Complete delayed breast reconstruction by lipofilling after skin-preserving mastectomy in breast cancer patients

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Aim
To evaluate delayed lipofilling for complete breast reconstruction after skin-sparing mastectomy or nipple-sparing mastectomy in breast cancer patients in terms of patient satisfaction, aesthetic results, and complications.

Patients and methods
The study included 25 patients admitted to the Medical Research Institute Hospital, Alexandria University. They underwent delayed lipofilling by Coleman's technique for total breast reconstruction after nipple-sparing mastectomy or skin-sparing mastectomy and immediate reconstruction by tissue expander or implant between January 2020 and August 2020. They were followed-up both clinically and radiologically for up to 1 year. The aesthetic outcome was assessed using Kyungpook National University Hospital questionnaires and volume reduction of fat injected was assessed by volumetric computed tomography assessment 3 months after the last session of lipofilling.

Results
The mean age of the patients was 42.56±7.42 years. The mean time after the last radiotherapy setting before lipofilling was 7.19±1.28 months; the shortest period was 6 months, while the longest one was 9e months. The aesthetic results were excellent. The patient satisfaction rate was very high, according to the patient surveys. The number of lipofilling sessions ranged from one to three sessions (average 1.96), and the injected graft volume per session varied from 80 to 470 ml (average 259.39 ml).

Conclusion
Delayed lipofilling for complete breast reconstruction is feasible in more than one session in motivated patients who want breast reconstruction and does not prefer other techniques for reconstruction like autologous flaps or implants. Lipofilling is a safe and effective technique with a low risk of complication and short-term hospitalization.

Keywords:
breast cancer, fat grafting, lipofilling, reconstructive surgery

Introduction

Breast reconstructive techniques have changed the concept of breast cancer surgery after mastectomy to leave the least potential harm to the patient as regards the cosmetic and psychosocial points of view [1].

Many methods of breast reconstruction are used including autologous flaps, prosthesis or combined with lipofilling for breast augmentation to correct deformities, or, tissue defects.

Nipple-sparing mastectomy (NSM) is considered one of the most recent advances in mastectomy techniques. In NSM, the entire breast is removed and the nipple–areola complex skin can be preserved with immediate reconstruction by an autologous flap or prosthesis that can be combined with lipofilling. The good aesthetic results after NSM are addressed to the preserved skin envelope including nipple–areola complex [2].

Currently, implant-based breast reconstruction is more common. However, there is an increasing interest in autologous breast reconstruction as it does not have the main drawbacks of implants (capsular contracture, device failure). Comparatively, it is characterized by long-lasting outcomes, natural appearance, responsiveness to change in body weight, and body contouring at the donor site [1].

Nowadays, the use of autologous fat grafting in breast cancer surgery is revolutionary. It can be used in primary breast reconstruction particularly after lumpectomies, as an adjunct to both autologous and implant-based breast reconstruction, and for the management of postradiotherapy fibrosis due to its rejuvenated effect [1].

Complete breast reconstruction with lipofilling is a quite new scarless technique. It is applicable, but may need multiple sessions [3].

Regarding the oncological safety of lipofilling, as yet there is no evidence that delayed lipofilling increases the incidence of locoregional recurrence after mastectomy or breast conservative surgery [4].

Patients and methods

This was a retrospective study that included all patients (25 females) admitted to the Surgical Department of Medical Research Institute Hospital, Alexandria University. They underwent NSM or skin-sparing mastectomy for breast cancer followed by either immediate primary breast reconstruction by tissue expander or implant-based breast reconstruction complicated by capsular contracture and were planned for secondary breast reconstruction from January 2020 to August 2020. The patients underwent complete secondary-staged breast reconstruction by lipofilling alone.

Eligibility criteria included female patients with non-ptotic small or moderate breast sizes (cups A and B) with adequate donor sites.

Patients with large, ptotic breasts, smokers, inadequate donor sites, or morbidly obese were excluded.

