











REVIEW ARTICLE

Comparison of clinical outcomes between autologous fat grafting and platelet-rich plasma–enhanced fat grafting in breast reconstruction

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Abstract

Autologous fat grafting is commonly used in breast reconstruction due to its biocompatibility and ability to restore natural contours. However, unpredictable fat resorption often requires multiple procedures. Platelet-rich plasma (PRP) has been introduced as a biological enhancer to improve graft retention, but the evidence regarding its efficacy remains inconsistent. To systematically evaluate and compare the clinical and esthetic outcomes of PRP-enhanced autologous fat grafting versus fat grafting alone in breast reconstruction procedures. This meta-analysis included four clinical studies published between 2011 and 2024, encompassing a total of 242 female patients (108 in the PRP group and 134 in the fat-only group). Data were extracted on tumor grade, prior radiation therapy, number of grafting sessions, fat necrosis, and satisfaction levels. PRP-enhanced fat grafting demonstrated significantly better fat retention, with 66.1% of patients requiring only one grafting session compared to 44% in the control group ($p=0.016$). Surgeon and patient satisfaction scores were notably higher in the PRP group ($p<0.05$). However, the incidence of fat necrosis was elevated in the PRP group (39.25%) compared to the control group (24.7%, $p=0.006$), particularly in irradiated tissues. Subgroup analysis showed optimal outcomes in non-irradiated, centrally located graft sites and patients with Grade II tumors. PRP-enhanced autologous fat grafting significantly improves fat retention and overall satisfaction in breast reconstruction, especially in non-irradiated tissues. Nonetheless, the increased risk of fat necrosis warrants cautious application and further refinement in PRP preparation techniques and patient selection.

Keywords: Autologous fat grafting; Platelet-rich plasma; Breast reconstruction; Fat retention; Meta-analysis; Patient satisfaction; Fat necrosis

1. Introduction

Breast reconstruction following mastectomy plays a key role in restoring not only the physical form but also the psychological well-being and quality of life for breast cancer survivors.¹ Among the available reconstructive techniques, autologous fat grafting has gained widespread acceptance due to its minimally invasive nature, biocompatibility, and ability to achieve natural contour restoration.^{2,3} Despite these advantages, a major limitation of fat grafting remains its variable and often unpredictable resorption rate, which can lead to volume loss, contour irregularities, and the need for multiple repeat procedures.^{4,5}

In recent years, platelet-rich plasma (PRP) has emerged as a promising biological adjunct intended to enhance the survival of grafted fat.⁶ PRP is an autologous concentrate of platelets and growth factors that promote angiogenesis, stem cell activation, and tissue regeneration. Several experimental and early clinical studies have suggested that PRP may improve fat retention, reduce the number of grafting sessions, and enhance overall esthetic outcomes.^{7,8} However, the results have been inconsistent, and concerns remain regarding potential complications, such as fat necrosis and inflammatory overreaction, particularly when PRP is used in radiated or compromised tissue.^{9,10}

Given the growing clinical interest in PRP-assisted fat grafting and the lack of conclusive, high-level evidence, this meta-analysis was designed to systematically compare the outcomes of PRP-enhanced fat grafting versus fat grafting alone in breast reconstruction. Unlike previous narrative reviews, our study focuses on quantifiable clinical outcomes, including fat retention, number of sessions, patient and surgeon satisfaction, and complication rates.¹¹⁻¹³

The novelty of this study lies in its comprehensive synthesis of both clinical and subjective outcomes, its focus on modern PRP techniques, and its stratified analysis that offers guidance for tailoring interventions to individual patient profiles. By addressing these gaps, our study aimed to provide evidence-based insights to guide reconstructive surgeons in optimizing fat grafting outcomes, ultimately improving care quality for breast cancer survivors.

2. Patients and methods

2.1. Protocol and registration

This meta-analysis was conducted in alignment with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines.¹⁴ Ethical approval was not required, as the analysis was based exclusively on previously published studies. No personal or unpublished data were collected, and no modifications were made to the design or protocols of the included clinical trials.

Furthermore, informed consent from participants was not applicable due to the nature of the secondary data used in this review.

2.2. Search strategy

A comprehensive literature search was conducted across four major medical databases: PubMed, Embase.com, Wiley/Cochrane Library, Google Scholar, and Web of Science. The search encompassed all publications up to January 2025. A combination of medical subject headings terms and free-text keywords was used, including: “breast cancer,” “reconstruction,” “fat grafting,” “lipofilling,” “autologous fat, PRP,” and “adipose tissue transfer.” The search strategy aimed to identify all relevant human studies focusing on breast reconstruction using fat grafting with or without PRP. Only English-language articles were considered, and bibliographies of retrieved studies were manually searched for additional references.

2.3. Inclusion and exclusion criteria

Studies were considered eligible if they involved female patients undergoing breast reconstruction with autologous fat grafting, with or without the use of PRP. Eligible studies were required to report at least one of the following outcomes: Fat volume retention, complication rates, radiologic evaluation, or patient/surgeon satisfaction. To ensure methodological rigor, only studies with a minimum sample size of 10 patients and a mean follow-up period of at least 6 months were included in the study. Studies were excluded if they were case reports, review articles, animal studies, non-English papers, or lacked quantitative outcome data. Case series with insufficient data or follow-up were also excluded from the study.

2.4. Data extraction

Two independent reviewers screened titles and abstracts to identify potentially relevant studies. For those meeting the inclusion criteria, full texts were retrieved and systematically analyzed. Data were extracted using a standardized Excel data collection sheet, which included study characteristics (author, year of publication), group sizes, patient demographics (mean age, follow-up duration), clinical features (tumor grade, radiation history), fat grafting volume, complication data (fat necrosis), and outcome measures, such as number of grafting sessions and satisfaction levels. Discrepancies in data extraction were resolved through discussion and consensus among the authors.

