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Monitoring and Management of Infection following Prepectoral Implant-based Breast Reconstruction: Retrospective Analysis of Conservative Treatment Versus Implant Removal

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Background: Infection following implant-based breast reconstruction (IBBR) represents a major complication, potentially leading to prosthesis removal. However, no clear protocol for its prevention and management exists. This study aimed to evaluate the efficacy of conservative treatment methods in preventing implant removal and analyze factors responsible for implant loss in the context of prepectoral IBBR.
Methods: A single-institution retrospective review chart of patients undergoing immediate prepectoral IBBR for breast cancer between October 2020 and January 2024 was performed. The inclusion criteria were the presence of at least one of the following postoperative complications: seromas, cellulitis, clinically suspected prosthesis infection, and confirmed periprosthetic infection. A comparative analysis between patients with successful conservative treatment (ultrasound-guided aspiration and antibiotic therapy) and patients undergoing implant removal was performed.
Results: A total of 219 immediate prepectoral IBBR cases were identified, 38 of which met inclusion criteria. Implant removal was required in 11 cases, whereas implant retention was achieved in 27 patients with conservative treatment. Implants were invariably removed when bacterial cultures were positive ($P < 0.05$). Conversely, when pathogens were not identified, the likelihood of implant removal decreased significantly ($P < 0.05$). Conservative treatment allowed implant salvage in all patients presenting with postoperative seroma alone, without other associated complications ($P < 0.05$).
Conclusions: This study suggests that when bacterial cultures are positive, implant removal is unavoidable. Conversely, noninfected seromas correlated with implant salvage. Infections from *Bacillus pumilus* and *Corynebacterium pseudodiphtheriticum* are reported for the first time. *(Plast Reconstr Surg Glob Open 2025; 13:e6516; doi: 10.1097/GOX.0000000000006516; Published online 5 February 2025.)*

INTRODUCTION

Breast reconstruction is one of the most common reconstructive procedures, with a predominance of implant-based breast reconstruction (IBBR).[1]

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Postoperative complications associated with these reconstructions include seroma, skin complications, hematoma, and periprosthetic infection, among others.[2] Left unmanaged, seromas increase the risk of periprosthetic infection significantly, as they cause fluid to build up around a foreign body in a poorly vascularized and proinflammatory environment.[3–5] Infection of the prosthesis is the most significant complication, potentially leading to implant loss.[6–8] Consequently, it is critical to manage these infections because of their significant impact on patient outcomes and healthcare costs.[9,10]

Prepectoral IBBR has gained popularity in recent years due to its less invasive approach and reduced postoperative

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pain compared with submuscular implants.[11] However, this technique is associated with higher rates of infection and seroma.[12,13]

Given the challenges of managing infections in IBBR, our study aimed to address this need by evaluating management strategies for postoperative complications, specifically focusing on seromas, cellulitis, clinically suspected infections, or confirmed infections of prepectoral breast implants.

Takeaways

Question: How effective are conservative treatment methods in preventing implant removal and what factors are responsible for implant loss in the context of prepectoral implant-based breast reconstruction.

Findings: A total of 38 patients met inclusion criteria. Implant removal was required in 11 cases, whereas implant retention was achieved in 27 patients with conservative treatment. Implants were invariably removed when bacterial cultures were positive. When no pathogens were identified, implant removal decreased significantly. Conservative treatment allowed implant salvage in all patients presenting with postoperative seroma alone.

Meaning: When bacterial cultures are positive, implant removal is unavoidable. Conversely, noninfected seromas correlated with implant salvage.

METHODS

A retrospective analysis of all female patients who underwent single-stage immediate prepectoral IBBR in the context of breast cancer at Geneva University Hospitals between October 2020 and January 2024 was conducted. A screening of all female patients who underwent this surgery and who provided informed consent was conducted.

