

Autologous Fat Grafting as a Stand-alone Method for Immediate Breast Reconstruction After Radical Mastectomy in a Series of 15 Patients

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Objective: To date, breast reconstruction after mastectomy essentially uses flap- or prosthetic-based surgery. Autologous fat grafting (AFT) largely used in breast conservative surgery is considered an additional technique in breast reconstruction. The aim of this retrospective study was to report our experience of AFT as a stand-alone method for immediate breast reconstruction.

Patients and Methods: Fifteen patients requiring a radical mastectomy underwent AFT for immediate reconstruction since 2014. Previous breast irradiation was not a contraindication. Procedures, complications, and cosmetic results were retrospectively analyzed.

Results: Fifteen patients with an average age of 60.5 (43–78) years were included in this retrospective study. They had a body mass index ranging from 19 to 40. Fourteen had a mastectomy for cancer and 1 for prophylaxis. Nine received breast irradiation (7 before surgery and 2 adjuvant). A mean of 3 (2–6) AFT procedures were required to achieve total breast reconstruction. Except for the first transfer, others were performed as outpatient surgeries. Only 2 minor complications (1 hematoma and 1 abscess) not impairing results were reported. The results after a mean follow-up of 26 months were considered by the patients and surgeon as highly satisfactory even in previously irradiated breast, as assessed using a qualitative scoring analysis.

Conclusions: Autologous fat grafting as a stand-alone method for immediate breast reconstruction after radical mastectomy is a safe procedure with very consistent results even for patients requiring radiation therapy.

Key Words: autologous fat transfer, lipofilling, breast reconstruction, mastectomy stand-alone

(Ann Plast Surg 2022;88: 25–31)

Patients undergoing mastectomy have an increased demand of immediate breast reconstruction with noninvasive procedures.¹⁻³ Many patients refuse flap- or implant-based reconstruction as they are considered to be complex and risky surgical procedures.³⁻⁸

Therefore, patients and plastic surgeons require autologous-based total breast reconstruction with minimal scarring and less donor site morbidity allowing to avoid foreign biomaterial-associated risk. Autologous fat transfer (AFT), a surgical technique in which adipose tissue is transferred from one area of the body to be grafted to the breast, is the method of choice to address these concerns.⁹ Autologous fat transfer is increasingly

used for breast reconstruction, immediate at the time of breast-conserving surgery, postponed to correct aesthetics sequelae after conservative treatment or achieve more satisfactory results in prosthesis reconstruction. Autologous fat is a highly biocompatible filling material for breast reconstruction.¹⁰⁻¹⁶ Autologous fat transfer has been demonstrated to achieve satisfactory cosmetic outcomes without significant differences in morbidity or locoregional recurrence when compared with surgery without reconstruction.¹⁷⁻²¹ This surgery is minimally invasive without scarring and usually performed in an outpatient setting.

Autologous fat transfer as an additional method for delayed breast reconstruction has been routinely used in the last 15 years in many centers.^{12,14,16,22,23} Recently, several studies reported very satisfactory results for AFT-based immediate breast reconstruction after radical mastectomy.^{16,24} Therefore, since 2014, we proposed AFT for immediate breast reconstruction.

Here, we report our experience from a consecutive series of 15 immediate breast reconstructions after radical mastectomy. Procedures, complications, and cosmetic results were retrospectively analyzed. We confirmed that AFT can be considered as a valuable method for stand-alone immediate breast reconstruction with minimal risk of complications and achieving very satisfactory aesthetic results.

PATIENTS AND METHODS

Patients Selection

For this retrospective monocentric study, the records of patients treated by AFT for stand-alone immediate whole breast reconstruction after radical mastectomy were retrieved from our 2014 to 2019 files of breast reconstruction. The study was reviewed by Weill Cornell Medicine in Qatar Institutional Review Board (IRB19-00155). Since 2014, it was proposed to patients not only with small to medium breast but also with larger breast (if enough fat could be collected and if they agreed to undergo a contralateral breast reduction). An excellent patients' adherence to treatment was required as several outpatient surgeries would be required every 3 or 4 months to achieve final reconstruction. Breast irradiation was not a contraindication. A body mass index (BMI) of less than 19 or greater than 40 was considered a contraindication. Every patient was informed, and their consent was acquired, including for taking photographs of their breast at the various steps of the reconstruction.

