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IDEAS AND INNOVATIONS

Breast

Subareolar Sealant Reduces Minor Complications and Surgery for Necrosis in Prosthetic Reconstruction after Nipple-sparing Mastectomy

Elizabeth E. Bushong, BA*
Nicholas Wesely, MD*
Cuyler Huffman, MS‡
Ewa D. Komorowska-Timek, MD†

Summary: Nipple-sparing mastectomy (NSM) is aesthetically superior to skin-sparing only mastectomy or reconstructed nipples. However, nipple-sparing mastectomy partially preserves nipple ducts, which are remaining communications between the environment and breast pocket that can potentially allow bacteria transfer and compromise the prosthesis. Previous methods to create a subareolar "barrier" to reduce through-duct bacteria penetration involve subpectoral implant placement, adjunct meshes or acellular dermal matrix, and external nipple adhesives. To further protect the implant from nipple-derived contamination, we propose subareolar sealant (SAS). SAS involves the application of a synthetic sealant on the nipple undersurface before implant placement. In our study, we analyzed 77 breasts that received prepectoral prosthetic breast reconstruction. SAS was used in 70 of 77 breasts. All breasts received adjunctive acellular dermal matrix. Comparing SAS versus no-SAS, we found that no-SAS was associated with 10.4-fold more infections ($P = 0.032$) and 17.3-fold more re-hospitalizations ($P = 0.017$). No-SAS also resulted in more "at least one major complication" ($P < 0.001$), capsular contracture ($P < 0.001$), and necrosis requiring surgery ($P < 0.001$). Due to the small no-SAS sample size, goodness-of-fit (Quasi-likelihood independence model) criteria was applied, and a post hoc power analysis was calculated. Erythema, all minor complications, dehiscence, and necrosis requiring surgery remained significant (all $P < 0.0001$). This innovative technique markedly reduces overall minor complications and necrosis requiring surgery. A larger no-SAS sample size is required to adequately determine whether SAS reduces infection and hospitalization rates. Nonetheless, SAS reduces complications and is cost effective compared with other adjunct materials. *(Plast Reconstr Surg Glob Open 2024; 12:e5820; doi: 10.1097/GOX.0000000000005820; Published online 7 August 2024.)*

INTRODUCTION

Nipple-sparing mastectomy (NSM) is aesthetically superior but poses an increased risk of potential implant contamination through the remaining severed nipple ducts.[1] Methods to reduce infection internally may involve the use of vascularized tissue "barriers," such as subpectoral implant placement. One could resort to a nonautologous biologic such as acellular dermal matrix (ADM) or mesh; however, ADM is costly ($16/cm² to $30/cm²).[2,3] External "barrier" strategies to inhibit skin flora penetration include "no touch technique" and temporary nipple adhesives.[4,5]

To further isolate the implant from nipple-derived contamination, we propose subareolar sealant (SAS). SAS involves the application of a synthetic sealant on the nipple undersurface before implant placement.

METHODS

All patients who underwent immediate prepectoral breast reconstruction after NSM between April 2013 and

*From *Corewell Health/Michigan State University, Integrated Plastic Surgery Residency, Grand Rapids, Mich.; †Corewell Health, Scholarly Activity and Scientific Support Team, Grand Rapids, Mich.; and ‡Advanced Plastic Surgery, Grand Rapids, Mich.*

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January 2021 were included. This study was approved by the institutional review board.

Surgical Technique

The breast surgeon established oncological NSM candidacy. All nipples were cored out, and tissue containing the milk ducts was pathologically analyzed and found to be negative for atypia or cancer.

Breasts receive a J-incision starting below the NAC and carried down and out toward the inframammary fold. After nipples are cored, the duct area is everted to visualize the ducts (Fig. 1A). A thin layer of sealant paints the undersurface (Fig. 1B). The painted area is oversewn, so only nonpainted tissue faces the implant (Fig. 1C).

Synthetic sealants used were LiquiBand BUTYL (LiquiBand; Cardinal HealthTM, Plymouth, United Kingdom), Dermabond (Dermabond, Ethicon Inc., Cornelia, Ga.), DermaFlex (DermaFlex; Chemence Medical Product, Inc., Alpharetta, Ga.), and SwiftSet (SwiftSet; Medtronic USA, Plymouth, United Kingdom).

