Microbiologic Safety of the Transareolar Approach in Breast Augmentation

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Abstract

Background: In aesthetic breast augmentation, especially by the transareolar approach, there is increasing concern regarding the occurrence of capsular contracture and its potential correlation with intraoperative implant contamination from putative endogenous breast flora of the nipple and lactiferous ducts. However, detectable bacteria cannot be considered synonymous with established resident microflora.

Objectives: The authors sought to elucidate the existence of endogenous breast flora and assess the microbiologic safety of transareolar breast augmentation.

Methods: In this prospective study (BREAST-MF), the authors collected microbiologic samples from the breast skin, ductal tissue, and parenchyma of 39 consecutive female patients who underwent breast procedures in a plastic surgery clinic. Swabs collected pre-, intra-, and postoperatively were processed for bacterial and fungal growth. Positive cultures underwent identification through VITEK and MALDI-TOF, as well as antimicrobial susceptibility testing.

Results: Staphylococcus species accounted for 95 of 106 (89.6%) positive results from native breast skin, 15 of 18 (83.3%) positive results from decontaminated breast skin, and 4 of 4 (100%) positive results from the breast parenchyma. Methicillin resistance was present in 26.4% of S. epidermidis, 25.3% of S. hominis, and 71.4% of S. haemolyticus strains.

Conclusions: During transareolar breast augmentation, in the nipple-areola region it is more likely to find bacteria populating the skin, rather than endogenous breast flora, as previously considered. Appropriate preoperative decontamination is essential for minimizing the risk of postoperative infections.

Level of Evidence: 3

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The incidence of capsular contracture following breast augmentation is a source of increasing concern in aesthetic surgery. One of the factors behind capsule formation is considered to be the intraoperative contamination of the implant. The transareolar approach is considered prone to such contamination, owing to putative endogenous flora of the lactiferous ducts.

Because the human body contains 10 times more bacterial cells than human cells, the identification of bacterial species should be expected when sampling virtually any compartment of the body, including the breast. However, the isolation of bacteria from an anatomic site is not synonymous with the existence of established local microflora. For bacterial communities to qualify as resident flora, the following 4 criteria must be met simultaneously: (1) The species identified are different from those of surrounding areas; (2) the habitat is rich in nutrients, enabling bacteria to survive and shielding them from the host’s local anti-infective protection; (3) the species isolated are nonpathogenic and consistently identified over a relatively large sample of subjects; and (4) the microorganisms perform a role in the anatomic area.

To elucidate the controversy regarding the existence of endogenous breast flora, we conducted a prospective study (BREAST-MF) to identify and characterize the microbial species present on the breast skin, ductal tissue, and parenchyma.

METHODS

The methodology of the prospective study BREAST-MF has been described previously. Microbiologic samples were systematically collected from 39 consecutive female patients who underwent breast surgery in the ProEstetica Medical Center (Bucharest, Romania) from February 2013 to September 2013. All patients signed a study-specific informed consent document endorsed by the Institutional Review Boards of the National Institute for Infectious Diseases “Prof. Dr Matei Balș” and the ProEstetica Medical Center prior to any study procedures. The study was conducted in line with the principles of Good Clinical Practice (ICH GCP).

Thirty minutes before the initial incision, patients received a single dose of cefuroxime intravenously (1.5 g). The skin was prepared successively with 70% ethanol (Scandic Distilleries, Romania) and a solution of iodine tincture (50 mL) in 70% ethanol (50 mL). The skin was then draped in the standard manner. The surgical technique aimed to minimize implant contamination, tissue trauma, and bleeding, as these factors are implicated in the etiology of capsular contracture. The implant pocket was washed intraoperatively with a double antibiotic irrigation solution (750 mg cefuroxime and 80 mg gentamicin in 100 mL saline) without active suctioning. Patients were monitored for a minimum of 2 years postoperatively. Results are currently available for 1 year of follow-up in all patients.

Microbiologic samples collected pre-, intra-, and postoperatively (Figure 1) were swabbed (Copan Diagnostics Inc, Murrieta, CA, USA) and processed for aerobic bacterial and fungal growth on Columbia agar with 5% sheep blood, cystine lactose electrolyte-deficient agar, and Sabouraud gentamicin chloramphenicol 2 agar (all Biomérieux, Marcy-l’Étoile, France). After 24 to 48 hours of incubation at 35 ± 2°C, positive cultures were submitted to microbial identification through Vitek (Biomérieux) and matrix-assisted laser desorption/ionization time-of-flight MALDI-TOF (Bruker, Germany) at the National Institute for Infectious Diseases “Prof. Dr Matei Balș” (Bucharest, Romania).

