

Short- to Medium-term Outcome of Prepectoral versus Subpectoral Direct-to-implant Reconstruction using Acellular Dermal Matrix

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Background: Subpectoral implant reconstruction (SIR) is associated with animation deformity and increased postoperative pain. The aim of our study was to compare the short- to medium-term outcome of prepectoral implant reconstruction (PIR) and SIR with acellular dermal matrix.

Methods: A review of prospectively collected data of patients who underwent PIR and SIR using biological mesh by a single surgeon between Nov 2016 and Nov 2020 was done. Presentation, smoking history, BMI, bra size, radiology size, pathology data, mastectomy weight, implant volume, radiation treatment, and outcomes were analyzed. For intergroup comparisons, the data were analyzed using Pearson chi-square test and the Student *t*-test. *P* values of less than 0.05 were considered statistically significant.

Results: Eighty-two patients had 109 implant reconstructions (85 PIR and 24 SIR). Median follow-up was 27 months (4–53). Twenty-five of PIR and six of SIR were risk reduction surgeries. Two groups were comparable except for significantly higher percentage of node positive (13/18, 72% versus 20/60, 33%; *P* = 0.003), Her 2-positive disease (7/18, 39% versus 9/60, 15%; *P* = 0.027), and radiotherapy (15/24, 63% versus 21/85, 25%; *P* = 0.001) in SIR. There was no statistically significant difference between the two groups with regard to hematoma, wound infection, red reaction, seroma needing aspiration, wound necrosis, and implant loss. Significantly more patients in the prepectoral group had rippling needing fat grafting (*n* = 13, 15% versus 0; *P* = 0.041) and significantly more patients in the subpectoral group had fat grafting for contour deformity (*n* = 6, 25% versus *n* = 6, 7%; *P* = 0.025).

Conclusion: PIR is comparable to conventional SIR with regard to most of the complications. (*Plast Reconstr Surg Glob Open* 2021;9:e3747; doi: [10.1097/GOX.0000000000003747](https://doi.org/10.1097/GOX.0000000000003747); Published online 5 August 2021.)

INTRODUCTION

Acellular dermal matrix (ADM) has been used for implant reconstruction since 2001.¹ Conventionally, the ADM was used for dual plane reconstruction technique where pectoralis major partially covered the implants and the rest of the implant pocket was developed with ADM.^{2–4} In addition to tissue reinforcement, ADM also allows better pocket control, without the compressive effects of total submuscular coverage.^{1,5} ADM gives the

surgeon an opportunity to reconstruct the breast with an adequate volume implant in a single stage, thus reducing the need for expanders. However, animation deformity and increased postoperative pain (which has been significantly attributed to total submuscular implant reconstruction) remain a concern even with partial muscle cover.^{5–8} Subpectoral reconstruction involves raising the pectoralis major muscle and partially detaching it from the chest wall. There have also been reports of significant reductions in function and strength of pectoralis major muscle amongst patients with subpectoral implants.^{9–11}

Breast is a prepectoral structure, and subcutaneous placement of the implants in front of the muscle has been tried in the past. However, there have been reports of significant capsular contracture and high rates of implant extrusion.^{12–14} With the more recent availability of ADM mesh, prepectoral implant reconstruction can be performed with full coverage of the implant anteriorly, giving an additional layer to the mastectomy flap. Prepectoral

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implant reconstruction with ADM is a new technique compared with subpectoral ADM reconstruction, and their short- to medium-term outcome is compared in this study.

METHODS

The author reviewed prospectively collected data of consecutive patients having immediate direct-to-implant (DTI) reconstruction (prepectoral and subpectoral), using biological mesh, by a single surgeon between Nov 2016 and Nov 2020. All patients had a minimum of 3 months follow-up (until March 2021). Patient-specific variables included presentation (screening or symptomatic), smoking history, BMI and bra size, radiology size at initial diagnosis, pathology data including type (DCIS/invasive), grade, ER status, Her2 status, nodal status, and radiation treatment. Types of mastectomies (nipple sparing/nipple compromising), mastectomy weight, and implant volume were recorded.