All breasts received ADM (AlloDerm; Allergan, Dublin, Ireland) (FlexHD; Musculoskeletal Transplant Foundation, Edison, N.J.) anchored to the undersurface of the mastectomy flap covering the nipple undersurface and incision line. Implants were permanent implants (DTI) or tissue expanders (Mentor; Mentor Worldwide LLC, Irvine, Calif.).

Data Collection and Analysis

Patient demographics and outcomes were collected (Table 1). Smoking status was defined as never, former (quit >2 months prior surgery), or current (smoking <2 months prior). All complications were measured within 30 days, except capsular contracture.

A generalized estimating equation (GEE) ran a logistic regression model, accounting for repeating patient sides (left and right breasts). Quasi-likelihood independence model criterion (QIC), QICu, and p-hoc power analysis were calculated. A *P* value of less than 0.05 defined significance. All analyses were completed using Statistical Analysis System 9.4.

Takeaways

Question: Does the application of subareolar sealant (SAS) beneath spared nipples after mastectomy protect the implant from nipple-derived contamination?

Findings: Retrospective analysis of 77 breasts that received prepectoral prosthetic breast reconstruction. SAS was used in 70 of 77 breasts. No-SAS was associated with more minor complications ($P < 0.0001$) and surgery for necrosis ($P < 0.0001$).

Meaning: This innovative technique markedly reduces postoperative minor complications and surgery for necrosis rates.

RESULTS

SAS was applied in 70 of 77 breasts (Table 1). The sealants most frequently used were LiquiBand BUTYL (60%), Dermabond (21.4%), and SwiftSet (12.9%).

Overall, the mean patient age was 49 ± 12 years with a body mass index of 27.3 ± 4.5 (both, P = NS). There were no significant differences in prior chemotherapy and radiation, smoking status, or length of follow-up duration. SAS patients exhibited more diabetes (5% versus 0%, $P < 0.0001$) and hypertension (32.5% versus 0%, $P = 0.0249$).

Complications: GEE Analysis

Minor complications were markedly greater in the no-SAS cohort (100% versus 74.3%, $P < 0.0001$). No-SAS exhibited 10.4-fold more infections (57.1% versus 11.4%, $P = 0.032$) and 17.3-fold more postoperative re-hospitalizations (57.1% versus 7.1%, $P = 0.018$). Capsular contracture also occurred more in no-SAS breasts (57.1% versus 7.1%, $P = 0.033$) as did necrosis requiring surgical debridement (100% versus 68%, $P < 0.001$). No-SAS was associated with less dehiscence (7.1% versus 0%, $P < 0.001$).

Complications: GEE Analysis with Goodness of Fit Criteria

The outcomes that remained significant were at least one minor complication, erythema, dehiscence, and surgery for any necrosis type (all, $P < 0.0001$). A post hoc power analysis demonstrated a range of ideal sample sizes.

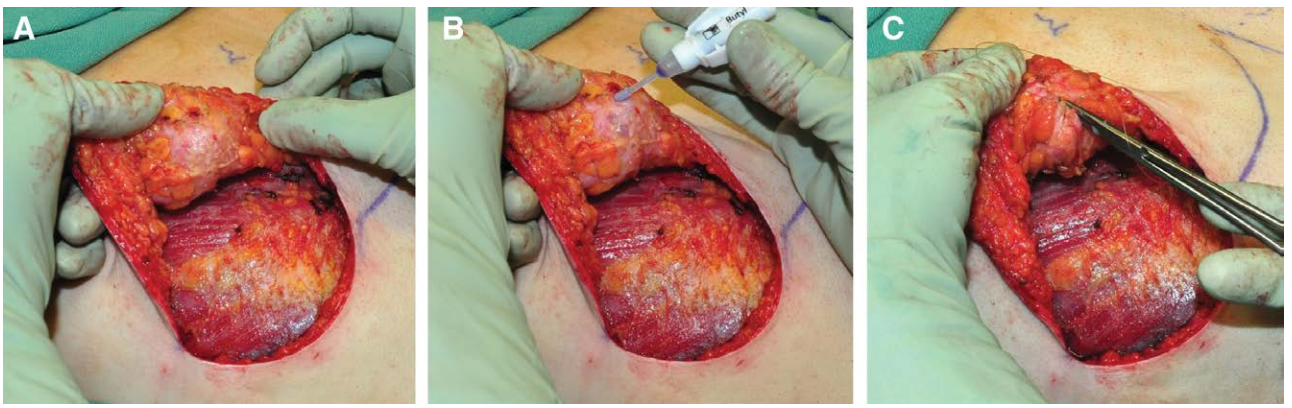

Fig. 1. SAS technique. A, Assessment of subareolar area and severed nipple ducts. B, Application of synthetic sealant beneath areola. C, Oversewing of nipple ducts to ensure only tissue without glue faces the implant.