METHODS

All the procedure steps were consensually predefined with patients.

Fat Donor-Site Selection

The best sites for fat harvest varied according to the women's body size and shape. Fat was collected in a specific order depending on the planned number of fat transfers: mostly upper or lower abdomen body wall and inner and then outer sides of the leg. Fat harvest was done

Received November 23, 2020, and accepted for publication, after revision March 17, 2021.

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Conflicts of interest and sources of funding: none

This study was reviewed and approved by Weill Cornell Medicine in Qatar Institutional Review Board (IRB19-00155).

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concurrently to mastectomy for the first transfer and as outpatient procedures for the consecutive ones.

Fat Sampling and Processing

Fat was harvested without any fluid infiltration or adrenaline using a 3- or 4-mm sterile cannula (Mercedes cannula) under a low-pressure suction (-30 to -50 cmH₂O). A total of 300 to 500 mL of fat was collected using a sterile "catch-fat system" connected to a 500-mL vacuum standard suction drain bottle (Braun) in series with the liposuction cannula.²³ The collected fat was rinsed once for 15 seconds with 100 to 200 mL of sterile Ringer solution at room temperature, thereafter centrifuged (2000 r/min for 40 seconds), discarded, kept in 10-mL syringes, and ready for the transfer. This method produced approximately 30 mL of purified lipoaspirate every 3 to 4 minutes. Between 200 and 400 mL of pure fat was distributed among 25 to 50 syringes.

Autologous Fat Transfer Injection Procedure

The first AFT was achieved by injections in the upper part of the breast into the pectoral muscle under visual control right after the mastectomy was completed, the removed breast was weighted, and the hemostasis was satisfactory. We used sterile cannulas (1.5- to 2-mm diameter; 15–25 cm in length) for injecting in all the muscle thicknesses (from depth to surface), in the subcutaneous tissue and the transversalis fascia, when feasible. The skin was closed over a drain, which was usually removed after 1 or 2 days.

The thoracic wall skin of the receiving site was prepared 15 days before the second and consecutive fat transfers using at first the Dr Khouri's BRAVA system (Brava LLC, Miami, Fla) and since 2016

the CELLU M6 Alliance LPG system (Technoarc de la Plaine, Valence, France).^{25–28} The transfers were done through 1 or 2 small holes in the external or internal lower (under the inframammary fold) breast poles and one in the external upper pole (axillary extension of the breast). Multiple rigotomies were necessary to get a better shape and a high projection of the reconstructed breast.

Aesthetic Outcome

The quality of the cosmetic outcome was at first subjectively assessed by the plastic surgeon (A.F.) as well as by the patient throughout the procedure and at the last visit. Standardized digital preoperative and postoperative photographs were taken: frontal views (arms along the body and elevated to the horizontal plane) and oblique views. A retrospective analysis by examining the digital photographs was independently performed by 2 observers. According to Gahm et al,²⁹ they assessed 6 categories for the aesthetic outcome: breast symmetry, breast volume, position of submammary fold, scar appearance on the breast, appearance of the reconstructed nipple-areola complex, and overall aesthetic result. A scale of 6 grades was used in each category (6 = excellent, 5 = good, 4 = acceptable, 3 = bad, 2 = very bad, and 1 = not completed reconstruction). The mean score of the 2 investigators in each category was set as the final score for the patient.²⁹

Statistics

The quantitative data were expressed as the mean, median, and SD. The coefficient correlation (CC) was calculated using the Excel software. When necessary for comparison, the Wilcoxon signed rank test was used.

