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The Role of Antibiotics in Nasal Fractures after Closed Reduction

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Background: Nasal fractures represent the most common fracture in facial trauma. The role of prophylactic antibiotics in these injuries is debated, given low infection rates and demonstrated risks of antibiotics. We studied the isolated effect of prophylactic antibiotics on infection rate in patients with nasal fracture after closed reduction.

Methods: Retrospective cohort study of a prospectively maintained facial trauma database was conducted. Demographics, comorbidities, fracture classifications, and management of patients who received antibiotics at the time of closed nasal reduction were compared against those who did not receive antibiotics. Infection rates between groups were analyzed. Multivariate analysis was conducted to control for confounding variables. Qualitative analysis was performed for patients who experienced infection following nasal fracture.

Results: A total of 282 patients met inclusion criteria (n = 144, antibiotic; n = 138, nonantibiotic). Six patients experienced infection. There was no difference in infection rate between antibiotic and nonantibiotic groups (2.0% versus 2.2%; P = 0.90). On multivariate regression, antibiotics did not significantly decrease odds of infection (OR 1.7 [0.17–13.6]; P = 0.64). Moreover, patients with open nasal fractures did not have significantly higher odds of infection (OR 1.9 [0.08–20.8]; P = 0.64). Similarly, increasing severity of injury based on Rohrich classification did not significantly impact odds of infection (OR 0.68 [0.23–1.9]; P = 0.46). All six infections were managed at the bedside, with zero infections following operating room management (P = 0.32).

Conclusions: Prophylactic antibiotics do not decrease infection rates following nasal fractures managed by closed reduction. Bedside management may be a risk factor for the development of infection; however, this finding requires further evaluation.
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INTRODUCTION

Nasal bone fractures account for over 58% of facial fractures in adults, and are most often due to blunt trauma.[1–3] Sequelae of nasal fractures include structural changes to the osseous framework, septal deformity, and potential airway compromise.[4] Infection is less common, documented at a rate of approximately 2%.[4]

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Treatment of nasal bone fractures involves repositioning of the nasal bones or bony fragments through open or closed reduction. Closed reduction is often preferred due to greater efficiency, avoidance of general anesthesia, and decreased invasiveness.[5,6] To minimize bacterial infection and complications from corrective procedures, antibiotics can be given prophylactically for nasal fractures. Unfortunately, there is minimal available data and guidance regarding antibiotic administration or prescribing practices in facial fractures.[7–10] Studies have begun to address this gap in the literature with regard to mandibular, midface, and upper face fractures[11–15]; however, high-quality data regarding isolated nasal fractures are lacking. Current guidelines are largely anecdotal and recommend

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antibiotics in patients with open nasal fractures, nasal packing, concomitant mandibular fractures, or septal hematoma.[7–9]

Although antibiotics serve a critical role, it is essential to establish guidelines for their prescription to avoid overuse.[16,17] Without proper stewardship, the over-prescription of antibiotics may continue to drive resistance, conferring immunity for pathogenic organisms and limiting the utility of certain formulations.[16] Furthermore, unnecessary antibiotic use can increase healthcare costs and confer risk due to polypharmacy without tangible benefit.

Few studies have examined the relationship between antibiotic use and nasal fractures. In a single-center retrospective study in South Korea, Jung et al found no significant benefit in administering perioperative antibiotics to prevent infections after closed reduction of nasal fractures.[4] This finding was corroborated in another cohort of patients who underwent closed nasal reduction in South Korea.[18] There are no studies from the United States that evaluate prophylactic antibiotic use for the treatment of nasal fractures. Furthermore, no existing literature studies open fractures or utilizes standardized scoring systems to adjust for fracture severity. These variables are considered by physicians in their decision to prescribe antibiotics, and warrant investigation.[7–9] This study assessed the impact of antibiotic use on infection rate after traumatic nasal fracture within a large cohort of patients all managed by closed reduction. We hypothesize the use of prophylactic antibiotics will not significantly decrease infection rates in nasal fractures following closed nasal bone reduction.