The author performed both extirpative and reconstructive surgeries for all the patients. All patients were offered both reconstructions. However, patients predicted to have thin mastectomy flaps were warned regarding the likelihood of rippling with prepectoral reconstruction and the need for revision surgery on a later date. [Figure 1a](#) shows the preoperative picture of a woman with predicted thin mastectomy flap who had bilateral nipple sparing mastectomy (NSM) and prepectoral Braxon reconstruction. [Figure 1b](#) shows the postoperative picture after 5 months showing rippling especially on the left side. She subsequently had fat grafting, and [Figure 1c](#) shows the patient photograph 6 weeks after fat grafting.

Outcomes reviewed included hematoma, wound infection, red reaction, seroma needing aspiration, wound necrosis, and threatened wound needing revision and implant loss. Other outcomes included any delay in adjuvant treatment, revisional procedures such as fat grafting for rippling and contour deformities. Incidence of local recurrence, regional recurrence, and distant metastasis were also recorded.

Three types of biological mesh were used in subpectoral reconstruction (Strattice, Native, and Surgimend) and two types of biological mesh were used in prepectoral reconstruction (Braxon and Surgimend meshed). Except for Surgimend meshed, all the other products were nonmeshed. These biological products were from three different companies, and any differences in outcome among them with regard to wound problems and implant loss within 1 year of surgery were analyzed. There were no selection criteria for the different mesh products and their use was based on what product was ordered in the breast unit at the time. [Figures 2–4](#) show preoperative, immediate postoperative and delayed postoperative pictures of DTI reconstruction using the three different company products. [Figure 5](#) shows the preoperative and postoperative picture of a patient who initially had right NSM and PIR with Braxon for breast cancer followed by left NSM and PIR with Surgimend meshed 18 months later for contralateral breast cancer.

All patients were offered immediate DTI reconstruction irrespective of age, smoking history, BMI, and the

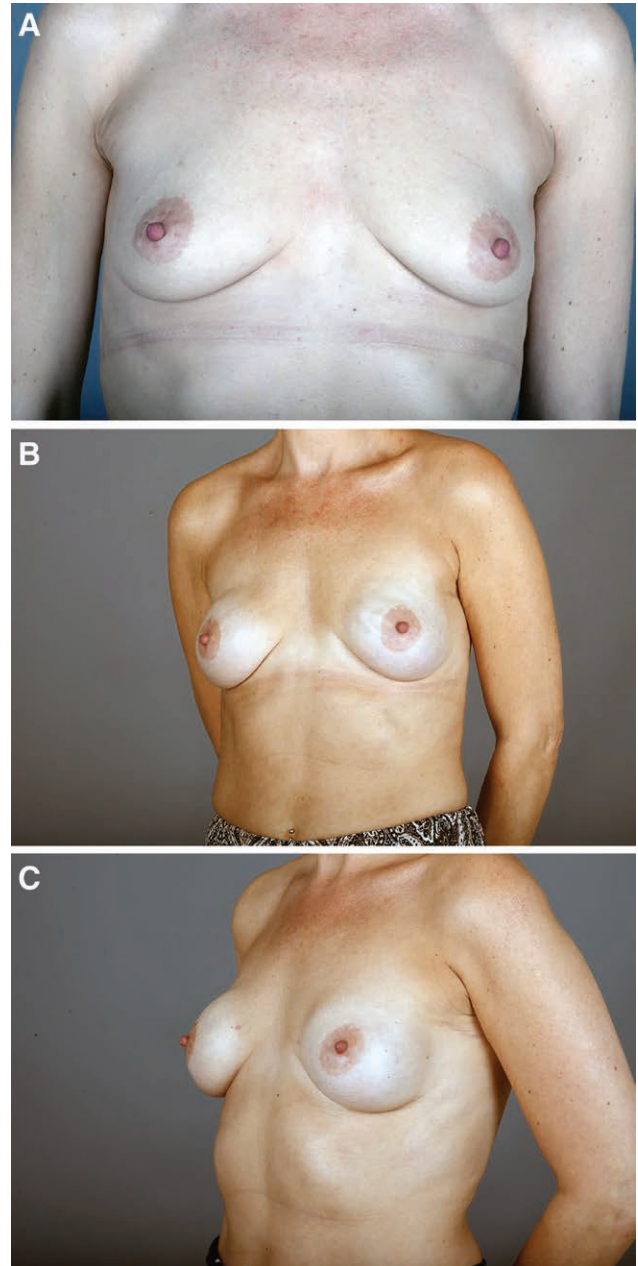


Fig. 1. Patient underwent bilateral NSM and bilateral immediate DTI reconstruction with prepectoral Braxon. A, Preoperative photograph. B, Photograph at 5 months postoperative showing rippling especially on the left reconstructed breast. C, Postoperative photograph 6 weeks after fat grafting.

