Salvage of Infected Prosthetic Breast Reconstructions

Amy S. Xue, MD¹ Katarzyna E. Kania, MPH¹ Rodger H. Brown, MD¹ Jamal M. Bullocks, MD¹
 Larry H. Hollier, Jr., MD, FACS¹ Shayan A. Izaddoost, MD, PhD¹

¹ Division of Plastic and Reconstructive Surgery, Baylor College of Medicine, Houston, Texas

Address for correspondence Shayan A. Izaddoost, MD, PhD, Department of Surgery, Baylor College of Medicine, 1977 Butler Blvd., Suite E6.100, Houston, TX 77030 (e-mail: shayani@bcm.edu).

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Abstract

Keywords

- ▶ infected prosthetic breast reconstruction
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Periprosthetic infection is a major complication in breast reconstruction, leading to implant loss and delayed and sometimes abandoned reconstruction. Traditional management of persistent infections requires explantation followed by secondary reconstruction after 6 months of delay. Although effective in treating the infection, this approach often leads to distortion and/or loss of tissue envelope, making secondary reconstruction very difficult. As a result, there is significant interest in salvaging infected prosthetic breast reconstructions. Recent studies reported variable success through systemic antibiotic therapy and surgical interventions. The aim of this article is to review the management of periprosthetic infection and to provide a potential salvage algorithm.

One- or two-stage implant-based breast reconstruction accounts for more than 80% of all breast reconstructions in the United States.¹ Prosthetic breast reconstruction has been associated with high complication rates, including peri-implant infection, skin and nipple necrosis, device exposure, and capsular contracture. The reported rates of infection range from 1% to 35.4% for expander-implant reconstruction.^{2,3} Risk factors include age > 50 years, high body mass index (>30), and radiation therapy after reconstruction.^{3–5} In addition, smoking, irradiation, chemotherapy, and mastectomy skin necrosis are predictive factors for developing pocket infection.⁶

The traditional management of persistent severe peri-implant infections, defined as those refractory to intravenous (IV) antibiotics and percutaneous drainage, has been explantation with subsequent secondary reconstruction after a sufficient 6-month delay for resolution of the inflammatory process. Although successful in treating the infection, this approach often leads to adverse consequences, including scarring, capsular contracture, distortion of the breast tissue envelope, and poor aesthetic outcomes.^{6,7} Moreover, rates of

abandoned reconstructive efforts after immediate explantation due to implant infection range from 58% to 67%. Expectedly, the psychological implications can be significant and detrimental.^{2,3,8}

History of Device Salvage in Periprosthetic Infections

In 1965, Perras first reported successful implant salvage for infections after primary augmentation mammoplasty using antibiotic lavage.⁹ Courtiss et al relied on systemic antibiotic therapy and passive wound drainage, reporting salvage rates of 44.8% and 50% for breast augmentation and breast reconstruction patients, respectively.¹⁰ Toranto and Malow utilized antibiotic lavage with systemic antibiotic therapy, pocket curettage, and device exchange.¹¹ In addition, capsulotomy, local flap reinforcement, and postoperative closed-system irrigation were performed; the salvage rate was reportedly 62.5%.¹² In addition to reducing the need for explantation, one-stage implant salvage decreases the length of hospital stays, number of operative procedures, and time

Table 1 Traditional approach to periprosthetic infection

	Infection	Exposure	Treatment
Group 1	Minor	--	Antibiotics alone
Group 2	Severe	--	If infection improves with antibiotic treatment, proceed with salvage; if no improvement, explantation.
Group 3	--	Threatened	Tissue coverage local or distant as applicable or explantation
Group 4	Minor	Threatened	Antibiotic + salvage + tissue coverage, local or distant as applicable
Group 5	Severe	Threatened	If infection improves with antibiotics, proceed as in Group 4. If no improvement, explantation
Group 6	Minor	++	Antibiotic + salvage + tissue coverage. local or distant as applicable or explantation
Group 7	Severe	++	Antibiotic + explantation

Source: Adopted from Spear SL et al. The infected or exposed breast implant: management and treatment strategies. *Plast Reconstr Surg* 2004;113:1634.

to improved aesthetic appearance.¹³ In a large study of 1,952 implant-based reconstructions, the incidence of periprosthetic infections was 5.1%. In 18% of cases, implant salvage was attempted using immediate device exchange and IV antibiotics, resulting in a 37.3% success rate for clearance of infection. Other studies have demonstrated an implant salvage rate ranging from 45% to 76.7% using varying techniques.^{2,14–17}

