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RESEARCH

Use of the axillary suspensory ligament as an adipo-fascial flap for total subpectoral implant coverage in breast reconstruction: a retrospective review

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Abstract

Background Subpectoral breast reconstruction following mastectomy requires adequate soft tissue coverage to prevent prosthetic complications such as extrusion, capsular contracture, and poor aesthetic outcomes. The suspensory ligament of the axilla (SLA), a fascial structure often overlooked, may offer a novel autologous solution for complete implant coverage without the morbidity or cost associated with acellular dermal matrices or synthetic mesh.

Methods This study assessed postoperative outcomes and complication rates in patients undergoing alloplastic breast reconstruction utilizing the SLA as an adipo-fascial flap for total subpectoral coverage. Twenty patients (24 breasts) underwent immediate reconstruction with the SLA technique between January 2018 and January 2024.

Results The cohort had an average age of 49 years and a mean follow-up duration of 12 months. A total complication rate of 16.6% was observed, including 8.33% minor complications and 8.33% major complications. No cases of skin flap necrosis, implant extrusion, hematoma, or donor site morbidity were reported. Patient satisfaction based on informal self-reporting during follow-up was generally high, with 75% reporting their aesthetic outcome as very good.

Conclusion Early findings suggest the SLA-based subpectoral reconstruction technique may offer a safe, cost-effective alternative for achieving total prosthetic coverage. It eliminates the need for foreign materials, preserves muscle function, and demonstrates a low complication rate. While early outcomes are promising, prospective studies with larger cohorts are needed to further validate its long-term efficacy and safety.

Level of evidence Level IV, therapeutic study.

Keywords Axillary suspensory ligament · Adipo-fascial flap · Total subpectoral implant · Breast reconstruction · Total implant coverage

Introduction

Mastectomy, whether therapeutic or a prophylactic procedure, is one of the primary breast cancer treatment modalities that involves the removal of one or both breasts [1]. The American Society of Plastic Surgeons [20] Procedural Statistics Report highlights a significant increase in the number of plastic surgery procedures performed in the United States. According to the report, there has been a 19% growth in cosmetic surgery procedures since the pre-pandemic year of 2019. Additionally, the field has evolved significantly since the Halsted principles were first described in 1882.

The removal of breast tissue may result in thin dermal flaps, providing insufficient soft-tissue coverage for

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prosthesis-based breast reconstruction. Thus, despite the paradigm shift in recent years toward prepectoral breast reconstruction, owing to the introduction of an acellular dermal matrix [2], subpectoral implant placement provides several beneficial factors [3]. Primarily, a layer of well-vascularized autologous tissue serves to protect and supply blood to the thin dermal flaps remaining after a mastectomy. Hence, preventing prosthesis extrusion decreases palpability and rippling and may decrease capsular contracture [3].

Numerous techniques for achieving complete tissue coverage of prosthetic devices in the subpectoral plane have been described in the literature [4]. The primary limitation of this technique is that the pectoralis major muscle alone cannot adequately accommodate the lower lateral aspect of the prosthetic device. Thus, the coverage of the infero-lateral portion is subjected to various soft tissue manoeuvres to provide total musculo-fascial coverage [1]. In this article, we report on a technique for total sub-pectoral soft tissue coverage of the prosthetic device in alloplastic breast reconstruction, utilizing and raising awareness of the existence of the suspensory ligament of the axilla (SLA), as an adipo-fascial flap.

Methods

This study aimed to assess the rate of complications in patients who underwent SLA total subpectoral coverage-based breast reconstruction, including seroma, hematoma, skin flap necrosis, wound dehiscence, and infections. In this retrospective study, we reviewed public hospital data from January 2018 to January 2024, focusing on patients who underwent breast reconstructive surgery utilizing the SLA as an adipo-fascial flap.

The inclusion criteria were patients undergoing alloplastic breast reconstruction with total subpectoral coverage, utilizing the SLA as an adipo-fascial flap for primary or revisionary breast reconstruction after undergoing a prophylactic or therapeutic mastectomy. Exclusion criteria included breast reconstructions that did not utilize the suspensory axillary ligament for total subpectoral coverage and patients with incomplete or inadequately detailed medical records ($n = 145$ patients were excluded).