Patient characteristics, as well as previous exposures to the healthcare system and to antimicrobial treatments were quantified for each study subject by means of the Carmeli score, which enables infectious disease practitioners to evaluate the preliminary risk of antimicrobial resistance of...
The procedure to manage mammary asymmetry involved transareolar subpectoral augmentation of the right breast and transareolar subpectoral augmentation with vertical mastopexy of the left breast.

only 2 patients (6.3%) presenting for reintervention following rupture of the previous implant. Patients presenting for aesthetic surgery were significantly younger ($P = 0.018$) and more likely to be current smokers ($P = 0.010$) than patients who presented for oncologic surgery (Table 2). Of 39 patients, a Carmeli score of 1 was computed for 11 patients (28.2%), while 17 patients (43.6%) had a score of 2, and 11 patients (28.2%) had a score of 3.

**Microbial Flora of the Breast**

**Native Breast Skin**

Of 106 identifications of flora on native skin, 95 (89.6%) corresponded to staphylococci, with *Micrococcus luteus*, *Leuconostoc mesenteroides*, and other microorganisms populating the skin less frequently (Figure 2). Among the strains of *Staphylococcus* that were identified on native skin, *S. epidermidis* and *S. hominis* were most prevalent, accounting for 46 (48.4%) and 35 (36.8%) of the 95 strains identified, respectively (Figure 3). *S. lugdunensis* accounted for 5 microbial identifications (5.3%), *S. haemolyticus* and *S. capitatis* each accounted for 3 identifications (3.2%), and *S. aureus*, *S. auricularis*, *S. cohnii*, and *S. warneri* each accounted for 1 identification (1.1%).

**Decontaminated Breast Skin**

After preoperative decontamination, fewer swabs yielded positive culture results (18 vs 106 swabs, an 83% decrease). The identified flora primarily comprised staphylococci (15 of 18 swabs [83.3%]; Figure 4) with a slightly different distribution compared with native skin in which *S. hominis* (8 of 15 staphylococci identifications [53.3%]) and *S. epidermidis* (5 of 15 [33.3%]) changed places in order of prevalence (Figure 5).

**Areolar Incision (Ductal Tissue)**

Two of 64 swabs from the ductal tissue (3.1%) yielded positive bacterial growth, in 2 patients from the aesthetic surgery group. The results of further testing identified these bacteria as *S. hominis* and *S. lugdunensis*. The patient with detectable *S. hominis* in the ductal tissue had periareolar folliculitis in the contralateral breast for which *S. hominis* was the etiologic agent. The patient with detectable *S. lugdunensis* in the ductal tissue also had this species on her native skin before preoperative decontamination. The bacterial load determined by the number of colony-forming units (CFUs) associated with these positive identifications was roughly 1000-fold lower than that of microorganisms cultured from swabs of native skin from the same subject and 30-fold lower than that of decontaminated skin (data not included). In addition, culture positivity was not associated with early or late stage postoperative infection.

**RESULTS**

**Patient Characteristics**

The median age and standard deviation for the study population were 36.0 ± 11.7 years, and the mean age was 38 years (range, 25-75 years; Table 2). Twenty-three of 39 subjects (59%) had not undergone breast surgery previously. Of 32 women presenting for aesthetic surgery, the reason for the current intervention was primarily aesthetic, with
Breast Parenchyma

Four of 66 samples collected from the breast parenchyma at medium depth (6.1% of all swabs collected from this region) were positive for staphylococcal growth, including 1 from a patient who underwent oncologic surgery and 3 from aesthetic surgery patients. These positive results corresponded to bacterial loads roughly 300-fold lower than those of native skin and 4-fold lower than those of decontaminated skin. For the oncologic surgery patient, *S. epidermidis* had also been identified on the ipsilateral native inframammary fold, the nipple-areola area, and on the decontaminated axillary skin. Of 3 aesthetic surgery patients, 1 had *S. hominis* in the ipsilateral nipple-areola area before and after decontamination, 1 had *S. capitis* on the ipsilateral native axillary skin, and 1 had staphylococcal colonization with high bacterial loads in both breasts despite *S. lugdunensis* being absent from previous culture identifications of that patient.