Microbiology of Periprosthetic Breast Infections

The most commonly isolated organisms are *Staphylococcus aureus*, coagulase-negative staphylococcus, or *Staphylococcus*

epidermidis.^{6,14,16} Of note, the absence of bacterial growth on culture does not impact the likelihood of device salvage.^{6,15} In several studies, methicillin-resistant *S. aureus* has been universally associated with breast implant infections and poor salvage outcomes.^{6,15,18,19} Failed device salvage is additionally associated with the presence of *S. epidermidis* and a significantly higher degree of atypical pathogens, such as gram-negative rods, methicillin-resistant *S. aureus*, and *Candida parapsilosis*.^{14,15} For this reason, Spear et al do not routinely offer device salvage in the presence of these organisms. Interestingly, a higher prevalence of gram-negative rod infections, most commonly *Pseudomonas aeruginosa*, was isolated in our previous study. We found that these atypical organisms can be cleared by sterilization of the prosthetic

Fig. 1 Severe periprosthetic infection salvage algorithm. (Modified from Albright SB et al. Pilot study: one-step salvage of infected prosthetic breast reconstruction using antibiotic-impregnated polymethylmethacrylate plates and concurrent tissue expander exchange. *Ann Plast Surg* 2015 [Epub ahead of print].)

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pocket with antibiotic-impregnated plates or beads, enabling the direct delivery of high bactericidal levels to biofilm-producing organisms.⁷

Biofilm formation has implications on the adverse outcomes associated with periprosthetic breast infections. Using a porcine model, Tamboto et al have demonstrated a link between inoculation with biofilm-producing *S. epidermidis* and development of capsular contracture.²⁰ In a similar model, Jacombs et al have demonstrated that the use of an antibiotic-impregnated mesh can reduce bacterial access to breast implants during surgical insertion. This technique may serve as a protective mechanism against subclinical infection, biofilm formation, and capsular contracture.²¹

Traditional Approach to Implant Salvage

In 2004, Spear et al presented an implant salvage algorithm that has become a gold standard for managing breast periprosthetic infections.²² Seven categories of infections were classified, based upon severity of infection and degree of implant exposure ranging from Group 1 (minor infection, no risk for exposure), managed with antibiotics only, to Group 7 (severe infection, actual implant exposure), managed with explantation with or without delayed reconstruction (► **Table 1**). Implant salvage was attempted only in patients with minor infections upon presentation or those patients with severe infections that improved or downstaged to minor infections with antibiotics. Minor infection was defined clinically by warmth, swelling, or cellulitis without drainage that was responsive to antibiotic treatment. Salvage technique included capsulectomy or pocket curettage, pulse lavage, device replacement, and closure (primary or tissue transfer depending on degree of implant exposure). The reported salvage success rate was 95%.

Approach to Severe Periprosthetic Infection

Spear et al²² previously defined severe infection by persistent edema despite antibiotics, purulent drainage with or without cellulitis, aggressive or atypical organisms on culture (*Pseudomonas*, mycobacteria, or gram-negative rods), or evidence of systemic infection. In this 2004 series, if infection severity could have been downgraded, salvage based on their algorithm was attempted; those patients whose infections did not downgrade underwent device removal.

In 2015, Albright et al⁷ presented a pilot study specifically evaluating implant salvage in severe periprosthetic infections using antibiotic-eluting polymethylmethacrylate (PMMA) plates and implant exchange. Severe infection in this series was defined as infections that failed to improve with antibiotics, and required drainage by interventional radiology (if applicable). Salvage success rate was 100%. (See ► **Fig. 1** for a treatment algorithm.)

The salvage technique included surgical debridement of the implant pocket, and removal of any acellular dermal matrix material. Pocket lavage with 50,000 U of bacitracin in 3 L of lactated ringer was performed. During the initial debridement and irrigation, each prosthetic device, whether

a tissue expander or a permanent implant, was replaced with a new tissue expander, after a thorough soak in triple antibiotic solution (1-g vancomycin, 50,000-U bacitracin, and 80-mg gentamicin).