Takeaways

Question: What role do prophylactic antibiotics play toward infection prevention in nasal fractures managed by closed reduction?

Findings: Patients who received antibiotics at the time of closed nasal reduction were compared against those who did not receive antibiotics. There was no difference in infection rate between groups (2.0% versus 2.2%; $P = 0.90$). When controlling for confounding variables, use of prophylactic antibiotics did not significantly decrease odds of infection in closed or open nasal bone fractures (OR 1.7 [0.17–13.6]; $P = 0.64$).

Meaning: Given concerns of antibiotic over-prescription and side effects, the nonsignificant clinical benefit found in our study argues against routine prescription of antibiotics in noncontaminated cases of isolated nasal fracture.

METHODS

Study Design and Population

A prospectively maintained facial trauma database at an academic medical center was queried. A retrospective analysis was conducted to identify patients presenting to the emergency department (ED) with nasal fractures between December 2018 and December 2021, for which plastic surgery was consulted. Institutional review board approval was obtained with a waiver of informed consent for retrospective chart review. The antibiotic group included all patients who either received prophylactic antibiotics in the ED before discharge, or directly before their procedure if their nasal fracture was reduced at a later date. The nonantibiotic group included patients who were not prescribed antibiotics at either of the aforementioned timepoints. Patients with no follow-up were excluded, as were patients with grossly contaminated or purulent wounds on presentation. Patients with concomitant facial trauma or compound facial fractures, such as naso-orbito-ethmoid or Le Fort pattern fractures, were excluded. Only patients receiving isolated closed nasal bone reductions were included. Those who underwent open nasal bone reduction were excluded; however, open fractures treated with closed nasal reduction were included in the study. Patients who did not undergo reduction for their nasal fracture were likewise excluded.

Data Collection and Outcomes

Patient demographics and characteristics were recorded, including age, gender, mechanism of facial trauma, history of prior nasal fracture, and comorbidities. Nasal fracture was defined as any fracture to the bony vault, septum, and/or cartilaginous framework (upper lateral/lower lateral). The severity of nasal fracture was characterized by a simplified version of the Rohrich classification, a previously established metric for clinical severity of nasal bone violation.[7] Description of this classification system is shown in Figure 1. All type V fractures were excluded, as they were not isolated nasal fractures. Rohrich classification was primarily determined by radiographic findings on computed tomography scan of the head and face. In the minority of patients who did not receive a computed tomography scan or other imaging, fracture classification was made by review of the patient's clinical examination and assessment by the plastic surgery service. Open versus closed fracture status was recorded under clinical grade. Information was collected on the time from initial presentation to intervention by plastic surgery, and on duration of follow-up. Data regarding the management of the nasal fracture were also collected, including the need for packing and external splinting, and whether the fracture was reduced at the bedside or within the operating room.

The rate and quality of infection were recorded. Infection was defined by one or more of the following symptoms: erythematous and/or swollen local nasal areas with a positive bacterial culture, abscess with or without drainage, radiographic evidence of osteomyelitis, paranasal sinus infection, or recurrent swelling of the nares with pain and fever. Other upper or lower respiratory tract infections were also characterized due to their continuity with the nasopharynx. Finally, nonspecific symptoms related to infectious etiologies were included, such as mucosal swelling, synechia, and anosmia. In patients who developed an infection, a review was performed to characterize the type of infection and demographic information.