potential need for radiation treatment. All patients had IV Co-amoxiclav at induction and were sent home with oral antibiotics. Antibiotics were continued until the drains were in place for a maximum of 2 weeks. Subpectoral and prepectoral implant reconstruction were performed as reported previously.¹⁵

The results were presented as number of cases with percentage in brackets or median with range in brackets. For intergroup comparisons, the data were analyzed using Pearson chi-square test and the independent *t*-test.

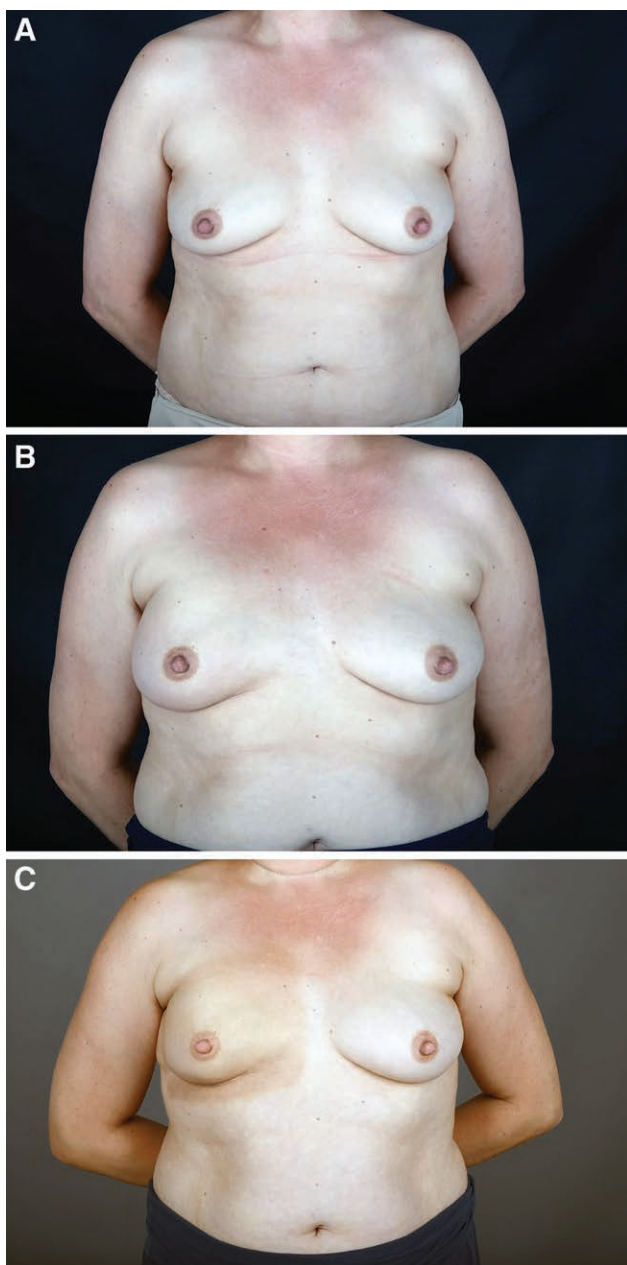


Fig. 2. The patient underwent right NSM and immediate DTI reconstruction with subpectoral Strattice. A, Preoperative photograph. B, Photograph at 2 months postoperative. C, Photograph at 16 months postoperative. The patient had radiotherapy to the right side.

P values of less than 0.05 were considered statistically significant. Statistical analysis was done on Microsoft Excel, version 16 (Microsoft Inc, Redmond, Wash.).