TABLE 1. Patients Characteristics and AFT Procedures for Immediate Breast Reconstruction

No.	Age, y	BMI	Type	Patients Characteristics			Irradiation†	Breast Weight,‡ g	AFT				
				Cancer*					Nodes, N	N	Total Fat, mL		
				Focal Size, mm	Grade	N					Procedure Total Time, mo		
1	53	26.7	IDC	5 + 8	1	6 N-	—	450	4	1070	21		
2	53	22.1	Rec DCIS	4	—	8 N-	5 y	150	3	970	15		
3	59	27.2	Rec IDC	10	2	—	6 y	370	2	650	11		
4	67	21.7	—	—	—	—	—	300	2	510	8		
5	50	20	IDC	Multi	—	2 N+	Ante	280	3	850	10		
6	55	22.5	IDC	30 + 12	—	2 N+	Post	450	2	600	11		
7	69	28	DCIS	Multi	2	1 N-	—	360	4	990	18		
8	62	22.6	DCIS	Multi	—	1 N-	—	160	2	660	24		
9	57	25.3	DCIS	Multi	—	1 N-	—	400	3	1130	22		
10	78	20.4	Rec DCIS	20	—	1 N-	8 y	80	3	880	14		
11	72	21.9	Rec IDC	6 + 4	2	1 N-	14 y	230	2	700	6		
12	65	22	Rec ILC	10	2	1 N-	2 y	180	4	1000	34		
13	62	25.3	Rec DCIS	20	—	1 N-	9 y	360	4	1400	17		
14	43	19.6	IDC	25 + 12	3	1 N+	Post	600	6	2045	42		
15	58	20	DCIS	6	—	1 N-	—	130	4	1050	18		
M	60.5	23	—	—	—	—	—	300	3	967	18		
SD	8.5	2.8	—	—	—	—	—	145.5	—	380	9.7		

*Cancer: rec recurrence, multi, multifocal; when bifocal, the size of the 2 lesions is indicated.

†Irradiation (radiotherapy), in years before the current mastectomy; post, adjuvant radiotherapy after the current mastectomy; ante, neoadjuvant radiotherapy before the current mastectomy.

‡Weight in grams of the removed breast at time of total mastectomy.

§N, number of procedures; total fat injected.

M, mean; SD, standard deviation.

RESULTS

Patients

Fifteen patients, treated between 2014 and 2019, were included in the study. Patient characteristics are shown in Table 1. Patients were 43 to 78 years old (mean, 60.5 ± 8.5 years) with a mean BMI of 23 ± 2.8 (19.6–28). All except 1 (patient 4 underwent a prophylactic mastectomy, 14/15) required mastectomy for breast cancer (invasive ductal carcinoma [IDC, 6/14], ductal carcinoma in situ [DCIS, 7/14], or invasive lobular carcinoma [ILC, 1/14]). Six patients were treated for a recurrence, and they had undergone previous breast irradiation (from 2 to 14 years before the mastectomy). One patient had neoadjuvant radiotherapy and 2 others adjuvant radiotherapy 45 days after surgery (mastectomy + first AFT) because of unexpected node involvement (patients 6 and 14). In summary, the reconstruction was performed over an irradiated thorax wall in 10 (66.6%) of 15 patients. Radiotherapy was performed before the surgery in 8 of 15 patients or after AFT procedure in 2 of 15 patients. Nipple-sparing mastectomy was done in 11 patients and skin sparing mastectomy in 4 patients.

In 3 patients (patients 1, 4, 13), an initial attempt of reconstruction using implants failed because of skin intolerance. The implants were removed within 2 weeks, and the first AFT was done at that time. The consecutive fat injections were not delayed when compared with other patients (Table 2).