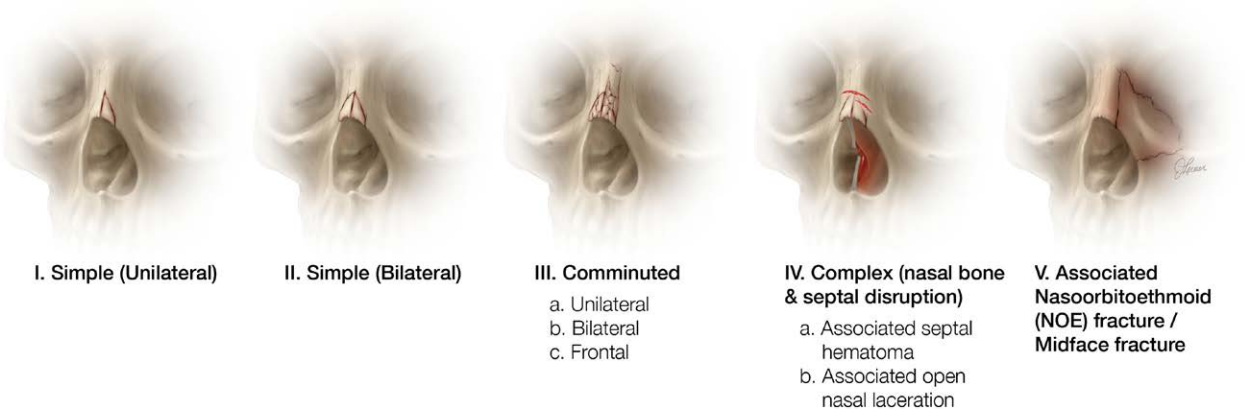

Fig. 1. A modified version of the Rohrich nasal fracture classification (originally in Rohrich et al., 2000[7]). A type I fracture is defined as a simple unilateral fracture, a type II fracture as a simple bilateral fracture, a type III fracture as a comminuted unilateral or bilateral or frontal fracture, a type IV fracture as a complex fracture with either nasal bone or septal disruption or associated septal hematoma, and a type V fracture as a nasal fracture with associated naso-orbito-ethmoid or other midface fracture.

Statistical Analysis and Outcomes

All data were collected and stored in a departmental REDCap (Research Electronic Data Capture, Nashville) database and analyzed in R version 4.10 (R Foundation for Statistical Computing, Vienna, Austria). Univariate analysis was conducted on patient characteristics, demographic information, and outcomes. A Shapiro-Wilk test was used to test for normality among each continuous variable. Variables that were nonnormally distributed were analyzed by the Mann-Whitney-Wilcoxon test. The remaining continuous variables were analyzed using a Student *t* test. For categorical variables, a Fisher exact test was used if greater than 20% of expected cell counts were less than five; otherwise, a Pearson chi-squared test was used. A multivariate regression model was utilized to determine the isolated association between prophylactic antibiotics and the development of infection by controlling for relevant confounding variables. Variables investigated in the model were selected based on existing literature, to control for known risk factors, and demographic differences between control and experimental group. We adjusted the model for age, follow-up time, insertion of nasal packing, external splinting, clinical grade, Rohrich classification, and time to intervention. Sub-analysis was conducted on patients managed at the bedside. For each outcome, an odds ratio (OR), 95% confidence interval, and *P* value were calculated and reported as "(OR [95% confidence interval]; *P* value)." Statistical significance was set at *P* less than 0.05.

RESULTS

Patient Characteristics

A total of 282 patients met inclusion criteria (antibiotic, n = 144; nonantibiotic, n = 138). Details on patient demographics and fracture management are presented in Supplemental Digital Content 1. **(See table, Supplemental Digital Content 1,** which displays the patient and fracture characteristics. **http://links.lww.com/PRSGO/C468**.)

