Microbiology and Antibiotic Prophylaxis in Rhinoplasty
A Review of 363 Consecutive Cases

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IMPORTANCE A practical technique for reducing infectious complications from rhinoplasty would represent an important surgical advance.

OBJECTIVES To describe the microbial flora of patients undergoing septorhinoplasty and to evaluate the role of preoperative and postoperative antibiotic prophylaxis.

DESIGN, SETTING, AND PARTICIPANTS We performed a retrospective medical record review of 363 consecutive adult patients who underwent preoperative nasal swab testing and rhinoplasty or septorhinoplasty in a single private practice: 279 women (76.9%) and 84 men (23.1%). The average patient age was 35.9 years (age range, 17-70 years).

MAIN OUTCOMES AND MEASURES Identification of endogenous nasal flora and pathogenic bacteria treated with culture-directed antibiotics; evaluation of comorbidities, perioperative infections, and antibiotic treatments.

RESULTS A total of 174 patients (47.9%) underwent primary rhinoplasty, and 189 (52%) underwent revision rhinoplasty. On preoperative nasal culture, 78.2% of patients had normal flora; 10.7% had Staphylococcus aureus; and 0.28% had methicillin-resistant S aureus (MRSA). In 7.4% of patients, fecal coliforms including Escherichia coli, Enterobacter species, and Citrobacter species were found. Age, sex, smoking, the use of oral contraceptives, or the presence of seasonal allergies did not significantly change the nasal flora or the postoperative infection rate. Patients with adult acne were found to have an increased incidence of colonization with fecal coliforms (43.8%; P < .001). Patients with diabetes were found to have an increased incidence of colonization with S aureus (66.7%; P = .002). The overall infection rate was 3.0% (11 of 363 patients), with 4.0% (7 of 174 patients) seen in primary septorhinoplasties and 2.1% (4 of 189 patients) seen in revision cases. Coliforms accounted for 5 cases (45.5%) of postoperative infections, while S aureus was responsible for 4 cases (36.4%), including 1 case of MRSA.

CONCLUSIONS AND RELEVANCE The results of this study suggest that risk factors alone may not reliably predict the subset of patients in whom antibiotic prophylaxis is indicated. Knowledge of the endogenous nasal flora and the microbiology of common pathogens in patients undergoing septorhinoplasty will help to further reduce the incidence of infectious complications.

LEVEL OF EVIDENCE 3.

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Patients with nasal carriage of potentially pathogenic bacteria such as *Staphylococcus aureus* have been shown to have an increased risk of surgical site infections caused by the organism. In addition, rapid screening and decolonization of nasal carriers of *S aureus* on admission have been shown to decrease the incidence of surgical site *S aureus* infections. Despite the considerable attention directed toward reducing infectious complications in nasal surgery, studies have predominantly focused on postoperative prophylactic antibiotic treatment rather than preoperative screening and treatment of at-risk individuals.

The literature notes a disparate range of infection rates after rhinoplasty, from 0% to 15%, but generally 2% or less. However, the small scale of these studies, heterogeneity of patient populations, variation in surgical techniques, and differences in routine perioperative care combine to create some difficulty in extrapolating these data to predict the risk for a patient. Indeed, although infection after rhinoplasty is reportedly uncommon, prophylactic antimicrobial therapy is generally the rule and not the exception.

In the past decade, concern over methicillin-resistant *S aureus* (MRSA) has heightened awareness of this organism as a perioperative culture. Prior studies have found rates of 25% to 32% of *S aureus* and 0.8% MRSA colonization in the general population. Besides MRSA and *S aureus*, the nose serves as a reservoir for a variety of bacterial species such as *Streptococcus pyogenes*, *Streptococcus pneumoniae*, coagulase-negative staphylococci, *Corynebacteria*, and a number of other aerobic and anaerobic bacteria considered normal nasal flora. To our knowledge, no prior study has examined the endogenous nasal flora of patients undergoing septorhinoplasty or evaluated its impact on postoperative infection rate.

There remains a lack of data convincing enough to form a consensus with regard to appropriate preoperative screening and use of prophylactic treatment techniques. The aim of this study was to identify the bacterial pathogens present endogenously in patients undergoing sechthorinoplasty, identify risk factors for postoperative wound infection, and review the role of preoperative screening and antibiotic prophylaxis on patient outcomes.

