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Cartilage on the Floor: How Effective Is Antibiotic Sterilization?

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ABSTRACT

Objective: **To determine the incidence of positive cultures from contaminated nasal cartilage and to demonstrate the effectiveness of antibiotic irrigation as a means of sterilization.**

Design: **A prospective study.**

Setting: **Tertiary referral centre.**

Methods: **Nasal septal cartilage was harvested during routine endoscopic septoplasties. The harvested cartilage was then dropped on the floor for 60 seconds. The cartilage was then divided into four equal portions, which were then divided into four experimental groups: (1) untreated, (2) normal saline soak for 60 seconds, (3) 40 mg/mL gentamicin solution soak for 60 seconds, and (4) 300 seconds. All specimens were sent for bacterial culture and sensitivity, along with nasal swabs and floor swabs. The incidence of bacterial contamination in the different groups was analyzed using the McNemar hypothesis.**

Main Outcome Measures: **Correlation between bacterial culture results and treatments of contaminated nasal septal cartilages.**

Results: **Thirty-two patients were enrolled in this study. Thirty-one percent of the untreated specimens had bacterial contamination. Thirty-one percent of the saline-soaked specimens had significant bacterial growth. Bacterial growth was not observed in any of the specimens treated with gentamicin irrigation for 60 seconds (absolute reduction of 31%); one specimen (3%) in the 300 seconds gentamicin group had a positive culture. A correlation of 70% was observed in the bacterial growth observed in the swab of the operating room floor and the untreated cartilage.**

Conclusions: **When no other options are available, this study demonstrates that cartilage dropped on the floor can be decontaminated by washing with gentamicin.**

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Objectifs: **L'étude avait pour objectifs de déterminer l'incidence de cultures positives à partir de cartilages contaminés de cloison nasale et de démontrer l'efficacité de l'irrigation antibiotique comme moyen de stérilisation.**

Type d'étude: **Il s'agit d'une étude prospective.**

Lieu: **L'étude a été menée dans un centre spécialisé de soins tertiaires.**

Méthodes: **Des cartilages de cloison nasale ont été prélevés en cours de septoplastie endoscopique ordinaire. Nous avons ensuite laissé tomber ces cartilages au sol et nous les avons laissés là durant 60 secondes. Les cartilages ont été divisés en quatre parties égales, formant ainsi quatre groupes expérimentaux: (1) aucun traitement; (2) trempage dans une solution physiologique salée durant 60 secondes; (3) trempage dans une solution de gentamicine concentrée à 40 mg/mL durant 60 secondes; (4) trempage durant 300 secondes. Tous les prélèvements ont été soumis à une culture bactérienne et à un examen de la sensibilité, de même que les prélèvements effectués par écouvillonnage dans le nez et au sol. L'incidence de la contamination bactérienne dans les différents groupes a été analysée à l'aide du test de McNemar.**

Principaux critères d'évaluation: **Le principal critère d'évaluation consistait en la corrélation entre les résultats de la culture bactérienne et le traitement des cartilages contaminés de cloison nasale.**

Résultats: **Trente-deux patients ont participé à l'étude. Trente et un pour cent des prélèvements non traités présentaient une contamination bactérienne; 31% des pièces ayant trempé dans la solution physiologique salée présentaient une forte croissance bactérienne; 0% des pièces ayant trempé dans la solution de gentamicine durant 60 secondes présentait une croissance bactérienne**

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(réduction absolue de 31%); 3% des pièces (1) ayant trempé dans la solution durant 300 secondes avaient une culture positive. Une corrélation de 70% a été établie entre la croissance bactérienne observée sur les pièces tombées au sol en salle d'opération et les cartilages non traités.

Conclusions: **L'étude a démontré qu'en l'absence d'autre solution il est possible de décontaminer les cartilages tombés au sol, par lavage à la gentamicine.**

Key words: *antibiotic sterilization, cartilage, contaminated*

The risk of contaminating cartilage by accidentally dropping it on the operating room floor during a nasal reconstruction procedure remains an uncommon event that can usually be avoided with careful handling of the cartilage and attention to surgical technique. However, anecdotally, some surgeons report at least one such occurrence during their surgical career. Various surgeons, particularly in the fields of neurosurgery and orthopedic surgery, have examined whether contaminated tissue can be sterilized using different techniques. Jankowitz and Kondziolka described a series of eight contaminated cranial bone flaps that were "sterilized" using betadine and/or antibiotic irrigation.[1] None of the patients developed any postoperative infections. To our knowledge, no known previously published studies have examined dropped cartilage and the potential for infection. The purpose of this study was to determine the incidence of positive cultures from contaminated cartilage and to demonstrate the effectiveness of antibiotic wash as a means of sterilization.