Patients' medical records were screened for comorbidities. Operative characteristics, including implant type, weight of the resected breast, whether surgery was primary or revision, tissue expander size, primary filling volume, and any complications recorded, were reviewed, and data extracted.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were employed to summarize patient sociodemographic data, clinical characteristics, and complications. Frequencies and percentages are used to present categorical variables, whereas continuous variables are expressed as means and standard deviations.

Relevant surgical anatomy

The superficial pectoral fascia, which surrounds the breast, seamlessly continues into the superficial abdominal fascia below and the superficial cervical fascia above [5]. The deep pectoral fascia encases the pectoralis major muscle and extends directly into the deep abdominal fascia below [6]. It connects medially to the sternum and the clavicle and axillary fascia on the upper and lateral parts of the chest wall. The axillary fascia, located at the base of the axillary pyramidal space, is a continuation of the fascia from the pectoralis major [7]. It extends as the fascia of the latissimus dorsi muscle, creating the dome of the axilla. Underneath the pectoralis major muscle, the clavipectoral fascia surrounds the pectoralis minor and part of the subclavius muscle, anchoring to the lower surface of the clavicle. It splits into anterior and posterior layers around the subclavius [6].

Along the lateral border of the pectoralis major muscle, the deep pectoral fascia's anterior lamina unites with the clavipectoral fascia's posterior lamina. This layer of fascia, which links the pectoral muscles to the anterior edge of the latissimus dorsi, is recognized as the suspensory ligament of the axilla. (see Fig. 1A and B). It is a triangular structure which inserts into the coracoid process [8]. The suspensory ligament of the axilla connects the clavipectoral fascia to the axillary fascia [8].

Surgical technique

After completing the skin-sparing or nipple-areola complex-sparing mastectomy and vigorous intra-operative hemostasis, the sub-pectoral pocket is formed by releasing the pectoralis major muscle through its lateral border by blunt dissection. If required, the dissection continues until 1–2 cm inferior to the inframammary fold (IMF). Great care is taken to preserve the superficial pectoral fascia down to the IMF, maintaining the continuity of the pocket roof. The SLA is then released medially and laterally and elevated as an adipo-fascial flap (see Fig. 2A and B).

Before implant insertion, the breast skin is disinfected with a sterile Polydine solution. Additionally, pocket irrigation and prosthesis soaking are carried out using 0.5 L of normal saline, which contains a double antibiotic solution, including gentamycin 240 mg, cefazolin 1 gm, and a 10% povidone-iodine solution. The prosthesis is subsequently placed into the sub-pectoral pocket (See Fig. 2C).