Of 67 samples collected from the deep breast parenchyma, only 1 (1.5%) yielded bacterial growth. This positive result was identified as *S. epidermidis* and was obtained from a patient presenting for oncologic surgery who previously had positive results for this species on her ipsilateral decontaminated nipple-areola area. The bacterial load from this swab was roughly 1000-fold lower than that of native skin and 10-fold lower than that of decontaminated skin. The results of all 59 swabs from the axillary parenchyma were negative.

When applicable, swab sampling was conducted to assess colonization of intracapsular fluid. In this compartment, no bacterial or fungal growth was detected from the 18 swabs collected. Twenty samples were obtained from capsules during secondary augmentation for preexisting capsular

### Table 2. Patient Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Aesthetic Surgery Group (n = 32)</th>
<th>Oncologic Surgery Group (n = 7)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, y (range)</td>
<td>35.0 (25-56)</td>
<td>55.3 (25-75)</td>
<td>0.018 a</td>
</tr>
<tr>
<td>Nulliparous, n (%)</td>
<td>10 (31.3)</td>
<td>1 (14.3)</td>
<td>0.368</td>
</tr>
<tr>
<td>Previous breastfeeding, n (%)</td>
<td>20 (62.5)</td>
<td>4 (57.1)</td>
<td>0.794</td>
</tr>
<tr>
<td>Current smoker, n (%)</td>
<td>17 (53.1)</td>
<td>0 (0)</td>
<td>0.010 a</td>
</tr>
<tr>
<td>Mastitis during the past 5 years, n (%)</td>
<td>10 (31.3)</td>
<td>1 (14.3)</td>
<td>0.368</td>
</tr>
<tr>
<td>First breast surgical procedure, n (%)</td>
<td>19 (59.4)</td>
<td>4 (57.1)</td>
<td>0.912</td>
</tr>
<tr>
<td>Comorbidities, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1 (3.1)</td>
<td>0 (0)</td>
<td>0.638</td>
</tr>
<tr>
<td>HIV</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>NA</td>
</tr>
<tr>
<td>HBV</td>
<td>1 (3.1)</td>
<td>0 (0)</td>
<td>0.638</td>
</tr>
<tr>
<td>HCV</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>NA</td>
</tr>
</tbody>
</table>

HBV, hepatitis B virus; HCV, hepatitis C virus; HIV, human immunodeficiency virus; NA, not applicable. aStatistically significant difference.
contracture, and implants were sonicated to observe the presence of biofilms. None of the 20 samples yielded bacterial growth, supporting a chronic inflammatory (foreign body) reaction, rather than an infection, as the underlying etiology of capsular contracture. Sonication results are not included in the present report due to logistic reasons.

No postoperative infections occurred in the study subjects, regardless of swab culture results. During 1 year of follow-up, no patients developed capsular contracture, regardless of intraoperative swab status.

Sealed Nipple

Swabs of the sealed nipple after the surgical procedure yielded bacterial growth in 4 patients (5 of 54 swabs, 9.3%). The 5 positive results corresponded to 4 identifications of \textit{S. epidermidis} and 1 identification of \textit{S. hominis}; these \textit{Staphylococcus} species had also been isolated from the corresponding patients’ native skin. Swab positivity was not associated with a different postoperative clinical evolution. Because our study was not designed to evaluate the efficacy of nipple shields, we cannot provide recommendations regarding their utility in surgical practice.

Antimicrobial Susceptibility Patterns

We identified a relatively low prevalence of methicillin resistance among coagulase-negative \textit{staphylococci} (CoNS) isolated in this study. Specifically, methicillin resistance was identified in 19 of 72 (26.4%) \textit{S. epidermidis} strains, 19 of 75 (25.3%) \textit{S. hominis} strains, 5 of 7 (71.4%) \textit{S. haemolyticus} strains, and 0 of 10 \textit{S. lugdunensis}, 6 \textit{S. capitis}, 1 \textit{S. warneri}, 1 \textit{S. auricularis}, and 1 \textit{S. cohnii} strains.

