

# Complications after Breast Augmentation with Fat Grafting: A Systematic Review

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**Background:** Breast augmentation with fat grafting is used as an alternative to breast implants. However, a systematic evaluation of the complication rates after fat grafting using only studies with consecutive patients has not previously been performed. In this study, the authors compiled studies reporting complication rates and radiologic changes in consecutive patients undergoing cosmetic breast augmentation with fat grafting.

**Methods:** Studies reporting on consecutive patients undergoing breast augmentation with fat grafting were included. Complication rates, radiologic changes, Breast Imaging Reporting and Data System assessments, and the number of patients undergoing revision surgery were extracted. Mean complication rates and radiologic changes were calculated with meta-analytical methods.

**Results:** Twenty-two studies with 2073 patients were included. The rates of major complications were low (hematoma, 0.5 percent; infection, 0.6 percent; and seroma, 0.1 percent). None of these patients needed revision surgery. The most frequent minor complication was palpable cysts in 2.0 percent of the patients; 67 percent of these were treated with aspiration. The radiologic changes in the patients after fat grafting were as follows: oil cysts, 6.5 percent; calcifications, 4.5 percent; and fat necrosis, 1.2 percent. The risk of being referred for additional radiologic imaging (e.g., to exclude malignant changes) was 16.4 percent, and the risk of being referred for biopsy was 3.2 percent.

**Conclusions:** The complication rates after breast augmentation with fat grafting are low and support fat grafting as an alternative to breast augmentation with implants. The rates of radiologic changes are high after fat grafting, but the changes do not seem to have any therapeutic consequences for the patients. (*Plast. Reconstr. Surg.* 145: 530e, 2020.)

**F**at grafting is increasingly used as the sole treatment modality for cosmetic breast augmentation.<sup>1</sup> Thorough knowledge of the complication rates after breast augmentation with fat grafting could improve the shared decision-making between patients and clinicians when deciding whether fat grafting is the better alternative to breast implants in selected cases.<sup>2</sup>

To our knowledge, five previous attempts have been made to review the literature on complications after breast augmentation with fat grafting.<sup>3–7</sup> Unfortunately, these reviews have combined

patients undergoing fat grafting for simple breast augmentations with a variety of other types of patients undergoing more extensive procedures. This included fat grafting in patients who underwent breast reconstruction with radiotherapy and flap-reconstruction or implant-based breast augmentations with fat grafting as an adjunct. We suspect that the complication rates reported in these reviews may be overestimated.

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This systematic review aims to evaluate the complication rates and radiologic changes after breast augmentation with fat grafting using meta-analytical methods on a nonmixed patient population. Also, we assess the risk of undergoing any further procedures on account of the fat grafting procedure (e.g., revision surgery, aspiration, diagnostic imaging, or biopsy).

## PATIENTS AND METHODS

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses<sup>8</sup> and Meta-analysis of Observational Studies in Epidemiology<sup>9</sup> guidelines and the Cochrane handbook of systematic reviews<sup>10</sup> when applicable. The review protocol was constructed a priori, and the selection of studies was independent from the reported results of the studies, to prevent selection bias. The literature screening process and data extraction were conducted by two independent reviewers (M.O. and A.L.). All discrepancies were discussed with a third author (M.N.H.) until consensus was reached.

### Search Strategy and Inclusion Criteria

The literature search was performed in PubMed, EMBASE, EBSCO, and the Cochrane Library using the following search terms: Breast AND (fat graft\* OR autologous fat graft\* OR lipofilling OR fat transfer OR lipotransfer OR lipograft\* OR fat transplantation OR lipomodelling OR lipomodeling). Studies were included if they reported on at least 10 consecutive patients undergoing bilateral breast augmentation with fat grafting or fat grafting after a bilateral breast implant removal. Patients were included only if they received fat grafting as the only treatment modality. Studies were excluded if they reported on patients with breast cancer, congenital deformities, unilateral hypoplasia, or patients receiving fat grafting as an adjunct to breast augmentation with implants. Commentaries, discussions, letters, reviews and studies in languages other than English, German, French, or Spanish were excluded.