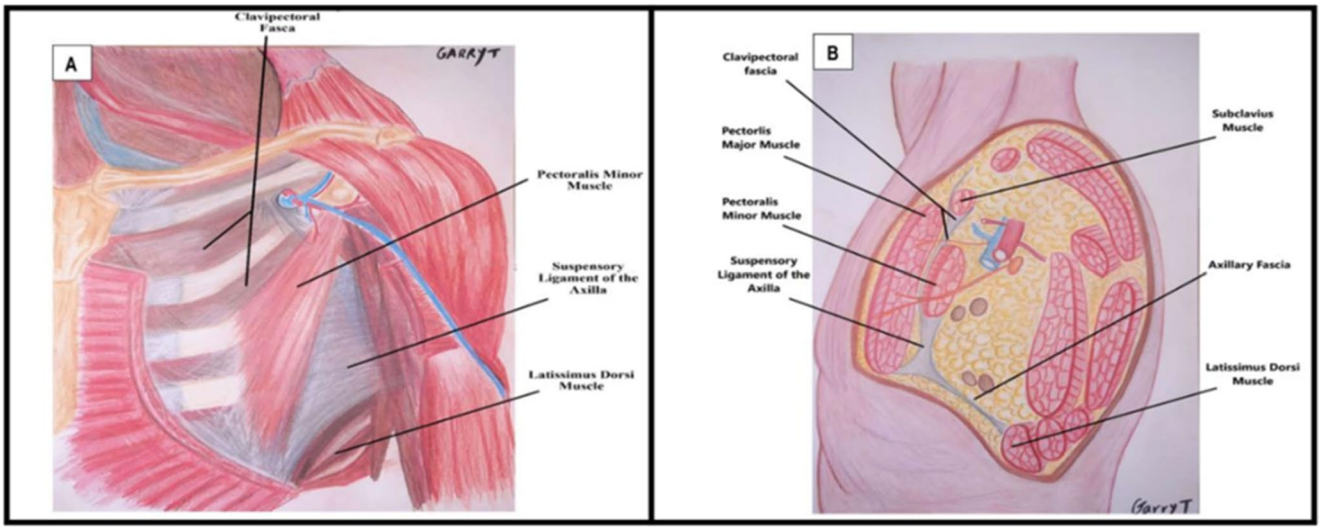

Fig. 1 **A**. Pectoral musculature and fascia system – frontal view **B**. Pectoral musculature and fascia system – lateral view

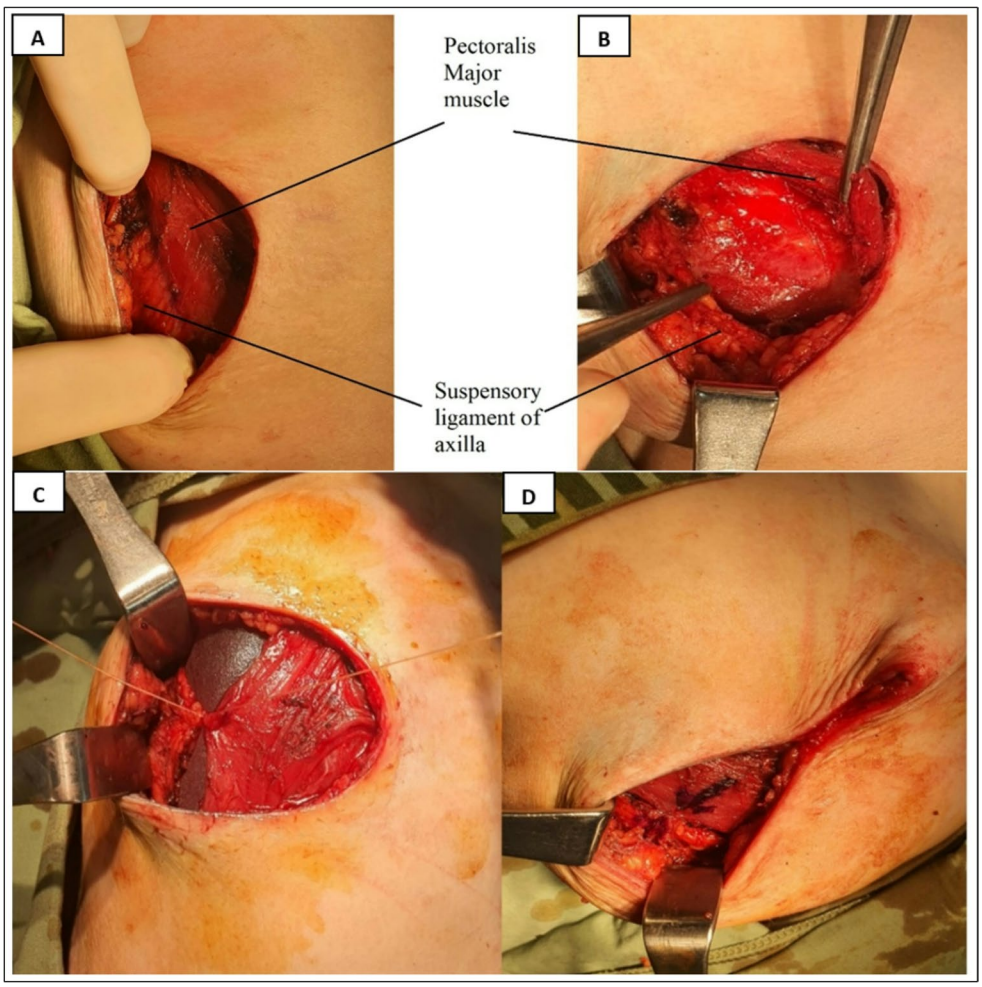

Fig. 2 **A**: Left: Intraoperative view showing the identification of the SLA laterally and inferiorly to the lateral border of the pectoralis major muscle. **B**: Right: Elevation of the SLA as an adipo-fascial flap following medial and lateral release. **C**: Completion of implant pocket formation with the prosthesis placed in the subpectoral plane and covered superiorly by the pectoralis major muscle and inferior-laterally by the raised SLA flap. **D**: Final closure with the adipo-fascial flap and muscle sutured over the implant. Skin closure is performed with layered absorbable sutures.