Table 1. Antibiotics Prescribed

Antibiotic	No. (%), n = 144
Cefazolin	18 (12.5%)
Bacitracin	1 (0.69%)
Ceftriaxone	1 (0.69%)
Clindamycin	3 (2.1%)
Doxycycline	1 (0.69%)
Fluoroquinolone	1 (0.69%)
Cefalexin	68 (47.2%)
Penicillin-based	51 (35.4%)

Average time to intervention was 1.58 hours ± 5.8 hours for patients managed in the ED and 7.2 days ± 3.6 days for patients managed in the operating room. Antibiotics prescribed are presented in Table 1. Patients in the antibiotic group were older than their nonantibiotic counterparts (40.6 years versus 34.0 years; $P = 0.01$), but were well-matched with regard to comorbidities and mechanism of injury. Antibiotic patients had a significantly different Rohrich classification ($P < 0.01$) when compared with nonantibiotic patients. Specifically, those who received antibiotic prophylaxis had more severe fractures than those who did not receive antibiotics (69% Type III/IV versus 45% Type III/IV). With regard to management, the antibiotic patients had higher rates of packing (78% versus 36%; $P < 0.01$), and splinting (94% versus 82%; $P < 0.01$), and longer follow-up time (39.7 days versus 29.2 days; $P = 0.04$).

In total, 242 patients had their nasal fracture reduced at the bedside, 120 of whom received antibiotics. Amongst these patients, 119 received antibiotics and had their fracture reduced on their index ED visit, whereas one had the fracture reduced at a later date (this patient received antibiotics both in the ED and before reduction). An estimated 40 patients had their nasal fracture reduced in the operating room, 24 of whom received antibiotics. Amongst these patients, 12 received antibiotics both on initial ED visit, and before their reduction, eight received antibiotics only in the ED, and four received antibiotics only before their reduction in the operating room.

Table 2. Comparison of Outcomes between Patients Receiving Antibiotics and Patients not Receiving Antibiotics after Nasal Fracture

Outcome	Total(%)	Antibiotics(%)	No Antibiotics(%)	*P*
Infection	6 (2.1)	3 (2.1%)	3 (2.2%)	0.90
Abscess	1 (0.3)	1 (0.6%)	0	0.36
Sinus infection	5 (1.8)	2 (1.4%)	3 (2.2%)	0.61
Symptom duration	19.5 (12.5)	18 (11)	21 (14)	0.86
Upper respiratory infection	0	0	0	—
Pneumonia	1 (0.3%)	1 (0.3%)	0	0.52
Synechia	1 (0.3%)	0	1 (0.7%)	0.32
Mucosal swelling	8 (2.8%)	5 (3.4%)	3 (2.2%)	0.54
Anosmia	2 (0.7%)	1 (0.6%)	1 (0.7%)	0.92

Statistically significant at $P<0.05$.

Outcomes after Nasal Fracture

Per study criteria, six patients had a nasal fracture-related infection (antibiotic, n = 3; nonantibiotic, n = 3). These infections included one draining abscess and five sinus infections. The unadjusted analysis of outcomes is contained in Table 2. There was no significant difference in rate of infection between antibiotic patients and nonantibiotic patients (2.0% versus 2.2%; $P = 0.90$), or duration of symptoms from onset (18 days versus 21 days; $P = 0.9$). No patients in the nonantibiotic group experienced upper or lower respiratory infections after their nasal fracture. One patient in the prophylactic antibiotic group developed viral pneumonia after their nasal fracture. There was no difference in rate of synechia (0% versus 0.7%; $P = 0.32$), mucosal swelling (3.4% versus 2.2%; $P = 0.54$), or anosmia (0.6% versus 0.7%; $P = 0.92$) between antibiotic patients and nonantibiotic patients, respectively. On binomial regression analysis controlling for potential confounders (Table 3), the use of antibiotics did not significantly decrease odds of infection (OR 1.7 [0.17–13.6]; $P = 0.64$). No other variables studied were associated with increased odds of infection, including the presence of packing (OR 0.18 [0.01–1.9]; $P = 0.19$), splinting (OR 1.3 [0.13–29.4]; $P = 0.84$), open fracture classification (OR 1.9 [0.08–20.8]; $P = 0.64$), or time to intervention (OR 1.5 [0.95–2.9]; $P = 0.16$). Increasing Rohrich classification, and thus fracture severity, did not increase odds of infection (OR 0.68 [0.23–1.9]; $P = 0.46$).