Table 1. No-SAS versus SAS

No-SAS versus SAS										
Demographics	**Overall (*N* = 44 Patients), n (%)**			**No-SAS (*N* = 4 Patients), n (%)**			**SAS (*N* = 40 Patients), n (%)**			***P***
Age (Mean ± SD)	49 ± 12			42.3 ± 9.5			49.8 ± 12			0.530
BMI (kg/m^2)	27.3 ± 4.5			24.4 ± 3.1			27.5 ± 4.5			0.543
Prior radiation	4 (9.1%)			1 (14.3%)			3 (7.5%)			0.089
Prior chemotherapy	6 (13.6%)			1 (14.3%)			5 (12.5%)			0.132
Diabetes	2 (4.5%)			0 (0%)			2 (5%)			**<0.0001**
Hypertension	13 (29.5%)			0 (0%)			13 (32.5%)			**0.0249**
Smoking										
Never	28 (63.6%)			2 (50%)			26 (65%)			
Former	11 (25%)			1 (25%)			10 (25%)			0.249
Current	5 (11.4%)			1 (25%)			4 (10%)			
Follow-up (d)	734 ± 495 d			1526 ± 606 d			655 ± 416 d			0.0521
Complications	**No-SAS**	**SAS**	**Estimate**	**GEE Model**						**Post-GEE Fit Criteria**
	N = 7 Breasts, n (%)	**N = 70 Breasts, n (%)**		**SE**	**95% Confidence Limits**		**Odds Ratio**	**Z**	**Pr >|Z|**	**QIC, QICu**	**Pr > Z**
≥1 Minor complication*	7 (100%)	52 (74.3%)	24.6	0.62	(23.3–25.8)		4.8×10^{10}	39.2	**<0.001**	83.2, 83.8	**<0.001**
≥1 Major complication†	6 (85.7%)	34 (48.6%)	1.85`	1.02	(−0.14 to 3.8)		6.4	1.82	0.07	106.5, 105.9	0.142
Capsular contracture	4 (57.1%)	10 (14.3%)	2.1	0.98	(0.16–4.0)		8.2	2.1	**0.03**	69.2, 68.1	0.147
Dehiscence	0 (0%)	5 (7.1%)	−24.2	0.74	(−25.7 to −22.7)		3.1×10^{-11}	−32.51	**<0.001**	38.7, 40.0	**<0.001**
Erythema	7 (100%)	25 (35.7%)	25.8	0.60	(24.7–27.0)		1.6×10^{11}	43.1	**<0.001**	94.3, 95.2	**<0.001**
Extra-antibiotics	6 (85.7%)	37 (52.9%)	1.67	1.2	(−0.67 to 4.0)		5.3	1.4	0.162	107.9, 105.8	0.316
Flap necrosis	4 (57.1%)	23 (32.9%)	1.00	1.07	(−1.1 to 3.1)		2.7	0.94	0.35	101.9, 99.4	0.809
Hospitalization	4 (57.1%)	5 (7.1%)	2.85	1.2	(0.5–5.2)		17.3	2.37	**0.017**	50.1, 46.7	0.121
Infection	4 (57.1%)	8 (11.4%)	2.34	1.1	(0.2–4.5)		10.4	2.15	**0.03**	62.1, 60.5	0.206
Loss of implant	4 (57.1%)	17 (24.3%)	1.42	1.08	(−0.7 to 3.6)		4.1	1.3	0.19	91.2, 88.3	0.572
Nipple necrosis	4 (57.1%)	19 (27.1%)	1.27	1.07	(−0.8 to 3.4)		3.5	1.19	0.24	95.0, 92.6	0.65
Seroma	2 (28.6%)	19 (27.1%)	0.07	1.21	(−2.3 to 2.4)		1.1	0.06	0.95	95.1, 92.6	0.65
Surgery for necrosis	4/4 (100%)	17/25 (68%)	24.7	0.88	(23.0–26.5)		5.3×10^{10}	28	**<0.001**	34.4, 35.3	**<0.001**
Surgery for any complication	4 (57.1%)	21 (30%)	1.14	1.07	(−0.9 to 3.2)		3.1	1.1	0.29	98.9, 96.3	0.73

