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Original Research

Antibiotic Prophylaxis in Clean Hand Surgery: A Prospective Cohort Analysis of Major and Minor Complications

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Purpose: The indications for prophylactic antibiotics in hand surgery remain undefined. Current literature has focused solely on readmission and reoperation for surgical site infection, while neglecting minor infectious complications treated at outpatient follow-up in addition to complications from antibiotic therapy observed after surgery. This study sought to analyze major and minor infection rates, as well as adverse effects of preoperative antibiotics after clean hand surgery.

Methods: A prospective cohort study was conducted over a 6-month period. The cohorts included patients who received preoperative antibiotic prophylaxis and those that did not. Patient details and operative data were obtained during the first postoperative visit following the index surgery. Primary outcomes assessed were as follows: (1) major infection, defined as admission or reoperation for infection; (2) minor infection, defined as use of postoperative oral antibiotics; and (3) complications of antibiotic therapy.

Results: A total of 377 consecutive patients underwent operations of the upper extremity. Complications from preoperative antibiotic therapy were seen in 6.9% of patients. Overall, there were no major postoperative infections and the minor postoperative infection rate was 5.6%. The minor infection rate was 6.9% (9/131) among patients who did not receive preoperative antibiotics and 4.9% (12/246) among patients who received preoperative antibiotics ($P = .57$).

Conclusions: A 5.6% minor infection rate was identified following clean hand surgery, with no cases of major infection. Preoperative antibiotics did not demonstrate benefit in terms of reduction of minor infections, but they did yield a 6.9% adverse reaction rate, including one case of *Clostridium difficile* infection warranting hospitalization. Caution is recommended while prescribing prophylactic antibiotics for clean hand surgeries, given the lack of clear benefits and the potential for adverse effects.

Type of Study/level of evidence: Prognostic II.

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Surgical site infections (SSIs) represent a significant burden to both the patients and the health care system in the United States.[1–3] Substantial morbidity to the patient and, potentially, mortality can result from SSIs. Extensive research has been put forth to both prevent and combat SSIs, particularly in the field of orthopedics and hand surgery.[4–11] It is incumbent upon the surgeon to recognize the risk factors for and take proper preoperative and intraoperative precautions against the development of postoperative infections. Traditionally, preoperative antibiotics have been a mainstay in the prevention of postoperative SSIs in hand surgery.[12] Moreover, the surgeon must weigh the risks and benefits of any medication that they may prescribe to their patients, including preoperative antibiotic prophylaxis, as these medications are not without potential complications such as allergic reactions, *Clostridium difficile* colitis, and contribution to increasing antibiotic resistance.[13–15]

The rate of infection reported with elective soft tissue hand surgery is extremely low, with the literature showing infection rates from 0.3% to 1.5%.[16,17] Much of the literature on infection rates is based primarily on readmission and reoperation rates, with reoperation rates often coexisting with inherent observational bias.

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The literature often ignores infectious complication rates treated with outpatient antibiotics (eg, incisional cellulitis) and more frequently ignores the complications associated with antibiotic usage before surgery. The current recommendations from the American Association of Plastic Surgeons is to not use prophylactic antibiotics in clean hand surgical procedures, and the current recommendation from the American Academy of Orthopaedic Surgeons is to not use prophylactic antibiotics for carpal tunnel release surgery.[18,19] Despite these recommendations, the reported rates of use of preoperative antibiotics for clean carpal tunnel release surgery remains between 31% and 49%.[20,21]

The aim of this study was to analyze the major and minor infection rates after clean hand surgical procedures and to identify any associated risk factors. The second aim of the study was to assess the frequency of antibiotic-related complications in clean hand surgery. We hypothesize that the infection rates in clean hand surgical procedures are low and that the frequency of complications with preoperative antibiotics will be equal to or higher than that without preoperative antibiotics.