RESULTS

Eighty-two patients had 109 implant reconstructions (85 PIR and 24 SIR) performed during this period. The two groups were analogous in view of patient-specific variables except for node positive disease, Her 2-positive disease, and patients receiving radiation treatment,

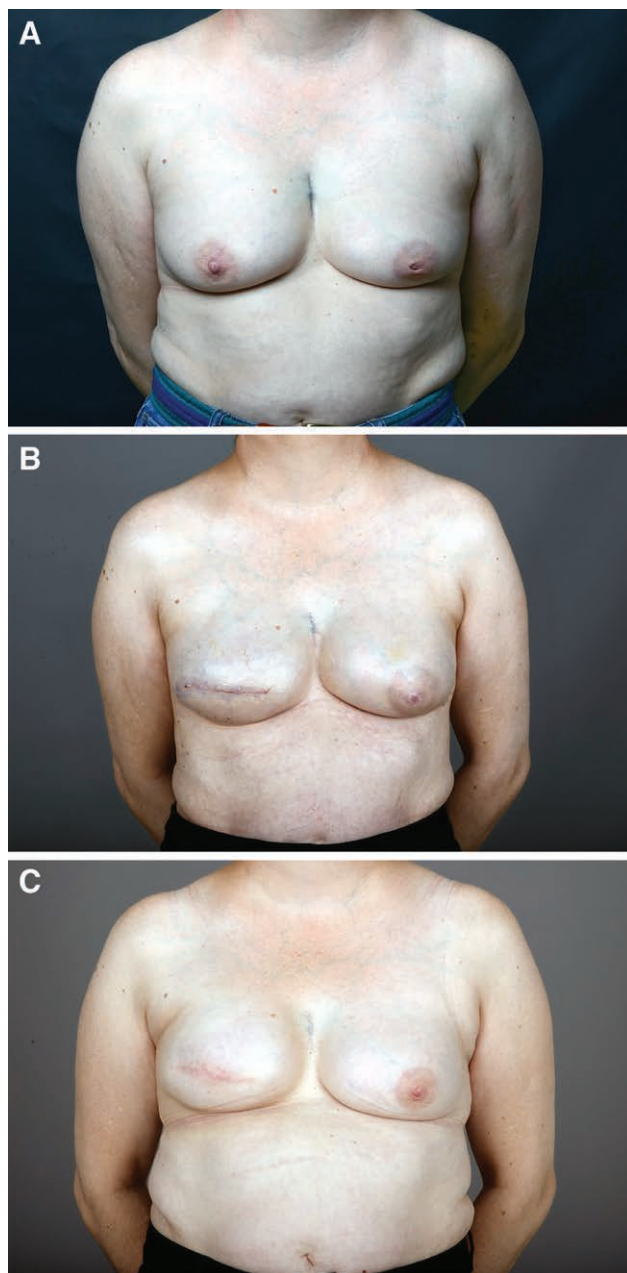


Fig. 3. The patient underwent right skin sparing mastectomy and left NSM + bilateral immediate implant reconstruction with prepectoral Braxon. A, Preoperative photograph. B, Photograph at 2 months postoperative. C, Postoperative photograph at 12 months. The patient had radiotherapy to the right side.

which was significantly higher in the subpectoral group, as shown in [Table 1](#). In the prepectoral group, 60 reconstructions were done for cancer, and 25 were risk reduction procedures. In the subpectoral group, six reconstructions were risk reducing procedures.

There was no significant difference between the two groups with regard to recorded complications, including hematoma, wound infection, red reaction, seroma needing aspiration, wound issues (necrosis/threatened wound) needing revision, and implant loss, as shown in