### Methods

All patients in this retrospective review were from the private practice of the senior author (P.S.N.), and all procedures were performed at an outpatient surgical center separate from the institutions at which the authors have privileges. No patients or patient records included in this report were associated with institutions at the time of the study, and so institutional review board approval was not obtained. However, written informed consent was obtained for each procedure, and the present review adheres to the standards of the Declaration of Helsinki and complies with the Health Insurance Portability and Accountability Act.

A retrospective medical record review was performed on all patients undergoing rhinoplasty or sechthorinoplasty in a private practice by the senior author (P.S.N.) during a 4-year period (April 2008 to April 2012). Patients were excluded if they underwent sechthoplasty alone or records were missing preoperative or postoperative culture results. A total of 363 qualifying patients were identified. Medical records were reviewed for patient age, rhinoplasty revision status, comorbid conditions, preoperative nasal carrier status, and prophylaxis. The postoperative course, presence of infectious complications, and treatments given were noted.

Directed nasal swab cultures were taken by the surgeon from the nasal vestibule 4 to 14 days prior to surgery using a culture swab (ESwab Collection and Transport System for Aerobic, Anaerobic and Fastidious Bacteria; Becton, Dickinson and Company). All patients used chlorhexidine gluconate (Hibiclens; Mölnlycke Health Care) mixed with water prior to surgery to clean inside the nose as well as to wash their hair and face and also applied mupirocin ointment intranasally twice daily for 5 days prior to surgery. If normal flora was cultured, no additional antibiotics were given. However, in the presence of potentially pathogenic bacteria, patients were treated with culture-directed oral antibiotics (Table 1). Trimethoprim-sulfamethoxazole was most commonly prescribed (34 of 67 patients), especially for patients with coliform bacteria (19 of 27 patients), followed by cefadroxil (13 of 67 patients). A fluoroquinolone was chosen primarily in the case of penicillin or sulfa allergy or when dictated by antibiotic sensitivities. All patients received a prophylactic dose of 1 g of intravenous cefazolin, or 450 mg of clindamycin in the case of penicillin allergy, 30 minutes prior to first incision.

Patients were seen on a routine basis postoperatively according to the following timeline: 1 day after surgery, 1 week after surgery, 2 weeks after surgery, 1 month after surgery, and at increasingly longer intervals thereafter. Patients exhibiting any postoperative signs or symptoms of developing or active infection were recultured. Culture results and antibiotic sensitivities directed treatment.

### Results

This study included 363 patients with an average age of 35.9 years (age range, 17-70 years). Our study population had 279 women (76.9%) and 84 men (23.1%) (Table 2). A total of 174 patients (47.9%) underwent primary rhinoplasty, and 189 (52.1%) underwent a revision procedure. There was no statistically significant difference in age, sex, or comorbidities between patients undergoing primary and revision surgery.

Normal nasal flora included a combination of coagulase-negative *Staphylococcus* (considered normal flora), diphtheroids, *Alpha streptococcus*, and/or *Neisseria* species. Of our 363 patients, 284 (78.2%) showed normal nasal flora on preoperative cultures. Thirty-nine patients (10.7%) had *S aureus*, and only 1 (0.28%) had MRSA. There were 27 patients (7.4%) whose cultures grew out one of the fecal coliform species, including *Escherichia coli*, *Enterobacter* species, and *Citrobacter* species.

Among the 174 patients undergoing primary rhinoplasty, 75.3% (n = 131) grew normal flora; 10.3% (n = 18) grew *S aureus*; and 15.5% (n = 27) grew coliforms. Among the 189 pa-
Table 1. Preoperative Antibiotics

<table>
<thead>
<tr>
<th>Culture Result</th>
<th>Bactrim DS</th>
<th>Duricef</th>
<th>Ciprofloxacin</th>
<th>Levofloxacin</th>
<th>Augmentin</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. aureus</em></td>
<td>15</td>
<td>11</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>MRSA</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Coliform</td>
<td>19</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Abbreviations: MRSA, methicillin-resistant *S. aureus*; *S. aureus*, Staphylococcus *aureus*.

a Bactrim DS is the proprietary name for trimethoprim-sulfamethoxazole (Mutual Pharmaceutical Company Inc); Duricef (cefadroxil monohydrate; Bristol-Myers Squibb); and Augmentin (amoxicillin-clavulanate potassium; GlaxoSmithKline).

b Patients with potentially pathogenic bacteria on nasal swab culture were given preoperative oral antibiotics based on antibiotic sensitivities.