The antibiotic plates were created with one package of PMMA, which includes 1 g of tobramycin (Simplex P with tobramycin; Stryker), an additional 1.2 g of tobramycin (X-GEN Pharmaceuticals), and 4 g of vancomycin hydrochloric acid (Pfizer, Inc.), for a total of 2.2 g of tobramycin and 4 g of vancomycin. Each antibiotic plate measured 0.2 cm to 0.5 cm in thickness, and was contoured to the chest wall, then allowed to solidify on the operating room table. Each plate was crosshatched to maximize the surface area for antibiotic elution (► **Fig. 2**). The PMMA plate was then placed at the base of the pocket between the chest wall and a tabbed tissue expander, which was secured into place with 2-0 PDS (polydioxanone; Ethicon) suture. Alternatively, antibiotic beads can be placed above the tissue expander. Beads are not the preferred method; They are linked to an increased risk of pressure necrosis.⁷ Prior to closure, one or two closed-suction drains were placed in the pocket to allow for serial drain fluid cultures.

Fig. 2 Protocol for antibiotic plate creation. PMMA, polymethylmethacrylate plates.

Fig. 3 A 70-year-old woman with diabetes was treated with an antibiotic plate for a left breast infection. (A) Preoperative. (B) Patient fully expanded after debridement of left breast and antibiotic bead and tissue expander exchange. (C) Patient after tissue expander to implant exchange.

For the duration of the hospital admission, patients remained on broad-spectrum IV antibiotics, which were tailored and transitioned to oral formulations once the culture results were available and clinical improvement was seen, respectively. Drain fluid cultures were ordered weekly, beginning approximately 1 week after initial washout and debridement. After two consecutive negative fluid cultures, patients underwent removal of the antibiotic plate or beads and subsequent implant exchange. The drains were removed once sterility of the implant pocket was assured and output decreased to below 30 mL daily for 48 continuous hours. Tissue expansion typically began 2 to 3 weeks postoperatively. Finally, the exchange to permanent silicone gel-filled implants was performed once two consecutive negative cultures were obtained and desired tissue expansion was reached (► **Fig. 3**). Of note, patients with large areas of skin flap necrosis, or those waiting to initiate postmastectomy radiation or chemotherapy treatments were not included in this series, and underwent explantation of implant followed by delayed reconstruction.

Use of Antibiotic-Impregnated Delivery Devices

In 1970, antibiotic-impregnated PMMA beads were first used in orthopedic surgery for deep infection following total hip arthroplasty.²³ Shaped as beads or plates, these delivery devices create high bactericidal antibiotic concentrations directly at the site of infection, while minimizing systemic adverse effects from parenteral administration. Both in vitro and in vivo studies have shown that these methods reduce local bacterial counts, and are effective in sterilizing or eradicating local infection.^{24–29} Similar methods using PMMA beads have been used for additional orthopedic, vascular, and cardiothoracic surgery.^{24,30–37} Sterilization rates in the literature range from 60% to 100% with infection recurrence rates between 0 to 20%.^{7,24,30,31,35} More recently, the use of antibiotic-impregnated PMMA beads in left ventricular assist device infections has resulted in a salvage rate of 65.4% with a recurrence rate of 17.6%.³²

Albright et al⁷ reported a breast pocket vancomycin level up to 335 µg/mL on postoperative day 1, and 2.4 µg/mL on postoperative day 48. Serum levels from parenteral treatment ranged from 0.8 µg/mL to 28 µg/mL. A serum vanco-

mycin level of 80 µg/mL to 100 µg/mL is associated with nephrotoxicity and ototoxicity. In this situation, local delivery allows for direct and targeted therapy, while avoiding toxicities. Nevertheless, similar safeguards should be taken with antibiotic-containing implants as one would with systemic antibiotics. Drug-drug interactions and effect on renal function remain important considerations. Although adverse effects appear to be rare, delayed hypersensitivity and nephrotoxicity have been observed in antibiotic-laden bone cement studies.^{38–40}

Conclusion

Historically, explantation and delayed secondary reconstruction have been the primary approach for the treatment of periprosthetic breast infections. Though effective, this traditional method has led to poor outcomes, including scarring, capsular contracture, distortion of the breast tissue envelope, and suboptimal aesthetic appearance. Moreover, it causes patients significant undue psychological stress by increasing the time to an improved aesthetic appearance.

Although several implant salvage techniques have been utilized with varying rates of success, our salvage algorithm, consisting of surgical washout and debridement, device exchange, and antibiotic-impregnated PMMA plates/beads placement, has proven to be an effective, safe, and reliable alternative method for implant salvage without explantation.

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