Aesth Plast Surg (2019) 43:905–909
https://doi.org/10.1007/s00266-019-01369-7

ORIGINAL ARTICLE BREAST SURGERY

Surgeons' Dilemma: Treatment of Implant-Associated Infection in the Cosmetic Breast Augmentation Patient

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Received: 9 February 2019 / Accepted: 18 March 2019 / Published online: 3 July 2019

Abstract

Background Augmentation mammaplasty is the most common plastic surgical procedure performed in the USA. The management of severe implant-associated infection is a challenge, and the traditional two-stage treatment is associated with significant limitations. The aim of this literature review is to provide a comprehensive analysis of all studies dealing with the management of severe infection or implant exposure following cosmetic breast augmentation.

Methods The PubMed and Cochrane databases were searched through February 2018 for studies on the management of severe infection and threatened or actual implant exposure following primary augmentation mammaplasty. Search terms used were "breast implant," "breast prosthesis," "breast augmentation," "breast augmentation complications," "infected implant," "implant salvage" and "implant exposure."

Results Five articles met inclusion criteria. There was inconsistency in the reporting of several key factors, such as the antibiotic regimens employed, culture sensitivities, time from diagnosis to treatment, implant characteristics, as well as the precise treatment of the capsule and pocket. A total of 58 implants were treated, of which 37 (63.8%) were exposed in the setting of infection and 21 (36.2%) were infected without exposure. One-stage implant salvage was employed in 31 implants and was successful in all. The capsular contracture rate with this approach was 6.5%. Antibiotic-alone, non-operative treatment was employed in the salvage of 22 implants, with success and capsular contracture rates of 77.3 and 13.6%, respectively. In the setting of severe periprosthetic infection in the absence of implant exposure, antibiotic-alone treatment was successful in the salvage of 13 out of 14 implants (92.9%).

Conclusions The inconsistency and paucity of the data in the literature preclude definitive conclusions with regard to the optimal management of the threatened implant following augmentation mammaplasty. Given the excellent salvage rates in this setting, a more prominent role and liberal utilization of implant salvage are proposed.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Breast augmentation · Implant salvage · Implant-associated infection · Literature review

Introduction

Augmentation mammaplasty remains the most common aesthetic plastic surgical procedure performed in the USA. In 2017, it was reported that 300,378 breast augmentation surgeries were performed, compared to 212,500 in 2000, a 41% increase during this period [1]. Postoperative infection is among the most common complications following augmentation mammaplasty with the incidence ranging from 0.1 to 2.7% [2–7].

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There is no consensus as to the best approach for the management of severe, deep tissue implant-associated infections, with or without implant exposure in the setting of cosmetic augmentation mammaplasty. Traditionally, common practice has been explanted followed by placement of new implants at a later stage although, as a general concept, this approach might result in lesser aesthetic outcomes and potentially lower patient satisfaction. In addition, the two-stage procedure will potentially have a significant financial and psychological effect on the patient.

Therefore, implant salvage, either through aggressive non-operative management with antibiotics or through one-stage implant exchange, constitutes an attractive alternative. However, in cases of deep, periprosthetic infections following cosmetic augmentation mammaplasty, antibiotic therapy alone is an unfavorable modality that for a long time has been associated with high capsular contracture rates [7, 8]. Similarly, no study to date has adequately examined the outcomes of one-stage implant salvage, despite reports of this technique dating back to the 1960s [9, 10].

Through this literature review, we aim to provide a comprehensive analysis of all studies dealing with the management of severe infection or implant exposure following cosmetic breast augmentation. We hypothesize that there is a significant paucity of data on the management of severe infections and threatened or actual implant exposure following primary augmentation mammaplasty. In addition, we hypothesize that one-stage implant salvage and non-operative (antibiotic-alone) treatment are underutilized in the management of these complications.

Methods

A comprehensive review of the literature was performed of articles published from January 1960 to February 2018 (Fig. 1). Articles were identified using the PubMed and Cochrane databases. The search strategy used the following procedure-related MeSH terms: "mammoplasty," "breast implants," "breast diseases/surgery" and "prosthesis-related infections." Search terms used were "breast implant," "breast prosthesis," "breast augmentation," "breast augmentation complications," "infected implant," "implant salvage" and "implant exposure."

Inclusion criteria were studies reporting prospective results, retrospective data and case series. Studies were excluded if they were non-human laboratory trials. Only studies of implant placement in the setting of cosmetic breast augmentation were included. Studies of non-implant breast augmentation as well as studies that included patients with implant-based post-mastectomy reconstruction or that did not describe the management of the complications in question were excluded.