Table 2. Patient Characteristics and Postoperative Infections in Revision vs Primary Rhinoplasty Procedures

<table>
<thead>
<tr>
<th>Surgery Type</th>
<th>Total, No.</th>
<th>Sex, M/F, No.</th>
<th>Age, Mean (range), y</th>
<th>Postoperative Infections, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>174</td>
<td>43/131</td>
<td>34.0 (18-70)</td>
<td>7</td>
</tr>
<tr>
<td>Revision</td>
<td>189</td>
<td>41/148</td>
<td>37.2 (17-69)</td>
<td>4</td>
</tr>
</tbody>
</table>

Patients undergoing revision rhinoplasty, 81.0% (n = 153) grew normal flora; 11.1% (n = 21) grew *S. aureus*; 12.7% (n = 24) grew coliforms; and 0.53% (n = 1) grew MRSA.

Thirty-two patients (8.8%) had a history of acne, and within this group, only 12 (37.5%) had normal flora colonization. The difference in the amount of nonnormal flora in the population with acne (62.5%, 20 patients) compared with the amount of nonnormal flora in the overall population (21.8%) was statistically significant (P < .001). In the acne group, the incidence of *S. aureus* was 12.5% (n = 4). The fecal coliform percentage in the acne group was 43.8% (n = 14) which was significantly greater than that in the overall study population 7.44% (n = 27) (P < .001).

Seventy-eight (28.0%) of the women in our study used hormonal contraception, which showed no statistically significant effect on normal flora colonization (78%; 61 of 78) compared with the overall study population (78.2%; 284 of 363). The *S. aureus* incidence was 5% (4 of 78 patients), and the coliform incidence was 10% (8 of 78) among women using hormonal contraceptives, though this difference was not statistically significant. In this group, the rate of infection (3%; 2 of 78) was comparable to the overall infection rate (3%; 11 of 363).

Seventy-six patients (20.8%) reported seasonal allergies. Of note, 84% (n = 64) of these patients were colonized with normal flora, and 13% (n = 10) had *S. aureus*. Of all the groups examined, this group had the lowest incidence of coliform bacteria (5%; n = 4), and this group experienced no postoperative infections.

Twenty patients reported smoking, and *S. aureus* colonization in smokers was 15% (3 of 20) compared with 10.7% (39 of 363) in the total study population, but this difference did not reach statistical significance (P = .56). The rate of postoperative infections among smokers was 10% (2 of 20) compared with 3% (11 of 363 patients) for the total study population (P = .09).

Our study included 3 patients with type 2 diabetes. Of these patients, the cultures for 2 (67%) grew out *S. aureus*, and 1 (33%) showed normal flora. There were no postoperative infections in this group (Table 3).

Symptoms that led to reculturing after surgery included pain, discharge, foul odor, septal perforation, and erythema.

The overall postoperative infection rate was 3.0% (11 patients). Of these 11 cultures, 1 grew out *Citrobacter*; 2, *E. coli*; 2, *Klebsiella*; 4, *S. aureus* (of which 2 were MRSA); 1, *Pantoea agglomerans*; 2, coagulase-negative *Staphylococcus*; and 2, normal flora other than *Staphylococcus*. Of these 11 patients, 2 were taking oral contraceptive drugs, 2 had acne, 2 were smokers, 1 had gastroesophageal reflux disease, and 1 had tested positive for human immunodeficiency virus. The revision group had 4 cases (2.1%) of postoperative infection compared with 7 (4.0%) cases of infection in the primary group, though this difference was not statistically significant. Some patients grew out more than 1 organism. However, only 1 case cultured the same organism postoperatively as preoperatively, and that was the case with *Citrobacter*.

Discussion

Perhaps even more than in other surgical types, complications after elective cosmetic surgery are difficult to accept for both the patient and the surgeon. Weinstein3 recognized the link between nasal carriage of *S. aureus* and the proclivity of these patients to develop postoperative infections half a century ago.3 Although Weinstein3 recognized the link between nasal carriage of *S. aureus* and the proclivity of these patients to develop postoperative infections half a century ago.3 Studies since focused on clarifying the link between carrier state and the risk of infection and on identifying those patients at increased risk in a variety of surgical specialties.

Recently, the rate of infection has been evaluated in several articles on septrhaphy and rhinoplasty.4-6 However, preoperative treatment of patients labeled high risk has largely been limited to application of mupirocin calcium, 2%, ointment (Bactroban Nasal; GlaxoSmithKline).1,2 There remains a lack of data convincing enough to form a consensus on appropriate preoperative screening and use of prophylactic treatments, and the common practice remains to administer empirical perioperative antibiotics per surgeon preference.