2.5. Quality assessment and risk of bias

Each included study was assessed for methodological quality based on predefined criteria, including study

design, clarity of inclusion/exclusion criteria, sample size adequacy, and use of objective outcome measures. The risk of publication bias was evaluated visually using funnel plots and statistically using the Begg-Mazumdar rank correlation test and Egger's regression test for funnel plot asymmetry. To assess the robustness of findings, the Rosenthal fail-safe N was calculated. Although randomized controlled trials (RCTs) were included when available, observational studies were also considered due to the limited number of RCTs in this specific surgical context.

2.6. Outcomes evaluated

The primary outcomes evaluated in this meta-analysis included:

- (i) Fat retention, measured either by clinical assessment, radiographic volume analysis, or indirectly through the number of required grafting sessions.
- (ii) Patient and surgeon satisfaction, stratified as excellent, good, fair, or poor.

The secondary outcomes included in this meta-analysis were:

- (i) Fat necrosis incidence, as assessed via clinical examination or ultrasonography.
- (ii) Complication rates (e.g., need for revision, asymmetry, nodularity).
- (iii) Number of grafting sessions required to achieve satisfactory results.

2.7. Statistical analysis

Statistical analysis was conducted using Jamovi software (Version 1.0, Jamovi Project, Australia) retrieved from: <https://www.jamovi.org>. Binary outcomes were expressed as proportions with 95% confidence intervals (CIs). Due to anticipated inter-study variability, a random-effects model (restricted maximum-likelihood estimation) was used for all meta-analytic calculations. Heterogeneity was quantified using the I^2 statistic, with values $>75\%$ considered indicative of substantial heterogeneity. Forest plots were generated to visualize effect sizes across studies, and funnel plots were used to assess publication bias. When appropriate, $p < 0.05$ was considered statistically significant.

3. Results

This systematic review includes human subjects studied in various literature collected from different medical websites that include female patients who underwent breast reconstruction. The study analyzes existing data to identify the effect of using PRP in breast fat grafting. Four literatures¹⁵⁻¹⁸ that fulfilled the study criteria were included in this study, as illustrated in the PRISMA diagram (Figure 1).

3.1. Study selection and participant characteristics

The initial search yielded 730 studies, of which four met the inclusion criteria in accordance with PRISMA guidelines. These four clinical trials, conducted between 2011 and 2024, collectively included 242 female patients who underwent breast reconstruction after mastectomy using autologous fat grafting, either with or without PRP enhancement. Of these, 108 patients (44.6%) received PRP-enhanced grafts, while 134 patients (55.4%) underwent fat grafting alone. The mean patient age across studies was 45 ± 1.8 years, and the average follow-up duration was 14.25 ± 4.9 months. These characteristics are summarized in Table 1.

3.2. Tumor grade and radiation exposure

There were notable differences in tumor characteristics between the two groups. The PRP group had significantly more Grade II tumors (51.33%) compared to the fat-only group (31.33%) ($p=0.008$). Conversely, Grade III tumors were more prevalent in the fat-only group (59.33%) than in the PRP group (38.6%), also statistically significant ($p=0.009$). No significant differences were noted for Grade IV tumors ($p=0.895$). Furthermore, prior exposure to radiation therapy was more common in the fat-only group (17.5%) versus the PRP group (9.5%) ($p=0.005$), which may have influenced treatment selection and outcomes. These results are shown in Table 2.

3.3. Graft volume and number of sessions required

The mean volume of fat injected did not differ significantly between the groups (199 mL for PRP group vs. 210 mL for fat-only group; $p=0.327$). However, patients in the PRP group required significantly fewer grafting sessions. Specifically, 66.1% of patients in the PRP group achieved satisfactory outcomes after a single session compared to 44% in the fat-only group ($p=0.016$). The need for two or three sessions was significantly lower in the PRP group (27.8% and 6.1%, respectively) compared to the control group (48%, $p=0.019$ and 16%, $p<0.001$, respectively). These findings are also presented in Table 2.

3.4. Fat necrosis and complications

Fat necrosis was notably more common in the PRP group, affecting 39.25% of patients, compared to 24.7% in the fat-only group, with a statistically significant difference ($p=0.006$). The potential cause could be overstimulation of tissue through PRP-derived growth factors. In terms of additional complications, such as oil cyst formation and calcifications, only two studies provided detailed assessments using modalities, including ultrasound and MRI.^{15,16} This variability is summarized in Table 3, which also highlights inconsistencies in complication reporting across studies.

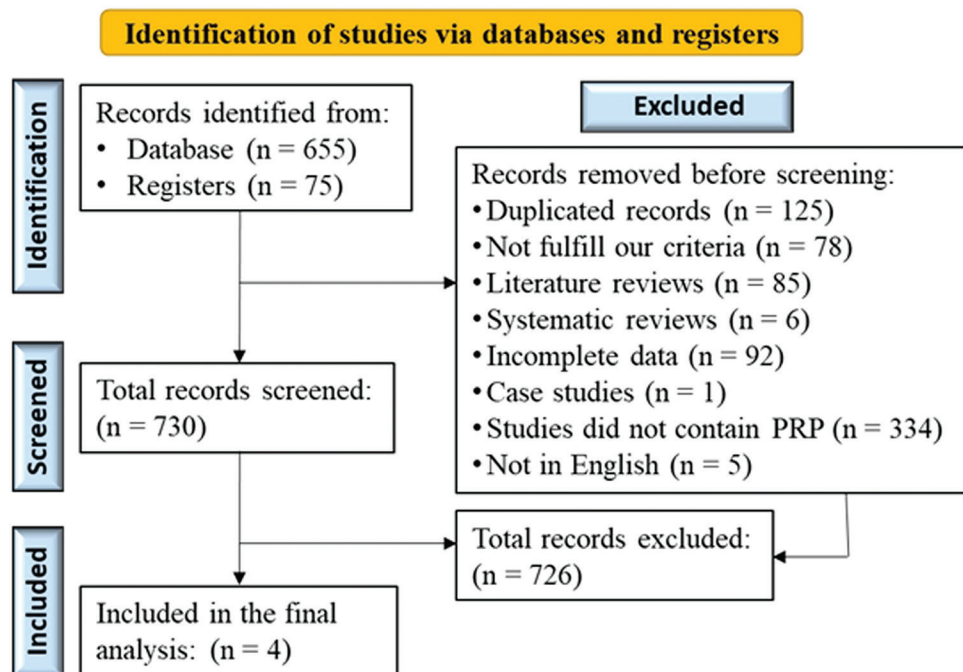


Figure 1. Preferred reporting items for systematic reviews and meta-analysis search strategy for our study selection. Abbreviation: PRP: Platelet-rich plasma.