Autologous Fat Transfer Procedures

The global data are shown in Table 1 and details in Table 2. A mean of 3 AFT sessions (2–6) were necessary to achieve complete breast reconstruction with an appropriate shape and volume. A total of 967 ± 380 mL

of fat was injected. The ratio of the total volume of fat removed to breast weight (BW) extended from 1.3 to 11 (Table 2). There was no difference ($P = 0.2$, Wilcoxon test) between the ratio when comparing higher ($n = 7, >300$ g) to lower BW ($n = 8, <300$ g). The CC between the total fat needed and the BW at time of mastectomy was 0.47, and for the mean volume per transfer, the CC was 0.23. Therefore, it is difficult to anticipate the total amount of fat, which would be needed for each patient. Indeed, regardless of breast size, a mean of 300 mL of fat per transfer was required.

A mean of 272 ± 66 mL of fat was injected during the first transfer at the time of mastectomy (Table 2). The interval between this first procedure and second fat transfer ranged from 18 to 49 weeks. A mean of 327, 315, and 255 mL of fat was injected for the second, third, and fourth transfer, respectively. For 5 patients, a satisfactory result was obtained with only 2 fat transfers. Among the 10 others, 4 of them required 3 fat transfers, 5 needed 4, and for 1 patient, 6 fat transfers were required. The mean time of the total procedure was 18 ± 9.7 months.

Complications

The mean follow-up was 26 (7–66) months. No hematoma in the donor site was reported. Minor complications in the reconstructed breast were reported. Patient 2 presented with a hematoma requiring surgical evacuation after mastectomy, axillary node dissection, and first fat transfer. The second fat transfer could be done 34 weeks after. Patient 3 underwent a drainage of a localized abscess in the axillary extension of the treated breast after the second fat transfer. The reconstruction was not impacted for any of these patients. Only nonsignificant changes were observed over time as calcifications in 1 case and cysts in 3 cases. No local cancer recurrence was reported.

TABLE 2. Autologous Fat Transfer Procedures for Each of the 15 Patients

Patient No.	Breast Weight, g*	Serial AFT Procedures												Total AFT	
		AFT 1		AFT 2		AFT3		AFT4		AFT5		AFT6		Total Volume,† mL	Mean Volume,‡ mL
		Volume, mL	Interval, wk	Volume, mL	Interval, wk	Volume, mL	Interval, wk	Volume, mL	Interval, wk	Volume, mL	Interval, wk	Volume, mL	Interval, wk		
1	450	210	39	300	34	350	26	210	—	—	—	—	—	1070	268
2	150	290	34	310	28	370	—	—	—	—	—	—	—	970	323
3	370	350	49	300	—	—	—	—	—	—	—	—	—	650	325
4	300	260	31	250	—	—	—	—	—	—	—	—	—	510	255
5	280	190	20	360	20	300	—	—	—	—	—	—	—	850	283
6	450	300	48	300	—	—	—	—	—	—	—	—	—	600	300
7	360	260	20	380	24	250	28	100	-	—	—	—	—	990	248
8	160	260	24	400	—	—	—	—	—	—	—	—	—	660	330
9	400	400	22	400	14	330	—	—	—	—	—	—	—	1130	377
10	80	290	44	330	22	260	—	—	—	—	—	—	—	880	293
11	230	370	22	330	—	—	—	—	—	—	—	—	—	700	350
12	180	200	21	220	17	280	48	300	—	—	—	—	—	1000	250
13	360	300	18	400	29	350	20	350	—	—	—	—	—	1400	350
14	600	200	28	320	22	340	28	350	31	450	44	385	—	2045	341
15	130	200	22	310	22	320	26	220	—	—	—	—	—	1050	263
M	300	272	29	327	23	315	29	239	—	—	—	—	—	967	—
Median	300	273	24	323	21	325	27	237	—	—	—	—	—	970	—
SD§	145	66	11	52	6	21	10	86	—	—	—	—	—	380	—

*Weight of the removed breast at time of total mastectomy.

†Total volume of fat injected.

‡Mean volume of fat injected per procedure.

§Ratio total volume of fat/breast weight.

M, mean; SD, standard deviation.



