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ORIGINAL RESEARCH ARTICLE

Autologous fat transplantation prior to permanent expander implant breast reconstruction enhances the outcome after two years: a randomized controlled trial

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ABSTRACT

Radiotherapy is important in breast cancer treatment. A side effect of the treatment is fibrosis that decreases the possibility for a successful breast reconstruction with expanders and with high patient satisfaction with the result. The most common option for mastectomized, irradiated women wishing for a breast reconstruction is autologous tissue transplantation. However, some patients are not suitable for flap surgery. Fifty mastectomized and irradiated women were included in a randomized controlled trial. They underwent breast reconstruction with expanders and were allocated 1:1 to either receive pre-treatment with autologous fat transplantation (AFT) or not. Primary outcomes were frequency of reoperations and complications. Secondary outcomes were number of days in hospital, number of outpatient visits to surgeon or nurse and patient reported outcome as reported with Breast Q. Follow-up time was 2 years. Fifty-two per cent of the intervention group and 68% of the controls underwent reoperations ($p = 0.611$). Thirty-two per cent of the intervention group and 52% of the controls had complications ($p = 0.347$). The median number of consultations with the nurse was four in the intervention group and six in the control group ($p = 0.002$). The AFT patients were significantly more satisfied with their breasts and psychosocial well-being after 2 years. They also had higher increase in satisfaction with breasts, psychosocial well-being, and sexual well-being when comparing baseline with 2 years postoperatively. This randomized controlled trial indicates benefits of AFT prior to breast reconstruction with expanders, especially on patient reported outcome even if the study sample is small.

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Introduction

Radiotherapy is essential in breast cancer treatment. It reduces recurrences and breast cancer specific mortality [1, 2]. Unfortunately, adverse effects of radiotherapy are a well-known problem, even if improved irradiation programs have decreased the unwanted side effects. A common and not as feared as damages on heart and lungs [3], is radiodermatitis, which often emerges within weeks after radiotherapy but may also develop after several years. Clinical presentations of radio dermatitis include atrophy and fibrosis of the skin and underlying tissue [4–6]. Radio dermatitis also increases the complication rate if breast reconstruction is performed [7, 8]. Breast edema, unevenness, and capsular contracture around the breast implant are common problems [9–11] leading to morbidity, deteriorated aesthetic result, pain and unwanted reoperations [11, 12]. Complete failure of the breast reconstruction with implant loss is more common in patients after treatment with radiotherapy [7, 12]. Thus, women who have undergone mastectomy and radiotherapy are generally not recommended reconstruction with implants but autologous tissue transplantation, preferably without implants. The latissimus dorsi flap has been widely used, but the deep inferior epigastric perforator flap has become more popular as it does not require implants to achieve desired volume. However, some patients are not suitable for flap surgery some patients are not interested in flap surgery, even though it would be ideal for them and opt for expander reconstruction if feasible. The outcome after implant-based breast reconstruction varies from excellent to inferior aesthetic result with capsular contracture and harder breast than desired because of the fibrosis in the tissues surrounding the implant. Reoperation rate for delayed breast reconstruction after radiotherapy was at the time of study design not reported in the literature but in our experience up to 80% (all indications). Visible rippling of the implant, skin indurations, asymmetry and bad scar healing is common, problems that can be treated with autologous fat transplantation (AFT) to the area. Clinical studies have shown that AFT improves the quality of irradiated tissue and seems to reverse radio dermatitis [13–15]. It has also been shown that gene expression alterations related to radio dermatitis can be normalized with AFT [16]. Salgarello et al. [15, 17] prepared the chest wall with AFT in mastectomized, irradiated women before implant-based breast reconstruction. After this treatment they reported no complications and high patient reported outcome (PRO) using the BREAST-Q questionnaire [18]. Case-series [19–21] correspondingly report good results with this method. No experimental studies have confirmed this. We aimed to investigate if AFT before expander reconstruction can decrease complications and reoperations, compared to expander reconstruction alone by performing a randomized controlled trial. We also wanted to assess PRO compared to the control group. The

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hypothesis is that AFT to the irradiated tissue prior to expander surgery leads to less morbidity, better aesthetic outcome and patient satisfaction. If this would be the case, expander reconstruction after mastectomy and radiotherapy could be an alternative for more patients if AFT is added to the treatment protocol.