Statistically significant differences in methicillin resistance were observed between the 2 patient groups with respect to \textit{S. hominis}. A 60% resistance prevalence was observed among patients presenting for oncologic surgery compared with a 20% prevalence among aesthetic surgery patients \(P = 0.007\). In contrast, \textit{S. epidermidis} had a 30% resistance prevalence among patients in the oncologic surgery group and a 25.8% resistance prevalence in the aesthetic surgery group \(P = 0.779\). Statistically significant differences were identified for methicillin resistance vs Carmeli score, but not for primary vs nonprimary breast interventions (Table 3).

DISCUSSION

\textit{Staphylococcus} species are recognized components of the human microbiota, ranking second in skin flora (mostly CoNS) after \textit{Propionibacterineae} and third in the nasal cavity (mostly \textit{S. aureus}) after \textit{Propionibacterineae} and \textit{Corynebacterineae}. Methicillin resistance has been well studied in \textit{S. aureus} strains, with prevalences ranging from 0.9% to 12% in colonization and 62% in infection. However, there is less information regarding methicillin resistance in CoNS, with an estimated prevalence of 20% to 62% in colonization and up to 46% to 84% in infection.

In the present study, methicillin resistance was fairly low in CoNS with the exception of \textit{S. haemolyticus}, an important finding, as CoNS are thought to harbor resistance determinants transferable to \textit{S. aureus}, such as the \textit{staphylococcal cassette chromosome mec}. Although classically applied for evaluating infections with Gram-negative bacilli, we found that the Carmeli score is also applicable for computing methicillin resistance in Gram-positive cocci.

An aim of this study was to identify the microbial species present on the breast skin and parenchyma and to establish whether these constitute a specific resident flora of the breast. The results of our study indicated that the primary criterion for defining resident flora, that “the species identified are different from those of the surrounding areas,” was not met. Instead, the species we identified on and inside the breast are notoriously present on all skin areas of the body and are nonspecific for the breast area. We were unable to identify a specific microbial flora of the breast, other than the expected local skin flora.

![Figure 4. Bacterial species identified after decontamination of the breast skin.](https://academic.oup.com/asj/article-abstract/36/1/51/2613983/55)

![Figure 5. \textit{Staphylococcus} species identified after decontamination of the breast skin.](https://academic.oup.com/asj/article-abstract/36/1/51/2613983/55)
CONCLUSIONS

During transareolar breast augmentation, we occasionally encountered bacterial populations in the nipple-areola region that were consistent with those of the skin surface. Our findings do not support the existence of specific resident microorganisms of the breast, as previously suggested. Appropriate preoperative decontamination is essential for minimizing the risk of postoperative infections. If antibiotic prophylaxis is administered before breast surgery, the antimicrobial agent should display activity against staphylococci because these types of microorganism were identified most frequently.

Disclosures

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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REFERENCES


Table 3. Methicillin Resistance in Staphylococcus Strains by Carmeli Score of Patients and by Primary vs Nonprimary Breast Intervention

<table>
<thead>
<tr>
<th>Staphylococcus Species</th>
<th>Carmeli 1, %MR</th>
<th>Carmeli 2, %MR</th>
<th>Carmeli 3, %MR</th>
<th>P Value Carmeli 1 vs 2</th>
<th>P Value Carmeli 1 vs 3</th>
<th>P Value Carmeli 2 vs 3</th>
<th>Primary Breast Intervention, %MR</th>
<th>Nonprimary Breast Intervention, %MR</th>
<th>P Value Primary vs Nonprimary Breast Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. epidermidis</td>
<td>0</td>
<td>33.3</td>
<td>23.1</td>
<td>0.025&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.089</td>
<td>0.478</td>
<td>25.9</td>
<td>26.7</td>
<td>0.944</td>
</tr>
<tr>
<td>S. hominis</td>
<td>14.3</td>
<td>20.6</td>
<td>45</td>
<td>0.555</td>
<td>0.031&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.057</td>
<td>20.5</td>
<td>32.3</td>
<td>0.246</td>
</tr>
<tr>
<td>S. haemolyticus</td>
<td>66.7</td>
<td>66.7</td>
<td>100</td>
<td>1</td>
<td>0.503</td>
<td>0.503</td>
<td>71.4</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

<sup>a</sup>%MR, percentage of methicillin-resistant isolates; NA, not applicable. <sup>a</sup>Statistically significant difference.