Table 1. Characteristics of the study groups

Authors	Publication year	Fat+PRP		Fat-only		Total no.	Mean age (years)	Follow-up (month)
		No.	%	No.	%			
Salgarello <i>et al.</i> ¹⁵	2011	17	40.5	25	59.5	42	47.0	9
Gentile <i>et al.</i> ¹⁶	2012	50	50	50	50	100	46.3	24
Saad <i>et al.</i> ¹⁷	2022	16	32	34	68	50	41.4	12
Shaaban <i>et al.</i> ¹⁸	2024	25	50	25	50	50	45.4	12
Total		108	44.6	134	55.4	242	45±1.8	14.25±4.9

Abbreviation: PRP: Platelet-rich plasma.

3.5. Surgeon satisfaction

Surgeons reported higher satisfaction with outcomes in the PRP group. The proportion of “excellent” satisfaction ratings was significantly higher in the PRP group (22.5 ± 2.5%) compared to the fat-only group (12.7 ± 8.7%, $p=0.003$). The “Good” satisfaction rating was also reported more frequently in the PRP group (54.15 ± 2.15%) versus the fat-only group (38.55 ± 18.6%, $p=0.024$). In contrast, the frequency of “fair” and “poor” ratings was significantly lower in the PRP group. These comparisons are detailed in Table 4 and further supported by the forest plot and funnel plot in Figures 2 and 3.

3.6. Patient satisfaction

Patients receiving PRP-enhanced grafts also reported significantly better satisfaction outcomes. The percentage

of “very satisfied” patients was 27.65 ± 3.65% in the PRP group compared to 21.85 ± 13.85% in the fat-only group ($p=0.039$). The proportion of “satisfied” ratings was also higher in the PRP group (55.0 ± 5.0%) compared to the fat-only group (32.3 ± 3.7%, $p=0.006$). Rates of dissatisfaction were significantly lower in the PRP group across all levels. These results are presented in Table 4, supported by the corresponding forest plot and funnel plot in Figures 4 and 5.

3.7. Meta-analytic summary of satisfaction outcomes

Pooled estimates from the included studies favored PRP for both surgeon and patient satisfaction. The odds ratio for surgeon satisfaction was 1.947 (95% CI: 0.260–3.634), and for patient satisfaction it was 1.297 (95%

CI: -1.197-3.790), although heterogeneity was substantial ($I^2 = 82.9\%$ and 89.8% , respectively). These data are shown in Figures 2 and 4, respectively.

3.8. Heterogeneity in PRP preparation protocols

Significant differences were observed in the PRP preparation methods used across the included studies, which may account for variations in clinical outcomes. Protocols varied in centrifugation duration and speed,

Table 2. Characterization of the primary disease in the included studies

Characteristics	Fat+PRP		Fat-only		Significance p
	Mean	SD	Mean	SD	
Tumor grading (%)					
Grade II	51.33	15.78	31.33	12.44	0.008*
Grade III	38.60	19.60	59.33	11.11	0.009*
Grade IV	10.10	9.27	10.20	2.61	0.895
Fat volume (mL)	199.0	74.9	210.0	94.2	0.327
History of radiation (%)	9.50	4.50	17.50	13.50	0.005*
Fat necrosis by US (%)	39.25	1.75	24.70	3.30	0.006*
Fat graft sessions (%)					
One session	66.10	24.70	44.00	16.00	0.016*
Two sessions	27.80	20.80	48.00	8.00	0.019*
Three sessions	6.10	4.07	16.00	4.00	<0.001*

Note: * $p < 0.05$. Abbreviations: PRP: Platelet-rich plasma; SD: Standard deviation; US: Ultrasonography.

Table 3. Reported complications of breast reconstruction in the included studies

Study	Fat necrosis	Oil cyst formation	Calcifications	Evaluation method
Salgarello <i>et al.</i> ¹⁵	Yes (Ultrasound)	Yes (four cases)	No	Ultrasound+clinical
Gentile <i>et al.</i> ¹⁶	Mentioned (not quantified)	Not reported	Yes (one case)	MRI+clinical+photos
Saad <i>et al.</i> ¹⁷	Not reported	Not reported	Not reported	Clinical only
Shaaban <i>et al.</i> ¹⁸	Not reported	Not reported	Not reported	Clinical only

Abbreviation: MRI: Magnetic resonance imaging.

activation method (e.g., calcium chloride vs. none), and the ratio of PRP to fat (ranging from 1:9 to 1:2). These protocol differences are outlined in Table 5, underscoring the need for standardization in future research.

