per year). A total of 50% of cases were performed by surgeons with an annual volume between 16 and 52; 25% of cases were performed by surgeons with an annual volume less than 16; and the other 25% of cases were performed by surgeons with an annual volume greater than 52. There was no statistically significant difference in surgical site infection rate between surgeons when comparing volume of cases (p > .05). The majority of the study population was female (2067). The difference in the rate of surgical site infection between male (5) and female patients (6) was not statistically significant (p = .33). The rate of diabetes in the overall study population was 546, with an infection rate of 3 (Table 2). This was not statistically different from the nondiabetic population (8) infection rate (p = .432).

**Group B**

Of 3003 patients, 1419 received prophylactic antibiotics and 917 did not. In 667 of 3003 cases, the administration of antibiotics could not be confirmed; these cases were therefore included in the group B study population (Table 3). Six infections occurred in patients without prophylactic antibiotics, and 5 occurred in patients with prophylactic antibiotics. This difference was not statistically significant (p = .354; Table 4). Three patients developed an organ/space infection in the group without prophylactic antibiotics, whereas 1 patient had an organ/space infection in the group with prophylactic antibiotics. This difference was not statistically significant (p = .999). The use of prophylactic antibiotics was higher in women, 997 of whom received prophylaxis, whereas only 422 men received prophylaxis (p = .026). The rate of antibiotic prophylaxis varied between the 11 medical centers, with a low of 12.3% to a high of 89.4%, as well as between surgeons, with a low of 0% to a high of 100%. The rate of antibiotic usage was 244 in diabetic and 1175 in nondiabetic patients; there

### Table 2. Study Group A Demographics and Diabetes Status With Surgical Site Infection Status

<table>
<thead>
<tr>
<th>Patients With No Infection (n = 2,992)</th>
<th>Patients With Surgical Site Infection (n = 11)</th>
<th>Total (n = 3003) (p Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Female</strong></td>
<td><strong>Male</strong></td>
<td></td>
</tr>
<tr>
<td>2,061 (69%)</td>
<td>931 (31%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median 56</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>IQR 48–66</td>
<td>46–67</td>
<td></td>
</tr>
<tr>
<td>Diabetes 543 (18%)</td>
<td>3 (27%)</td>
<td></td>
</tr>
</tbody>
</table>

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was no statistically significant difference between groups (\(p = .136\)) (Table 3).

Of the 11 patients who developed postoperative wound infections, 3 were diabetic. Two of the diabetic patients suffered organ/space infections. The remaining 8 infections were in nondiabetic patients, with 2 organ/space and 6 incisional. One of the 3 diabetic patients who developed a postoperative wound infection was insulin dependent. The other 2 patients were non–insulin dependent. The insulin-dependent diabetic patient had an organ/space infection associated with dehiscence of a trigger thumb incision that was performed in conjunction with the CTR. The infection may have started in the thumb wound and subsequently formed a horseshoe abscess with involvement of the carpal tunnel incision. The patient was treated with irrigation and debridement and intravenous antibiotics. One of the non–insulin-dependent diabetic patients was taken to the operating room for irrigation and debridement of an organ/space infection, whereas the other was treated with oral antibiotics and local wound care for an incisional wound infection that subsequently resolved without the need for surgical debridement.

Of the 8 nondiabetic patients who developed an infection, 2 had organ/space infections. They were treated with surgical wound irrigation and debridement and intravenous antibiotics. One of the 2 patients required 2 surgical debridements.

All 4 patients who developed an organ/space infection had cultures taken at the time of irrigation and debridement. Two cultures grew methicillin-resistant \(S.\) \(aureus\), 1 grew methicillin-sensitive \(S.\) \(aureus\), and 1 culture was negative for bacterial growth. Only 1 of 4 patients who had a deep infection had received antibiotic prophylaxis before the original CTR (Table 4). One of the patients with a superficial infection had cultures taken and grew methicillin-sensitive \(S.\) \(aureus\) and did not receive antibiotic prophylaxis at the time of the original CTR.