Materials and methods

This randomized controlled trial has an allocation ratio of 1:1. Inclusion criteria were mastectomized women who had had radiotherapy, aged 25–70 years and not suitable or opting for breast reconstruction with flaps. At the first breast reconstruction surgery at least 1 year should have passed since previous breast surgery or radiotherapy, and a radiological examination not older than 3-month, to rule out cancer recurrences, was required. Exclusion criteria were no current local recurrence or distant metastases, contraindication for anesthesia, severe systemic disease and BMI above 30. Two senior plastic surgeons treated all patients. Data were collected from the patients' medical records. The tax-funded Swedish health insurance covered all treatment costs.

The patients in the intervention group underwent AFT with injections into the pectoralis major muscle as well as in the subcutaneous fat of the chest 70–180 days before expander surgery with the aim to transplant a minimum of 100 cc fat to the reconstruction site in one or more sessions. AFT was either done with dry technique [22, 23] or wet technique using tumescent solution with Ringer's acetate, mepivacaine and adrenaline. AFT was performed under general anesthesia as outpatient procedures. Both groups underwent breast reconstruction with permanent silicone/saline expanders with detachable injection domes. The expanders were placed sub-pectoral with muscular coverage with access via the mastectomy scar and with a single pocket approach and the distal insertion of the muscle divided (intervention group at least 3 month after AFT) under general anesthesia. Different implants were used to be able to tailoring the reconstruction to the specific needs of the patients. One to seven doses of mepivacaine were given, 2 g pre and 2 g repeatedly post-operatively if the surgeon found it necessary. Specialized nurses performed all the postoperative expansions. After completed size adjustments the injection dome was removed. Following expander surgery all patients had follow-up appointments with the surgeon after 6, 12 and 24 months. The patients also saw the nurses for all minor problems or complications and surgeons were consulted if necessary. If the patients had a more serious complication or had to discuss further surgery, they saw the surgeons.

Primary outcomes: number of patients with and rate of complications and reoperations from first operation (intervention group: AFT; control group: expander insertion) up to 2 years after expander surgery. Complications included pneumothorax, laryngospasm, infection, contracture and seroma. Reoperations included all unscheduled operations after expander surgery, breast nipple reconstruction and removal of injection dome not included.

Secondary outcomes: total number of days of hospitalization due to AFT, expander surgery, reoperations and complications; number of visits to the outpatient clinic to surgeon and nurse, respectively. after the first operation (including the pre-operative consultations before a second AFT if needed and expander surgery for the intervention group). PRO was assessed with the first edition of the Breast-Q reconstruction module [18]. Eight domains of Breast-Q were analyzed Tables 5–7. They were compared between the groups at three time points and over time within each group. Baseline was compared to 6 and 24 months follow-up (referred to as baseline vs. 6, baseline vs. 24 and 6 vs. 24). Baseline was before any surgery (AFT or expander). Three domains considered quality of life and five considered satisfaction with reconstruction results and with care. The results are given as scores ranging from 0 to 100. A change of 5 to 10 on the scale is regarded as 'a little' change, 10 to 20 as 'a moderate' change and more than 20 as 'very much' change [24].