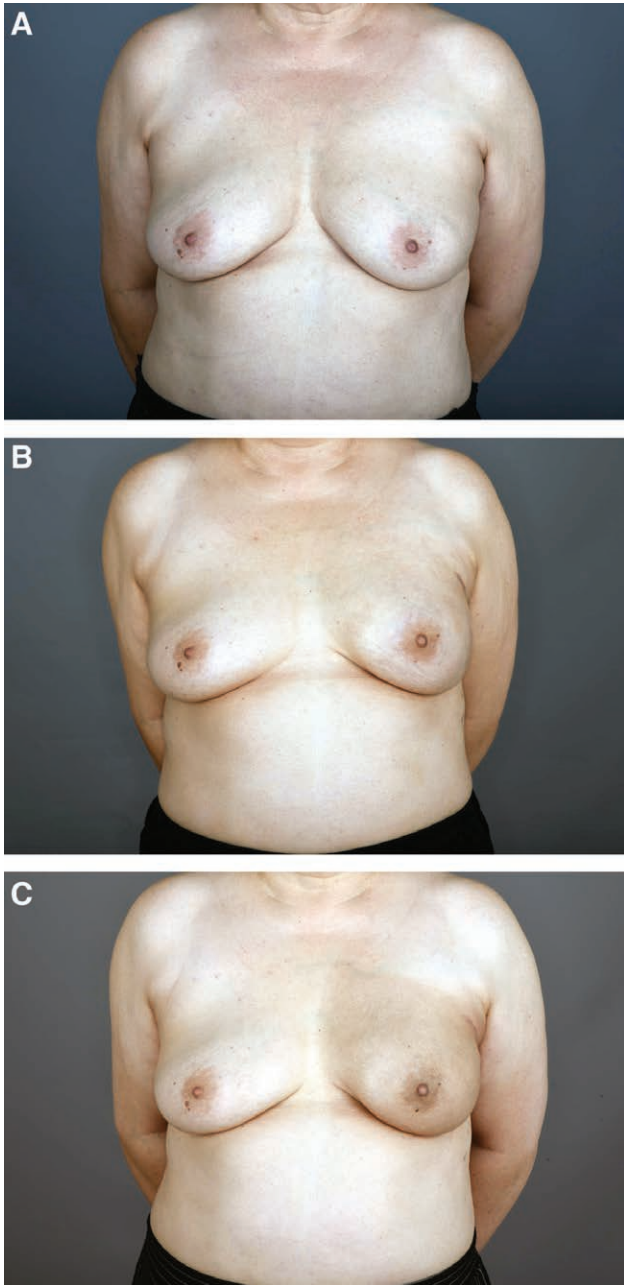


Fig. 4. The patient underwent left NSM and immediate DTI reconstruction with prepectoral Surgimend meshed. A, Preoperative photograph B, Photograph at 2 months postoperative. C, Photograph at 9 months postoperative. The patient had radiotherapy to the left side.

Table 2. There were three hematomas; two needed evacuation and one was managed conservatively.

Forty-two of 85 (49%) prepectoral reconstructions had NSM compared with four of 24 (17%) in the subpectoral group. **Table 3** shows the complications recorded in two types of mastectomies. There was no statistical difference between the overall complications between NSM and nipple compromising mastectomy (9/46 (20%) versus 18/63 (29%); $P=0.282$).