Methods

A prospective study was performed to determine the effectiveness of gentamicin (40 mg/mL) wash of contaminated cartilage. The purpose of the study was described to the patients during the preoperative clinic visit, and consent was obtained prior to surgery. Ethics approval was granted from the Clinical Ethics Review Board at the University of British Columbia. Nasal septal cartilage (approximately 1 cm × 1 cm) was harvested during a routine endoscopic septoplasty. The harvested cartilage was then dropped on the floor for 60 seconds. The cartilage was then divided into four equal portions measuring 5 mm × 5 mm. The four portions of cartilage were divided into the experimental groups 1 to 4 (Table 1): group 1, cartilage control without any treatment; group 2, cartilage soaked and stirred gently in 5 mL normal saline for 60 seconds; group 3, cartilage soaked and stirred gently in 5 mL of 40 mg/mL gentamicin for 60 seconds; and group 4, cartilage soaked and stirred gently in 5 mL of 40 mg/mL gentamicin for 300 seconds. Swabs of the operating room floor (group 5), which is cleaned prior to each case, and nasal swabs (group 6) were also taken at the time of the procedure. The specimens were then sent in separate containers for culture and sensitivity; the cartilages were first incubated in a Fildes broth at 37°C for 48 hours. If the broth turned turbid, the broth was then plated on blood agar plates (7% sheep blood) as well as chocolate agar plates; these were then incubated under microaerophilic conditions for 48 hours to up to 7 days if any of the cultures were positive.

The results were then analyzed using the McNemar hypothesis to compare the number of cultures showing contamination (other than normal flora) in the (1) saline rinse group, (2) gentamicin 60 seconds group, (3) gentamicin 300 seconds group, (4) nasal swab group, and (5) positive cultures in the floor swab group to the number of contaminated cultures in the untreated group. The absolute percent risk reductions of contamination for the first three groups were calculated.

Results

Thirty-two patients were enrolled in this study (17 males and 15 females). The average age was 44 years at the time of surgery. The results of the cultures from the experimental groups are summarized in Table 2. Nasal swabs and floor swabs were not obtained in 3 and 4 of the 32 cases, respectively, so these cases were excluded for the McNemar comparison of the nose swab and floor swab to the control.

Table 1. Experimental Groups

Group	*Description*
1	Control sent for C&S: no treatment
2	Cartilage soaked in a 5 mL normal saline (0.9%) bath for 60 s then sent for C&S
3	Cartilage soaked with 5 mL of gentamicin (40 mg/mL) bath for 60 s and then sent for C&S
4	Cartilage soaked with 5 mL of gentamicin (40 mg/mL) bath for 300 s and then sent for C&S
5	Culture swab of the operating room floor
6	Culture swab of the nasal vestibule

C&S = culture and sensitivity.

