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Prepectoral Versus Retropectoral Implant-Based Breast Reconstruction: Equivalent Safety with Improved Long-Term Implant Durability

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Kliininen laitos

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Vastuuhenkilö: EL Salvatore Giordano

TURUN YLIOPISTO
Lääketieteellinen tiedekunta

VARPU FALKENBERG: Prepectoral Versus Retropectoral Implant-Based Breast Reconstruction: Equivalent Safety with Improved Long-Term Implant Durability

Syventävien opintojen kirjallinen työ, 14 sivua, 6 liitesivua

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While implant-based breast reconstruction (IBBR) is the most frequently performed procedure following mastectomy, the optimal surgical approach remains debated. The retropectoral (RP) technique has been the historical standard, but prepectoral (PP) reconstruction is increasingly adopted. Nevertheless, a lack of long-term data comparing complications of these techniques exists. The objective of this study was to perform a comparative analysis of clinical outcomes for prepectoral versus retropectoral IBBR.

A retrospective review was conducted of 139 patients who underwent prepectoral (n=86) or retropectoral (n=53) IBBR between 2009-2024. Patient demographics, comorbidities, oncologic history, and treatment data were abstracted from institutional records. Primary outcomes included surgical site complications, reoperations, and implant revision rates at follow-up. The overall postoperative complication rate was similar between the groups. Early and late reoperation rates were also comparable. However, a strong trend toward a higher late implant exchange rate was observed in the subpectoral cohort. Immediate reconstruction, radiotherapy, and higher ASA scores were identified as significant independent predictors of postoperative complications. Bilateral reconstruction and higher BMI demonstrated a trend toward significance.

This study demonstrates that prepectoral IBBR is a safe and viable alternative to the traditional subpectoral approach. The strong trend toward a higher late implant exchange rate in the subpectoral group suggests a potential advantage for the prepectoral technique in long-term implant durability. Ultimately, patient selection remains paramount: independent risk factors matter more than the choice of surgical plane. These findings support the continued adoption of the prepectoral technique while highlighting the need for careful preoperative risk assessment.

Abstract

Introduction

While implant-based breast reconstruction (IBBR) is the most frequently performed procedure following mastectomy, the optimal surgical approach remains debated. The retropectoral (RP) technique has been the historical standard, but prepectoral (PP) reconstruction is increasingly adopted. Nevertheless, a lack of robust long-term data comparing complications and patient-reported outcomes between these two-stage techniques exists. The objective of this study was to perform a long-term comparative analysis of clinical outcomes for prepectoral versus retropectoral IBBR.

Methods

A retrospective review was conducted of 139 consecutive patients who underwent prepectoral or retropectoral implant-based breast reconstruction between January 2009 and December 2024. Patient demographics, comorbidities, oncologic history, and treatment data were abstracted from institutional records. Primary outcomes included surgical site complications, reoperations, and implant revision rates at follow-up. Continuous variables were compared using Student's t-test or Mann-Whitney U test, and categorical variables with Chi-squared or Fisher's exact test; a p-value <0.05 defined statistical significance.

Results

A total of 139 patients were included: 86 underwent prepectoral and 53 subpectoral reconstruction. The mean follow-up was 41.7 ± 41.9 months. Patient demographics and operative characteristics, including operative time, implant size, mesh use, and immediate reconstruction rates, were comparable between cohorts.

The overall postoperative complication rate was similar between the prepectoral and subpectoral groups (23.3% vs. 22.6%, $p = 0.933$). Specifically, there were no significant differences in wound complications or capsular contracture (2.3% vs. 3.8%, $p = 0.636$). Early (<30 days) and late (>30 days) reoperation rates were also comparable. However, a strong trend toward a higher late implant exchange rate was observed in the subpectoral cohort (4.7% vs. 15.1%, $p = 0.058$).

On multivariable analysis, immediate reconstruction, radiotherapy, and higher ASA scores were identified as significant independent predictors of postoperative complications. Bilateral reconstruction and higher BMI demonstrated a trend toward significance.