Inclusion criteria were the presence of at least one of the following postoperative complications: seromas, cellulitis, clinically suspected prosthetic infection (indicated by pain, heat, erythema, and swelling), and confirmed periprosthetic infection. Exclusion criteria were patients who did not develop the postoperative complications required for inclusion or patients with incomplete medical records.

Patient data, including demographic characteristics, comorbidities, oncologic characteristics, treatment details, and surgical procedures, were extracted from medical and operative charts. Postoperative outcomes, management of complications, and follow-up duration were retrieved from the hospital discharge letters and outpatient consultation reports. Data were saved into an anonymized standard spreadsheet file to ensure patient confidentiality.

The surgical method was similar in all patients, with the first part, consisting of different types of mastectomies performed by the breast surgeons, including nipple-sparing mastectomy, skin-sparing mastectomy, and skin-reducing mastectomy, and their team consisted of 4 surgeons. Indocyanine green with the Novadaq system was used intraoperatively, whenever a doubt about the viability of the flap occurred, to provide an assessment about the vascular supply of the mastectomy flaps. The second stage, which consisted of immediate prepectoral IBBR, was conducted by the plastic surgery team of 6 surgeons. All patients received intraoperative and postoperative antibiotic prophylaxis. Intraoperative antibiotic prophylaxis consisted of cefuroxime 1.5 g IV.

Samples for bacterial cultures were collected at 2 specific points in the care process: during ultrasound-guided aspiration and during implant removal. When a fluid collection was identified, ultrasound-guided aspiration was performed. Fluid samples were collected and sent for bacterial culture before the administration of antibiotics to avoid interference with culture results. In cases where implant removal was necessary due to infection, deep tissue samples were taken intraoperatively at the time of implant removal. Given the critical nature of these cases, empirical antibiotic therapy had already been initiated based on clinical judgment to manage the condition. All cultures were processed in our laboratory using standardized protocols. Both aerobic and anaerobic bacterial cultures were consistently ordered for all samples.

All patients provided informed consent for the use of their data in research during preoperative consultations. The study received approval from the Geneva ethics committee "Commission Cantonale d'Ethique de la Recherche sur l'être humain" (project ID: CCER 2024-00071).

Descriptive statistics were used to analyze the data, with continuous variables presented as mean ± SD and categorical variables as absolute values and percentages (%). Statistical analyses were conducted using SPSS version 29.0.2.0 (IBM, Armonk, NY), using the chi-squared test or Fisher exact test, as appropriate, to analyze associations between categorical variables and outcomes. This statistical approach was chosen due to its suitability for the categorical nature of the clinical data analyzed. A significance level of P value less than 0.05 was considered statistically significant for all analyses.

RESULTS

The retrospective study reviewed patient data from October 2020 to January 2024. A total of 219 immediate prepectoral IBBRs were carried out in 192 patients. We selected patients presenting with the following complications: suspected infection, seroma confirmed by ultrasound (US), cellulitis, and infection confirmed by bacterial culture. A total of 38 patients were included, corresponding to 17.4% of the total study population.

Patients presenting with such complications had a mean age of 53.6 years old (from 28 to 83 y, SD 13.8, median age: 53 y). The mean body mass index was measured at 26.7 kg/m^2 (SD 5.0). Twelve patients were active smokers (31.6%). The most common underlying condition was ductal carcinoma, representing 55.3% of cases with complications. No significant differences were found in the characteristics between the patients who experienced complications and those who did not (Table 1).

Thirty-two patients underwent unilateral IBBR, and 6 patients underwent bilateral IBBR. The implants used in these reconstructions varied in size from 220 to 625 cm^3.