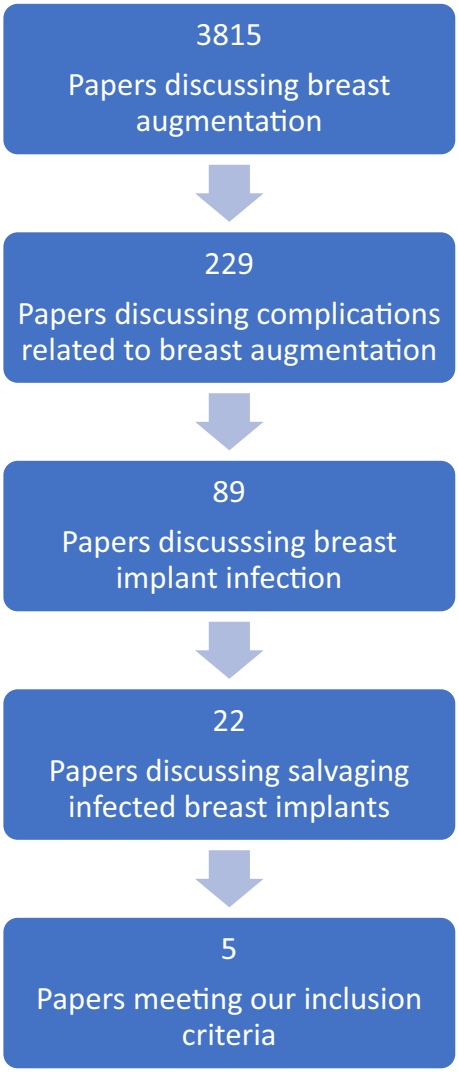

Fig. 1 Overview of the article selection process

Articles selected were carefully assessed for content and data related to the management of severe infection and threatened or actual implant exposure following primary augmentation mammaplasty. Implant salvage was defined as the sustained presence of the implant after surgical intervention or completion of the antibiotic regimen for at least 1 year. Each selected article's reference listing was examined to identify additional articles, which were further similarly assessed for content.

Results

A search using the aforementioned methodology revealed 5 articles (Table 1). All dealt with the management of implant-associated infections, implant exposure or both

Table 1 Summary of studies

References	Study type	Implant characteristics	Treatment approaches	Follow-up	No. of implants treated[a]
Weber and Hentz [16]	Retrospective review	Silicone gel	One-stage implant salvage	> 6 years	11
Fodor et al. [17]	Prospective cohort	Textured silicone gel	Antibiotics only	2 years	8
Basile et al. [18]	Prospective cohort	Textured silicone gel	Antibiotics only	> 2 years	10
			One-stage implant salvage		
			Two-stage implant exchange[b]		
Khan [14][c]	Retrospective review	Silicone gel (98.8% were textured)	Antibiotics only	> 1 year	15
			One-stage implant salvage		
			Two-stage implant exchange[d]		
Sforza et al. [13]	Retrospective review	Textured cohesive gel	One-stage implant salvage	3–6 years	17

[a]Mild, superficial infections were excluded

[b]Four- to six-month interval

[c]One patient (two implants) was excluded as she opted to not proceed with reimplantation following implant removal

[d]Six-month interval

Table 2 Summary of events

Total events	Infection and exposure (%)	Infection, no exposure (%)
58	37 (63.8)	21 (36.2)

following cosmetic augmentation mammaplasty. Table 2 summarizes the events leading to implant compromise. A total of 40 implant exposures were reported, of which an infection was identified as the inciting factor or cultures were positive in 37 (92.5%). The three exposed implants without clinical signs or microbiologic evidence of infection were excluded from the study. Twenty-one implants were infected without exposure.

Three of the five studies reported infection rates. In these, a total of 9814 implants were analyzed, 44 of which were complicated by infections that were characterized as moderate, severe, deep or periprosthetic by the respective authors—corresponding to an incidence rate of 0.45%. All five studies reported microbiologic results; 84.5% of infected breasts yielded positive bacterial cultures (Table 3). The most prevalent organism identified was *Staphylococcus (S.) aureus* (56.8%). Details of culture sensitivities, onset of infection and time to treatment were not consistently reported. The authors of the studies did not address the etiology of the lack of bacterial growth in cultures obtained in cases of clinical infection.

Tables 4 and 5 summarize the outcomes of the studies. One-stage implant salvage had a 100% success rate. Bilateral capsular contracture requiring capsulotomies occurred in one patient (6.5%). In every case of one-stage implant salvage in the setting of infection, systemic antibiotics were an integral part of the surgical and post-operative protocol and varied among the studies.

Table 3 Organisms in periprosthetic infections after augmentation mammaplasty

Culture	Incidence (%)
Staphylococcus aureus (including MRSA)	33 (56.8)
Staphylococcus epidermidis	7 (12.1)
Enterobacter species	5 (8.6)
Pseudomonas aeruginosa	1 (1.7)
Lactose fermenting coliform	1 (1.7)
Acinetobacter lwoffi	1 (1.7)
Negative cultures[a]	9 (15.5)
Mixed flora	3 (5.2)
Total implants cultured	58

[a]Following antibiotic administration

Non-operative antibiotic therapy was employed to salvage 22 implants with a 77.3% success rate. The incidence of capsular contracture in these patients was 13.6%. Of the 22 implants, 8 were exposed in the setting of periprosthetic infection, and despite aggressive wound care the salvage rate was 50%. All of the remaining 14 patients demonstrated signs of moderate or severe infection without exposure, and salvage was successful in 13 implants (92.9%). In the one failed instance, the patient required reimplantation 6 months later and subsequently developed Baker 4 capsular contracture.