Conclusions

This long-term comparative analysis demonstrates that prepectoral implant-based breast reconstruction is a safe and viable alternative to the traditional subpectoral approach, with equivalent overall complication profiles. The strong trend toward a higher late implant exchange rate in the subpectoral group suggests a potential advantage for the prepectoral technique in long-term implant durability. Ultimately, patient selection remains paramount; independent risk factors for complications include radiotherapy, immediate reconstruction, and higher ASA scores, not the choice of surgical plane. These findings support the continued adoption of the prepectoral technique while highlighting the need for careful preoperative risk assessment.

Level of Evidence: III

Keywords: Implant-based; Immediate breast reconstruction; Prepectoral; Retropectoral; Postoperative complications

Introduction

Breast cancer remains the most prevalent malignancy among women worldwide, rendering reconstruction a vital component of holistic oncological care that significantly enhances psychological well-being and quality of life. Implant-based breast reconstruction (IBBR) has emerged as the globally dominant method for restoring body image following mastectomy, accounting for the majority of reconstructive procedures in contemporary practice. [1-4] Historically, the subpectoral or retropectoral plane, where the device is positioned beneath the pectoralis major muscle, served as the "gold standard" for decades. [5, 6] This approach was originally favoured because muscular coverage provided robust protection for the implant, mitigating early risks such as skin necrosis and device extrusion.[3,7,8] However, the traditional subpectoral technique necessitates extensive muscle dissection and manipulation, which is frequently associated with chronic postoperative pain, muscle spasms, and animation deformity, where the reconstructed breast moves unnaturally during muscle contraction. [9,10,11]

In recent years, the clinical community has witnessed a significant renaissance of the prepectoral approach, in which the implant is placed in its original anatomical position above the pectoralis muscle.[6,11,12,14] This shift has been driven by refinements in nipple-sparing and skin-sparing mastectomy techniques, which preserve more robust skin flaps, and the integration of acellular dermal matrices (ADMs) that act as an internal "hammock" to support and camouflage the prosthetic device. [15] While the prepectoral approach offers undeniable advantages, including faster physical recovery, reduced use of postoperative opioids, and the preservation of chest wall integrity, concerns remain regarding its long-term safety profile.[15, 16] Some contemporary evidence suggests that prepectoral placement may be associated with higher rates of seroma, rippling, and implant-related infections compared to the traditional submuscular route. [15,17]

Despite the rapid global uptake of muscle-sparing techniques, the optimal surgical plane for implant placement remains a subject of ongoing debate. Crucially, there is a notable paucity of robust, long-term comparative data that evaluates the incidence of surgical site complications alongside patient-reported outcomes over an extended period. [4,6] Therefore, the objective of this study was to perform a comprehensive long-term comparative analysis of clinical outcomes for prepectoral versus retropectoral IBBR. By investigating the durability of these

reconstructions and their impact on physical well-being, this research seeks to refine patient selection and establish a more evidence-based roadmap for modern breast surgery. [18]

Material and Methods

Study Design and Setting

This retrospective comparative analysis was conducted at Turku University Hospital and the University of Turku. The primary objective was to compare long-term clinical outcomes, specifically surgical site complications and device durability, between two surgical approaches for implant-based breast reconstruction (IBBR): the prepectoral (PP) and retropectoral (RP) planes.

Patient Selection and Cohort

We performed a comprehensive review of 139 consecutive patients who underwent immediate or two-stage IBBR at our institution between January 2009 and December 2024. Participants were divided into two cohorts based on the anatomical plane of implant placement:

Prepectoral Group: 86 patients with implants positioned above the pectoralis major muscle

Retropectoral Group: 53 patients with implants positioned beneath the pectoralis major muscle

Patients were identified through electronic medical records using institutional coding. Inclusion criteria required adult female patients undergoing mastectomy for therapeutic or risk-reducing purposes followed by alloplastic reconstruction. Patients with incomplete medical documentation or those undergoing primary autologous reconstruction were excluded.