The pectoralis major muscle's lateral edge is then brought together and sutured by interrupted absorbable Vycril 2−0 (Ethicon, Somerville, NJ) sutures to the adipo-fascial flap over the inserted implant/tissue expander (See Fig. 2D). Two closed suction drains are inserted, one in the submuscular pocket and one in the subcutaneous pocket. Skin

is closed using interrupted dermal (Vycril 3/0, Ethicon, Somerville, NJ) and continuous intracuticular absorbable sutures (Monocryl 3/0, Ethicon, Somerville, NJ).

Results

Between January 2018 and January 2024, 20 consecutive patients (24 breasts) were admitted for primary or with previous breast surgery (for example, post lumpectomy) mastectomy and immediate breast reconstruction, utilizing SLA total sub-pectoral coverage of the prosthetic device, in direct to implant or expander breast reconstruction.

The average age of the patients in the study was 49 ± 12.2 (range, 23–73) years, with an average BMI of 26.9 ± 6.18 (range, 18.8–39) kg/m². The mean duration of follow-up was 12 months (range: 8–60 months). Patient comorbidities, as well as neo-adjuvant and adjuvant treatment, were recorded.

At their initial clinic visit, two patients had a Breast Cancer Gene (BRCA) mutation, six had ductal carcinoma in situ, and 12 had invasive ductal carcinoma, which were the indications for breast reconstruction. Two patients were diagnosed with lobular carcinoma in situ; two patients presented with invasive lobular carcinoma, and one case of angiosarcoma of the breast was recorded (several patients had multiple reasons for undergoing surgery). Four patients underwent bilateral reconstruction, and 16 had unilateral reconstruction. A family history of breast or ovarian cancer was positive in nine patients. Patient comorbidities were recorded (See Table 1).

Table 1 Patient demographics

Demographics	Value (*n*)	%
Patients		
Total	20	100
Unilateral	16	80
Bilateral	4	20
Breasts	24	100
Age (years)		
Mean	49 ± 12.2	
Range	23–73	
BMI, kg/m^2		
Mean	26.9 ± 6.18	
Range	18.8–39	
Patient characteristics		
Smoking	6	30
Hypertension	4	20
Diabetes mellitus	3	15
Asthma	1	5
Hypothyroidism	4	20
Status post breast carcinoma	2	10
Status post lumpectomy	4	20
Hypercoagulation	2	10
Chronic obstructive pulmonary disease	1	5
Hyperlipidemia	3	15
Fatty liver	2	10
B-cell Lymphoma	1	5
Fibromyalgia	2	10
Lobectomy (carcinoid)	1	5
Psoriasis	1	5
Post-operative follow-up, month		
Mean	12	
Range	8–60	

Operative characteristic: Four breasts (three patients) underwent direct-to-implant reconstruction, utilizing Mentor implants. Twenty breasts (17 patients) underwent a two-stage expander to implant breast reconstruction. The right breast's average excision weight was 398 ± 205 (range: 120–674) gm, and the left breast's average excision weight was 573 ± 194 (range: 197–850) gm. All the expanders were Mentor, either 8100 or 8200. The primary inflation volume ranged from 0 to 300 cc, with an average of 100 ± 97 cc. The average total inflation volume was 500 ± 244 cc (range, 180–1090 cc). The average implant volume was 418 ± 167 (range, 225–515) cc in direct-to-implant (DTI) procedures and 455 ± 235 (range, 160–800) cc in two-stage procedures. A sentinel lymph node biopsy was taken during all procedures. The average expander-to-implant exchange time was 13 months (range: 5–18 months). Drains were removed 14 days postoperatively (range: 7–21 days) (See Table 2).