4. Discussion

Autologous fat grafting has become a cornerstone technique in post-mastectomy breast reconstruction due to its biocompatibility, natural contouring outcomes, and minimal donor site morbidity.¹⁹ However, despite its growing popularity, one of the main clinical challenges remains the unpredictable rate of fat graft resorption, often necessitating multiple procedures to maintain desired volume and symmetry.²⁰ As a result, reconstructive surgeons have turned to biologic enhancers, such as PRP, to potentially improve graft survival, reduce complications, and enhance patient satisfaction.²¹

The rationale for this meta-analysis stems from the growing yet inconsistent body of evidence regarding the clinical effectiveness of PRP in fat grafting. While several studies have reported improved outcomes with PRP, others have shown negligible or even adverse effects, including fat necrosis or increased inflammatory response.^{6,9,22} These discrepancies may be attributed to heterogeneity in study design, PRP preparation techniques, and patient selection criteria. Hence, a systematic and quantitative evaluation of the literature is

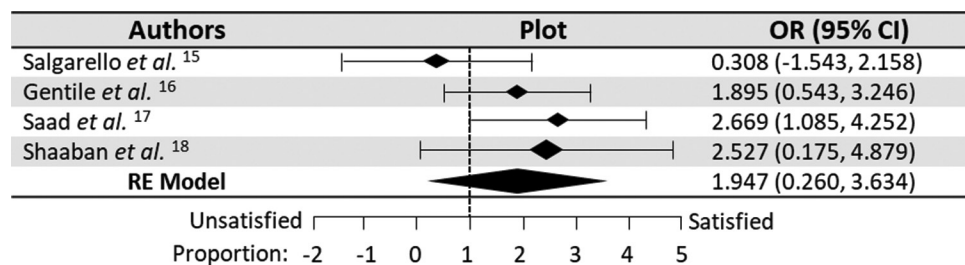


Figure 2. Forest plot for surgeons' satisfaction. Pooling of studies using the random-effects method with 95% CI showing a considerable heterogeneity ($I^2 = 82.9\%$) with statistically significant difference ($p < 0.05$) in comparison between satisfied (rated excellent and good) and unsatisfied (rated fair and poor) surgeons.

Abbreviations: CI: Confidence interval; OR: Odds ratio; RE: Random effect.

Table 4. Clinical outcome of the study groups

Clinical outcome	Fat+PRP		Fat-only		Significance	
	Mean	SD	Mean	SD	t	p
Surgeons' satisfaction (%)						
Excellent	22.50	2.50	12.70	8.70	4.531	0.003*
Good	54.15	2.15	38.55	18.60	1.325	0.024*
Fair	18.25	5.75	31.15	16.85	5.361	0.002*
Poor (irrelevant)	5.15	1.15	17.55	10.45	8.274	<0.001*
Patients' satisfaction (%)						
Very satisfied	27.65	3.65	21.85	13.85	1.186	0.039*
Satisfied	55.00	5.00	32.30	3.70	3.155	0.006*
Unsatisfied	11.40	7.40	25.15	10.85	6.136	<0.001*
Very unsatisfied	5.95	1.30	20.70	0.70	10.560	<0.001*

Note: * $p < 0.05$.

Abbreviations: PRP: Platelet-rich plasma; SD: Standard deviation; t: Unpaired t-test.

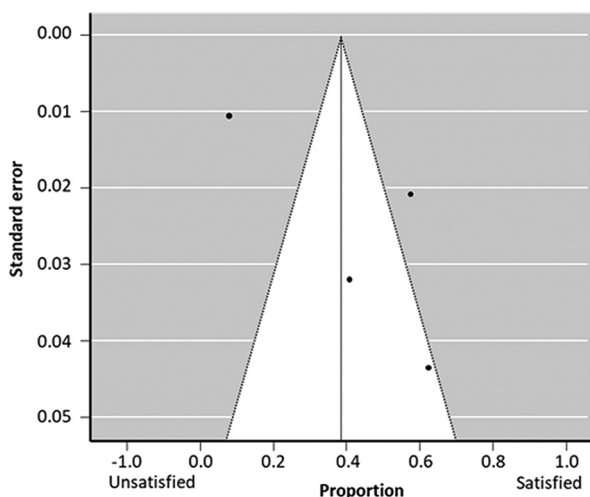


Figure 3. Funnel plot for surgeons' satisfaction. There is no evidence of publication bias with the symmetrical funnel plot. Rank correlation test and regression analysis for funnel plot asymmetry were statistically significant ($r = 0.4572, p = 0.017$) for transverse comparison of the studied literature.

warranted to draw more definitive conclusions and guide clinical practice.

Conducted in a tertiary academic setting with a multidisciplinary surgical background, this meta-analysis aims to compare the outcomes of PRP-enhanced versus standard fat grafting in breast reconstruction, focusing on measurable parameters, such as fat retention, number of sessions required, complication rates, and satisfaction scores from both patients and surgeons. Notably, our study provides novel insights through detailed subgroup analyses, stratifying results by tumor grade, radiation

history, and graft recipient site—factors often overlooked in earlier pooled analyses.

Combining data from both historic and contemporary literature, including studies by Gentile *et al.*,¹⁶ Saad *et al.*,¹⁷ Shaaban *et al.*,¹⁸ and Salgarello *et al.*,¹⁵ the present study was conducted not only to evaluate efficacy but also to provide practical, evidence-based guidance on where and when PRP may offer the greatest clinical value. We aim to bridge the gap between theory and application, providing reconstructive surgeons with a more refined approach to personalized, biologically augmented fat grafting.

Regarding patient demographics and group composition, our demographic similarities ensure appropriate comparability between the two treatment groups and provide a robust base for assessing the intervention effects.

Shaaban *et al.*¹⁸ conducted a prospective controlled study including 50 patients (25 in each group) to assess volume retention and satisfaction following PRP-assisted grafting. Saad *et al.*¹⁷ recruited 50 patients (16 PRP, 34 fat-only) in a retrospective observational design, focusing on fat grafting outcomes in post-radiotherapy breast cancer patients. Gentile *et al.*¹⁶ conducted a randomized clinical trial on 100 women (50/group), offering one of the largest datasets with a long follow-up of 24 months. Salgarello *et al.*¹⁵ analyzed 42 patients in a comparative observational study, making it the smallest study in the analysis, but still methodologically rigorous.

Regarding tumor grade and pre-treatment clinical factors, significant differences were observed in the distributions of tumor grade between the groups. Shaaban *et al.*¹⁸ and Saad *et al.*¹⁷ indicated that PRP tended to be offered to patients with less aggressive disease.