### Data Extraction and Quality Assessment

The general study characteristics of the included studies were noted (e.g., number of patients, follow-up period, fat grafting processing method) and the complication rates, radiologic changes, and the Breast Imaging Reporting and Data System<sup>11</sup> assessments were extracted. The number of patients undergoing revision surgery or other further procedures on account of the complications

or radiologic changes was also extracted. In cases where data were not readily extractable, we contacted the corresponding author for clarification. If multiple studies included patients from the same population, we included only data from the most recent study. The Methodological Index for Non-randomized Studies score<sup>12</sup> was used to assess the quality of the included studies.

### Statistical Analysis

All complication rates were calculated with a random effects model with the estimator described by DerSimonian and Laird.<sup>13</sup> Major complications (i.e., hematoma, infection, and seroma) were calculated as the percentage of patients who experienced the complication versus the total number of patients. The rates of minor complications were only calculated based on studies that explicitly reported the complication. Calculation of the frequency by which radiologic changes gave rise to additional procedures were strictly based on studies that examined all included patients with a routine screening as a part of the follow-up program (i.e., excluding studies where radiology was used on a subset of patients). All statistical analyses and figures were performed in the statistical software R, version 3.4.1 with the metafor and ggplot2 packages.<sup>14,15</sup>

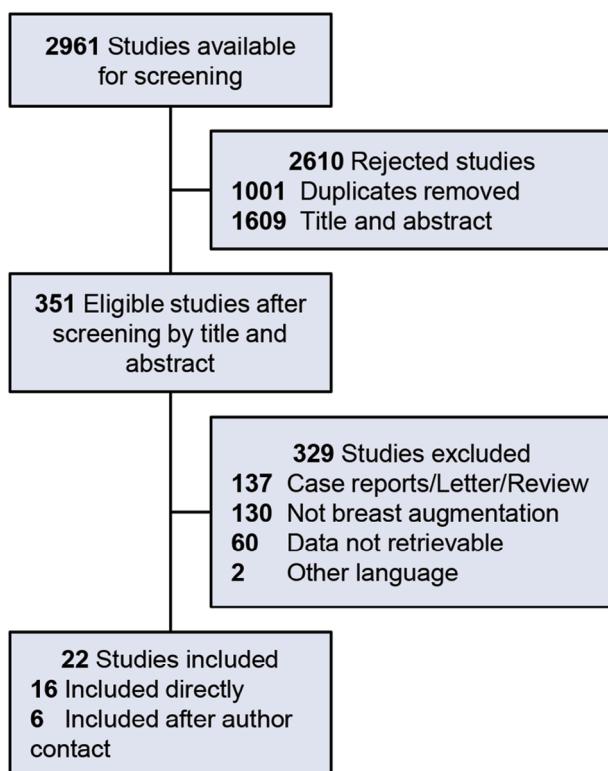
## RESULTS

### Search Results

The search provided a total of 2961 citations. Sixteen studies could be included directly after the review process, and six additional studies could be included after correspondence with the authors (60 corresponding authors were contacted). A total of 22 studies were included in the systematic review. The flow chart describing the screening process is shown in Figure 1.

### Study Characteristics

Twenty studies reported outcomes for a total of 2073 patients undergoing cosmetic breast augmentation with fat grafting and five studies reported outcomes for 151 patients undergoing fat grafting after breast implant removal. The included studies are summarized in Table 1.<sup>16-48</sup> The mean patient age was 33.7 years (range, 24.7 to 38.0 years) and the mean follow-up period was 21.0 months (range, 6 to 60 months). The included studies were of moderate quality, with a mean Methodological Index for Nonrandomized Studies score of 9.80 (95 percent CI, 9.00 to 10.6) (the maximum score is 16 for noncontrolled,



**Fig. 1.** Flowchart of the screening process.

observational studies). The surgical characteristics of the studies (e.g., number of sessions and injected volumes) are summarized in [Table 2](#).