Postoperative antibiotic prophylaxis varied according to surgeon's preference, because no clear protocol is established in the literature, and included amoxicillin/clavulanic acid, cefuroxime, clindamycin, cefazolin, or ciprofloxacin.[7,8,14–17]

In the included patients, seroma was the most frequent postoperative complication (38.8%), followed by cellulitis in 12 patients (31.6%). Subacute complications—defined as those appearing between the first week to 30 days after the operation—were observed in 29 patients. The mean time to onset of these complications was 18.8 days following the initial surgery for cases in which implants were preserved, compared with 15.7 days in instances where the implant was removed. Among this group, 9 patients underwent implant removal. For complications arising after 30 days, 9 patients were affected; of these, 2 patients had their implant removed. The average onset for late complications in cases where the implant was preserved was 43.8 days postoperatively. In 1 case presenting with a postoperative complication developing 34 days after the operation, the implant had to be removed. In addition, 2 complications were recognized as notably late complications: the first, occurring 570 days postoperatively, involved a patient who experienced discomfort around the implant, and an ultrasound revealed a compartmentalized and retroprosthetic effusion, which was managed successfully with ultrasound-guided aspirations. The second case involved a patient presenting with clinical and biological signs of infection 131 days after the operation. Despite receiving intravenous amoxicillin/clavulanic acid 4 times daily for 5 days, no clinical improvement was observed, leading to the decision to remove the implant. An average of 21.7 days (SD 19.5) elapsed from the first sign of a complication to the decision to remove the implant.

Among the 38 patients, infection was confirmed by bacterial culture in 8 patients, all of whom required implant removal ($P < 0.05$), and when bacterial cultures were negative, the implant retention rate was significantly higher ($P < 0.05$). (**See table, Supplemental Digital Content 1,** which displays treatment modalities, **http://links.lww.com/PRSGO/D839**.) Pathogens identified included *Staphylococcus epidermidis,* which was significantly associated with implant removal ($P < 0.05$), and methicillin-sensitive *Staphylococcus aureus*, but also rarer pathogens such as *Bacillus pumilus, Corynebacterium pseudodiphtheriticum,* and *Serratia marcescens* complex. (**See table, Supplemental Digital Content 2**, which displays bacterial pathogens and prosthesis sizes, **http://links.lww.com/PRSGO/D840**.) These atypical infections were referred to infectious diseases specialists for expert

Table 1. Complications, Risk Factors, and Context

	n (%)	Implant Retained n, (%)	Implant Removed n, (%)	*P*
Total	38	27	11	
Complications				
Clinical suspicion of infection	6 (15.8)	6 (100)	0	0.1322
Infection with positive culture	5 (13.2)	0	5 (100)	**0.0002**
Seroma	11 (28.9)	11 (100)	0	**0.0415**
Cellulitis	8 (21.1)	6 (75)	2 (25)	0.4808
Seroma + cellulitis	1 (2.6)	1 (100)	0	0.5388
Infection with positive culture + seroma + cellulitis	3 (7.9)	0	3 (100)	**0.0145**
Infection with positive culture + seroma	4 (10.5)	3 (75)	1 (25)	0.6181
Tobacco				
Nonsmoker/former smoker	26 (68.4)	21 (80.8)	5 (19.2)	0.2746
Smoker	12 (31.6)	6 (50.0)	6 (50.0)	0.1078
Diabetes	1 (100)	1 (100)	0	
BMI, kg/m^2				
Between 19 and 24.9	15 (39.5)	12 (80)	3 (20)	0.4448
Between 25 and 29.9	15 (39.5)	11 (73.3)	4 (26.7)	0.8455
>30	8 (21.1)	4 (50)	4 (50)	0.1891
Pathologies				
Ductal carcinoma in situ	5 (12.8)	2 (40)	3 (60)	0.1141
Ductal carcinoma invasive	21 (53.8)	14 (66.6)	7 (33.3)	0.6015
Lobular carcinoma invasive	3 (7.7)	3 (100)	0	0.2776
Tubular carcinoma invasive	1 (2.6)	1 (100)	0	0.5308
Mucinous carcinoma invasive	1 (2.6)	1 (100)	0	0.5308
Micropapillary carcinoma invasive	2 (5.1)	2 (100)	0	0.3754
Mixed invasive carcinoma (ductal and micropapillary)	1 (2.6)	1 (100)	0	0.5308
Mutation BRCA 1 or 2	1 (2.6)	1 (100)	0	0.5308
Mutation BRCA 1 or 2 with ductal carcinoma invasive	4 (10.3)	3 (75)	1 (25)	0.8867
Intervention types				
NSM	20 (51.3)	16 (80)	4 (20)	0.4148
SSM	17 (43.6)	10 (58.8)	7 (41.2)	0.2346
SRM	2 (5.1)	2 (100)	0	0.3754