Ethical approval

The research was approved by the Institutional Research Board of Medical Research Institute, and the Ethics Committee of Faculty of Medicine, Alexandria University (IRB 00012098). All precautions were taken to conceal the identity of the patients. All procedures performed in this study were in accordance with the ethical standards of the Institutional and/or National Research Committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Written informed consent was taken from all patients participating in this study regarding the steps of the operation and the potential complications.

Preoperative workup

All patients were subjected to thorough history taking and physical examination of both breasts and axillas. They underwent bilateral mammograms and ultrasonography and/or MRI. The process of lipofilling was discussed with the patients regarding complications and fat resorption that may need multiple sessions to achieve the desired size. A written informed consent was taken from all patients regarding the surgical procedure and sharing in the research.

Drawing of the patient

Drawing of the patient was achieved while the patient was standing with marking the donor site and the site of incision, which is usually part of the previous incision. The midline was marked with the suprasternal notch, nipple and areola, and the inframammary fold and sites needed to be filled. The donor sites were marked including the abdomen, the flanks, the thighs, and the gluteal region (Fig. 1).

Operative workup

All patients were operated under general anesthesia. The expander or prosthesis was removed by a small incision of the scar of previous surgery (Fig. 2). Coleman's technique [5] was used in this study as the standard and the preferred method for fat harvesting, processing, and injection. The number of sessions needed to restore the breast volume ranged from one session up to three

Figure 1

Preoperative marking for bilateral nipple-sparing mastectomy with expander and recipient sites for fat harvesting.

Figure 2

Patient with tissue expander removal bilateral.

sessions. The first session of lipofilling should be at least 6 months after the last session of radiotherapy.

Frist session
Fat was injected in the layer between the skin and the capsule of implant or expander in multiple layers and we stopped injection of fat when there was flow back of fat droplets from the capsule of firmness of skin to avoid overinjection and the following complication as fat necrosis and oil cyst. Fat was injected on withdrawal of cannula on multiple levels and in multiple directions (Fig. 3).

Fat was injected into the pectoralis muscle, serratus anterior muscle in first session, and into the cushion of fat in the complementary sessions to increase projection (Fig. 3).

Riggotomy technique [6] was performed in cases with deformed, tight scar tissue by passing and puncturing a sharp needle below and parallel to the scar to breakdown fibrous tissues to give a space for fat graft (Figs 4 and 5).

Further sessions of fat grafting can be scheduled, if needed, for patients at intervals of 3–6 months. Fat grafting session numbers depended on the patient's anatomy, breast volume, fat tissue availability, and fat graft amount for each session.