### Complications

Thirteen of the 22 studies<sup>16–28</sup> reported complication rates for 1892 patients. The complication rates and types are summarized in [Table 3](#). The most frequent complication was palpable cysts, which occurred in 2.0 percent (95 percent CI, 0.26 to 3.8 percent) of the patients. Of the 2.0 percent of patients who experienced palpable cysts, six of nine patients underwent aspiration of the cysts (67.9 percent; 95 percent CI, 46.0 to 89.8 percent); the rest were treated conservatively. Hematomas were reported in 0.5 percent (95 percent CI, 0.1 to 1.0 percent) of the patients, and they were all treated conservatively. Infections were reported in 0.6 percent (95 percent CI, 0.3 to 1.0 percent) of the patients, but only one study<sup>16</sup> described the subsequent treatment consisting of oral antibiotics. Seroma occurred in 0.1 percent (95 percent CI, 0.0 to 0.3 percent) of the patients, and they were all treated conservatively.

### Radiologic Changes

Fourteen of the 22 studies<sup>17–23,25–31</sup> reported radiologic changes based on mammography,

ultrasound, magnetic resonance imaging, or computed tomography. The reported radiologic changes are shown in [Table 3](#). The most frequent radiologic change after fat grafting was oil cysts (6.5 percent; 95 percent CI, 3.7 to 9.2 percent) followed by calcifications (4.5 percent; 95 percent CI, 2.1 to 6.9 percent). Fat necrosis was reported in 1.2 percent (95 percent CI, 0.5 to 1.8 percent) of the patients. Two studies<sup>25,29</sup> used the Breast Imaging Reporting and Data System classification for a total of 30 patients. Mammograms were classified as benign (Breast Imaging Reporting and Data System category 2) in 81.5 percent (95 percent CI, 67.8 to 95.2 percent) of the patients. The Breast Imaging Reporting and Data System classification resulted in additional radiologic imaging in 16.4 percent (95 percent CI, 3.2 to 29.7 percent) of the patients (Breast Imaging Reporting and Data System category 0/3) and a biopsy was performed in 3.2 percent (95 percent CI, -2.9 to 9.4 percent) of the patients (Breast Imaging Reporting and Data System category 4). No malignancy was found after any of the additional procedures and the mammograms of all the patients were subsequently reclassified as benign (Breast Imaging Reporting and Data System category 2). The distribution of complications and radiologic changes are shown in [Figure 2](#).

### Fat Grafting after Breast Implant Removal

Five of the 22 studies reported outcomes on 151 patients undergoing fat grafting after breast implant removal.<sup>17,19,31–33</sup> Four of the studies<sup>17,31–33</sup> ( $n = 141$ ) performed a preoperative radiologic examination of the patients to assess radiologic changes after previous breast surgery. None of the studies reported any radiologic changes in the patients before the fat grafting procedure. The surgical characteristics are summarized in [Table 2](#). The complication rates and radiologic changes are listed in [Table 3](#). Palpable cysts occurred in 10.0 percent (95 percent CI, 3.8 to 16.2 percent) of the patients, and two of nine patients with palpable cysts (37.3 percent; 95 percent CI, -22.6 to 97.3 percent) were treated with aspiration. Infection treated with antibiotics occurred in 2.7 percent (95 percent CI, -0.7 to 5.9 percent) of the patients. No hematomas or seromas were reported. The reported radiologic changes were higher compared to the patients undergoing breast augmentation with fat grafting. The included studies were of moderate quality, with a mean Methodological Index for Nonrandomized Studies score of 11.2 (95 percent CI, 9.91 to 12.5 percent).