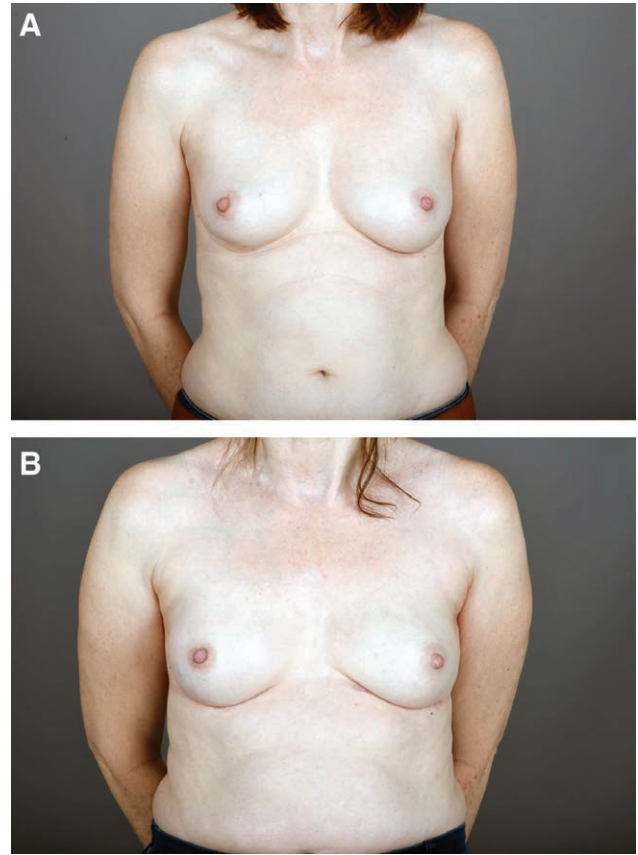


Fig. 5. The patient underwent right NSM and immediate implant reconstruction with prepectoral Braxon. She subsequently developed contralateral breast cancer and underwent left NSM and immediate DTI reconstruction with prepectoral Surgimend meshed. A, Preoperative photograph. B, Postoperative photograph, 28 months postprocedure on the right side and 6 months postprocedure on the left side.

Significantly more patients in the prepectoral group had rippling needing fat grafting ($n=13$ 15% versus 0; $P=0.041$), as shown in **Table 4**. In contrast, significantly more patients in the subpectoral group had fat grafting for contour deformities ($n=6$ 25% versus $n=6$ 7%; $P=0.025$).

Overall, 36 patients (33%) had radiotherapy. Two of 36 (6%) patients who received radiotherapy lost their implants compared with one in 73 (1%) who did not receive radiotherapy ($P=0.209$). All other complications reported in **Table 2** were treated in the immediate postoperative period before any radiotherapy was delivered. Eight patients (22%) in this radiotherapy group had fat grafting compared with 17 (23%) in those who did not receive radiotherapy, and this was not statistically significant ($P=0.900$).

One patient in each group had delay in adjuvant treatment because of wound issues. One patient in the prepectoral group who refused all forms of adjuvant treatment developed regional recurrence. Three patients in the subpectoral group developed distant metastasis.

There was no significant difference in the overall outcome (wound problems and implant loss within 1 year)

Table 1. Comparison of Patient-specific Variables between Prepectoral and Subpectoral Implant Reconstruction

Patient Characteristics	Pre pec- 85 NSM-42 NSacriM-43	Sub pec-24 NSM-4 NSacriM -20	P
	Median FU-24 (4-48)	Median FU-44 (23-53)	
Presentation—symptomatic versus screening	72 (85%) versus 13 (15%)	21 (87%) versus 3 (13%)	0.732
Median age	48 y (27–73)	47 y (28–63)	0.614
Smoking history	18 (21%)	9 (38%)	0.101
BMI > 30	26 (19–45)	27 (19–48)	0.247
Bra cup A, B, and C versus D and above	49 (58%) versus 36 (42%)	11 (46%) versus 13 (54%)	0.304
Median size on radiology	37 (7–100)	50 (11–90)	0.389
DCIS versus invasive	8/60 (13%)	1/18 (6%)	0.365
Grade	25/60 (42%) G3 or HG	12/18 (67%) G3 or HG	0.062
Node positive	20/60 (33%)	13/18 (72%)	0.003
ER positive	41/60 (68%)	12/18 (67%)	0.894
Her 2 positive	9/60 (15%)	7/18 (39%)	0.027
Radiation treatment	21 (25%)	15 (63%)	0.001
Mastectomy weight	412 g (112–1864)	387 g (190–1772)	0.304
Implant volume	415 cm ³ (120–565)	420 cm ³ (255–565)	0.116

NSacriM, nipple sacrificing mastectomy.

Table 2. Comparison of Complications between Prepectoral and Subpectoral Implant Reconstruction

Complications	Prepectoral Reconstruction (N = 85)	Subpectoral Reconstruction (N = 24)	P
Hematoma	1 (1%)	2 (8.3%)	0.058
Wound infection	1 (1%)	1 (4%)	0.335
Red reaction	8 (9%)	1 (4%)	0.409
Seroma needing aspiration	1 (1%)	0	0.593
Wound necrosis/ threatened wound	8 (9%)	1 (4%)	0.409
Overall implant loss	2 (2%)	1 (4%)	0.631

between the biological mesh products of the three different companies used, as shown in Table 5.