Table 2. Results of Specimen Cultures

Case Number	Control after Dropping on Floor	NS Soaking	Gentamicin 60 s	Gentamicin 300 s	Floor Swab	Nasal Swab
1	NRF	NSG	NSG	NSG	NRF	NRF
2	NSG	NSG	NSG	NSG	NSG	NSG
3	*Staphylococcus epidermidis*	*S. epidermidis Haemophilus influenzae*	NSG	NSG	NSG	NRF
4	NRF	NRF	NSG	NSG	NSG	NRF
5	*Serratia marcescens*	*S. marcescens*	NSG	*S. marcescens*	NA	NA
6	NRF	NSG	NSG	NSG	NSG	NRF
7	NSG	NSG	NSG	NSG	NSG	NSG
8	NSG	NSG	NSG	NSG	NA	NRF
9	Coagulase-negative *Staphylococcus*	Coagulase-negative *Staphylococcus*	NSG	NSG	NSG	NRF
10	NSG	NSG	NSG	NSG	NSG	NSG
11	NRF	NRF	NSG	NSG	NA	NA
12	NRF	NSG	NSG	NSG	NSG	NSG
13	NRF	NRF	NSG	NSG	NSG	NRF
14	NSG	Coagulase-negative *Staphylococcus*	NSG	NSG	NA	*Staphylococcus aureus*
15	NRF	NRF	NSG	NSG	NRF + *S. aureus*	NRF
16	NSG	NSG	NSG	NSG	NSG	NRF
17	NSG	NSG	NSG	NSG	NSG	NRF
18	NRF	NSG	NSG	NSG	NRF	NA
19	NSG	NSG	NSG	NSG	NRF	NRF
20	NSG	NSG	NSG	NSG	NSG	NRF
21	*Bacillus, S. epidermidis*	*BACILLUS*	NSG	NSG	*BACILLUS*	NRF
22	NSG	NSG	NSG	NSG	Coagulase-negative *Staphylococcus*	NRF
23	*Bacillus*	*Bacillus*	NSG	NSG	*Bacillus*	NRF
24	Coagulase-negative *Staphylococcus*	Coagulase-negative *Staphylococcus*	NSG	NSG	Coagulase-negative *Staphylococcus*	NRF
25	NSG	NSG	NSG	NSG	NSG	NRF
26	Coagulase-negative *Staphylococcus*	Coaulase-negative *Staphylococcus*	NSG	NSG	Coagulase-negative *Staphylococcus*	NRF
27	*S. epidermidis*, coagulase-negative *STAPHYLOCOCCUS*	*S. epidermidis*, coagulase-negative *STAPHYLOCOCCUS*	NSG	NSG	*S. epidermidis*	NRF
28	*S. epidermidis*	*S. epidermidis*	NSG	NSG	*S. epidermidis*	NRF
29	NSG	NSG	NSG	NSG	*Bacillus*	NRF
30	NSG	NSG	NSG	NSG	Coagulase-negative *Staphylococcus*	NRF
31	Coagulase-negative *Staphylococcus*	NSG	NSG	NSG	Coagulase-negative *Staphylococcus*	NRF
32	NSG	NSG	NSG	NSG	*S. epidermidis*	NRF

NA = not available; NRF = no respiratory flora; NS = normal saline; NSG = no significant growth.

Swabs of the operating room floor were positive in 53.6% (15 of 28) of specimens. Ninety-seven percent (28 of 29) of the nasal vestibule swabs demonstrated no growth or normal respiratory flora; one nasal vestibule swab (3%) was positive for *Staphylococcus aureus*, showing a significant difference ($p = .027$) of contamination between the nasal swab group and the untreated group (Table 3). Bacterial contamination of the untreated group (control) was

Table 3. McNemar Comparison of Results

	Number of Contaminated Cultures in Nontreated Group	*Number of Noncontaminated Cultures in Nontreated Group*	*Absolute % Risk Reduction*	p *Value*
Number of contaminated cultures in saline wash group	9	1	0	.479
Number of noncontaminated cultures in saline wash group	1	21		
Number of contaminated cultures in gentamicin 60 s wash group	0	0	31	.004
Number of noncontaminated cultures in gentamicin 60 s wash group	10	22		
Number of contaminated cultures in gentamicin 300 s wash group	1	0	28	.008
Number of noncontaminated cultures in gentamicin 300 s wash group	9	22		
Number of positive nose swab cultures other than normal flora	0	1	NA	.027
Number of negative nose swab cultures including normal flora	9	19		
Number of positive floor swab cultures	9	6	NA	.289
Number of negative floor swab cultures	2	11		

NA = not available.

demonstrated in 31% (10 of 32), which was similar to the normal saline wash group, so the absolute risk reduction (0%) was not statistically significant ($p = .479$). Of note, one contaminated normal saline (NS) wash specimen had a negative culture for control, whereas one contaminated control had a negative culture for its normal saline wash counterpart (see Table 2). Bacterial growth was not observed in any of the specimens treated with gentamicin wash for 60 seconds, and an absolute risk reduction of 31% was obtained ($p = .004$). Similarly, a risk reduction of 28% ($p = .008$) was obtained for the gentamicin 300 seconds group (see Table 3); one specimen in the latter group (3%) had bacterial growth similar to that of the control group.