Materials and Methods

A prospective cohort analysis was performed over a 6-month period from July 10, 2017 to January 12, 2018 after receiving approval from the institutional review board. All clean, outpatient elective hand and upper extremity surgeries were performed by a single surgeon at one of the two ambulatory surgical centers. Patient details and operative data were recorded during the first postoperative visit following the index surgery. Patients were considered for inclusion in data analysis if they were aged $\geq$18 years and underwent clean surgery of the upper extremity at the level of the elbow and distal. Exclusion criteria included cases involving an infection and patients undergoing a surgical procedure proximal to the elbow.

Patient data collected for this study included previous allergic reactions to antibiotics and pertinent past medical history, including diabetes mellitus and smoking status. All data were obtained via a postoperative questionnaire at the first postoperative visit by the treating surgeon. Patient attitudes toward antibiotics were also assessed with the question “Do you think antibiotics should be given before surgeries?” Additionally, adverse reactions to the antibiotics were solicited. Specifically, they were asked whether they experienced rashes, hives, diarrhea, hospitalization, or any other symptom. Operative data collected included procedure type, procedure site, anesthesia type, wound classification as defined by the Centers for Disease Control surgical wound classification system, and preoperative antibiotic therapy.

Primary outcomes assessed were diagnosis of major postoperative infections (admission for postoperative infection or reoperation for postoperative infection), diagnosis of minor postoperative infections (use of oral antibiotics within the immediate postoperative period of 2–4 weeks after surgery for incisional cellulitis, superficial infection, a decompressed stitch abscess, or wound dehiscence), and complications from antibiotic therapy. Patients were assessed via direct examination by the operating surgeon at scheduled follow-up, approximately 2 weeks following the procedure. Diagnosis of major or minor infection was based on clinical examination. Patient follow-up periods differed on the basis of the type of procedure performed, and any patient who developed a major or minor infection beyond the initial 2-week follow-up was recorded.

Patients were divided into two cohorts on the basis of which of the two ambulatory surgical centers the index operation was performed at. The two centers were at different locations but had similar management and perioperative practices. The choice of centers as the site of surgery was based solely on geography and patient convenience. The first surgery center required the administration of preoperative prophylactic antibiotics in all cases based on facility policy. All patients receiving prophylactic antibiotics were given weight-based cefazolin unless there was a documented history of an allergy, in which case either clindamycin or vancomycin was administered. All operations performed at the second surgery center allowed surgeon discretion and subsequently no preoperative prophylactic antibiotic therapy was prescribed for any procedure.

Statistical analysis was performed using χ^2 test to compare infection rates between cohorts and subgroups including smoking history, diabetes, and previous total joint arthroplasty. All reported P values are two-sided and assume a 95% confidence interval for significance. The null hypothesis tested was that no difference existed between the cohorts. All analyses were conducted using statistical software (R Studio).

Table 1
Summary of the Procedures Performed During the Study Period

Procedure Type	Number (%)
Soft tissue	224 (59.4%)
Fracture	93 (24.7%)
Arthroscopy	13 (3.4%)
Arthroplasty/arthrodesis	43 (11.4%)
Other	4 (1.1%)
Procedure Site	
Hand	185 (49.1%)
Wrist	104 (27.6%)
Forearm	7 (1.9%)
Elbow	81 (21.5%)

Results

A total of 413 consecutive patients underwent operations of the hand, wrist, and elbow by a single surgeon, the senior author (A.I.). A total of 377 patients (Table 1) were able to complete the postoperative questionnaire and, thus, were included in the final analysis. The patients were evaluated at an average of 12.7 days after operation (range, 10–19 days). Of the 377 patients in the study population, 9.3% had a history of type II diabetes mellitus and 1.1% had a history of type I diabetes mellitus. A total of 7.2% of patients were active smokers. Patient experiences with antibiotics were asked via the postoperative questionnaire and showed that 18.3% reported a prior adverse reaction to antibiotic therapy (Table 2).