Without objective data to direct appropriate treatment, surgeons are frequently driven more by fear of untoward outcomes and litigation than by evidence. This, in turn, may promote overzealous use of antibiotics, further contributing to the rise in antibiotic-resistant microbials.
Our examination of patients undergoing septorhinoplasty revealed a significantly lower rate of nasal colonization with *S. aureus* and MRSA strains than previously reported. Prior studies have found a rate of 25% to 32% of *S. aureus* and 0.8% MRSA colonization in the general population.\(^7\)\(^8\) In our Beverly Hills office, with patients predominantly from Southern California, we found a rate of 10.7% *S. aureus* and 0.28% MRSA colonization preoperatively in our patients undergoing septorhinoplasty. This finding was further analyzed and found to be 0% among primary septorhinoplasty patients and 0.53% in revision patients. Without directly evaluating and comparing the patient populations within each of the studies, it is not possible to draw a definitive conclusion on the reasons for these observable differences. However, one plausible explanation is that differences in socioeconomic factors have a role in the increased rate of colonization in the general population vs the population undergoing elective cosmetic rhinoplasty. Besides socioeconomic status, geography may contribute to differences in nasal carrier status as well, just as patterns of antibiotic resistance display geographic variability. Our study population included a much larger proportion of women (76.8%) than men, though we draw no conclusions from that alone. Whatever the underlying reason may be, the lower rate of colonization suggests that less antibiotic prophylaxis may be more appropriate in the septorhinoplasty population than in the general population.

Of note, several studies have suggested smoking as a protective factor against colonization with *S. aureus*.\(^9\)\(^11\) Our study did not corroborate this finding and actually showed a higher percentage of *S. aureus* colonization in smokers (15%, 3 of 20 patients) compared with the total study population (10.7%, 39 of 363 patients), though this difference did not reach statistical significance (*P* = .56). Although none of the 3 patients colonized with *S. aureus* preoperatively developed postoperative infections, smoking patients in our study did have a higher rate of postoperative infections (10%, 2 of 20 patients) than the total study population (3%, 11 of 363 patients); but this was also not statistically significant (*P* = .09). Further studies with larger sample sizes will be beneficial in determining the true effect of smoking on the rate of colonization with *S. aureus* and the postoperative infection rate.

Other studies have observed increased nasal carriage of *S. aureus* with elevated serum glucose levels, as seen in patients with diabetes and with oral contraceptive use.\(^10\)\(^12\) Our study showed a similar trend in our patients with diabetes: 67% (2 of 3 patients) had preoperative colonization with *S. aureus* (*P* < .05). However, in our study population, the percentage of *S. aureus* carriage was lower in the subset of patients taking hormonal contraceptives (5% [4 of 78] vs 10.7% [39 of 363]; *P* = .83).

The prevalence of certain comorbidities elicited by our history taking may grossly underrepresent the true prevalence of these factors in our patient population. Understandably, patients often choose to filter information from their medical history. They might not disclose items that they (1) feel are irrelevant (eg, gastroesophageal reflux disease when undergoing elective cosmetic surgery) or (2) are reluctant to admit (eg, history of drug use). For example, the latest report from the Centers for Disease Control and Prevention\(^13\) estimates the prevalence of smokers in the United States at 18.1% (42.1 million people) of all adults (18 years or older), while a prevalence of only 5.5% (20 of 363 patients) was detected in our study population. Some of this discrepancy may be explained by the self-selection of this generally motivated and health-conscious patient population, but some is also likely owing to underreporting as well. Given the size of our sample, there is a real possibility that even when statistically significant, some of the comorbidities may not have practical significance in terms of treatment decisions, and vice versa.

Our study population included a nearly equal number of patients undergoing revision and primary rhinoplasty and thus included a higher proportion of patients undergoing revision surgery (189 of 363) than previous studies. Interestingly, there did not seem to be an increased incidence of postoperative infections in the subset of revision rhinoplasty patients vs primary. This is somewhat contrary to what might be expected and to what has been described in prior studies. Primary surgery effects alterations to the anatomy, blood supply, and lymphatic drainage of the nose. In addition, the presence of scar tissue and previously placed graft materials, whether autologous or synthetic, would reasonably be thought to increase the susceptibility to infection. One likely explanation for the lower rate of postoperative infection in our cohort is that all of our patients received preoperative screening for nasal colonization and were treated with culture-directed antibiotics when nonnormal flora was detected. In addition, all patients were also treated with mupirocin prior to surgery. Except in 1 case, the bacteria cultured from a postoperative infection did not correlate with the preoperative culture result. This seems to suggest that preoperative screening and directed treatment is effective at preventing postoperative infections with bacterial colonizers.