FIGURE 1. Sequential photographs breast reconstruction by stand-alone AFT. A–F, A 53-year-old patient 1. A, Exposure of the implant in the right breast after initial attempt. B, The implant has been removed and the first AFT done. C, Second AFT and reduction of the left breast. D, Third AFT and lift of the left breast. E, Last (fourth) AFT and nipple reconstruction. F, Still satisfactory result 3 years later (5/6 overall aesthetic result score). G–L, A 69-year-old patient 7's left breast. G, Before mastectomy. H, Left mastectomy and first 400 mL of AFT in the pectoral muscle. I, Second AFT filling the breast lower part. J, Third AFT and positioning of the right nipple-areola complex. K, Fourth AFT and tattooing of the left breast. L, Result 5 years later (6/6 overall aesthetic result score). full color online

Aesthetic Results

At the end of the procedure, all patients considered their breast reconstruction satisfactory. The results are illustrated with Figures 1 to 3. The scoring retrospective analysis after digital photographs examination by 2 investigators is reported for each patient in Table 3. More than 70% of the items were quoted 5 and above (ie, good and excellent). A selection of these results is shown in Figures 1 to 3. Three patients (patients 4, 8, and 11) underwent only 2 fat transfers and preferred not to proceed to the last third scheduled fat grafting; hence, a slightly smaller volume of the reconstructed breast was obtained when compared

with the other breast, but the patients felt satisfied with the results regardless. Two patients (patients 6 and 9) decided not to have a nipple reconstruction because of bone metastasis onset and personal choice, respectively.

Two patients (patients 6 and 14) received postoperative radiotherapy (6 weeks after mastectomy). In these cases, the second fat injection was performed 6 months after radiotherapy completion without complication. Similar outcome was obtained compared with nonirradiated patients (see Fig. 3 for patient 14). At completion, the reconstructed breast was soft, warm, moving freely, and painless for all patients. No loss of volume in the reconstructed breast was observed even after more than

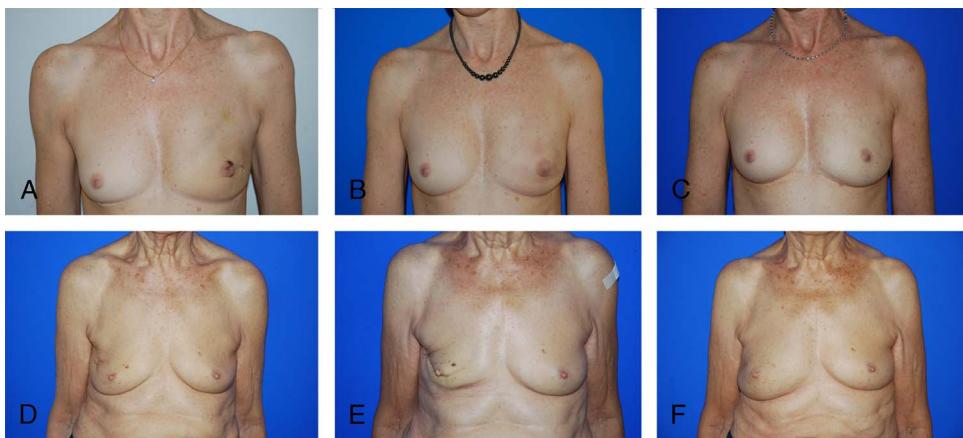


FIGURE 2. Sequential photographs of breast reconstruction by stand-alone AFT. A–C, A 58-year-old patient 15. A, Nipple-sparing left breast mastectomy and first AFT. B, Second AFT without symmetrization. C, Four years after the fourth AFT (5/6 overall aesthetic result score). D–F, A 78-year-old patient 10. A, Lumpectomy and radiotherapy of the right breast 8 years before with aesthetic sequelae of the conservative treatment. B, Right nipple-sparing mastectomy and first AFT. C, Two years after second AFT with no more aesthetic sequelae (5.5/6 overall aesthetic result score). full color online

2 years of follow-up. In 2 cases, an increased volume of the reconstructed breast was observed, in relationship to weight gain.