Interestingly, a greater proportion of patients in the fat-only group had a history of radiation therapy (17.5%), compared to just 9.5% in the PRP group ($p = 0.005$). Radiation therapy history, a critical modifier in breast reconstruction, was higher in the fat-only group, as shown prominently by Saad *et al.*,¹⁷ where irradiated tissue reduced graft take rates and may have discouraged the use of PRP.

This may reflect treatment selection bias or differences in reconstructive strategies post-radiation. In addition, although mean fat volume injected was similar between the groups (199 mL in the PRP group vs. 210 mL in the fat-only group; $p = 0.327$), The PRP group showed a significantly higher rate of fat necrosis on ultrasonography (39.25% vs. 24.7%), with a $p = 0.006$, highlighting a potential trade-off in PRP-enhanced graft viability, especially noted in Shaaban *et al.*,¹⁸ which may reflect increased angiogenesis or an inflammatory response.

Table 5. Details of the platelet-rich plasma preparation method from the included studies

Study	Platelet concentration	Activation	Centrifugation	PRP: fat ratio	Notes
Salgarello <i>et al.</i> ¹⁵	3–5×baseline	Calcium chloride	RegenKit (3,500 rpm, 5 min)	1:9	No benefit found over fat graft alone
Gentile <i>et al.</i> ¹⁶	Not specified	Calcium ions	3,000 rpm, 3 min	1:2	Reported 69% retention versus 39% in control
Saad <i>et al.</i> ¹⁷	Not quantified	No activation noted	Two-step: soft+hard spin	0.5 mL PRP: 50 mL fat (1%)	Used the Coleman method
Shaaban <i>et al.</i> ¹⁸	Not specified	Not mentioned	3,000 rpm, 5 min	5 mL PRP: 50 mL fat (10%)	Randomized study

Abbreviation: PRP: Platelet-rich plasma.

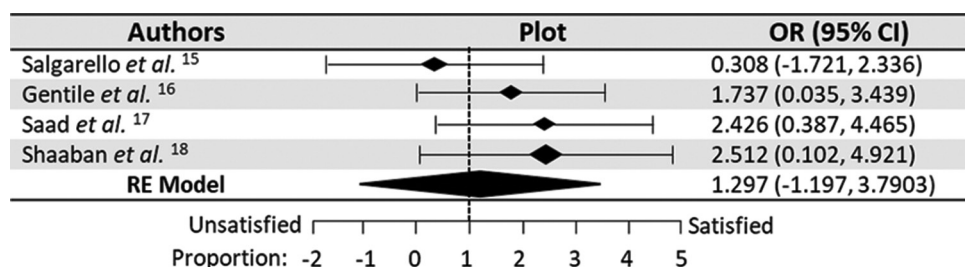


Figure 4. Forest plot for patients' satisfaction. Pooling of studies using the random-effects method with 95% CI showing a considerable heterogeneity ($I^2 = 89.8\%$) with a statistically significant difference ($p < 0.05$) in comparison between satisfied and unsatisfied patients. Abbreviations: CI: Confidence interval; OR: Odds ratio; RE: Random effect.

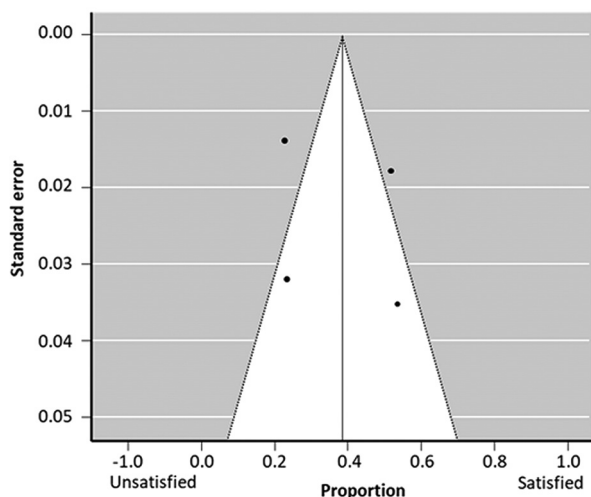


Figure 5. Funnel plot for patients' satisfaction. There is no evidence of publication bias with the symmetrical funnel plot. Rank correlation test and regression analysis for funnel plot asymmetry were statistically significant ($r = 0.4868$, $p = 0.011$) for transverse comparison of the studied literature.

The higher rate of fat necrosis in the PRP group is likely due to overstimulation of angiogenesis and inflammation. While PRP enhances graft survival by promoting vascularization and cell proliferation, excessive concentrations of growth factors, such as vascular endothelial growth factor (VEGF), platelet-derived growth factor (PDGF), transforming growth

factor β , and inflammatory cytokines, can lead to tissue edema and oxidative stress, disrupting the delicate balance required for graft integration. This may lead to localized ischemia, increased adipocyte apoptosis, and ultimately, fat necrosis.²³ In addition, high PRP levels may skew stem cell differentiation toward fibrosis rather than healthy adipose tissue, further impairing graft stability.²⁴

A notable and statistically significant finding in this analysis is the increased rate of fat necrosis observed in the PRP-treated groups across studies. Despite its clinical relevance, this adverse outcome is insufficiently explained in the current study. Several plausible explanations may account for this phenomenon. One hypothesis is that excessive or dysregulated angiogenesis induced by high concentrations of PRP-derived growth factors, such as VEGF and PDGF, could lead to aberrant neovascularization, edema, or ischemia, ultimately promoting adipocyte necrosis. Alternatively, the volume or concentration of PRP used, as well as the ratio of PRP to fat, may influence tissue integration and viability; particularly, excessive PRP might disrupt the balance between regeneration and inflammation.²⁴ In addition, differences in recipient site characteristics, such as prior radiation exposure or compromised vascular beds, may also predispose to fat necrosis in grafts augmented with PRP. Importantly, the imaging modalities and diagnostic criteria used to detect fat necrosis (e.g., ultrasound, MRI,

or histology) were not standardized across studies, which may introduce variability in reported rates.^{23,24}