**Table 1. Study Characteristics of All Included Studies**

Reference	Country	Study Design	Size (no.)	Age (yr)	Follow-Up (mo)	SVF/PRP	Fat Graft Processing	MINORS Score
Breast augmentation with fat grafting								
Carvajal and Patino, 2008 <sup>29</sup>	Colombia	Retrospective	20	36.9	34.5	—	—	9
Cervilla-Lozano, 2014 <sup>16</sup>	Spain	Retrospective	45	31	18	—	Centrifugation	9
Chiu, 2015 <sup>17</sup>	Taiwan	Retrospective	284	33.6	22.8	SVF	Centrifugation	12
Chiu, 2018 <sup>18</sup> (no SVF)	Taiwan	Retrospective	105	33	15.8	—	Centrifugation	13
Chiu, 2018 <sup>18</sup> (SVF)	Taiwan	Retrospective	101	37	13.4	SVF	Centrifugation	13
Doi et al., 2013 <sup>45</sup>	Japan	Retrospective	24	—	—	SVF	Centrifugation	8
Dos Anjos et al., 2015 <sup>19</sup>	Spain	Retrospective	33	32	18	SVF	Wash	9
Fulton, 1992 <sup>20</sup>	United States	Retrospective	20	38	19	—	—	9
Fulton, 2003 <sup>21</sup>	United States	Retrospective	65	38	min. 12	PRP	—	9
Herold et al., 2011 <sup>46</sup>	Germany	Retrospective	10	—	6	—	—	9
Li et al., 2014 <sup>22</sup>	China	Retrospective	103	31.3	18	—	—	9
Muench, 2016 <sup>23</sup>	Switzerland	Retrospective	239	35.8	24.5	—	Sedimentation	8
Negrete-Hernández et al., 2013 <sup>24</sup>	Mexico	Retrospective	50	34	60	—	—	8
Rubin et al., 2012 <sup>47</sup>	United States	Retrospective	27	35.9	12	SVF	Both	11
Spear and Pittman, 2014 <sup>25</sup>	United States	Prospective	10	30	12	—	Centrifugation	14
Tiryaki et al., 2011 <sup>48</sup>	Turkey	Prospective	12	—	12	SVF	—	10
Ueberreiter et al., 2010 <sup>26</sup>	Germany	Retrospective	52	—	6	—	Centrifugation	11
Wang et al., 2010 <sup>30</sup>	China	Retrospective	41	35	16	—	—	8
Yoshimura et al., 2008 <sup>27</sup>	Japan	Retrospective	40	35.8	12	SVF	Both	9
Zheng et al., 2008 <sup>31</sup>	China	Retrospective	47	—	37	—	Centrifugation	13
Zocchi and Zocchi, 2017 <sup>28</sup> (non-SVF) <sup>28</sup>	Italy	Retrospective	643	30.4	36	—	Both	8
Zocchi and Zocchi, 2017 <sup>28</sup> (SVF)	Italy	Retrospective	102	24.7	36	SVF	Both	8
Fat grafting after breast implant removal								
Abboud and Dibo, 2015 <sup>32</sup>	Belgium	Prospective	80	42	24	—	—	12
Chiu, 2015 <sup>17</sup>	Taiwan	Retrospective	27	39.1	27.1	SVF	Centrifugation	12
Dos Anjos et al., 2015 <sup>19</sup>	Spain	Retrospective	10	41	18	SVF	Wash	9
Yoshimura et al., 2010 <sup>33</sup>	Japan	Retrospective	15	37.1	12	SVF	Centrifugation	10
Zheng et al., 2008 <sup>31</sup>	China	Retrospective	19	—	37	—	Centrifugation	8

SVF, stromal vascular fraction; PRP, platelet-rich plasma; MINORS, Methodological Index for Nonrandomized Studies; —, data not reported.

## DISCUSSION

### Key Results

In this systematic review, we evaluated the risk of complications after breast augmentation with fat grafting using meta-analytical methods on a nonmixed patient population. Overall, breast augmentation with fat grafting is associated with very few complications; 2.1 percent of patients experienced any kind of complication, with 1.6 percent major complications (e.g., hematoma, infection and seroma) and 0.5 percent minor complications (palpable cysts). None of the patients included in this review had revision surgery on account of the fat grafting procedure, but six of nine patients who experienced palpable cysts were treated with aspiration. The radiologic changes after fat grafting consisted of benign changes such as oil cysts (6.5 percent; 95 percent CI, 3.7 to 9.2 percent), calcifications (4.5 percent; 95 percent CI, 2.1 to 6.9 percent), and fat necrosis (1.2 percent; 95 percent CI, 0.5 to 1.8 percent). The risk of additional radiologic imaging was 16.4 percent (95 percent

CI, 3.2 to 29.7 percent), and the risk of biopsy was 3.2 percent (95 percent CI, -2.9 to 9.4 percent). No malignant changes were found as a result of the follow-up procedures.

### Interpretation

Our results support that fat grafting is a minimally invasive procedure for breast augmentation and may serve as an alternative to breast augmentation with implants. A direct comparison between fat grafting and implants, in terms of efficacy for performing a breast augmentation, is not possible based on the data used in this review. Thus, the applicability of our analysis is limited to the subgroup of patients who are candidates for fat grafting [i.e., patients with a desire for a moderate breast augmentation (<300 ml) with a “natural appearance,” and who have adequate fat deposits available for liposuction].