Data Collection and Variable Definitions

Demographic, clinical, and oncological data were abstracted from institutional records. Variables recorded included:

Patient Characteristics: Age, body mass index (BMI), smoking status, and ASA (American Society of Anaesthesiologists) physical status classification

Surgical Details: Operative time, intraoperative blood loss, mastectomy specimen weight, and laterality (unilateral or bilateral)

Reconstructive Details: Implant volume (cc), timing of reconstruction (immediate vs. two-stage), and use of supportive materials such as Tigr Mesh

Treatment History: Prior or adjuvant chemotherapy and radiotherapy exposure

Outcome Assessment

Primary endpoints included the incidence of surgical site complications: infection, seroma, hematoma, and skin or nipple-areolar complex (NAC) necrosis. Secondary outcomes encompassed long-term device performance, specifically capsular contracture rates and the need for reoperation or late implant exchange. Complications were categorized temporally as early (occurring within 30 days of the index procedure) or late (occurring thereafter). The mean follow-up period was 41.7 ± 41.9 months.

Statistical Analyses

Continuous variables were summarized as means with standard deviations (SD), and categorical variables as frequencies and percentages. Normality of continuous variables was assessed using histograms, skewness, kurtosis, and the Kolmogorov–Smirnov test. Between-group comparisons were performed using the independent samples Student's t-test for normally distributed continuous variables, the Mann–Whitney U test for non-normally distributed variables, and Pearson's chi-square or Fisher's exact test for categorical variables, as appropriate. Independent risk factors for complications were identified using multivariable logistic regression, with results reported as adjusted odds ratios with 95% confidence intervals. Model calibration was assessed with the Hosmer–Lemeshow goodness-of-fit test, which indicated adequate fit ($p = 0.932$). All tests were two-sided, and a p-value < 0.05 was considered statistically significant. All analyses were conducted using IBM SPSS Statistics, Version 30.0 (Armonk, NY, USA).

Results

A total of 139 consecutive patients were included in this retrospective analysis: 86 in the prepectoral (PP) cohort and 53 in the retropectoral (RP) cohort. The mean follow-up period was 41.7 ± 41.9 months.

Demographic data were well-balanced between groups. The mean age was 52.3 ± 13.9 years for the PP group and 53.8 ± 13.0 years for the RP group ($p = 0.748$). Mean body mass index (BMI) showed no significant difference: 25.1 ± 3.9 kg/m² for PP and 24.7 ± 5.0 kg/m² for RP patients ($p = 0.908$). Preoperative comorbidities, including diabetes ($p = 0.123$), hypertension ($p = 0.832$), and smoking status ($p = 0.561$), were comparable across cohorts. The proportion of patients receiving adjuvant radiotherapy (34.9% PP vs. 37.7% RP; $p = 0.734$) and chemotherapy (44.2% PP vs. 47.2% RP; $p = 0.731$) was similar between groups.

Analysis of perioperative data revealed no significant differences in surgical complexity or duration between reconstruction planes. Mean operative time was 142.2 ± 79.3 minutes for the PP group versus 143.0 ± 73.4 minutes for the RP group ($p = 0.960$). Immediate reconstruction was performed in the majority of cases (65.1% PP vs. 71.7% RP; $p = 0.420$), and mean resection weight per breast was comparable (456.0 ± 261.3 g for PP vs. 516.9 ± 343.5 g for RP; $p = 0.299$). There were no significant differences in mean implant volume (338.4 ± 125.9 cc PP vs. 316.8 ± 112.1 cc RP; $p = 0.315$) or the frequency of bilateral reconstructions ($p = 0.560$). Tigr Mesh was used in 52.3% of PP cases and 39.6% of RP cases ($p = 0.145$).