### DISCUSSION

The role of prophylactic antibiotics in CTR surgery is unclear. Part of the difficulty is due to the lack of standardized reporting in the literature and failure to use the CDC classification of infection. One study of 378 patients undergoing open CTR documented a 1% rate of “stitch abscess” and a 0.7% rate of deep surgical site infection requiring intravenous antibiotics. \(^{17}\) Another randomized study with 61 patients comparing various suture materials for closure of open CTR incisions found that no patients developed infection with metal or nylon sutures and 8% developed infection with Vicryl sutures. \(^{25}\) A number of studies document the incidence of surgical site infections after endoscopic carpal tunnel release, which varied between 0% \(^{9}\) and 5%. \(^{26}\) Unfortunately, those studies were small, with fewer than 100 patients. Hanssen et al’s retrospective review of CTR surgeries at the Mayo Clinic between 1976 and 1985 had a 0.47% rate of deep wound infection. \(^{15}\) However, the study did not document the number of superficial wound infections, nor did it address the use of prophylactic antibiotics or the effect of comorbidities such as diabetes on the incidence of postoperative wound infection. There were 17 cases of deep infection; of these, 13 had undergone tenosynovectomy with steroid infiltration intraoperatively along with use of a drain postoperatively. The authors related that the combination of

### TABLE 3. Study Group B Demographics and Diabetic Status With Prophylactic Antibiotic Data

<table>
<thead>
<tr>
<th></th>
<th>Patients Without Prophylactic Antibiotic (n = 917)</th>
<th>Patients With Prophylactic Antibiotic (n = 1,419)</th>
<th>Total (n = 2,336)</th>
<th>(p) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>604 (66%)</td>
<td>997 (70%)</td>
<td>1,601</td>
<td>.026</td>
</tr>
<tr>
<td>Male</td>
<td>313 (34%)</td>
<td>422 (30%)</td>
<td>735</td>
<td>.021</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>57</td>
<td>56</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>IQR</td>
<td>49–69</td>
<td>48–66</td>
<td>49–69</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>180 (20%)</td>
<td>244 (17.2%)</td>
<td>424</td>
<td>.136</td>
</tr>
</tbody>
</table>

### TABLE 4. Study Group B Surgical Site Infection With Prophylactic Antibiotic Usage

<table>
<thead>
<tr>
<th></th>
<th>Patients Without Prophylactic Antibiotic (n = 917)</th>
<th>Patients With Prophylactic Antibiotic (n = 1,419)</th>
<th>Total (n = 2,336)</th>
<th>(p) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical site infection</td>
<td>6 (0.7%)</td>
<td>5 (0.4%)</td>
<td>11 (0.5%)</td>
<td>.354</td>
</tr>
<tr>
<td>Organ/space infection</td>
<td>1 (0.1%)</td>
<td>3 (0.2%)</td>
<td>4 (0.2%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Incisional infection</td>
<td>5 (0.5%)</td>
<td>2 (0.1%)</td>
<td>7 (0.3%)</td>
<td>.115</td>
</tr>
</tbody>
</table>
these factors increased the risk of infection 8-fold. In addition, the authors noted a clinical impression that the use of these ancillary procedures was causing more postoperative infections after CTR surgery, ultimately leading the authors to abandon those procedures. The authors also believed that the true rate of infection may be higher than 0.47% owing to the possibility that some patients may have been managed outside the system that composed the data set. If both deep and superficial infections had been included in the study, the infection rate might have been considerably higher than what was reported.