Postoperative workup
Patients were discharged on the same day or on the next day of the operation. Patients were followed up during the first month to detect early postoperative complications (e.g. infection, bruises, and hematoma) to both donor and recipient sites. The need for complementary sessions was assessed subjectively after 3 months. Then, patients were followed up at 12 months by ultrasound and mammogram for late postoperative complications (e.g. fat necrosis, oil cysts, microcalcifications, irregular lumps, breast edema, mastitis, and local recurrence).
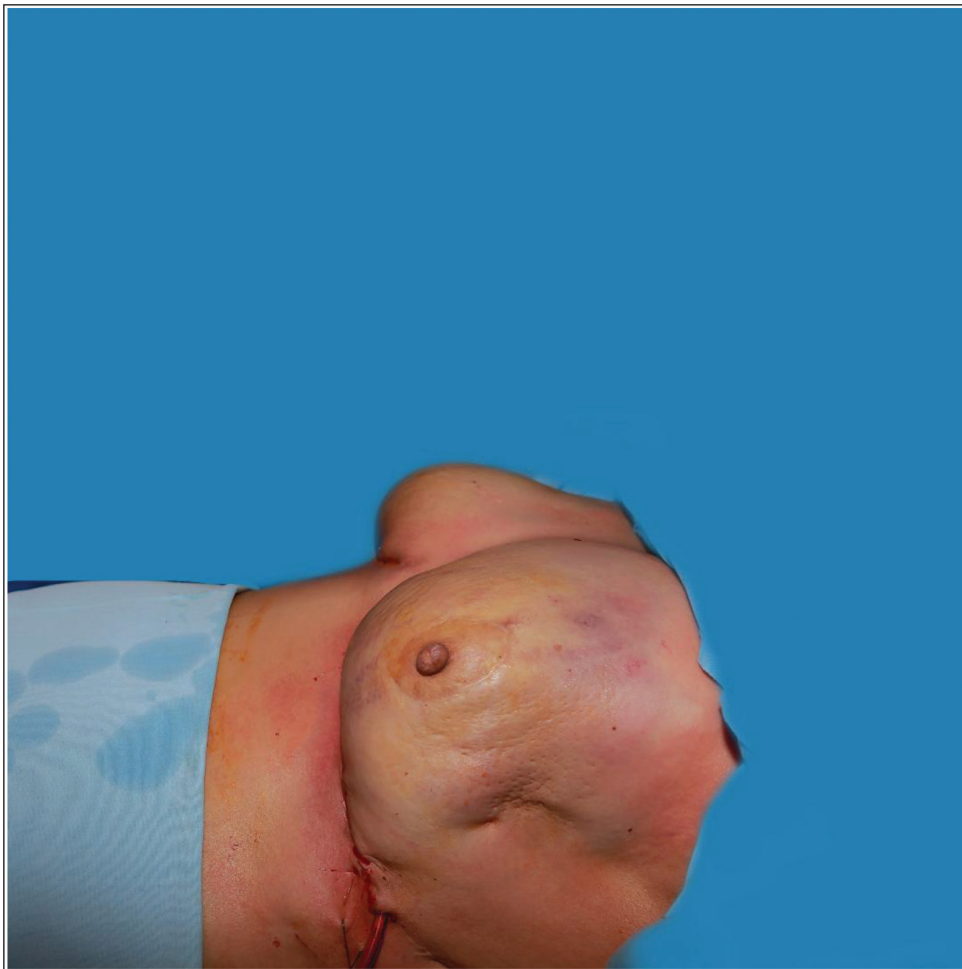
Aesthetic evaluation of the patients was done using Kyungpook National University Hospital (KNUH) Breast Reconstruction Satisfaction Questionnaire [7].