It was estimated that 80% of patients who underwent expander breast reconstruction had to undergo additional reoperations. To detect a decrease to 40% with 80% power at a significant level of 0.05, the minimum sample size was calculated to be 44 patients. We chose to add 10 patients to that number for our target sample size. At breast reconstruction consultations the plastic surgeons invited the patients eligible to the study. The enrollment was carried out by one of the two treating plastic surgeons. A research nurse carried out the randomization by blocking; allocations were equally divided into intervention and control in blocks of four. The statistician was blinded to allocation group. Allocation concealment to patients, surgeons and nurses was not possible. The characteristics of participants are described in Table 1. Continuous variables that are normally distributed are presented as mean with standard deviation. The continuous variables that are not normally distributed are shown as median with inter quartile range (IQR). Categorical variables are listed as number of cases with proportions in each group. Different indications and treatment types of complications and reoperations in the two intervention groups are shown in Table 2. The number of reoperations and complications were compared between the groups by Fisher's exact test. Using two-sample Mann–Whitney test, the numbers of visits to a nurse and to a surgeon were compared. The number of days hospitalized during AFT and prosthesis surgery, and the number of days during the whole study period, were presented and compared between the two randomized groups, by using chi-square test. The mean score of the breast-Q in different domains were described, and the difference of the score between the two randomized groups were calculated (with 95% confidence interval [CI]). The Breast-Q scores were also analyzed longitudinally by comparing results at baseline with those at 6 and 24 months. The crossover comparisons were made in the two randomized groups. Intention-to-treat principle was applied in all the above-mentioned analyzes. The significant level was set as *p*-values less than 0.05. All the analyzes were conducted by using Stata MP 15.1 (StataCorp; College Station, Texas, USA).

Ethics

All patients gave informed consent. The Ethical Review Board in Stockholm approved the study. Ethical clearance number 2010/2072-31/3.

Results

The patients were included between 15 of December 2012 and 17 of September 2017. Due to decreased inclusion rate the inclusion was closed after 50 patients. Twenty-five patients were randomly assigned to each group. In the intervention group, 23 patients underwent AFT, 21 patients underwent expander surgery. In the control group, 22 patients underwent expander surgery (Figure 1). Table 1 shows baseline demographic and clinical characteristics.

Primary outcomes

Fifty-two per cent of the patients in the intervention group and 68% of the controls underwent at least one reoperation ($p = 0.611$). Twelve patients in the intervention group and nine of the controls underwent one reoperation. One and seven patients, respectively,

Table 1. Patients' characteristics and details concerning breast reconstruction.

	AFT group		Control group	
	Median/*n*	IQR	Median/*n*	IQR
Age at reconstruction (years)	58.6	14.4	56.7	16.3
Radiation dose (Gy)	50	0	50	0
Anti-hormone therapy at baseline	19		15	
Diabetes mellitus type II. Rheumatic decease	2		2	
BMI at baseline	25	4.9	24	3.8
BMI after 2 years	25.4 (n = 15)	5.0	23.4 (n = 17)	3.5
Time from mastectomy to first reconstructive surgery (years)	2.4	1.1	2.5	2.2
Time from radiotherapy to first reconstructive surgery (years)	1.9	1.7	2.1	2.3
AFT				
Transplanted fat volume (cc)	135.0 (64–275)	70.8		
Patients undergoing two AFT sessions (*n*)	5			
Type of implant				
Mentor Siltex Contour Profile Becker 35	14		13	
Allergan Natrelle 150 SH	5		9	
Mentor Siltex contour 8100 Low height	1		0	
Mentor CPG 323	1		0	
Volume of expander saline + gel (cc)				
At surgery	225	100	223	69
Maximum expansion	368	133	358	134
Final	310	120	273	98
Antibiotics dosage* (g)	1 (1–5)	3	1 (1–7)	2
Contralateral surgery during implant surgery	13		15	
Contralateral surgery after implant surgery	3		6	
Breast cancer recurrence	4		1	

IQR: inter quartile range.