$P < 0.05$ indicated in boldface.
NSM, nipple-sparing mastectomy; SRM, skin-reducing mastectomy; SSM, skin-sparing mastectomy.

advice, and appropriate antibiotic therapy was initiated. Three other implants were removed despite the absence of positive bacterial culture results. In the first case, the patient manifested fever and pain around the prosthesis, which did not respond to 10 days of antibiotic therapy. In the second case, although the patient received 14 days of amoxicillin/clavulanic acid (1 g orally 3 times daily) and US-guided aspirations, the patient continued to have pain at the surgical site and subsequently requested removal of the implant. The last patient had developed wound dehiscence with prosthesis exposure and needed the removal of the prosthesis. The bacterial cultures for this were positive on deep smear during the implant removal.

The duration of antibiotic therapy varied widely, from 2 to 29 days, with an average duration of treatment of 10.8 days (SD 7.9). Antibiotic treatment was administered for an average of 3.1 days (SD 5.3) before implant removal. In 4 patients, when antibiotic therapy was initiated and no clinical improvement was observed, the decision to remove the implant was made after 2 days of treatment, which was statistically significant ($P < 0.05$).

Implants were invariably removed when the bacterial culture was positive ($P < 0.05$). Conversely, when culture was not performed or did not identify bacterial pathogens, the likelihood of implant removal decreased significantly ($P < 0.05$).

DISCUSSION

This retrospective study examined 3 main therapeutic approaches for managing complications following immediate prepectoral breast reconstruction. Those approaches included US-guided aspiration for seromas, oral and/or intravenous antibiotic therapies, and breast implant removal.[18] All noninfected seromas were treated conservatively, and none of the implants needed to be removed.

Several studies have investigated prevention and management of these infections through antibiotic therapy, surgical interventions, or a combination thereof.[9,15,19–23] The primary focus of these studies has been the potential for implant salvage. However, several factors have been reported to influence the success of salvage, including the timing of intervention, the type of bacteria involved, and other patient-specific risk factors (eg, chemotherapy, diabetes, obesity).[10,24–29] Moreover, Talwar et al[13] suggested that infection in prepectoral implants may require different antibiotic management strategies compared with submuscular implant infections due to differences in the microbiology of those 2 different regions.

In other centers, oral antibiotic therapy is used in mild infection and includes clindamycin, trimethoprim-sulfamethoxazole, linezolid, or ciprofloxacin for 10–14 days.[9,18,30,31] Intravenous antibiotic is usually administered in the case of moderate to severe infection and includes broad antibiotics, such as vancomycin, or piperacillin-tazobactam.[9,30–32] Our study shows that implants were consistently removed when bacterial culture was positive, highlighting the ineffectiveness of intravenous antibiotic therapy in these cases. This is also demonstrated in our results, where we can observe that the administration of antibiotics in patients with an already outdated situation is unnecessary, and implant removal is carried out within a few days. This outcome established a clinical threshold in the decision to remove the implant, suggesting that positive bacterial cultures are a definitive indicator for removal and early management of seromas, which shows good prognosis for implant salvage. Despite advancements in understanding risk factors and implementing treatment strategies, salvage failure rates remain high.[21,29,33,34] This indicates a significant gap in the ability to predict and improve implant salvage outcomes.