Figure 3
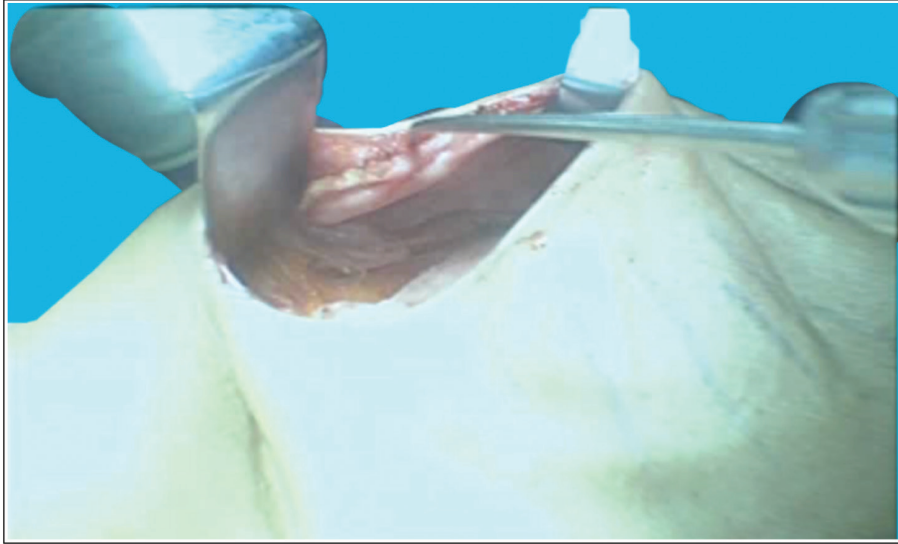
Fat injection by a 3 mm lipoinjection needle into the layer between the capsule and skin in multiple directions in the cushion of fat.
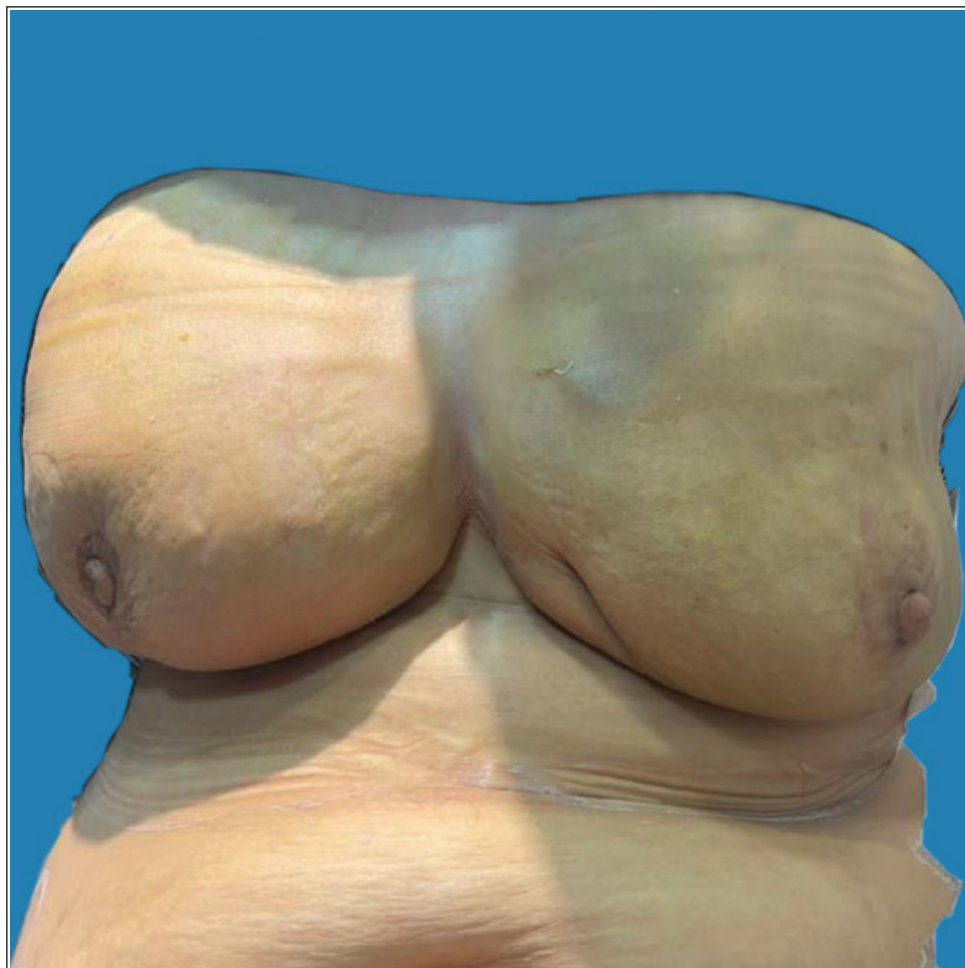
Figure 4

Immediate postoperative frontal view.

Volumetric computed tomography (CT) assessment of the reconstructed breast was done 3 months after the last session of fat injection to detect the decrease in volume of the reconstructed breast in comparison to the other normal breast to detect the reduction of fat volume.

Figure 5

The 3-month postoperative view.

Outcomes

Primary endpoints

(1) Patient satisfaction was recorded by asking the patient to fill KNUH Breast Reconstruction Satisfaction Questionnaire [7] during the follow-up visits at 3 months after areola and nipple reconstruction.

Secondary endpoints

(1) Early postoperative complications (e.g. infection, bruises, and hematoma) to both donor and recipient sites were detected by examination by the surgeon during the follow-up visits within the first month postoperatively.
(2) Late postoperative complications (e.g. fat necrosis, oil cysts, microcalcifications, irregular lumps, breast edema, mastitis, and local recurrence) were detected by examination by the surgeon during the follow-up visits after 12 months postoperatively.
(3) Volume of fat reduction by volumetric CT assessment.