Qualitative Analysis of Patients with Infections

Information regarding patients diagnosed with infection is presented in Table 4. There was no trend in antibiotic class, trauma mechanism, Rohrich classification, or clinical grade. The incidence of infection was not associated with patient morbidity. Only one infection occurred in a patient with significant comorbidities; this patient had chronic obstructive pulmonary disease, hypertension, and coronary artery disease. There was a consistent trend noted with regard to management. All six infections occurred in patients whose nasal fractures were managed at the bedside (6/242), as opposed to the operating room (0/40). This indicates an overall infection rate of 2.5% at the bedside versus 0% in the operating room ($P = 0.32$).

Table 3. Multivariate Regression of Characteristics between Patients with Infection and without Infection

	Infection versus No Infection		
Covariate	OR	95% Confidence Interval	*P*
Antibiotics	1.7	0.17–13.6	0.64
Age	0.97	0.91–1.0	0.28
Packing	0.18	0.01–1.9	0.19
Splinting	1.3	0.13–29.4	0.84
Open fracture	1.9	0.08–20.8	0.64
Rohrich classification†	0.68	0.23–1.9	0.46
Time to intervention (d)	1.5	0.95–2.9	0.16
Follow-up time	1.00	0.99–1.01	0.84

Of note, *Infection* was used as the reference value, such that odds ratios should be interpreted relative to *infection*.
Each model included the following covariates: age, antibiotic use, presence of packing, presence of splinting, open versus closed fracture, Rohrich classification, time to intervention (d), and follow-up time.
*Statistically significant ($P<0.05$).
†Odds of infection versus no infection with increasing severity by Rohrich classification.
‡Odds of infection versus no infection with increasing number of days before intervention.

Subgroup Analysis of Clinical Setting

Given that all infections occurred at the bedside, a sub-analysis of these patients was conducted to control for clinical setting as a potential confounder. On binomial regression analysis of patients managed at the bedside, the use of antibiotics did not significantly decrease odds of infection (OR 1.05 [0.25–4.1]; $P = 0.95$) (Table 5). No other variables studied were associated with increased odds of infection in these patients, including open fracture classification (OR 0.58 [0.03–3.8]; $P = 0.63$) or increasing Rohrich classification (OR 0.84 [0.44–1.6]; $P = 0.59$).

DISCUSSION

Antibiotic prophylaxis in nasal fractures is commonplace, with our study and others suggesting prescription rates of over 50%.[4] Minimal research has assessed the utility of prophylactic antibiotics in the setting of open and closed nasal fractures in patients managed with closed reduction. We studied the impact of antibiotics on the development of infection for isolated nasal fractures managed by closed reduction, with the goal of providing specific guidelines for antibiotic stewardship.

Table 4. Pertinent Information on Patients Diagnosed with Infection

Age (y)	Antibiotics	Trauma Mechanism	Rohrich Classification	Time to Intervention (d)	Follow-up (d)	Management	Comorbidities	Packing	Splinting	Clinical Grade	Symptoms	Symptom Duration(d)	Management
11	None	Fall	2	0	17	Bedside	None	No	Yes	Open	Right-sided sinus infection	17	Augmentin (7-d course)
28	Keflex	Fall	2	0	8	Bedside	None	Yes	No	Open	Bilateral sinus infection	8	Symptomatic care
93	None	Fall	3b	0	9	Bedside	COPD, hypertension, CAD	Yes	No	Closed	Bilateral sinus infection	14	Symptomatic care followed by augmentin (7-d course)
37	Moxifloxacin	Vehicle trauma	3b	1	32	Bedside	None	No	No	Open	Acute abscess lateral to the nose under left eye. Draining pus. Culture grew group B Streptococcus	8	Bedside incision and drainage followed by oral Cephalexin (10-d course)
34	None	Vehicle trauma	1	0	23	Bedside	None	No	No	Open	Recurrent sinus infections	20	Symptomatic care followed by augmentin (7-d course)
24	Keflex	Assault/ violent	3a	0	39	Bedside	None	No	Yes	Closed	Right sinus infection, rhinorrhea, epiphora	15	Augmentin (7-d course)