The complication rates found in our study are substantially lower compared with previously published reviews.<sup>3-7</sup> The main reason for this discrepancy is that the previous reviews seem to have

**Table 2. Surgical Characteristics Showing Number of Sessions and Injected Volumes**

	No. of Patients/Total	Value (95% CI)
Breast augmentation with fat grafting		
Mean no. of sessions	1869/2073	1.25 (1.04–1.47)
Percentage of patients choosing:		
1 session	1611/1869	85.1%
2 sessions	241/1869	12.9%
>3 sessions	38/1869	2.03%
Injected volume, ml		
Mean volume per first session	523/2073	254.6 (240.6–268.5)
Mean volume per second session	422/2073	217.4 (176.8–258.0)
Mean volume per subsequent sessions	329/2073	276.2 (270.8–281.7)
Total injected volume	1929/2073	297.3 (263.7–330.8)
Fat grafting after implant removal		
Mean no. of sessions	132/151	1.08 (1.04–1.13)
Percentage of patients choosing:		
1 session	121/132	91.7%
2 sessions	11/132	8.33%
Injected volume, ml		
Mean volume per first session	105/151	385.3 (314.2–456.3)
Total injected volume	132/151	377.5 (320.7–434.4)
Mean implant size	95/151	262.9 (224.1–301.8)

**Table 3. Rates of Complications and Radiologic Changes for Patients Undergoing Breast Augmentation with Fat Grafting and Patients Undergoing Fat Grafting after Breast Implant Removal**

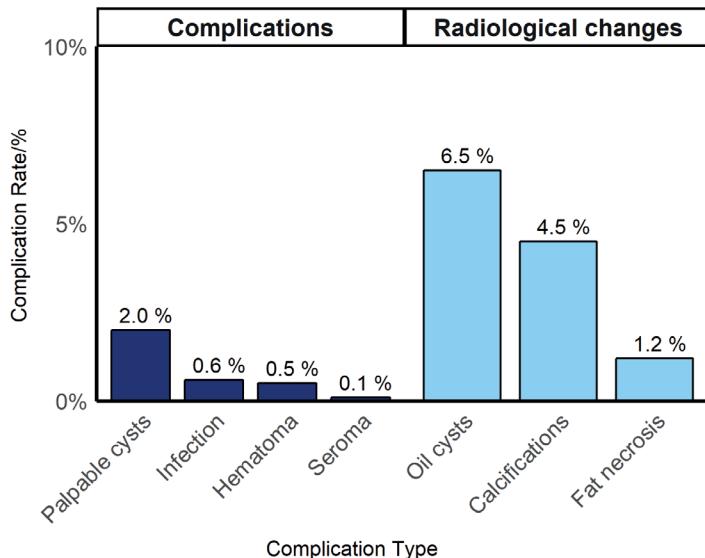
	Events/Total	Rate (95% CI) (%)	Range (%)
Breast augmentation with fat grafting			
Complications			
Palpable cysts	9/283	2.0 (0.26–3.8)	0–15
% leading to aspiration	6/9	67.9 (46.0–89.8)	40–100
Infection	14/1686	0.6 (0.3–1.0)	0–2
Hematoma	15/1686	0.5 (0.1–1.0)	0–5
Seroma	2/1686	0.1 (0.0–0.3)	0–4
Radiologic changes			
Oily cysts	86/1666	6.5 (3.7–9.2)	0–83
Calcifications	79/1666	4.5 (2.1–6.9)	0–80
Fat necrosis	31/1666	1.2 (0.5–1.8)	0–10
BI-RADS score			
0	2/30	7.0 (–8.2 to 22.1)	0–20
1/2	24/30	81.5 (67.8–95.2)	70–85
3	3/30	8.6 (–1.4 to 18.6)	0–15
4	1/30	3.2 (–2.9 to 9.4)	0–10
0/3	5/30	16.4 (3.2–29.7)	15–20
Fat grafting after breast implant removal			
Complications			
Palpable cysts	9/90	10.0 (3.8 to 16.2)	10–10
% leading to aspiration	2/9	37.3 (–22.6 to 97.3)	12–100
Infection	2/90	2.7 (–0.7 to 5.9)	0–2
Radiologic complications			
Oily cysts	7/136	4.1 (–1.9 to 10.2)	0–30
Calcifications	5/136	3.5 (–1.7 to 8.7)	0–19
Fat necrosis	1/136	0.9 (–0.6 to 2.5)	0–4