DISCUSSION

Breast reconstruction is an integral part of breast cancer treatment.^{1–3} The most popular methods use implant or flap surgery after radical mastectomy. Immediate reconstruction using implants, chosen in more than 70% of cases, delivers many benefits, mainly a fast restoration of shape and volume of the breast but at the expense of functional outcome.^{22,30–32} Reconstruction by musculocutaneous flaps remains the most preferred method when choosing autogenous reconstruction. It offers a better feeling to the touch and is a method of choice in case of cancer recurrence as it is considered to give the best results when the breast has been previously irradiated. However, flap procedures can be associated with high morbidity (tissue necrosis due to insufficient blood supply leading to a total or partial flap loss), requiring plastic surgeons with microsurgery skills, longer time of hospitalization, and more scars.^{5,33} Therefore, patients are often reluctant to choose such a method for breast rehabilitation.

Autologous fat transfer or lipofilling, using autologous material, with less donor-site morbidity and no foreign biomaterial-associated risk can be considered as a method of choice. Autologous fat transfer is increasingly used as an additional technique for breast reconstruction in various situations. Its advantages include the lack of reactive inflammation, foreign body reaction, and scars as well as a more natural result (more volume, improved contour, a fuller cleavage, and natural consistency).^{10–14,16,34–36} Many groups have used AFT for breast

reconstruction for the last 15 years as an adjunctive technique to the implant method to improve the shape of the reconstructed breast and/or to prepare the thoracic wall to insert implants even in cases of radiation damaged skin.^{12,16,24} For instance, associating small implant prosthesis with an equivalent or greater volume of fat gives a better result than implant alone in shape, flexibility, warmth, and skin quality. In addition, adding fat results in a stabilization of results over time, which degrade after 5 years otherwise.^{12,16}

Autologous fat transfer has been proposed as a stand-alone immediate reconstruction technique after radical mastectomy.^{16,24,37–40} The main benefit of such an approach is to obviate the use of either prosthesis or musculocutaneous flaps. During the 2014 to 2019 period, we have performed 110 immediate reconstructions of various types, of which 15 patients (14%) had a stand-alone AFT breast reconstruction. The outcome and cosmetic results of this approach were very satisfactory even in irradiated patients. The morbidity was quite low and related to the mastectomy and axillary node dissection rather than the AFT. The completion usually required 3 sessions. Very satisfying results were obtained on previously irradiated breasts. Indeed, in cases of irradiated breasts, this method significantly improves the quality of tissues.^{41–43}

However, there are certain prerequisites required to obtain such results. Patients should have enough subcutaneous fat to be sampled for 3 or 4 surgical procedures. We considered a BMI of less than 19 as a contraindication.

The main disadvantage of this method is in the requirement of 2 to 3 procedures of fat collection and reinjection. However, these additional procedures can be performed as outpatient surgery. Hence, patients need to be clearly informed, and an excellent adherence to

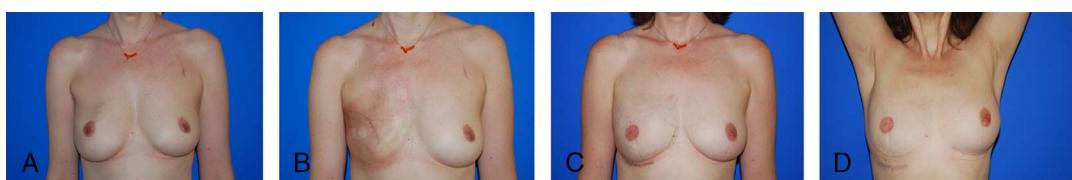


FIGURE 3. Sequential photographs of right breast reconstruction by stand-alone AFT in a 43-year-old patient 14. A, Before mastectomy. B, After mastectomy with nipple resection, first AFT and adjuvant radiotherapy because of nodes involvement. C, After 4 AFT and areola-nipple complex reconstruction. D, One year later, showing the mobility of the reconstructed right breast (6/6 overall aesthetic result score). full color online