Table 5. Subanalyses of Patients Managed at the Bedside: Multivariate Regression of Characteristics between Patients with Infection and without Infection

	Infection versus No Infection		
Covarite	**OR**	**95% Confidence Interval**	***P***
Antibiotics	1.05	0.25–4.1	0.95
Age	0.98	0.93–1.0	0.38
Packing	0.56	0.12–2.5	0.44
Splinting	0.42	0.1–1.9	0.24
Open fracture	0.58	0.03–3.8	0.63
Rohrich classification*	0.84	0.44–1.6	0.59
Time to intervention (d)†	1.3	0.07–7.8	0.82
Follow-up time	1.00	0.99–1.01	0.97

Of note, *Infection* was used as the reference value, such that odds ratios should be interpreted relative to *infection*. Each model included the following covariates: age, antibiotic use, presence of packing, presence of splinting, open versus closed fracture, Rohrich classification, time to intervention (d), and follow-up time.

*Odds of infection versus no infection with increasing severity by Rohrich classification.

†Odds of infection versus no infection with increasing number of days before intervention.

To limit potential confounding variables, we narrowed our study to isolated nasal fractures managed by closed reduction.[19,20] Per our predefined criteria for infection, an unadjusted analysis demonstrated no difference in infection rate between patients who received prophylactic antibiotics and those who did not (2.0% versus 2.2%; $P = 0.90$). Multivariate regression controlling for differences in patient demographics, fracture characteristics, and management suggested prophylactic antibiotics did not significantly impact the odds of infection (OR 1.7 [0.17–13.6]; $P = 0.64$). Altogether, these findings suggest antibiotic prophylaxis may not improve outcomes after closed reduction of nasal fractures.

Antibiotics are thought to serve multiple functions in nasal fractures. First, they are generally prescribed in open fractures, where violation of the skin barrier may increase risk of infection.[21,22] However, our results demonstrate open fractures were not associated with significantly increased odds of infection (OR 1.9 [0.08, 20.8]; $P = 0.64$), irrespective of antibiotic prescription. Special considerations should be taken in nasal fractures due to the proximity of any injury to the nasal flora, and thus high likelihood of bacterial inoculation. However, the clinical relevance of bacterial inoculation is unclear, as prior research has demonstrated colonization of the nares with methicillin-resistant *Staphylococcus aureus* does not affect infection rates after intranasal procedures.[23] Additionally, the standard of care is to thoroughly irrigate any nasal laceration or wound and, as the face is relatively privileged with regard to vascularity, the risk of infection may be lower than other parts of the body.[8,22,24] Our results support this notion, indicating when skin breaks are appropriately irrigated and managed, risk of infection is lower, and need for prophylactic antibiotics diminished.

Grossly contaminated or purulent wounds were not evaluated in this study. Other wound types, such as animal and human bite wounds, have been well documented to

increase risk of infection[25,26]; however, we were unable to identify such wound etiologies in our patient population. Further investigation is warranted to determine the utility of antibiotic use in these populations. In the interim, we support clinical decision-making in these high-risk patients based on comorbidities, fracture severity, and degree of contamination.

We found patients with more severe nasal fractures had high rates of antibiotic prescription (75.4% of patients with type IV fractures). However, increasing Rohrich classification did not increase the odds of infection after reduction (OR 0.68 [0.23–1.9]; 0.46). No literature exists studying whether comminuted nasal fractures, or those with nasal bone and septal deviation, are associated with increased rates of infection. Studies have found septal hematoma is a risk factor for infection and nasal abscess formation.[27,28] We had four patients who experienced septal hematoma. Each of these patients received antibiotics and had relatively uncomplicated clinical courses. In these circumstances, we support the use of antibiotic prophylaxis. However, in fractures not associated with hematoma or high-risk wounds, timely intervention, irrigation, and wound care should obviate infection risk.