Table 4 Summary of outcomes

Treatment modality	Number of implants treated	Implant salvage rate (%)	Capsular contracture rate (%)
One-stage implant salvage	31	31/31 (100)	2 (6.5)
Antibiotics alone	22	17/22 (77.3)	3 (13.6)
Two-stage implant exchange	5	–	1 (16.7)

Table 5 Event-based outcomes summary of salvage procedures

Event	Treatment approach			
	One-stage implant salvage		Antibiotics alone	
	No. of implants	Salvage rate (%)	No. of implants	Salvage rate (%)
Exposure and infection	25	25/25 (100)	8	4/8 (50.0)
Infection, no exposure	6	6/6 (100)	14	13/14 (92.9)

In the patients who underwent two-stage implant exchange, 4 implants were exposed in the setting of a periprosthetic infection and 1 implant was infected but not exposed. The latter patient suffered Baker 4 capsular contracture within 6 months and underwent capsulotomies and change of the implant.

Discussion

Severe infections and implant exposure in cosmetic augmentation mammaplasty constitute very challenging complications that can lead to prolonged sequelae and treatment as well as compromising the aesthetic outcome of the procedure. In addition, depending on the setting, these complications are associated with significant financial cost, often burdening both the patient and the surgeon [6].

This review highlights the relative paucity of data on the management of implant-associated infections and threatened or actual implant exposure following primary augmentation mammaplasty. The studies offer incomplete reporting of several key factors, such as the antibiotic regimens employed, culture sensitivities, time from diagnosis to treatment, detailed implant characteristics. In addition, the lack of standardization of the technique and approach among the studies prevents any meaningful conclusions with regard to differences in capsular contracture rates. These details are essential in drawing definitive conclusions with regard to the optimal management of the threatened implant following augmentation mammaplasty, and there is a need for prospective studies with standardized salvage technique and protocol.

There is also lack of consistent definition and stratification of implant-associated infection and threatened implant exposure in the literature [11]. Accurate stratification and appreciation of the degree of infection as well as assessment of the response to the initial antibiotic therapy would provide key guidance to promptly control the infectious process and maximize the opportunity for successful salvage of the implant [7, 12]. In this review, following the exclusion of mild and superficial tissue infections, the incidence of implant-associated infection was found to be 0.45%. In the literature reviewed, the terminology is not clear in distinguishing mild from severe or superficial from deep infections. However, generally mild superficial tissue infections are used to describe incision site cellulitis with no drainage or evidence of dehiscence. On the other hand, severe or deep tissue infections are defined by purulent drainage and wound dehiscence with or without implant exposure.

Non-operative, antibiotic-based therapy in the absence of implant exposure showed salvage rates of 92.9%. In the presence of implant exposure, salvage rates with antibiotics alone dropped to 50%. A prompt operative approach in the presence of implant exposure is thus recommended.

One-stage implant salvage following cosmetic augmentation mammaplasty is not recommend in cases of prolonged infection (over 48 h) and those demonstrating features of severe deep tissue infection, defined by the purulent drainage with implant exposure [13, 14]. This is challenged here as a salvage rate of 100% was found with one-stage implant exchange or replacement. This is strikingly different from experiences with implant-based breast reconstruction. More specific, Spear and Seruya [7], and Reish et al. [15] reported salvage rates of the severely infected or exposed implant with intravenous antibiotics and implant exchange of 30.8% and 37.3%, respectively. Although the superiority of one-stage management against the traditional two-stage treatment of the infected or

exposed implant cannot be assessed here, a more prominent role of one-stage implant salvage as well as its liberal utilization in severe infections and prolonged implant exposure in the setting of cosmetic breast augmentation is worth considering.

We acknowledge the limitations of this systematic review, such as the lack of standardization of the studies and the variability of the data. Our results were restricted by the lack of strength of the available data and small patient population. Inter-study comparisons were not possible. On the other hand, this is the first study to examine the literature on the management and salvage of the infected or exposed implant in cosmetic breast augmentation.

Conclusions

This review highlights the paucity of data on a topic that has not been well investigated in the literature, and a trend toward implant salvage being the procedure of choice is not yet observed or advocated. Nonetheless, given the excellent outcomes reported in these studies, a more prominent role and liberal utilization of implant salvage are proposed to avoid the morbidity and cost associated with the traditional two-stage approach. Future studies should offer a standardized technique and approach toward salvage, including details with regard to the antibiotic regimens employed, culture sensitivities, time from diagnosis to treatment, detailed implant characteristics, as well as the precise treatment of the capsule and pocket.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest to disclose. None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this manuscript.

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent For this type of study informed consent is not required.

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