Four cases of complications occurred (16.6%). The overall complication rate is displayed for each breast. Major complications, which correspond to Clavien-Dindo grade 3, required surgical intervention under local or general anesthesia, whereas minor complications, defined as Clavien-Dindo grades 1 and 2, resolved with conservative treatment. Two (8.33%) minor complications were treated conservatively. A major complication was observed in two breasts (8.33%), necessitating surgical intervention. Seroma was encountered in one breast (4.16%), mandating bedside aspiration. One post-operative infection was seen (4.16%). Capsular contraction (CC) backer grade 3–4 was observed in one DTI breast reconstruction (4.16%). No hematoma, local wound healing issues, skin flap ischemia, rippling, or asymmetry were noted among the patients in this cohort (See Table 3). No patients reported any postoperative pain sensation during their follow-up visits that was out of proportion to the regular postoperative course and required further evaluation or treatment. No cases of ptosis were seen during the follow-up period. In one breast (in one patient, 4.16%), superior postoperative migration was observed. It is important to note that the patient had postoperative radiation treatment and capsular contracture. No cases of lateral migration were recorded. Based on patients' informal self-reported impressions during follow-up consultations, 15

Table 2 Operative characteristics

Characteristics	Value (*n*)	%
Indication		
BRCA	2	10
Ductal carcinoma in situ	6	30
Invasive ductal carcinoma	12	60
Lobular carcinoma in situ	2	10
Invasive lobular carcinoma	2	10
Angiosarcoma of the breast	1	1
Neo-adjuvant treatment		
Chemotherapy	5	25
Radiation therapy	4	20
Hormonal therapy	4	20
Biological therapy	1	5
Adjuvant treatment		
Chemotherapy	2	10
Radiation therapy	2	10
Hormonal therapy	1	5
Biological therapy	2	10
Excision weight gm (per breast)		
Right		
Mean	398 ± 205	
Range	120–674	
Left		
Mean	573 ± 244	
Range	197–850	
Implant volume, cc (per breast)		
Direct to implant		
Mean	418 ± 167	
Range	225–515	
Expander to implant		
Mean	455 ± 235	
Range	160–800	
Operative technique (per breast)		
Direct to implant	4	16.6
Expander to implant	20	83.3
Sentinel lymph node biopsy (per patient)	24	100%
Expander to implant exchange (month)	13 (range 5–18)	
Drain removal (days)	14 (range 7–21)	

Table 3 Complication rates

Complication	Value (*n*)	(%)
Total complication occurrence	4	16.6
Minor (Clavien–Dindo grades 1–2)	2	8.33
Major (Clavien–Dindo grades 3–4)	2	8.33
Postoperative pain	0	-
Ptosis	0	-
Malposition	1	4.16
Lateral migration	0	-
Rippling	0	-
Hematoma	0	-
Seroma	1	4.16
Total number of irradiated breasts	6	25
Capsular contraction, Total	1	4.16
Capsular contraction irradiated breast		
Backer grade 3–4	1	16.6 (*4.16)
Capsular contraction non-irradiated breast		
Backer grade 3–4	0	-
Capsular contraction neo-adjuvant radiation	0	-
Skin ischemia	0	-
Wound healing problem	0	-
Infection	1	4.16
Poor cosmetic result	1	4.16

*The percentage of complications of the irradiated breast is exhibited out of the total 6 irradiated breast (in brackets, the percentage of irradiated breast out of the total breast)

patients (18 breasts, 75%) reported being *very satisfied* with their postoperative aesthetic outcomes, and three patients (3 breasts, 12.5%) reported *good* outcomes. Responses from three patients were not documented. No patients expressed dissatisfaction with their aesthetic results.

Discussion

Breast reconstruction in the post-mastectomy patient is an important step toward a physical and psychological sense of femininity and is a crucial step in the path to complete recovery. The ongoing journey toward improved treatment modalities enables reconstructive plastic surgeons to meticulously tailor the best treatment modality for each patient, taking into account a wide array of changing parameters [9].

A wide range of methods for fully covering prosthetic implants with soft tissue have been detailed in the published literature. One of the most popular techniques for total muscle coverage of the prosthesis is the mobilization of the serratus anterior musculo-fascial flap. The disadvantage of this technique in two-stage reconstruction is the inadequate expansion of the lower pole of the breast and the cephalic displacement of the TE during the sequential expansion processes [11–13].