TABLE 3. Mean Aesthetic Outcome Score From Assessment Made by the 2 Plastic Surgeons

Patient No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	M
Breast symmetry	5.5	4.5	4.5	4	5	5	6	5.5	5	5.5	5	5.5	5.5	6	5.5	5.2
Breast volume	5	4	4	4.5	5.5	5	6	4.5	5	5.5	4.5	5	5.5	6	5.5	5
Position and appearance of submammary fold	5.5	4.5	4	4.5	5	5.5	6	5.5	5	5.5	5.5	5.5	5.5	6	6	5.7
Scar on the breast	5	4.5	4.5	4.5	5.5	5	5.5	6	5	6	4.5	6	5.5	6	5	5.9
Nipple-areolar complex	5.5	4.5	4	4.5	5.5	1†	5	5	1†	6	5	6	5.5	6	5	5.2
Overall total aesthetic result	5	4	4	4.5	5.5	4.5	6	5	5	5.5	4.5	5.5	5.5	6	5	5

*Scale: 6 = excellent, 5 = good, 4 = acceptable, 3 = bad, 2 = very bad, and 1 = not completed reconstruction.

†These patients did not complete the nipple-areolar complex reconstruction.

M, mean.

multiple surgical procedures is required. In our pilot study, 6 patients required 4 transfers and 1 had a reconstruction process lasting more than 2 years. Three patients preferred not to proceed to the total scheduled fat grafting as they were satisfied with the results already obtained. Patients must be particularly aware that after mastectomy and the first fat transfer, the reconstructed breast has a very small volume and that they will have to wait until the second or third for a substantial breast volume. Patients' information is critical; otherwise, they will be very disappointed and even upset during the first postoperative dressing.

The skin and subcutaneous tissue of the thoracic wall should be prepared before mastectomy using a soft skin aspiration. For this, we used Dr Khouri's BRAVA system and then the CELLU M6 Alliance LPG system.^{25–28} It requires 30-minute suction sessions under the control of a physiotherapist, twice a week, for 1 month before fat grafting. Both methods resulted in similar skin preparation.

Fat processing is also considered a critical step. We use a "fat-catch system" based on a low pressure of aspiration. A mean fat volume of 248 to 377 mL per procedure per patient was needed. It was difficult to precisely anticipate the volume needed according to the BW at time of mastectomy. However, whatever the breast size, a mean of 300 mL of fat per transfer was required. In addition, when choosing this method, it must be kept in mind that a total fat volume of up to 2000 mL may have to be collected. In our, indeed small, series of patients, we did not observe complications either at the collection site or after transfer as fat necrosis reported in various contexts by others.⁴²

This approach allows us to perform the breast reconstruction immediately after mastectomy, and it has been shown that delaying reconstruction negatively impacts the patient's expectations.^{44,45}

We do note some limitations of our study. Although our cosmetic results were very satisfactory with few minor complications, our study lacked the use of a validated patient-reported outcome tool to study the patients' overall experience of the procedure. We also note that although we did not record any locoregional cancer recurrence in our patients, these results must be viewed with caution with regard to oncological safety of the procedure as we had a limited follow-up period for our patients before reporting our results. Furthermore, it must be emphasized that all procedures in our cohort were performed by experienced surgeons at a single center.

Autologous fat transfer can be considered as a method for stand-alone immediate breast reconstruction after radical mastectomy particularly for the small or medium breast. It results in reconstructed breast with a natural look and consistency. Therefore, it must be considered as an alternative technique to microsurgical techniques as musculocutaneous flaps giving similar long-term results with significantly lower morbidity. Autologous fat transfer is also an excellent option when an adjuvant radiotherapy or chemotherapy is required as the reconstruction will be finished by only fat grafting. Therefore, we think that this method should be proposed more often to patients and further

studies performed to clearly determine the process, limitations, and risks of this approach.

ACKNOWLEDGMENTS

The authors thank JF Bernaudin for his help in editing the manuscript.

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