BI-RADS, Breast Imaging Reporting and Data System.

included patients undergoing more extensive procedures such as breast reconstruction with fat grafting or breast augmentation with a combination of implants and fat grafting in their calculation. Also, previous reviews have included studies with selected patients (e.g., all previous reviews included a study where all the patients experienced complications, which translates into a complication rate of 100 percent).<sup>34</sup> The inclusion of

such studies will distort the expected complication rates for the average patient.

We also found lower rates of radiologic changes compared to the previously published reviews. The reviews have considered any kind of radiologic change as a complication after fat grafting. Furthermore, none of the previous reviews have investigated the consequences after these radiologic changes. We argue that only radiologic



**Fig. 2.** Distribution and rates of complications (dark blue) and radiologic changes (light blue).

changes that lead to further procedures, and thereby cause discomfort for the patient, should be considered as complications (i.e., radiologic changes that are easily distinguishable from malignancy will not cause clinical discomfort for the patient and therefore should not be counted as a complication). In our review, 16.4 percent of the patients had to undergo further radiologic imaging and 3.2 percent had biopsy specimens taken. These results suggest that most radiologic changes are distinguishable from malignant changes, but there is a risk of undergoing further diagnostic procedures when undergoing a breast augmentation with fat grafting. Several studies have shown that fat grafting does not promote breast cancer<sup>35,36</sup> and thus we suggest that patients undergoing fat grafting should not have a more extensive radiologic follow-up compared with other types of patients undergoing breast surgery, such as mastopexy.

### Limitations

Despite our efforts to investigate a strictly homogenous patient population, there are some limitations. First, we included only studies that explicitly reported well-defined complications (contrary to studies reporting only an overall complication rate). The exclusion of these studies could result in either an overestimation or an underestimation of the complication rates reported in this systematic review. Second, we did not include case reports or case series of selected patients because we were unable to assign an estimate of frequency when the size of the overall pool of patients was

unknown. This decision, to include only studies of a certain size, has the inadvertent disadvantage of biasing the results toward large studies performed by the most experienced surgeons that may have lower complications rates than the true average. Also, it is important to note that some rare complications of fat grafting are not presented in the included studies of this review, such as radiologic changes that are not distinguishable from malignancy,<sup>37</sup> cases requiring extensive revision surgery,<sup>34,38</sup> or cases of giant oil cysts.<sup>39,40</sup> Third, the inclusion of studies with a short follow-up period could result in an underestimation of long-term complication rates, as some postsurgical changes in the breast stabilize after 1 to 2 years.<sup>41</sup> However, we did not find any association between short follow-up and lower complication rates or radiologic changes with meta-regression. Fourth, our analyses showed a large degree of heterogeneity in the complication rates and radiologic changes of the included studies. This could be attributed to a lack of consensus on how to report complications of the different radiologic modalities used to assess radiologic changes. The main outcomes of the studies differed substantially, ranging from studies specifically evaluating the radiologic appearance after fat grafting to studies where radiologic imaging was used as a supplemental diagnostic tool in the routine follow-up program. We did not attempt to provide a measure of fat graft volume retention because there is a lack of consensus regarding what method should be used to measure fat graft volume retention,<sup>42–44</sup> and none has been validated for this purpose. Patient-reported

outcomes, such as satisfaction with the aesthetic result or chronic pain after the procedure, were not analyzed in this review because the included studies did not use comparable measures.

## CONCLUSIONS

This systematic review supports that fat grafting is a minimally invasive technique for breast augmentation associated with very few complications (major complications, 1.6 percent; minor complications, 0.5 percent). The occurrence of radiologic changes in the breast gave rise to additional diagnostic imaging in 16.4 percent of the patients, and biopsy was performed in 3.2 percent of the patients. Unfortunately, we were unable to include patient-reported outcomes such as chronic pain and satisfaction with the aesthetic result. Further studies are needed to elaborate on these important topics.

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