We defined implant salvage differently than other studies. Unlike other studies that consider implant replacement as part of salvage treatment, we focused on the preservation of the original implant.[28–30,35] This distinction is crucial for understanding both the context and the results of our study. Indeed, these studies highlight their success in salvaging an infected implant by replacing it, in contrast to our salvage criteria, which involves keeping the same initial implant. Therefore, targeted research is needed to assess the effectiveness of multiple strategies for managing infections in IBBR, especially for preventing their aggravation, particularly in patients with numerous risk factors.[30,36,37]

Moreover, our observations align with previous studies indicating that half of the infection and implant losses occurred within 60 days, emphasizing the importance of timely intervention.[38] This is particularly pertinent in the context of prepectoral breast implant infections, which certainly require distinct management strategies due to their higher complication rates and unique microbiology.[11,13]

The competence of the surgeons in making appropriate decisions regarding the need for bacterial cultures and rapid evaluation to determine if an implant cannot be saved was also apparent throughout our study. However, their decision in borderline cases revealed a potential area for improvement, especially when considering the average time between complication onset and implant removal as well as the duration of antibiotic therapy used before implant removal.

Notably, no patients in our study had bacterial samples positive for a methicillin-resistant *Staphylococcus aureus* infection, in contrast to findings in countries such as the United States or South Korea, which may be explained by the lower prevalence of methicillin-resistant *Staphylococcus aureus* in Switzerland.[29,35,37] This regional difference not only affects the comparability of our study but also suggests the need for region-specific treatment protocols that consider the local microbial ecosystem. Furthermore, the identification of bacterial pathogens uncommon in the literature, such as *B. pumilus* and *C. pseudodiphtheriticum*, highlights the diversity of pathogens that can induce breast implant infections. Typical signs of breast implant infection are often seen in cases of common bacterial infections; however, when a less common bacterial infection is present, the

signs are usually much more subtle or may be entirely absent.[39] This highlights a potential gap in standardized guidelines, or the challenges created by the variability in clinical presentation.

Our study has considerable implications, particularly in the context of establishing or improving protocols for the management of breast implant infections. The absence of a standardized protocol highlights the need for an adaptation of antibiotic intervention and the development of more rigorous follow-up care. As an initial protocol, we could suggest performing blood tests, US-guided aspiration with culture of the fluid, and closer therapeutic management as soon as signs of inflammation appear. Punctures were only performed when there was a strong suspicion of infection, which may have potentially changed the result in terms of implant retention.

Our study has some limitations. First, the small sample size prevented multivariate analysis, which restricts the ability to adjust for potential confounding factors.

Second, a major limitation of this study is its temporal scope; only patients treated after October 2020 were included due to the introduction of a new surgical team, limiting historical comparative analysis. Furthermore, there was a variability in practices within the group; surgeons involved in our study used slightly different surgical techniques, such as draping techniques, sterility measures, irrigation of the implant and pocket, and suturing techniques. There were also variations in implant volumes and in postoperative antibiotic regimens with a duration of antibiotic therapy varying significantly from 2 to 29 days, potentially influencing the outcomes and limiting comparison. Initial breast size and ptosis were not considered, adding to the variability.

CONCLUSIONS

The present study sheds light on the complex dynamics of managing infections and the critical factors influencing the decision to salvage or remove an implant with a specific focus on prepectoral IBBR. In our series, the presence of a positive bacterial culture was always associated with the need for implant removal. Conversely, in patients presenting with noninfected seromas, the implants were consistently salvageable. The observed complication rate is relatively high in prepectoral breast implant reconstruction. There is an urgent need for enhanced management protocols, including closer monitoring and a standardized approach to early intervention, given the often-borderline nature of postoperative symptoms. Our findings provide a foundation for future research, requiring larger-scale studies to refine and validate the proposed management strategies, thereby enhancing treatment of breast implant infections.

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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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