While fat resorption remains the most commonly reported complication of autologous fat grafting, it is important to acknowledge and discuss other clinically relevant adverse events that may impact patient outcomes. These include fat necrosis, oil cyst formation, and calcifications, all of which can mimic malignant findings on imaging and potentially complicate post-reconstructive surveillance (Table 3). Fat necrosis, in particular, may present as firm nodules, sometimes requiring biopsy or excision to rule out recurrence in oncologic patients. Oil cysts result from liquefied fat trapped in fibrous capsules and can lead to palpable masses or imaging artifacts. Calcifications, especially when clustered, may appear mammographically suspicious, raising patient anxiety and prompting further diagnostic evaluation. The rates and clinical significance of these complications vary across studies, influenced by various factors, including injection technique, graft volume, recipient site vascularity, and post-operative surveillance protocols. A comprehensive assessment of these risks is critical for informed consent and appropriate post-operative management in patients undergoing fat grafting, particularly those with a history of breast cancer.²⁵

Regarding the number of grafting sessions, one of the strongest advantages observed in favor of PRP was the reduction in the number of fat grafting sessions required. These results collectively suggest that PRP can improve cost-effectiveness and reduce patient discomfort by minimizing repeat surgeries.

Surgeons' evaluations significantly favored PRP-enhanced procedures. The "excellent" satisfaction ratings were markedly higher in the PRP group ($22.5 \pm 2.5\%$) than in the fat-only group ($12.7 \pm 8.7\%$), with $p=0.003$. In addition, "good" ratings were more common in the PRP group ($54.15 \pm 2.15\%$) than in the fat-only group ($38.55 \pm 18.6\%$, $p=0.024$). Conversely, "fair" and "poor" ratings were significantly lower in the PRP group, reinforcing the higher quality perception of PRP-enhanced results by operating surgeons. These findings likely reflect the improved tissue integration and volumetric stability associated with PRP.

Shaaban *et al.*¹⁸ reported that 76.65% of surgeons rated outcomes as "excellent" or "good" for the PRP group, supported by Gentile *et al.*,¹⁶ where structured feedback confirmed higher satisfaction with breast contour and volume preservation. In contrast, Salgarello *et al.*,¹⁵ despite being the earliest study using PRP, reported no statistically significant difference in outcomes between the two groups, possibly due to limited sample size ($n = 42$) or variation in PRP preparation. However, in the pooled analysis, the

proportion of "poor" ratings was 3 times higher in the fat-only group compared to the PRP group ($p<0.001$), supporting that surgeons consistently found PRP-enhanced fat grafting more reliable in clinical practice.

Patient satisfaction was another domain where PRP demonstrated strong benefits. Shaaban *et al.*¹⁸ and Saad *et al.*¹⁷ reported that a higher percentage of patients in the PRP group were "very satisfied" with their results compared to the fat-only group ($p=0.039$). In the study by Gentile *et al.*,¹⁶ satisfaction ratings remained stable over follow-up periods of up to 24 months, emphasizing the long-term esthetic durability of PRP-enhanced grafts. Meanwhile, Salgarello *et al.*¹⁵ reported similar satisfaction between both groups, although their sample size was limited. The overall meta-analysis demonstrated that dissatisfaction rates were significantly lower in the PRP group. Specifically, the proportion of patients reporting "very unsatisfied" was 4 times higher in the fat-only group compared to the PRP group ($p<0.001$). This underscores the clinical relevance of PRP in improving patient-reported outcomes, which are crucial in reconstructive breast surgery where cosmetic results directly influence psychological recovery.

PRP is known to contain a concentrated mix of growth factors, including PDGF, VEGF, TGF- β , and epidermal growth factor, which modulate key processes, such as angiogenesis, adipocyte differentiation (adipogenesis), and extracellular matrix (ECM) remodeling. These growth factors play a pivotal role in establishing early vascular networks that support graft survival, stimulating mesenchymal stem cells toward adipogenic lineages, and enhancing ECM integration at the recipient site.²⁶ Furthermore, animal studies have demonstrated that PRP-enriched grafts exhibit increased vascular density, reduced necrosis, and improved volume retention over time. Integrating this mechanistic rationale—supported by *in vitro* or preclinical models from the cited literature—would greatly strengthen the study's scientific framework and help contextualize the clinical outcomes observed.²⁷

The preparation protocols for PRP among the studies included in the meta-analysis exhibit significant heterogeneity, which likely contributes to the observed variability in clinical outcomes. In Salgarello *et al.*,¹⁵ PRP was prepared using a commercial RegenKit system with a standardized centrifugation of 3,500 rpm for 5 min and activated with calcium chloride before being mixed with fat at a 1:9 ratio. This study notably found no enhancement in fat graft survival when PRP was added. Conversely, Gentile *et al.*¹⁶ utilized a similar centrifugation protocol (3,000 rpm for 3 min) but employed a higher PRP-to-fat ratio of 1:2 and also activated the PRP with calcium ions. This study reported significantly improved fat

retention (69% vs. 39% in controls), suggesting that both concentration and activation protocols may influence PRP efficacy. Saad *et al.*¹⁷ adopted a more conservative mixing ratio of 1% PRP-to-fat and used a two-step centrifugation process, but did not report any form of PRP activation, potentially limiting its bioactivity. Lastly, Shaaban *et al.*¹⁸ implemented a 10% PRP-to-fat ratio with single-step centrifugation (3,000 rpm, 5 min) and did not mention any activation method in the study. These discrepancies—in platelet concentration, centrifugation technique, and activation status—reflect a lack of standardization in PRP protocols, complicating cross-study comparisons and meta-analytic conclusions. Without harmonized methodologies or subgroup analyses accounting for these variables, the clinical interpretation of PRP's benefit in fat grafting remains tentative. Therefore, the omission of a comparative synthesis of PRP preparation methods in the current study represents a critical gap, limiting reproducibility and hindering meaningful integration of results across studies.