Statistical analysis

The statistical analysis of data was done using the Statistical Package for the Social Sciences (IBM, SPSS, version 25; SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were applied (frequency and percentage for categorical variables, range, mean, and SD for quantitative variables). Fisher exact test was applied to test the significance of differences based on postoperative satisfaction of patients. A statistically significant difference was considered at P values of less than 0.05.

Results

The study included 25 female patients with a history of breast cancer surgery admitted to the Surgical Department of the Medical Research Institute Hospital for delayed breast reconstruction from January 2020 to August 2020 and fulfilled the inclusion criteria. The demographic and preoperative clinical data of the patients are shown in Table 1.

We carried out 49 sessions on 25 patients who had undergone delayed lipomodelling. Of these, nine (36%)

Table 1 Demographic and preoperative clinical data of the patients

	Studied group (*N*=25)
Age (years)	
Range	23–62
Mean±SD	42.0±9.73
BMI (kg/m²)	
Range	21.50–33.40
Mean±SD	27.65±3.10
Affected side [*n* (%)]	
Left	16 (64)
Right	9 (36)
Breast size (cup size) [*n* (%)]	
A	10 (40)
B	15 (60)
History of radiotherapy [*n* (%)]	
No	9 (36)
Yes	16 (64)

Table 2 Operative and postoperative data of the patients

	Studied group (*N*=25) [*n* (%)]
No. of sessions	
1	8 (32)
2	10 (40)
3	7 (28)
Mean±SD	1.96±0.79
Amount of fat injected (ml) (mean±SD)	
Session 1	348.80±53.95
Session 2	192.35±60.06
Session 3	102.86±20.59
Nipple–areola reconstruction [*n* (%)]	
No	14 (56)
Yes	11 (44)
Follow-up period (months)	
Mean±SD	13.55±2.45
Late postoperative complications [*n* (%)]	
Fat necrosis	7 (28)
Oil cysts	5 (20)
Microcalcifications	3 (12)
Absorption rate after 6 months	
Mean±SD	36.30±10.87%

patients did not receive radiotherapy; however, 16 (64%) patients received radiotherapy and underwent delayed lipofilling at least 6 months after the last session of radiotherapy. The mean age of the patients at the time of lipofilling was 42 years (range, 23–62 years). The mean BMI was 27.65; the maximum BMI was 33.40; and the minimum BMI was 21.50. Of the cases 44% (11 cases) were cup size A and 56% (14 cases) of cases were cup size B.

The mean operative time for all sessions was 144.48 min, the minimum duration was 60 min, and the maximum was 240 min.

Tissue expander was removed in 15 (60%) cases and replaced by lipofilling; however, implant was complicated and removed in 10 (40%) cases.

Ten (40%) patients needed two sessions of lipofilling, eight (32%) patients needed one session, and seven (28%) patients needed three sessions. Two (8%) patients were noncompliant and did not continue the follow-up after the operation. In session 1 (25 patients), the mean amount of pure fat injected was 348.80±53.95 ml, the least amount was 250 ml, and the largest one was 470 ml. In session 2 (17 cases), the mean amount of pure fat injected was 231.76±70.91, the least amount was 100 ml, and the largest one was 330 ml. In session 3 (seven cases), the mean amount of pure fat injected was 138.57±37.16 ml, the least amount was 100 ml, and the largest one was 200 ml. There was also by Student's *t* test, a statistically significant correlation between the total amount of pure fat injected and fat necrosis (*P*=0.008).

The absorption rate of fat was measured by volumetric CT assessment 3 months after the last session of fat

injection when the patients obtained the desired volume of breast. The mean value was 36.30±10.87%, with a minimum of 20%, and a maximum of 60%.

Patients were followed up for early and late postoperative complications. The mean follow-up period was 13.56±3.79 months. Regarding early postoperative complications, ecchymosis and bruises occurred in all cases in donor sites and wound infection occurred in three (12%) patients.

Regarding late postoperative complications, microcalcifications occurred in three (12%) patients, oil cysts in five (20%) patients, and fat necrosis in seven (28%) patients and they were diagnosed by mammogram and ultrasound and MRI; and excision biopsy was done in five (20%) cases and proved to be benign (fat necrosis). All seven (100.0%) cases who developed fat necrosis were found to have received postoperative radiotherapy. By Fisher's exact for χ^2 test, there was a statistically significant correlation between history of postoperative radiotherapy and fat necrosis (*P*=0.027).