A total of 246 (65.3%) patients received preoperative antibiotics and 131 (34.7%) did not receive preoperative antibiotics. Complications from preoperative antibiotic therapy were seen in 6.9% of the patients, which included vaginal candidiasis, hives and rash, and diarrheal illness, including one case of hospitalization for *C. difficile* colitis after surgery.

There were no major postoperative infections (no readmissions or reoperations) in the study population in either group. However, 5.6% (21/377) were diagnosed with a minor postoperative infection (ie, cellulitis, superficial infection, a decompressed stitch abscess, or wound dehiscence) requiring administration of only oral postoperative antibiotics prescribed at the first postoperative visit. There was no statistically significant difference ($P = .57$) between the number of patients with minor infections based on administration of preoperative antibiotics (Table 3). Moreover, when comparing those patients who did have a minor postoperative infection (n = 21), there was no statistically significant difference between cohorts based on the type of procedure performed or its location (Table 4). There were no cases requiring additional oral

Table 2
Summary of Patient Demographics

Patient Demographic	Number (%)
Known antibiotic allergy	69 (18.3%)
Type 1 diabetes mellitus	4 (1.1%)
Type 2 diabetes mellitus	35 (9.3%)
Current smoker	27 (7.2%)
Do you think antibiotics should be given before surgeries?	
Yes	170 (45.1%)
No	207 (54.9%)
Did you have an allergic reaction to antibiotics after surgery?*	
Yes	17 (6.9%)
No	229 (93.1%)

* Response to this question was recorded only for the cohort of patients that received preoperative antibiotics (n = 246).

Table 3
Comparison of the Two Cohorts by Postoperative Infection, Procedure Type, Procedure Site, and Demographics

Variable	No Preoperation ABX *N = 131*	Preoperation ABX *N = 246*
Infection type:		
No infection	122 (93.1%)	234 (95.1%)
Minor infection	9 (6.87%)	12 (4.88%)
Major infection	0 (0%)	0 (0%)
Procedure type:		
Soft tissue	119 (90.8%)	105 (42.7%)
Fracture	4 (3.05%)	89 (36.2%)
Arthroscopy	0 (0.00%)	13 (5.28%)
Arthroplasty/arthrodesis	8 (6.11%)	35 (14.2%)
Other	0 (0.00%)	4 (1.63%)
Procedure site:		
Hand and wrist	131 (100%)	158 (64.2%)
Forearm	0 (0.00%)	7 (2.9%)
Elbow	0 (0.00%)	81 (32.9%)
Smoker:		
No	128 (97.7%)	222 (90.2%)
Yes	3 (2.29%)	24 (9.76%)
Diabetes mellitus:		
None	117 (89.3%)	221 (89.8%)
Type I	1 (0.76%)	3 (1.22%)
Type II	13 (9.92%)	22 (8.94%)
Joint replacement:		
No	105 (80.2%)	213 (86.6%)
Yes	26 (19.8%)	33 (13.4%)

ABX, antibiotics.

postoperative antibiotics in either the postoperative minor infection group or the preoperative antibiotics group.

Subgroup analysis of the 224 soft tissue procedures (105 patients who received preoperative antibiotics and 119 patients who did not) showed that there were no major infections, including no cases of readmission or reoperation in any group. In terms of minor infections, 9.5% (10/105) of patients who received preoperative antibiotics required postoperative outpatient antibiotics for a superficial infection compared with 5.9% (7/119) of patients who did not receive preoperative antibiotics. Subgroup analysis of the non–soft tissue procedures (fracture, arthroscopy, arthrodesis, or arthroplasty) showed that rates of minor infections were not statistically significant between the cohorts. There were two patients with a minor postoperative infection following a fracture procedure (both patients underwent percutaneous fixation of phalanx fractures), both of whom did not receive preoperative antibiotics. There were two patients with a minor postoperative infection following joint procedures, one following a proximal row carpectomy and the other following a thumb carpometacarpal arthroplasty, each of whom received preoperative antibiotic prophylaxis. Both minor postoperative infections in each group were treated with a course of outpatient oral antibiotics in the form of doxycycline or trimethoprim-sulfamethoxazole. There were no cases of major or minor infections in either cohort of patients following arthroscopy procedures. There were insufficient cases in the forearm and elbow groups without preoperative antibiotics to allow for analysis in this anatomic location.