<table>
<thead>
<tr>
<th>Organism</th>
<th>Acne</th>
<th>Allergies</th>
<th>Diabetes</th>
<th>Hormonal Contraception</th>
<th>Smoking</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>4 (12.5)</td>
<td>10 (13.2)</td>
<td>2 (66.7)</td>
<td>4 (3.1)</td>
<td>3 (15)</td>
<td>39 (10.7)</td>
</tr>
<tr>
<td>MRSA</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 (0.28)</td>
</tr>
<tr>
<td>Normal flora</td>
<td>12 (37.5)</td>
<td>64 (84.2)</td>
<td>1 (33.3)</td>
<td>61 (78.2)</td>
<td>12 (60)</td>
<td>284 (78.2)</td>
</tr>
<tr>
<td>Coliform bacteria(^b)</td>
<td>14 (43.8)</td>
<td>4 (5.26)</td>
<td>0</td>
<td>8 (10.3)</td>
<td>5 (25)</td>
<td>27 (7.4)</td>
</tr>
</tbody>
</table>

Abbreviation: MRSA, methicillin resistant *Staphylococcus aureus*.

\(^a\) All data reported as number (percentage) of patients.

\(^b\) Including *Escherichia coli* as well as *Citrobacter* and *Enterobacter* species.
The generous use of antibiotics before and after surgery is not without disadvantages. Elimination of endogenous flora potentially may leave an individual susceptible to proliferation of a more virulent pathogen. In addition to destroying the patient's protective native flora, antibiotic treatment may promote the selective growth of increasingly resistant organisms. This could potentially have significant long-term ramifications as multidrug-resistant strains of bacteria emerge and become more widespread. The potential for other adverse effects from administration of antibiotics exists as well, such as the common adverse effects of nausea, vomiting, upset stomach, diarrhea, and allergic reaction. In our study group, no severe adverse events were observed, and there were no instances of anaphylaxis, though 20.2% of patients given preoperative antibiotics had an allergy, developed a rash or other systemic reaction, and the antibiotic was switched to a different one.

While other studies have described an increased risk of MRSA infection and nasal colonization elderly populations, health care workers, and recently hospitalized patients, our review of patient comorbidities revealed some variance in preoperative nasal colonization but not a statistically significant difference in postoperative infection rate for any of the evaluated risk factors. We suspect that one of the most important factors contributing to postoperative infection is the preoperative nasal colonization status. In a large, multicenter study of S aureus bacteremia conducted by von Eiff et al,9 more than 80% of the blood isolates from patients with bacteremia were identical to those isolated from their anterior nares, demonstrating that a substantial proportion of systemic infections are of endogenous origin and suggesting that eliminating nasal carriage of S aureus may reduce systemic infections. This is consistent with other studies demonstrating an increase in postoperative infections in patients with nasal colonization.1-3 Incisions in rhinoplasty are made in an area of dense bacterial colonization, and with elimination of the bacterial load, the chances of infection would be expected to be reduced. This appears to be supported by our data: only 1 patient in our study developed an infection from a bacterial colonizer.

Our study results add valuable information for prophylaxis against infection. We believe that routine preoperative screening for nasal colonization, followed by culture-directed antibiotic treatment, should be considered for all patients undergoing septrhinoplasty. The size of our study limits its statistical power, and certainly examining a larger number of patients spanning different geographic and socioeconomic groups will be of additional benefit. In addition, a control group of patients undergoing rhinoplasty without receiving any kind of preoperative prophylaxis would enable further conclusions to be drawn, and represents an area of future investigation.

Conclusions

The results of this study suggest that risk factors alone may not reliably predict the subset of patients for whom prophylaxis is indicated. Preoperative evaluation of nasal carriage and culture-directed treatment appears to reduce the risk of infection, and consideration should be given to making it a routine practice. Knowledge of the endogenous nasal flora and the microbiology of common pathogens in patients undergoing septrhinoplasty will help to further reduce the incidence of infectious complications.

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Study concept and design: Yoo, Nassif.

Acquisition, analysis, or interpretation of data: Yoo, Peng, Azizzadeh.

Drafting of the manuscript: Yoo, Nassif.

Critical revision of the manuscript for important intellectual content: Yoo, Azizzadeh, Nassif.

Statistical analysis: Yoo, Peng.

Administrative, technical, or material support: Yoo.

Study supervision: Azizzadeh, Nassif.

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REFERENCES