Partial soft tissue coverage, by definition, has an internal shortcoming. The inadequacy of covering the prosthetic device's lower lateral part allows for lateral migration. Several techniques have been described in the literature to address the deficiency of the infero-lateral aspect and prevent prosthesis displacement and extrusion. Those include several options: Using de-epithelialized dermal flaps, the lower mastectomy skin flap is secured to the pectoralis muscle [13]. Alternatively, the adjacent serratus anterior muscle or fascia and occasionally part of the external oblique muscle or the anterior rectus fascia, can be used [1]. However, when the serratus fascia is friable and inadequate, the deep pectoral fascia can serve as an alternative [1]. Additionally, pectoralis minor flaps can be elevated [13], or acellular

dermal matrices and synthetic mesh have been described [1, 15].

Although Acellular Dermal Matrix (ADM) has created a paradigm shift toward pre-pectoral alloplastic breast reconstruction. It also plays an important role in subpectoral plain breast reconstruction, due to its capacity to offer a supportive barrier between the implant and a comparatively thin mastectomy flap [4]. Furthermore, ADM has been described by several systematic reviews and meta-analyses to lower postoperative capsular contraction rates [16, 17]. Nevertheless, ADM breast reconstruction remains a topic of debate in the literature, as several large case series have reported a higher incidence of postoperative complications [5, 14], in addition to increased operative costs and financial burdens.

Utilizing the suspensory ligament of the axilla is a simple, easy, and less invasive alternative for complete soft tissue prosthesis coverage. Breast reconstruction utilizing the suspensory ligament of the axilla provides an additional layer of coverage and reduces the risk of prosthetic device extrusion (none were observed in this cohort). Additionally, our study had no major complications related to skin flap ischemia and necrosis. We believe this stems from the unique SLA technique, which exploits the advantages of complete soft tissue coverage, allowing continuity with the pectoralis major muscle.

Furthermore, the use of the SLA technique for achieving complete soft tissue coverage is a crucial factor in reconstructive breast procedures. The SLA technique has no functional or donor site morbidity. No damage to the serratus muscle or fascia is inflicted, thus allowing for salvage operations, if needed, at a later stage. Furthermore, this technique reduces the risk of unnecessary postoperative complications by eliminating the need for additional foreign materials, such as ADM or synthetic mesh and their costs.

The aforementioned technique possesses several shortcomings. Very thin patients with atrophic axillary suspensory ligaments are not good candidates for this type of reconstruction. In addition, during the mastectomy procedure, especially when combined with axillary lymph node biopsy or dissection, SLA can be violated and thus be unavailable for use (during the procedure, the surgeon can pass through it without even noticing). Due to this fact, meticulous attention should be taken to preserve the anatomical integrity of the ligament that will be used for prosthesis coverage during the reconstructive procedure. Furthermore, the absence of the SLA was reported in the literature [8].

If SLA integrity is compromised, alternative options, such as the serratus anterior muscle, serratus anterior fascia, and acellular dermal matrix, can be used to complete the prosthesis' coverage. We use this technique routinely and utilize it in cases where a sub-pectoral approach was chosen, and the ligament remains after the mastectomy or sentinel lymph node dissection.

In our cohort, we extended the inclusion criteria to both direct implantation and a two-stage procedure, in which the expander was used in the first stage with total coverage. In the second stage, the expander was replaced with a breast prosthesis after the expansion of the covered pocket. We report an overall complication rate of 16.6%, which is comparable to or slightly lower than the rates reported in the literature, ranging from 13.8 to 37.9% [11, 12, 18] for single- or two-stage operations.

In comparison, Bordoni, Cadenelli [10] described a prospective comparison of 29 cases, immediate reconstruction followed by bilateral mastectomies, involving the insertion of a tissue expander beneath the pectoralis major and serratus anterior muscle on one side, and under the pectoralis major along with a serratus anterior fascia flap on the opposite side. A total complication rate of 13.8% was observed in the subfascial group, and a rate of 37.9% in the submuscular group [10]. In Seth, Hirsch [11] retrospective review of 177 patients (255 breasts) and 375 patients (487 breasts) that underwent breast reconstruction utilizing serratus fascia and serratus muscle elevation, respectively, a total complication rate of 15.7–18.5% was observed. Gschwantler-Kaulich, Leser [17] conducted a retrospective cohort study of 180 patients who underwent immediate or delayed alloplastic breast reconstruction following mastectomy, with tissue expanders placed under complete submuscular coverage, and in direct-to-implant procedures using the dual plane technique, either an ADM sheet or a patient-deepithelialized corium flap was used; complication rates ranged from 22.9 to 37.1% [17]. Saint-Cyr, Dauwe [12] evaluated a series of 31 immediate post-mastectomy breast reconstructions in 22 patients in their retrospective review, using the serratus anterior fascia for lateral expander coverage and reconstruction of the lateral mammary fold in all 31 cases, reporting a complication rate of 25.8% [12].