DISCUSSION

DTI reconstruction remains a small fraction of overall implant-based reconstruction (<15%) due to concerns of high revision rates and the steep learning curve.¹⁶ Prepectoral implant reconstruction being a new technique compared with subpectoral reconstruction remains predominantly tissue expander based.^{17–20} However, there is an increasing trend in prepectoral DTI reconstruction, with reports of favorable outcomes.^{21,22}

Present mastectomy techniques enable the surgeon to preserve all (NSM) or almost all of the mastectomy skin (skin sparing mastectomy), thus enabling the surgeon to insert a similar or even larger sized implant than

Table 3. Comparison of Complications between NSM and Nipple Compromising Mastectomy

Complications	NSM (N = 46)	Nipple Compromising Mastectomy (N = 63)	P
Hematoma	1 (2%)	2 (3%)	0.752
Wound infection	1 (2%)	1 (2%)	0.821
Red reaction	4 (9%)	5 (8%)	0.886
Seroma needing aspiration	1 (2%)	0	0.239
Wound necrosis/ threatened wound	2 (4%)	7 (11%)	0.205
Overall implant loss	0	3 (5%)	0.133

Table 4. Complications Needing Fat Grafting in the Prepectoral and Subpectoral Group

Complications Needing Fat Grafting	Prepectoral Reconstruction (N = 85)	Subpectoral Reconstruction (N = 24)	P
Rippling	13 (15%)	0	0.041
Contour deformity	6 (7%)	6 (25%)	0.025

the original breast volume.¹⁵ Breast being a prepectoral structure, implant reconstruction with ADM in the prepectoral pocket should allow complete implant coverage with excellent aesthetic outcomes. The present study comparing the prepectoral and subpectoral techniques of implant reconstruction has shown no difference in complication rates with regard to hematoma, wound infection, red reaction, seroma needing aspiration, wound issues (necrosis/threatened wound) needing revision, and implant loss. A multicenter large study reported by Ribuffo et al comparing prepectoral (207 breasts) and subpectoral reconstruction (509 breasts) with ADM reported overall complication significantly higher in the subpectoral group mainly attributed to seroma and hematoma formation and animation deformity, which were significantly higher in the subpectoral group.²³ Incidence of wound dehiscence was 1.9% in the prepectoral group and 2.5% in the subpectoral group, which was not statistically significant. All patients in the above study had a minimum follow-up of 1 year, and the incidence of implant loss was 2.4% in the prepectoral group compared with 3.9% in the subpectoral group, which was not statistically significant. There were significantly more patients receiving adjuvant radiotherapy in the subpectoral group but there was no clear correlation between radiotherapy and higher complication rate. Blinded evaluators extraneous to the study reported higher scores for prepectoral reconstruction concluding this as a better aesthetic option.

Safran et al reported a single surgeon retrospective review of prepectoral reconstruction using both biological and synthetic mesh involving 313 breasts.²⁴ Complications requiring operative intervention were reported in 24 breasts (7.7%) and minor complications occurred in 23

Table 5. Comparison of Wound Problems and Implant Loss between Biological Products from Three Different Companies

Complications	Strattice (Porcine ADM)—Subpectoral (Total = 11)	Braxon/Native (Porcine ADM)—Prepectoral (N = 44), Subpectoral (N = 13) (Total = 57)	Surgimend Meshed/Surgimend (Bovine ADM)—Prepectoral (N = 40), Subpectoral (N = 1) (Total = 41)
Red breast	1 (9%)	8 (14%)	1 (2%)
Infection	1 (9%)		5 (12%)
Wound necrosis/revision of scar	1 (9%)	3 (5%)	
Seroma needing aspiration		1 (2%)	
Loss of implant within 1 year of surgery		1 (2%)	1 (2%)

Chi-square test Strattice versus Braxon/Native $P = 0.749$.

Chi-square test Strattice versus Surgimend $P = 0.445$.

Chi-square test Braxon/Native versus Surgimend $P = 0.487$.

breasts (7.3%). Surgical complications did not differ with the type of mesh used, type of incision used, and the use of postmastectomy radiotherapy.