Bacterial contamination in the untreated control group could be explained by similar bacterial growth in the floor swab group in 70% of the cases (7 of 10); 1 of the 10 cases had no floor or nose swab to compare to, and the remaining 2 cases grew normal flora in the nose swabs and had no growth in the floor swabs. Multiple bacterial species were cultured in 6% (2 of 32) of the control specimens.

Discussion

Contamination of any graft material is a potentially serious problem as it can result in infection, extrusion, sepsis, and morbidity of the patient. Surgical procedures where this is particularly important include operations involving joints (joint replacements/tendon grafts) and neurosurgical procedures. Cartilage is a common graft material used by otolaryngologists in reconstruction of cancer-related nasal defects, cosmetic rhinoplasty, and endoscopic repair of cerebrospinal fluid leaks at the skull base. Most of the time when a cartilage graft is contaminated (dropped on the floor), another graft can be harvested and used in its place. However, situations do arise when no further cartilage can be harvested. In this setting, potential options include using (1) bone (if applicable), (2) alloplastic material, or (3) cadaveric tissue or sterilizing and reusing the (4) contaminated tissue.

Various methods of sterilization of infected tissue have been described in the literature, including antibiotic irrigation, chemical disinfectants (betadine, chlorhexidine), and mechanical methods (high-pressure saline washes).[1,2] Hirn and colleagues found that high-pressure saline irrigation significantly reduced the infection rate of contaminated bone allografts.[2] Betadine and chlorhexidine have demonstrated variable degrees of success in their ability to sterilize infected tissue.[3–5] These chemical disinfecting agents were not used as an experimental arm in this experiment because studies have

shown both proviodine and chlorhexidine to be toxic to cartilage.[6,7] Antibiotic irrigation has been the most studied method of decontamination and has demonstrated excellent efficacy in its ability to sterilize tissue. Some of the earliest data collection was performed by Cooper and colleagues, who observed a decrease in the incidence of positive cultures of contaminated tendon grafts soaked for 15 minutes in sterile solutions of 33.33 U/mL bacitracin with 333.33 U/mL polymyxin B.[8] However, the authors noted that 30% of the treated grafts still demonstrated positive bacterial cultures. Other studies have demonstrated a much higher ability of antibiotics to sterilized contaminated grafts.[3]

Our study demonstrated that soaking of contaminated cartilage in normal saline is an ineffective form of treatment. We found that only one saline-soaked specimen had a negative culture compared to its contaminated control. As mentioned earlier, the use of high-pressure saline irrigation was documented in the literature to be an effective sterilization technique; however, the limitation is that it can potentially damage less robust grafts such as cartilage, so we chose not to use high-pressure irrigation in our study.[2] Antibiotic treatment using gentamicin soak was found to be highly effective in sterilizing the contaminated cartilage in our study. None of the 32 contaminated specimens treated with 60 seconds of gentamicin irrigation demonstrated positive bacterial growth. One (3%) of the 300 seconds of gentamicin group still grew gentamicin-susceptible *Serratia marcescens*, although its gentamicin 60 seconds counterpart did not.

Gentamicin is an aminoglycoside antibiotic that works by interfering with bacterial protein synthesis by binding to 30S and 50S ribosomal subunits, resulting in a defective bacterial cell membrane. It is widely used for various bacterial infections, specifically those resulting from gram-negative bacteria. It is also effective against gram-positive bacteria, such as *Staphylococcus*.

Despite the data demonstrating that gentamicin soak is an effective method to sterilize contaminated cartilage, we do not suggest that this procedure be used as the first-line option to deal with infected tissue as the risk of contamination is still present. Other methods to obtain sterile tissue or material should be sought prior to disinfecting contaminated tissue as there is still the potential for infection. It is important to mention that the most important factor in dealing with contaminated cartilage is prevention. Careful handling and placement of the cartilage where it is less likely to be mishandled are simple preventive measures. Despite every effort, a mishap can occur, and in these cases, antibiotic irrigation seems to be a viable option.

Conclusion

Inadvertent contamination of cartilage on the floor rarely occurs during surgery of the head and neck. However, when this situation arises, when no other options are available, this study demonstrates that cartilage dropped on the floor can be decontaminated by washing with gentamicin.

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