The low complication rate in the present study may have resulted from the lead surgeon's experience and the avoidance of ADM or synthetic mesh, which minimized complications associated with additional foreign bodies. Due to the nature of the public system, a resident physician participated in each operation and was guided by the same experienced lead surgeon.

One infection occurred in our series. This mandated expander removal in the operating room and intravenous antibiotic treatment was due to pseudomonas aeruginosa colonization. The rate is comparable to or slightly lower than that in the literature [12, 20]. We attribute the low infection rate to the implementation of rigorous aseptic techniques in the operating theatre and careful wound and drain care postoperatively.

Capsular contracture was observed in one patient who received radiation treatment postoperatively, a comparable rate to the literature [18]. One seroma requiring aspiration was observed, a rate slightly lower or comparable to that reported in the literature [11, 12, 20]. The low seroma rate likely stems from the surgical technique of complete prosthetic coverage, which does not involve the use of additional foreign bodies. We believe that no skin flap ischemia or necrosis was observed due to collaboration with highly experienced oncologic breast surgeons, meticulous post-mastectomy flap evaluation, and increased blood supply resulting from the surgical technique of complete soft tissue coverage.

In terms of cost and the post-operative financial burden on patients [18], and out-of-pocket spending, in addition to increased healthcare insurance premiums, deductibles, and copayments. Our technique of complete autologous soft tissue coverage, utilizing the suspensory ligament of the axilla, is an important fact, without additional cost, in the complex landscape of the financial burden of medical care [18].

One case of superior migration was noted among the patients of this cohort. It is important to note that the patient had postoperative radiation treatment and capsular contracture. No cases of lateral migration were recorded. Subjective impressions of postoperative satisfaction were informally gathered through patient self-reports during routine follow-up consultations, as validated outcome measures such as the BREAST-Q questionnaire [19] were not conducted. While no patients explicitly reported dissatisfaction with the reconstructive outcome, one case following irradiation was noted to have a suboptimal cosmetic result. Overall, patient-reported satisfaction appeared high based on these informal assessments.

This study is limited by its retrospective design, small sample size, and the absence of a control or comparison group. Additionally, the subjective nature of aesthetic satisfaction assessments, conducted without validated PROMs such as the BREAST-Q, may introduce bias. Surgical outcomes may also reflect the lead surgeon's extensive experience, which may limit generalizability to broader clinical settings. The short average follow-up period may underestimate long-term complications such as implant malposition, capsular contracture, or patient dissatisfaction. Further prospective, randomized studies with validated outcome measures are needed to substantiate these findings.

Conclusions

Our findings suggest that utilizing the suspensory ligament of the axilla may offer a technically feasible option for soft tissue coverage in selected cases, with an acceptable early complication profile. Most importantly, the SLA technique possesses no additional cost or donor site morbidity. Using the suspensory ligament of the axilla for complete soft tissue coverage is a vital technique in the reconstructive plastic surgeon's armamentarium.

Author contributions Conceptualization: JH; Methodology: JH; Software: CK; MH; Validation: All authors; Formal analysis: CH; MH; JH; Investigation: JH; CK; MH; RR; GGT; Resources: JH; Data Curation: CK; RR; Writing - Original Draft: CK; Writing - Review & Editing: All authors; Visualization: All authors; Supervision: JH; Project administration: JH.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Ethics approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Sheba Medical Center Ethics Committee (1339-24-SMC).

Informed consent Informed consent was obtained from all individual participants in the study. The authors affirm that human research participants provided informed consent for publication of the images in Fig. 2.

Competing interests The authors declare no competing interests.

Clinical trial number Not applicable.

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