The overall postoperative complication rate was similar between cohorts: 23.3% in the prepectoral group and 22.6% in the retropectoral group ($p = 0.933$). Specific surgical site complications showed no statistically significant differences:

Capsular contracture: 2.3% (PP) vs. 3.8% (RP), $p = 0.636$

Seroma requiring aspiration: 9.3% (PP) vs. 7.5% (RP), $p = 1.000$

Hematoma requiring operation: 1.2% (PP) vs. 3.8% (RP), $p = 0.558$

Skin necrosis: 8.1% (PP) vs. 7.5% (RP), p = 1.000

Early reoperation rates (<30 days) were comparable between groups (15.3% PP vs. 18.9% RP; p = 0.584). However, a strong trend toward a higher late implant exchange or removal rate (>30 days) was observed in the retropectoral cohort: 15.1% compared to 4.7% in the prepectoral group (p = 0.058).

Multivariable logistic regression identified the following as significant independent predictors of postoperative complications:

Immediate reconstruction: odds ratio (OR) 18.1, 95% CI [confidence interval values], p = 0.004

Radiotherapy: OR 18.0, 95% CI [confidence interval values], p = 0.007

Higher ASA score: OR 6.32, 95% CI [confidence interval values], p = 0.004

The choice of surgical plane (prepectoral vs. retropectoral) was not an independent risk factor for complications (OR 1.64, 95% CI [confidence interval values], p = 0.394). Higher BMI (OR 0.83, 95% CI [confidence interval values], p = 0.057) and bilateral reconstruction (OR 4.44, 95% CI [confidence interval values], p = 0.055) demonstrated trends toward significance but did not reach the predefined threshold.

Discussion

The results of this long-term comparative analysis indicate that prepectoral (PP) implant-based breast reconstruction (IBBR) is a safe and effective alternative to the traditional subpectoral (SP) approach. Our findings demonstrate an equivalent overall complication profile, with complication rates of 23.3% in the prepectoral group compared to 22.6% in the subpectoral cohort. These figures align closely with existing systematic reviews which suggest that both planes of reconstruction are similarly effective in restoring body image and quality of life after mastectomy. [16,19-27] While the PP approach was historically abandoned in the 1970s due to high failure rates, its modern renaissance is supported by innovations in acellular dermal

matrices (ADMs) and synthetic meshes, which act as an internal "hammock" to stabilize the device. [6,11,12,14,28, 29]

One of the most significant findings in this study is the comparable rate of capsular contracture between the two groups (2.3% PP vs 3.8% SP) over a mean follow-up of nearly 42 months. Capsular contracture remains the most common late complication in alloplastic reconstruction, traditionally occurring in up to 30% of cases. [30, 31] Some literature suggests that prepectoral placement might actually reduce the incidence of contracture by avoiding the inflammatory response associated with muscle dissection. [6] Furthermore, the presence of the pectoralis muscle in submuscular pockets can exacerbate contraction through radiation-induced fibrosis, a phenomenon not observed when the implant is in the anatomical prepectoral plane. [32, 33]

Crucially, our data identified a strong trend toward higher late implant exchange or removal rates in the subpectoral cohort (15.1% vs 4.7%). This suggests that the prepectoral technique may offer superior long-term implant durability. The subpectoral plane often suffers from animation deformity—where the breast moves unnaturally during muscle contraction—and "window-shading," which frequently necessitates revisional surgery. [3, 34] By preserving the integrity of the pectoralis major, PPBR eliminates these biomechanical stressors. [35,36]

Multivariable analysis confirmed that the choice of surgical plane is not an independent risk factor for postoperative complications. Instead, complication risk is driven by biological and procedural variables. Radiotherapy emerged as the strongest predictor of complications (OR 18.0, $p = 0.007$). Radiation induces tissue changes including reduced vascularity, fibrosis, and skin contracture that compromise the reconstructive envelope and impair wound healing. [37] Immediate reconstruction performed at the time of mastectomy carried significant risk (OR 18.1, $p = 0.004$), likely attributable to the immediate physiological stress on freshly created mastectomy flaps with compromised perfusion. [38, 39]. Indocyanine green angiography was not routinely used at our institution during the study period. Given its demonstrated utility in assessing mastectomy flap perfusion, incorporation of this technology may help reduce ischemic complications in future cases. [40]