Breasts with SAS were the reference points in the analysis. The parameter estimates were generated in relation to no-SAS. Odds ratios were calculated using parameter estimates.

*Minor complications include erythema, extra-antibiotics, flap necrosis, nipple necrosis, and seroma.

†Major complications include capsular contracture, dehiscence, hospitalization, infection, loss of implant, surgery for necrosis, and surgery for any complication. *P* values in boldface denote significance. SE indicates standard error. GEE indicates general estimation equation, which is a logistic regression model that accounts for repeating sides per patient. Post-GEE fit criteria assessed the original GEE model outcomes after using QIC. QICu is a more simplified QIC that is then used to compare models with different mean specifications.

[**See table, Supplemental Digital Content 1,** which shows post hoc sample size calculation. Source: Sealed Envelope Ltd. 2012. Power calculator for binary outcome superiority trial (online). Available at https://www.sealedenvelope.com/power/binary-superiority/ (Accessed March 3, 2024). **http://links.lww.com/PRSGO/D212.**]

DISCUSSION

Infection rates involving breast prostheses range from 1% to 35%.[6] Per a 2008 analysis, a likely underestimate for today's costs, infections from any type of breast surgery incur a cost of $4091 per patient in the United States.[6]

Milk ducts harbor a significant amount of *S. aureus, S. Epidermidis*, and other endogenous flora.[7] External skin barrier drapes can markedly reduce intra- and postoperative complications but are often removed immediately or within a few days.[4,5] Even with external adhesives, augmented breasts still have a bacterial contamination rate of 34.9%.[7]

Submuscular implants might prevent contamination but are associated with animation deformity and greater postoperative pain.[8] ADM can also provide a barrier but is costly and associated with seroma and implant loss.[2–4] We founded SAS out of the lack of options to prevent infection internally.

Synthetic and fibrin sealants were initially developed for surgical closures and hemostatic control.[9] "Plaster of Paris" was the earliest bone and tissue adhesive, which led to the development of synthetic glues. All glues investigated in this study were cyanoacrylate: adhesives invented in the 1980s to polymerize bonding between surfaces. Cyanoacrylate glues are inexpensive, bactericidal, and form strong adhesions.

Although our experience did not demonstrate any adverse reactions, externally applied synthetic sealants have been associated with contact dermatitis, allergic reactions, chronic inflammation, and necrosis.[8,10] Our study demonstrated *less* tissue necrosis with SAS. This might be due to oversewing the tissues with highly vascularized tissues to contain the sealant to the ductal area.

All minor complications, erythema, and necrosis requiring surgery were the only outcomes that remained significant after QIC/QICu application. The power analysis conducted post hoc demonstrated that sample sizes of at least 14 and 10 per group are required to adequately determine whether infection and hospitalization rates differ between groups. We are hopeful that a larger no-SAS cohort might unveil that SAS does reduce these complications.

We acknowledge that our findings demonstrate high rates of complications (Table 1). We have a low threshold for impending signs of seroma and necrosis, intervening for even superficial necrosis.

Limitations

This is a retrospective, observational study with a small no-SAS cohort. There was no comparison between with and without oversewing the nipple ducts. Larger sample sizes might unveil sealant allergic reactions.

CONCLUSIONS

Although SAS involves the off-label use of a skin sealant in deeper tissues, we determined that SAS is superior and inexpensive. Future studies without ADM and larger no-SAS cohorts are imperative to ascertain whether SAS also reduces infection and hospitalization rates.

Ewa D. Komorowska-Timek, MD
Advanced Plastic Surgery
3855 Burton St SE
Grand Rapids, MI 49546
E-mail: etimek@sbcglobal.net

DISCLOSURE

The authors have no financial interest to declare in relation to the contents of this article.

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