*Per-operative at implant surgery and post-operative the following days if the surgeon found it necessary.

underwent two reoperations and none in the intervention group and 1 of the controls underwent three reoperations (p = 0.132) (Table 3). The most common indication was asymmetry. The most common interventions were replacement of expanders followed by capsulotomy (Table 2). Thirty-two per cent of the patients in the intervention group and 52% of the controls had at least one complication (p = 0.347). Five patients in the intervention group and nine of the controls had one complication. Two and three patients, respectively, had two complications and one in each groups had three complications (p = 0.713) (Table 3). The most common complication was infection. Complications that led to reoperation were two in the intervention group and four in the control group (Table 3).

Secondary outcomes

The median number of medical consultations with the nurse was 4 (IQR 2) in the intervention group and six (IQR 3) in the control group (p = 0.002). Ten of the patients in the intervention group and three of the controls had 1–4 visits. Nine in the intervention group and 18 of the controls had 5–9 visits. One of the controls had >10 visits (p = 0.027) (Table 3). In median 42.5 mL of saline was installed or removed per visit in the intervention group and 25.7 in the control group. The median of number of medical consultations with a surgeon was 5 (IQR 3) in the intervention group and five (IQR 2) in the control group (p = 0.961). Four of the patients in the intervention group and six of the controls had 1–4 visits. Fifteen patients in each group had 5–9 visits. One of the controls had >10 visits (p = 0.617) (Table 3). About 75% of the patients spent 3–6 days in hospital during the surgery and 4–10 days totally. There were no statistically significant differences between the groups neither for the surgery alone, nor total days (Table 4).

Patient-related outcome – Quality of life: Psychosocial well-being: There was No difference in between the groups at baseline but at 24 months the difference was 'moderate', 16.93 (95% CI 4.10–29.75).

Table 2. Number and types of complications and treatments. Number and types of reoperations and indications.

Complications	AFT group	Control group	Reoperations	AFT group	Control group
Type			Indications		
Pneumothorax*	1	0	Asymmetry	11	16
Laryngospasm* dental injury	0	1	Contracture	1	5
Infection	8	11	Unevenness	1	3
Suspected infection	1	3	Infection	1	1
Contracture	1	5	Pain	0	1
Seroma	3	2	Other aesthetic reasons	3	3
All	14	20	Other reasons	1**	2***
Treatment			Intervention		
Drainage	2	1	Implant replacement	11	17
Surgery	2	4	Capsulotomy	10	14
No intervention	1	0	AFT	5	10
Antibiotics. oral	6	11	Scar excision	4	8
Antibiotics. intravenous	3	3	Abdominal advancement	1	6
			Implant extraction	2	3
			Suture of sub-mammary fold	4	2
			All	37	60

*During expander implant surgery. **Expander extraction for psychological reasons. *** Leakage from expander implant and problems with the fill tube.