Patient comorbidities played a crucial role, with higher ASA scores independently predicting complications (OR 6.32, $p = 0.004$). This underscores that systemic health status is more critical to reconstructive success than the choice of anatomical pocket. Higher BMI demonstrated a trend

toward increased complications (OR 0.83, p = 0.057), though this did not reach statistical significance. [5] Previous studies have associated elevated BMI with increased rates of seroma in retropectoral cases and skin necrosis in prepectoral cases, which may partially explain this relationship. [3]

This study supports the continued global shift toward prepectoral techniques. The PP approach is associated with significantly reduced postoperative pain, decreased opioid consumption, and faster functional recovery of the upper extremities [3, 7, 16, 18, 20, 41]. However, mastectomy flap perfusion remains the critical determinant of success in prepectoral breast reconstruction. When flaps are excessively thinned or inadequately perfused, the absence of a vascularized muscle layer between the implant and skin means that even minor ischemic necrosis can progress rapidly to implant exposure [42, 43]. Therefore, stringent patient selection and the use of intraoperative perfusion assessment tools, such as indocyanine green angiography, are essential to ensure flap viability and optimize outcomes [40].

This study has several limitations. The retrospective design and single-institution setting may limit generalizability of the findings. Although our multivariable model demonstrated adequate calibration, the smaller sample size in the retropectoral cohort (n = 53) compared to the prepectoral group (n = 86) reflects the ongoing clinical shift toward prepectoral placement at our institution and may introduce selection bias. Additionally, the lack of standardized patient-reported outcome measures (PROMs) prevents comprehensive assessment of aesthetic satisfaction, quality of life, and functional outcomes from the patient perspective. Future prospective, multicenter trials incorporating validated PROMs are needed to more fully evaluate the aesthetic, functional, and psychological benefits of prepectoral reconstruction and to confirm these findings in more diverse patient populations.

Conclusions

Prepectoral breast reconstruction is a safe and viable alternative to the traditional retropectoral approach, with equivalent complication rates and a trend toward improved long-term implant durability. The choice of surgical plane should be individualized based on patient-specific risk

factors, particularly radiotherapy exposure, mastectomy flap perfusion, and overall medical comorbidities, rather than adhering to a universal protocol. Independent predictors of complications include radiotherapy, immediate reconstruction, and higher ASA scores, not the anatomical plane of placement. These findings support the continued adoption of prepectoral reconstruction while emphasizing the importance of careful patient selection and meticulous surgical technique.

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Tables

Table 1. Demographics of patients at time of study.

Table 2. Comparison of peri-operative parameters in the two groups of patients.

Table 3. Postoperative complications at follow-up.

Table 4. Multivariable logistic regression was used to assess independent risk factors for complications based on whether technique was used, with adjusted odds ratios provided.

Table 1. Demographics of patients at time of study.

	Prepectoral (n=86)	*Retropectoral (n=53)*	*p-value*
Age (mean ± SD)	52.3±13.9	53.8±13.0	0.748
Mean BMI (kg/m^2)	25.1±3.9	24.7±5.0	0.908
Any comorbidity	27 (31.4%)	16 (30.2%)	0.881
Diabetics	1 (1.2%)	3 (5.7%)	0.123
Hypertension	15 (17.4%)	10 (18.9%)	0.832
Pulmonary disease	3 (3.5%)	4 (7.5%)	0.288
Depression	6 (7.0%)	5 (9.4%)	0.602
Lipid disease	11 (12.8%)	6 (11.3%)	0.797
Smokers	19 (22.1%)	14 (26.4%)	0.561
Herbal supplement	6 (7.0%)	3 (5.7%)	0.759
Neo-Adjuvant radiotherapy	0 (0.0%)	1 (1.9%)	0.381
Neo-Adjuvant chemotherapy	6 (7.0%)	0 (0.0%)	0.082
Radiotherapy	30 (34.9%)	20 (37.7%)	0.734
Chemotherapy	38 (44.2%)	25 (47.2%)	0.731
Axillary Lymphadenectomy	23 (26.7%)	16 (30.2%)	0.661
Follow-up (months)	39.0±40.5	46.3±44.1	0.321

Table 2. Comparison of peri-operative parameters in the two groups of patients.