Operative and postoperative data of the patients are shown in Table 2.

The satisfactory aesthetic results were evaluated by the KNUH Breast Reconstruction Satisfaction Questionnaire filled by all patients after reaching the desired size of the breast in comparison to the other breast. Four (16%) patients were very satisfied, 11 (44%) patients were satisfied, six (24%) patients were unsatisfied, and only two (8%) patients were

Table 3 Postoperative patients'

Patient satisfaction	Studied group (*N*=25) [*n* (%)]
Very satisfied	4 (16)
Satisfied	11 (44)
Neutral	2 (8)
Unsatisfied	6 (24)
Very unsatisfied	2 (8)

very unsatisfied. Postoperative patients' satisfaction is shown in Table 3. By analysis of variance test, there was a statistically significant correlation between patients' satisfaction and absorption rate ($P<0.001$); patients were very satisfied with the least absorption rate (23.75 ± 4.79) and were very unsatisfied with the highest absorption rate (57.50 ± 3.54).

Discussion

Despite complications of breast reconstruction techniques, they are nowadays essential part of breast cancer treatment. The breast is a feminine organ, which when removed affect the patient physically and psychologically. Breast reconstruction is not a luxury for mastectomy patients, but a necessity [8,9].

The ideal criteria for the choice of a reconstructive technique are autologous, minimal scar, reproducible, feasible, easy to perform, rapid recovery, and with low impact on the patient's body integrity. Lipofilling as a breast reconstructive technique meets all these criteria for patients with breast cancer after mastectomy [9].

Unlike the increased evidence that autologous myocutaneous flaps (LD, TRAM, and DIEP) for breast reconstruction have long-term improved quality of life and patient satisfaction, there was a decline in the rate of these operations in the United States. This may be explained due to a longer operative time and more hospital stay than implant-based breast reconstruction with the scar of the donor site [10–13].

The evolution of the NSM technique with implant has improved the aesthetic results of breast reconstruction. Enhancement of silicone implants' sizes and shapes (anatomical, teardrop) with smooth surfaces and memory gel have improved individualized aesthetic outcomes. Also, the addition of acellular dermal matrix gives more natural appearance to the lower half of the breast, which improved cosmetic results and long-term patient satisfaction [14].

Over the last decade, implant-based breast reconstruction has gained popularity over autologous flaps due to its shorter operative time, no scar in the donor site, and good aesthetic results. However,

the formation of a capsule around implants in the reconstructed breast with different degrees of capsular contraction may interfere with the aesthetic results and affect the patients physically for severe pain [9].

However, lipofilling combined with implant-based breast reconstruction has improved rapid restoration of the shape and volume with natural consistency of the reconstructed breast. In addition, lipofilling improved contour irregularities, rippling of implant, and tissue defects with the rejuvenating effect of fat graft for the irradiated skin [9,15].

Autologous fat graft after breast cancer surgery has been used over the last two decades for many purposes; after breast conservative surgery however autologous delayed lipofilling for complete breast reconstruction has been reported in few studies. The main drawbacks for this technique were the longer operative time, the higher absorption rate, the need for multiple sessions, and noncompliance of patients [16–18].

Coleman's technique has been used since 1998 for fat grafting with successful results and low rate of complications as fat necrosis and oil cysts due to the placement of small amounts of fat in multiple tunnels, layers, and multiple directions using a blunt 2 mm needle that allows fat graft survival in well-vascularized tissue [19,20].

Lipomodelling is a time-consuming procedure when compared with implant-based breast reconstruction, which constitutes a major limiting factor. In our study, in session 1, the mean duration of operation was 199.20 ± 30.95 min for an average injection volume of 349 ml. In session 2, the mean duration of operation was 90.88 ± 10.79 min for an average injection volume of 192 ml. In session 3, the mean duration of operation was 72.86 ± 10.75 min for an average volume of 103 ml. Coleman reported an average of 180 min for the first 100 ml of fat injected and 45 min for any further 100 ml [21]. Others using the same technique reported an average time of 115 min (range, 60–165 min) for an average 144 ml fat injected in each breast [22].