The first UK national audit of implant reconstruction involving over 3000 DTI subpectoral reconstructions showed an overall complication rate of 14.7% and an implant loss rate of 9% within 3 months of surgery.²⁵ A more recent UK national audit done between Feb 2014 and June 2016 involving 81 centers looked into 2108 patients who underwent immediate implant reconstruction.²⁶ Biological mesh-assisted reconstruction was the most commonly performed procedure, with 1133 (54%) of the 2108 patients undergoing this technique, and an implant loss rate of 8% within 3 months of surgery was reported. Only 42 patients (2%) had prepectoral reconstruction, and implant loss rate in this group was 7% within 3 months of surgery. This did not meet the national criteria of implant loss of less than 5% within 3 months of surgery.²⁷ In the present study, one patient lost the implant due to delayed cellulitis at 3 years in the subpectoral group (4%). Two patients in the prepectoral group lost their implants within 1 year (2%).

One of the main drawbacks of prepectoral reconstruction is rippling of the skin as the folds of the implant become visible, especially in those with thin skin and subcutaneous tissue. Thirteen patients in the prepectoral group (15%) in the present study who reported rippling had fat grafting for correction. Jones et al in his 140 DTI prepectoral reconstruction with ADM reported minor rippling in 15% of cases and 38% of case had fat grafting as part of revisional surgery.¹⁶

In the present study, pros and cons of both subpectoral and prepectoral reconstruction were discussed with patients considered for immediate implant reconstruction and patients were warned regarding future need for potential revisional surgery, including fat grafting for rippling and contour deformities. Prepectoral reconstruction has become more popular, and patients more often choose this form of reconstruction. Both PIR and SIR were offered to patients irrespective of thickness of subcutaneous tissue, size of the breast, BMI, and need for radiation treatment. However, patients with predicted thin mastectomy flaps were warned regarding rippling and informed of the advantage of subpectoral reconstruction in this respect. Patients who develop rippling and patients with contour deformities were offered fat grafting as a part of revisional surgery.

Biological mesh products from three companies were used in patients in the present study. Unlike in the United States, human ADM is not licensed to be used in UK and Europe. Porcine and bovine ADM mesh products were used in this study. Native is a porcine ADM used for subpectoral reconstruction made by the same company as Braxon. In the present study, there was no significant difference in overall complications with regard to wound problems and implant loss within 1 year between the three groups. In a study comparing Strattice (45 reconstructions) and Surgimend (37 reconstructions) in patients who underwent immediate implant reconstruction, there was no statistical difference between the two groups with regard to implant loss.²⁸ The reoperation rate was significantly higher in the Strattice group ($n = 17$, 33% versus $n = 3$, 7%; $P = 0.002$). In contrast, the incidence of red breast was significantly higher in the Surgimend group ($n = 9$, 21%, versus $n = 3$, 6%; $P = 0.022$). In another study by Ball et al looking into 119 reconstructions (strattice 30 and surgimend 89), there was no statistically significant difference with regard to infection, wound dehiscence, skin necrosis, or seroma.²⁹ However, contrary to the previous study, Strattice was associated with higher rates of red breast postoperatively (16.7% versus 4.5%; $P = 0.044$). In the present study, significantly more patients in the prepectoral Braxon group had red reaction compared with prepectoral Surgimend group ($n = 8$ versus 0; $P = 0.012$). All the red reactions settled without any adverse effects.

LIMITATIONS

This is a relatively small study with limited follow-up. Most of the patient-related variables in this study were comparable between the two groups. However, the subpectoral group had significantly more patients with node positive, Her 2-positive disease, and significantly more patients in this group received radiotherapy. Although radiotherapy did not have a significant adverse outcome in the short to medium follow-up, its long-term impact has not been addressed.

In this study, there is a disparity in the number of cases and length of follow-up between the two groups. The selection bias could be multifactorial. PIR is a less cumbersome procedure than SIR, and there may be a bias for the surgeon to perform this operation. PIR is associated with less postoperative pain, and patients may prefer this procedure over SIR despite the limited knowledge of the long-term results. Randomized controlled trials comparing the two techniques should eliminate this selection bias. This

study is limited to surgical complication and oncological outcome between the two procedures and other important aspects of reconstruction including cosmetic outcome and patient related outcomes were not addressed.

CONCLUSIONS

In this study, most of the short-to medium-term outcomes between PIR and the conventional SIR were comparable. Further large trials with long-term follow-up comparing the outcome (including patient-related measures) are required.

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