Further, antibiotics are often used to combat the risk of toxic shock syndrome when nasal packing is utilized.[29,30] We did not see this complication occur in any patients who received nasal packings, likely due to its rarity. Still, our data demonstrated nasal packing was not associated with an increased risk of infection, even when controlling for antibiotic status (OR 0.18 [0.01–1.9]; $P = 0.19$). In a systematic review by Lange et al, the authors come to the same conclusion with a 990-patient cohort.[29] This is likely explained by the continuity between the nasopharynx and oropharynx, which creates a passage for drainage of contents when nasal packing is in place, decreasing the risk of bacterial entrapment.

All six patients who developed infection had their nasal fractures managed at the bedside. Bedside reduction occurs in an inherently less-controlled environment than the operating room, with a lower threshold for sterility and irrigation practices. Moreover, this reduction is performed closer to the time of injury at which some mucosal injury is likely to have taken place. These issues may play a role in the development of infection, especially in contaminated, open, or high-severity fractures. Regardless, on subgroup analysis controlling for clinical setting, prophylactic antibiotics did not significantly affect odds of infection in patients who had their fracture managed at the bedside. Zero nasal fractures managed in the operating room resulted in infection. While it is a common practice to administer perioperative antibiotics in the operating room, operative reduction is often delayed by multiple days. As such, bacterial inoculation and early infection would likely occur in the time interval between index ED visit and operative intervention.

There is scant literature on infectious manifestations after nasal fracture. We included sinus infections as a nasal fracture-related infection; however, further studies characterizing infectious sequalae of nasal fractures are required to support this decision. Other symptoms or functional deficits that we recorded after nasal fracture included upper respiratory infection, pneumonia, anosmia, synechia, and mucosal swelling. While not specific sequelae of nasal fracture, prior studies have used similar metrics as surrogates for possible infection.[4] Consistent with prior studies, antibiotic prescription did not significantly decrease the rates of any symptoms recorded. This further indicates the good outcomes patients have following nasal fracture without antibiotic therapy.

This study demonstrated no significant utility of prophylactic antibiotics to prevent infection after closed nasal bone reduction; however, it did not evaluate the adverse sequalae of these drugs. Over-prescription of antibiotics confers increasing antimicrobial resistance, leading to potential harm to society.[16] For the patient, antibiotics increase risk of hypersensitivity reactions, gastrointestinal issues, drug–drug interactions, nephrotoxicity, and *Clostridium difficile* associated diarrhea.[31] In our study, one patient experienced pneumonia, which can increase risk for superimposed infections.[32,33] These adverse outcomes are accepted given the mortality danger of unchecked infection. However, a risk–benefit analysis is warranted in the case of nasal fractures, where infection risk is low, and the benefit of antibiotics is unclear.

This study should be taken in the context of limitations. Its retrospective nature limits the number of variables that could be controlled for. Although we had a large sample size of 282 patients, the post hoc power of our study was 3.3%. This limited statistical power is expected in the context of low rate of infection in nasal fractures and the near identical rate of infection between our study populations. We submit that although more highly powered multicenter studies are required, this work contributes significantly to the limited literature evaluating antibiotic use in this population. Moreover, multiple physicians were involved in the interventions, resulting in heterogeneity in management based on provider preferences. Finally, patients whose nasal fractures were managed in the ED were lost to follow-up and therefore excluded. This limited our sample size and could have introduced a selection bias for more severe fractures.

CONCLUSIONS

The use of prophylactic antibiotics does not significantly decrease infection rates in closed or open nasal bone fractures. There was no relationship between fracture severity or clinical grade and the development of infection, although all fractures resulting in infection were managed at bedside. Our findings argue against the routine prescription of antibiotics in noncontaminated cases of isolated nasal fracture.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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