In our work, the number of lipofilling sessions ranged from one to three sessions mainly in cup B breast for total breast reconstruction. The mean total amount of pure fat injected for all sessions was 508.40 ± 106.60 ml, the least needed amount was 290 ml, and the maximum one was 630 ml. In session 1, the mean amount of pure fat injected was 348.80 ± 53.95 ml, the least amount was 250 ml, and the largest one was 470 ml. In session 2, the mean amount of pure fat injected was 192.35 ± 60.06, the least amount was 100 ml, and the largest was

290 ml. In session 3, fat was mainly injected to increase projection. The mean amount of pure fat injected in session 3 was 102.86 ± 20.59 ml, the least amount was 80 ml, and the largest one was 100 ml. In the work of Longo *et al.* [23], an average of three sessions was needed. The mean volume of injected fat each session for each breast was 137 ml (range, 90–175 ml), while the overall volume (including all sessions) averaged 574 ml (range, 330–720 ml).

The mean follow-up duration was 13.55 ± 2.45 months, the least period was 12 months, and the maximum one was 18 months. The mean follow-up duration in the work of Delay *et al.* [26], Coleman *et al.* [5], Longo *et al.* [22], Stillaert *et al.* [25], Siotos *et al.* [19], and Datta *et al.* [8] was 20, 62, 17, 14, 12 months, and more than 1 year, respectively.

Fat resorption seems to be the main drawback after lipofilling that occurred in almost all cases, constituting a major disadvantage, and may necessitate repeating the procedure or overcorrection. In our study, the mean absorption rate subjectively measured by the patient and the doctor after 6 months was 36.30 ± 10.87%, with minimum 20% and maximum 60%. In the work of Coleman [21] and Delay [16], the clinically reported absorption rate was 40–60% occurring almost in the first 4–6 months. In our study, the main complication was fat necrosis that appeared mainly in the first 6 months after lipofilling as a clinically palpable mass in seven (28%) cases. It was confirmed by both radiological assessment and excision biopsy in five (20%) patients. Delay [24] reported 15% fat necrosis on 1440 cases over 14 years. Fat necrosis seemed to increase in the irradiated breast, poorly vascularized tissue, longer operative time, and amount injected per session.

No local recurrence has been reported in this study, although the patients were informed about this coincidence with delayed lipofilling. Delay *et al.* [17], Illouz [27], Petit *et al.* [28], and the systematic review by Krastev *et al.* [29] reported no increased evidence of local recurrence after delayed lipomodelling.

In this study, the aesthetic results were evaluated by the patients satisfaction based on the KNUH reconstruction questionnaire. Four (16%) patients were very satisfied, 11 (44%) patients were satisfied, six (24%) patients were unsatisfied, and only two (8%) patients were very unsatisfied. Patient satisfaction was mainly related to breast volume and projection and occurrence of fat necrosis.

Delayed lipofilling for complete breast reconstruction is a revolutionary alternative with many advantages over autologous flaps and prosthesis. It is a noninvasive technique with low complication rate and better aesthetic results. Although the long operative time remains a challenge for the surgeon, this technique needs a learning curve to shorten the operative time. The high absorption rate and the need for multiple sessions mainly in cup B breasts are the main disadvantages of this technique.

Conclusion

Lipofilling may be one the promising tools for complete breast reconstruction after skin-sparing mastectomy or NSM in motivated patients with small-to-moderate-sized non-ptotic breasts after tissue expander or implant removal, but we need a large number of patients and longer follow-up and a multicentric study.

Lipofilling is an attractive and flexible tool for optimizing aesthetic outcomes during breast reconstruction, with no additional scar and low risk of complications. Although the high resorption rate and fat necrosis are the main drawback, a larger number of patients are needed on long-term follow-up.

Conflicts of interest
There are no conflicts of interest.

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