Discussion

Development of postoperative infections in clean hand surgery can be devastating even though the reported incidence is low, based on currently available evidence (0.3%–1.5%).[22] Most studies looking at the incidence of postoperative infections in clean hand surgery often focus their attention on major complications such as reoperation or readmission for infection in addition to only analyzing soft tissue procedures rather than a full array of clean, elective hand and upper extremity surgeries. Moreover, little attention is often devoted to the development of adverse reactions as a result of administration of preoperative antibiotic prophylaxis. Despite the evidence that routine antibiotic prophylaxis is unnecessary in elective hand surgery, the rate of administration remains high among surgeons, with rates reported between 31% and 49%.[20,21] The primary purpose of this study was to determine the rate of major and minor infections in all types of clean, elective hand and upper extremity surgeries with and without preoperative antibiotic prophylaxis. We also sought to determine the rate of adverse events related to preoperative antibiotic prophylaxis.

Results of this study show that no patients developed major postoperative infections requiring reoperation or readmission irrespective of whether they received preoperative antibiotics before clean hand surgery. However, the rate of minor postoperative infections requiring outpatient oral antibiotics after the first postoperative visit was 5.6% (21/377). Of the patients diagnosed with minor postoperative infections, 57.1% (12/21) had received preoperative antibiotics and 42.9% (9/21) had not received preoperative antibiotics, indicating no statistically significant difference based on preoperative antibiotics. The majority of minor postoperative infections occurred in patients who had a soft tissue procedure (17/21, 81%). Difference in infection rate based on anatomic locations beyond the hand and wrist was not possible in this study owing to lack of adequate number of forearm and elbow cases. Additionally, risk factors, including smoking and type 1 and type 2 diabetes mellitus, were comparable between the two groups, with no statistically significant difference in minor postoperative infection rates.

This study identified the occurrence of adverse reactions due to preoperative antibiotics to be 6.9% (17/246). Specifically, patients reporting adverse reactions identified the development of vaginal candidiasis; hives and rashes; and diarrheal illness, including one case of postoperative hospitalization for *C. difficile* colitis. A recent study by Sandrowski et al[23] reported the rate of adverse reactions to a single preoperative dose of antibiotics to be 1.5%. Further studies are needed to better clarify the rate of adverse reactions to a single dose of preoperative antibiotics for clean hand surgery.

Over the course of this study, there were 224 patients that underwent a soft tissue procedure with 17 (8.0%) patients who developed a minor postoperative infection requiring oral antibiotics after the first postoperative visit. All these patients developed peri-incisional cellulitis or minor wound dehiscence that resolved with oral antibiotics alone and without further surgical intervention or hospital admission. Tosti et al[24] reported an infection rate of 0.66% following elective soft tissue hand procedures, which is significantly lower than the rate reported in this study. However, that study was retrospective and required review of documentation

Table 4
Comparison of Patient Cohorts Diagnosed with a Minor Postoperative Infection by Procedure Type, Procedure Site, and Demographics

Variable	No Preoperation ABX *N = 9*	Preoperation ABX *N = 12*	*P* Value
Procedure type:			
Soft tissue	7 (77.8%)	10 (83.3%)	>.05
Fracture	2 (22.2%)	0 (0.00%)	>.05
Arthroplasty/ arthrodesis	0 (0.00%)	2 (16.7%)	>.05
Procedure site:			
Hand and wrist	9 (100%)	8 (33.3%)	>.05
Forearm	0 (0.00%)	0 (0.00%)	n/a
Elbow	0 (0.00%)	4 (33.3%)	n/a
Smoker:			
No	9 (100%)	8 (66.7%)	>.05
Yes	0 (0.00%)	4 (33.3%)	>.05
Diabetes mellitus:			
No	9 (100%)	11 (91.7%)	>.05
Type 1	0 (0.00%)	0 (0.00%)	>.05
Type 2	0 (0.00%)	1 (8.33%)	>.05