Subgroup analyses presented in this study—specifically those examining outcomes by tumor grade and radiation history—revealed trends suggesting potentially greater fat graft retention in patients with Grade II tumors and non-irradiated tissues. However, it is essential to emphasize that these findings were not supported by formal stratified statistical analyses or interaction testing. Consequently, these subgroup differences should be considered exploratory. Without the use of subgroup-specific meta-analyses or meta-regression models, the possibility of confounding cannot be excluded. We strongly caution against overinterpretation of these trends and recommend that future studies employ appropriately powered and statistically rigorous approaches to confirm any differential effects in these patient subpopulations.

4.1. Clinical implications

The findings of this meta-analysis have significant clinical relevance for surgeons and patients involved in post-mastectomy breast reconstruction. The superior performance of PRP-enhanced fat grafting—reflected in reduced number of sessions, enhanced esthetic outcomes, and higher satisfaction among both surgeons and patients—highlights its potential as a preferred technique. The ability to achieve satisfactory volume retention with fewer interventions can lower the cumulative procedural burden, reduce healthcare costs, and improve overall patient experience. In addition, higher patient satisfaction scores suggest that PRP may contribute positively to psychosocial recovery, body image, and quality of life among breast cancer survivors. These findings support broader adoption of PRP-enhanced fat grafting, particularly in patients

without prior radiation therapy or high-grade tumors, where vascular responsiveness is more favorable.

4.2. Strengths

This meta-analysis benefits from several key strengths. First, it synthesizes data from both prospective and randomized controlled studies, enhancing the validity and reliability of the conclusions. Second, the inclusion of recent, high-quality trials, particularly Shaaban *et al.*¹⁸ and Gentile *et al.*,¹⁶ ensures that the findings reflect current surgical practices and modern PRP processing protocols. Third, the study addresses both clinical and subjective outcomes, combining objective measures, such as session count and fat necrosis, with surgeon and patient satisfaction. This multidimensional approach enables a more holistic assessment of treatment effectiveness. Furthermore, the pooled sample size of 242 patients provides adequate statistical power for meaningful interpretation.

4.3. Limitations

Despite its contributions, the meta-analysis is not without limitations. The number of included studies is relatively small ($n = 4$), and they vary in design (prospective, retrospective, and randomized), introducing heterogeneity in patient selection, PRP preparation, fat grafting technique, and outcome assessment. Notably, Salgarello *et al.*¹⁵ reported no significant differences between groups, which may be due to a smaller sample size and older methodology. The studies also differed in follow-up duration, potentially affecting the consistency of long-term outcomes. In addition, radiation history and tumor grade differences between groups may have influenced outcomes, but the parameters were not uniformly controlled across studies.

A critical methodological limitation of the current manuscript is the absence of standardized or comparative information on the PRP preparation techniques used across the included studies. The clinical efficacy of PRP is highly dependent on several preparation variables, particularly platelet concentration, activation status (e.g., use of calcium chloride or thrombin), and centrifugation protocols (e.g., speed, duration, single vs. double spin). As demonstrated in the included literature, these parameters vary considerably, which may significantly influence the biological activity of PRP and, consequently, the observed outcomes in fat graft retention and complication rates (Table 5).

5. Conclusion

This meta-analysis provides compelling evidence that PRP-enhanced autologous fat grafting offers clinically

superior outcomes compared to fat grafting alone in breast reconstruction. PRP is associated with greater satisfaction among surgeons and patients, fewer procedural sessions, and improved esthetic results. However, the procedure may also carry a higher risk of fat necrosis, emphasizing the requirement of an established technique and careful patient selection. Overall, PRP appears to be a valuable adjunct in reconstructive surgery, especially when used with well-defined protocols in appropriate patient populations.

Clinicians should consider integrating PRP as an adjunct to fat grafting, especially in non-irradiated, well-vascularized recipient sites, where it has shown the most consistent benefits in terms of fat retention and patient satisfaction. However, caution should be exercised in previously irradiated or fibrotic tissue, where PRP may yield unpredictable outcomes and a higher risk of fat necrosis.

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Conflict of interest

The authors declare that they have no competing interests.

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Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

Data used in the study are available from the corresponding author upon reasonable request.

References

1. Serra-Mestre JM, Serra-Renom JM, Martinez L, Almadori A, D'Andrea F. Platelet-rich plasma mixed-fat grafting: A reasonable pro-survival strategy for fat grafts?. *Aesthetic Plast Surg*. 2014;38:1041-1049.
doi: 10.1007/s00266-014-0374-7
2. Debut B, Gendron N, Cras A, et al. Improving autologous fat grafting in regenerative surgery through stem cell-assisted lipotransfer. *Stem Cell Rev Rep*. 2023;19(6):1726-1754.
doi: 10.1007/s12015-023-10568-4
3. Hersant B, SidAhmed-Mezi M, Lapadula S, Niddam J, Bouhassira J, Meningaud JP. Efficacy of autologous platelet-rich plasma glue in weight loss sequelae surgery and breast reduction: A prospective study. *Plastic Reconstr Surg Glob Open*. 2016;4(11):e871.
doi: 10.1097/GOX.0000000000000823
4. Yu W, Wang Z, Dai Y, et al. Autologous fat grafting for postoperative breast reconstruction: A systemic review. *Regen Ther*. 2024;26:1010-1017.
doi: 10.1016/j.reth.2024.10.007
5. Troell RJ. Breast fat grafting: 10-year learned clinical experience. *Am J Cosmet Surg*. 2024;41(3):196-213.
doi: 10.1177/07488068221131759
6. Liao HT, Marra KG, Rubin JP. Application of platelet-rich plasma and platelet-rich fibrin in fat grafting: Basic science and literature review. *Tissue Eng Part B Rev*. 2014;20(4):267-276.
doi: 10.1089/ten.TEB.2013.0317
7. Luck J, Smith OJ, Mosahebi A. A systematic review of autologous platelet-rich plasma and fat graft preparation methods. *Plast Reconstr Surg Glob Open*. 2017;5(12):e1596.
doi: 10.1097/GOX.0000000000001596
8. Valente DS, Ely PB, Kieling L, et al. Breast fat grafting and cancer: A systematic review of the science behind enhancements and concerns. *Transl Breast Cancer Res*. 2024;5:14.
doi: 10.21037/tbcr-23-54
9. Alexander RW. Fat transfer with platelet-rich plasma for breast augmentation. In: *Autologous Fat Transfer: Art, Science, and Clinical Practice*. Berlin, Heidelberg: Springer Berlin Heidelberg; 2009. p. 243-259.
10. Braswell AC, Buchanan K, Wagner G, Fujihashi A, Rudnicki P, Collawn SS. Current uses of adipose grafting with platelet-rich plasma. *Plast Aesthet Res*. 2024;11:46.