The present study has some limitations. Of the 3003 patients who underwent surgery, 667 lacked sufficient information in their medical records to confirm preoperative prophylactic antibiotic use. This group of patients was excluded from the data analysis of antibiotic effectiveness, which decreased the overall power of the study; however, the use of a more limited data set for the statistical analysis was thought to be appropriate in this setting. The post hoc power analysis used for this study indicated that there was a power of 78% to yield a statistically significant result when the effect size (difference between the proportions) was 1.1%. Given the low rate of infection and the small difference between the patients who received antibiotic prophylaxis and those who did not, the study lacked sufficient power to detect a difference in infection rate had all 3003 patients been included in group B. A total of 9000 patients would have been needed to achieve adequate power to detect a difference between groups.

Another potential weakness of this study is that the infection rate was not stratified by open versus endoscopic release. It is possible that the rate of infection with an endoscopic approach is lower than that of open release, as all of the infections that occurred in this study were performed with an open technique. The rate of surgical site infection was shown to be unrelated to the surgical approach in a prior study; therefore, this topic was not specifically addressed.

Owing to the retrospective nature of the study, it is possible that some patients could have developed infection and were not captured in the data set. The chance of missing these patients was diminished by the fact that the patients treated in this study were all cared for in one unified, closed health system with the same electronic health record.

We did not study complications associated with the use of antibiotics as prophylaxis. It is possible that the use of antibiotics as prophylaxis may be more detrimental than helpful in CTR surgery. Drug reactions may result from antibiotic prophylaxis and range in severity from simple rashes to anaphylaxis. Antibiotics may promote the development of infection by selecting resistant organisms, resulting in complications such as *Clostridium difficile* colitis. Limiting the use of antibiotics to those patients who are at high risk for infection may help reduce the number of reactions and secondary infections.

Exclusion of CTR surgeries that were performed simultaneously with other elective hand procedures would have provided a more uniform patient population; however, the infection rate would be expected to be higher in the current study given the inclusion of these cases. In fact, the infection rate in the current study was lower than that in prior studies. Only 1 of 11 patients who developed a postoperative wound infection in this study had an associated surgical procedure (trigger thumb release) and all cases performed in the setting of trauma were excluded because this group of
patients would be expected to have an inherently higher risk of infection. The current study found that fewer diabetic patients (58%) received antibiotics compared with the nondiabetic patient population (62%). Traditionally, surgeons have given antibiotic prophylaxis to diabetic patients even if they normally refrain from antibiotic use in nondiabetics. The study population would be expected to have a higher rate of antibiotic prophylaxis in diabetic patients if this traditional view were followed. The major determinant of antibiotic prophylaxis may have been more strongly related to surgeon preference (i.e., all or none) rather than medical comorbidities. Thus, the rate of antibiotic prophylaxis was not statistically different between groups. Because the number of diabetic patients who received antibiotics was similar to those who did not, this study provides a unique opportunity to compare the rate of infection in 2 equally sized groups. The only study that has directly compared the infection rate of diabetic and nondiabetic patients after CTR surgery found no difference (4.2%). This result correlates with that of the current study. The risk of infection in diabetic patients should be assessed by the surgeon on an individual basis, taking into account the glucose on the day of surgery and the hemoglobin A1C level, which reflects diabetic control of glucose levels over an extended period of time. Antibiotic prophylaxis in a patient with poorly controlled diabetes may be appropriate even though the rate of infection after CTR surgery is low.

In this study, the deep (organ/-space) infection rate was much lower than previously reported. Antibiotic prophylaxis was confirmed in 47% of the cases and was unrelated to diabetic status. Based on these data, prophylactic antibiotic use did not result in a lower risk of infection including patients with diabetes. CTR surgery has a lower rate of postoperative infection compared with other orthopedic procedures, and the current study found no difference in infection rates between patients with and without antibiotic prophylaxis. Therefore, the routine use of antibiotic prophylaxis for CTR surgery is not indicated. Patients who are at higher risk for infection, including diabetics, should be treated with prophylactic antibiotics on an individual basis based on the overall risk profile of the patient. Surgeons must carefully consider the risks and benefits of the routine use of antibiotic prophylaxis in all patients undergoing CTR surgery.

REFERENCES