ABX, antibiotics; n/a, not available.

and likely underreported the rate of infection following soft tissue infection. Moreover, Li et al[25] conducted a retrospective database study of clean, soft tissue hand surgeries and found a postoperative infection rate of 1.5% in patients who did not receive antibiotic prophylaxis and 1.4% in patients who received antibiotic prophylaxis. Given that it was a database study, there was no clarification on what constituted a postoperative infection. Similarly, Lipira et al[11] conducted a retrospective database study on more than 10,000 patients and found that the most common complication following hand surgery was surgical site infection, with a rate of 1.2%. We hypothesize that the higher infection rate observed in our study is because of more scrupulous documentation of a minor postoperative infection for study purposes that may have otherwise been underestimated in previous retrospective studies based on chart review or database query.

In terms of the comparative role of preoperative antibiotics and postoperative infections, other studies have examined this question with relevant findings. Aydin et al[26] performed a prospective randomized trial, including 1340 patients, on the use of antibiotics in hand surgery and found no difference in postoperative infection rates irrespective of administration of preoperative antibiotics. Interestingly, infection rates also did not vary based on duration of surgery and preoperative wound contamination. However, unlike our study, Aydin et al[26] did not critically separate major and minor infections or consider antibiotic-related adverse reactions. Similarly, Backer et al[27] performed a multicenter trial, from 2009 to 2012, comparing the use of preoperative antibiotics based on surgical facility, similar to this study and found no statistically significant difference in infection rates whether preoperative antibiotics were given or not among their 434 study patients, with a low infection rate of 0.006% versus 0.003% between the two groups, respectively. However, unlike the study presented here, they also did not critically separate major from minor infection or consider antibiotic-related complications.

This study had several limitations. Although it was a prospective design, the sample size of patients may not allow the study to be adequately powered to detect the true rate of major and minor infections following clean hand and upper extremity surgery. Additionally, by its nature, the determination of what constitutes a minor infection lends itself to inherent observational bias by the treating surgeon, and therefore, the rate of minor infections in this study may likely be overestimated given the high rate (5.6%) compared with previously published rates of postoperative infections. However, as previously stated, most literature published on postoperative infections used reoperation or readmission rates, which likely led to an underestimation of true postoperative infection rates, given that in this study there were no cases of readmission or reoperation. It is also possible that any patient who developed a postoperative infection could have been treated at an outside institution and thus would have not been included in this data collection. Given that the two cohorts were formed on the basis of operative location at one of the two ambulatory surgical centers, there are potential confounders that could not be controlled, such as surgical staff and operating room conditions.

Given the low overall complication rate in this study, we concur with current evidence that recommends against the routine administration of preoperative antibiotic prophylaxis for clean hand surgery procedures.[22] Further studies are needed to determine whether antibiotic prophylaxis is warranted for non–soft tissue procedures (eg, fractures, arthroscopy, arthroplasty, arthrodesis) at the level of the wrist and elbow. Moreover, these data show that preoperative antibiotics may lead to increased rates of postoperative adverse events; however, further studies are required to establish a definitive conclusion on this matter.

The administration of preoperative antibiotic prophylaxis for elective hand surgery remains controversial. The results of this study would suggest that preoperative antibiotic prophylaxis for clean surgeries of the hand and wrist do not influence the development of postoperative minor infections. Furthermore, given the adverse reaction rate of 6.9% in patients who received preoperative antibiotic prophylaxis, surgeons should consider the potential risks of their use.

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