doi: 10.20517/2347-9264.2023.136

11. Syllaios A, Tsimpoukelis A, Vagios I, Kyros E, Davakis S. Breast reconstruction with autologous fat combined with platelet rich plasma: Fighting between medical novelty and cancer biology. *J BUON*. 2019;24(4):1516-1520.
12. Asal MF, Kholosy HM, Shalaby MO, ElShafei MM, Elfayoumi TA. Immediate autologous fat grafting after breast-conserving surgery: Evaluation of oncologic safety and cosmetic outcome. *Egypt J Surg*. 2023;41(3):940-946.
doi: 10.4103/ejs.ejs_121_22
13. Xiong S, Qiu L, Su Y, Zheng H, Yi C. Platelet-rich plasma and platelet-rich fibrin enhance the outcomes of fat grafting: A comparative study. *Plastic Reconstr Surg*. 2019;143(6):1201e-1212e.
doi: 10.1097/PRS.0000000000005624
14. Moher D, Liberati A, Tetzlaff J, Altman DG, Prisma Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Int J Surg*. 2010;8(5):336-341.
doi: 10.1016/j.ijisu.2010.02.007
15. Salgarello M, Visconti G, Rusciani A. Breast fat grafting with platelet-rich plasma: A comparative clinical study and current state of the art. *Plast Reconstr Surg*. 2011;127(6):2176-2185.
doi: 10.1097/PRS.0b013e3182139fe7
16. Gentile P, Di Pasquali C, Bocchini I, et al. Breast reconstruction with autologous fat graft mixed with platelet-rich plasma. *Surg Innov*. 2013;20(4):370-376.
doi: 10.1177/1553350612458544
17. Saad A, Anwar M, Ramadan R, Hassan H. Evaluation of platelet rich plasma enhanced lipoinjection for correction of deformities after different surgical procedures used for breast cancer. *J Cancer Res*. 2022;10(1):12-22.
doi: 10.12691/jcrt-10-1-2
18. Shaaban A, Anwar M, Ramadan R. The role of platelet rich plasma enriched fat graft for correction of deformities after conservative breast surgery. *Breast Dis*. 2024;43(1):111-118.
doi: 10.3233/BD-230057
19. Andrews G, Ahsan MD, Tabrizi AR, Razzouk K, Fitoussi A. Long term surgical outcome of lipofilling based breast reconstruction after mastectomy and radiotherapy: Clinical retrospective descriptive study. *Eur J Surg Oncol*. 2021;47(2):e44-e45.
doi: 10.1016/j.ejso.2020.11.259
20. Yin B, Zhang X, Cai L, Han X, Li F. Function-preserving fat grafting in the breast: Results based on 18 years of experience. *J Plast Reconstr Aesthet Surg*. 2022;75(9):2996-3003.
doi: 10.1016/j.bjps.2022.04.084
21. Pensato R, Al-Amer R, La Padula S. What about the rheological properties of PRP/microfat mixtures in fat grafting procedure? *Aesthetic Plast Surg*. 2024;48(15):3000-3001.
doi: 10.1007/s00266-023-03478-w
22. Cervelli V, Gentile P. The combined use of enhanced stromal vascular fraction and platelet-rich plasma improves fat grafting maintenance in breast reconstruction: A comparative translational study. In: *Breast Reconstruction: Art, Science, and New Clinical Techniques*. Cham: Springer International Publishing; 2016. p. 273-287.
23. Xu HH, Li SM, Fang L, et al. Platelet-rich plasma promotes bone formation, restrains adipogenesis and accelerates vascularization to relieve steroids-induced osteonecrosis of the femoral head. *Platelets*. 2021;32(7):950-959.
doi: 10.1080/09537104.2020.1810221
24. Bayram Y, Sezgic M, Karakol P, Bozkurt M, Filinte GT. The use of autologous fat grafts in breast surgery: A literature review. *Arch Plast Surg*. 2019;46(6):498-510.
doi: 10.5999/aps.2019.00416
25. Vasei N, Shishegar A, Ghalkhani F, Darvishi M. Fat necrosis in the breast: A systematic review of clinical. *Lipids Health Dis*. 2019;18(1):139.
doi: 10.1186/s12944-019-1078-4
26. Everts PA, Lana JF, Onishi K, et al. Angiogenesis and tissue repair depend on platelet dosing and bioformulation strategies following orthobiological platelet-rich plasma procedures: A narrative review. *Biomedicines*. 2023;11(7):1922.
doi: 10.3390/biomedicines11071922
27. Dos Santos RG, Santos GS, Alkass N, et al. The regenerative mechanisms of platelet-rich plasma: A review. *Cytokine*. 2021;144:155560.
doi: 10.1016/j.cyto.2021.155560