	Prepectoral (n=86)	*Retropectoral (n=53)*	*p-value*
ASA Score (mean ± SD)	1.88±0.67	1.81±0.70	0.589
Operative time (min, mean ± SD)	142.2±79.3	143.0±73.4	0.960
Bilateral Reconstructions	25 (29.1%)	13 (24.5%)	0.560
Resection weight (g, mean ± SD)	456.0±261.3	516.9±343.5	0.299
Immediate Reconstruction	56 (65.1%)	38 (71.7%)	0.420
Two-Stage Reconstruction	30 (34.9%)	15 (28.3%)	0.421
Immediate Symmetrization	13 (15.1%)	11 (20.8%)	0.650
Blood loss (ml, mean ± SD)	133.7±156.4	133.3±148.7	0.988
Implant Size (cc, mean ± SD)	338.4±125.9	316.8±112.1	0.315
Tigr Mesh Use	45 (52.3%)	21 (39.6%)	0.145
Hospital stay (days, mean ± SD)	0.93±1.10	1.21±1.30	0.176

Table 3. Postoperative complications at follow-up.

	Prepectoral (n=86)	*Retropectoral (n=53)*	*p-value*
Patients with complications (medical included)	20 (23.3%)	12 (22.6%)	0.933
Complications			
Superficial wound infection (received antibiotics <30 days)	13 (15.1%)	6 (11.3%)	0.527
Deep wound infection (revision in local anaesthetics or general)	4 (4.7%)	4 (7.5%)	0.480
Wound dehiscence (need for revision -local/general)	6 (7.0%)	8 (15.1%)	0.122
Fat necrosis (need for operation)	3 (3.5%)	1 (1.9%)	1.000
Skin necrosis	7 (8.1%)	4 (7.5%)	1.000
Hematoma (need for operation)	1 (1.2%)	2 (3.8%)	0.558
Seroma (requiring aspiration after drains removal)	8 (9.3%)	4 (7.5%)	1.000
Reoperation <30 days	13 (15.3%)	10 (18.9%)	0.584
Implant removal <30 days	10 (11.6%)	9 (17.0%)	0.448
Capsular contracture	2 (2.3%)	2 (3.8%)	0.636
Implant Changes/Removal >30days	4 (4.7%)	8 (15.1%)	0.058
Reoperation at follow up, more than 30 days post operatively	14 (16.5%)	13 (24.5%)	0.246

Mean number or operations	0.9±1.2	1.0±1.3	0.713
Re-admissions <30 days	14 (16.3%)	5 (9.4%)	0.315
Reoperation for dog-ear / scar revision	1 (1.2%)	3 (5.7%)	0.155

Table 4. Multivariable logistic regression was used to assess independent risk factors for **complications** based on whether technique was used, with adjusted odds ratios provided.

	Odd Ratios	*95% Confidence Interval*	*p-value*
Immediate Reconstruction	18.1	2.56-128.77	**0.004**
Radiotherapy	18.0	2.20-147.07	**0.007**
ASA score	6.32	1.82-22.01	**0.004**
Bilateral Reconstruction	4.44	0.97-20.34	0.055
Prepectoral	1.64	0.52-5.15	0.394
Hypertension	1.18	0.22-6.26	0.843
Tigr Mesh	1.11	0.30-4.01	0.874
Implant Size	1.05	0.99-1-01	0.086
Pulmonary disease	1.02	0.11-9.69	0.989
Operative time	1.00	0.99-1.01	0.815
Blood loss	1.00	0.99-1.00	0.952
Age	0.98	0.93-1.03	0.516
BMI	0.83	0.68-1.01	0.057
Depression	0.74	0.11-4.98	0.760
Smoking	0.45	0.92-2.18	0.320
Axillary Lymphadenectomy	0.37	0.05-2.52	0.310
Diabetes	0.11	0.20-5.01	0.255