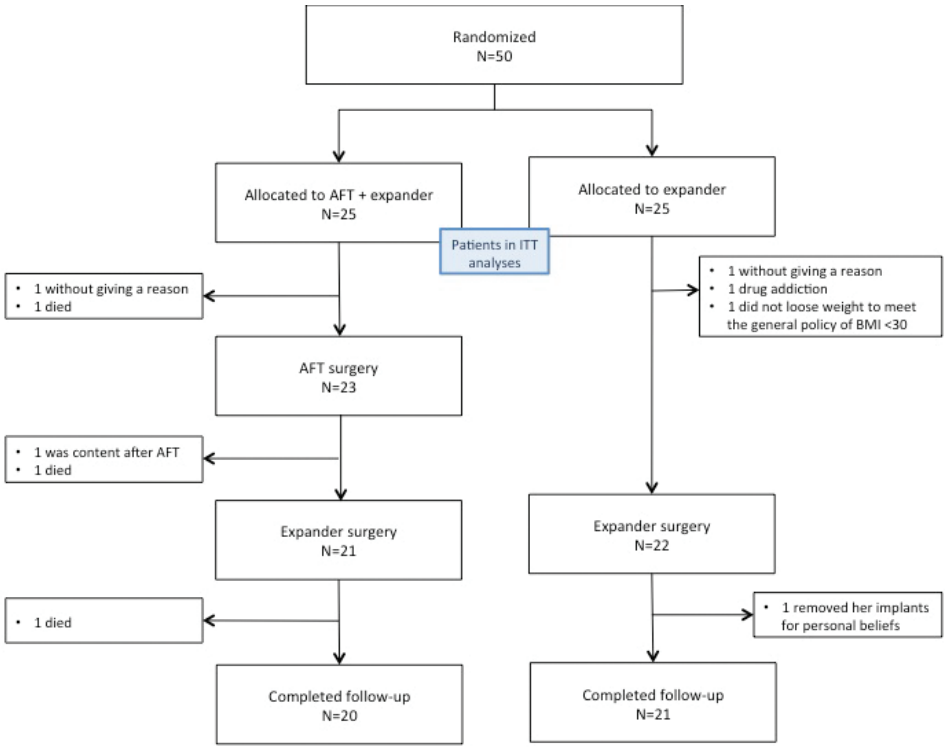

Figure 1. Flow diagram showing the recruitment of the participants in the study.
AFT: autologous fat transplantation.

Comparing baseline versus 6, both groups showed a 'moderate' change but comparing baseline versus 24, the intervention group showed significantly 'very much' change, 27.53 (95% CI 16.84–38.22) whereas the controls showed a non-significant 'little' change, 9.0 (95% CI –0.04 to 18.04). Sexual well-being: The analyzes showed no difference between the groups at baseline 0,6 (95% CI –8.9 to 10.1) but at 24 months there was a non-significant 'moderate' difference, 12.9 (95% CI –6.2 to 32.1). Comparing each group over time we found significant changes in both groups, both at 6 and 24 months, 'moderate' in the controls and 'very much' in the intervention group.

Table 3. Number of patients with complications and who underwent reoperation. Comparison of groups with Fisher's exact test. Number of outpatient visits to nurse or surgeon compared with the two-sample Mann–Whitney test.

	AFT group	Control group	*p*
Drop outs and dead	4 (16%)	3 (12%)	
Complications			
None	13 (52%)	7 (28%)	0.159
At least one	8 (32%)	15 (60%)	
Number of complications			
None	13	7	0.339
1	5	10	
2	2	4	
3	1	1	
Reoperations			
None	8 (32%)	5 (20%)	0.611
At least one	13 (52%)	17 (68%)	
Number of reoperations			
None	8	5	0.132
1	12	9	
2	1	7	
3	0	1	
Median number of visits to a nurse (IQR)	4 (2)	6 (3)	0.002
Number of visits to a nurse			
None	2	0	0.027
1–4	10	3	
5–9	9	18	
≥10	0	1	
Median member of visits to a surgeon (IQR)	5 (3)	5 (2)	0.961
Number of visits to a surgeon			0.617
None	2	0	
1–4	4	6	
5–9	15	15	
≥10	0	1	

IQR: inter quartile range.

Table 4. Number of days hospitalized. The distribution in the groups was compared using Pearson's chi-squared test.

	Days (n)	Patients (*n*)		*p*
		AFT group	Control group	
Total number of days hospitalized during AFT and implant surgery		112	90	
Days hospitalized during AFT and implant surgery	2	1	2	0.330
	3	6	8	
	4	1	3	
	5	2	5	
	6	4	3	
	7	3	1	
	8	3	0	
	9	1	0	
Total number of days hospitalized during the study period. All causes		157	155	
Days hospitalized during the study period. All causes	2	0	2	0.116
	3	1	2	
	4	2	2	
	5	3	2	
	6	3	2	
	7	3	5	
	8	4	0	
	9	3	0	
	10	0	2	
	11	0	3	
	12	0	1	
	13	1	0	
	15	0	1	
	20	1	0	

Table 5. Results of the Breast-Q questionnaire given as mean scores (range 0–100) for the two groups at different times after breast reconstruction. A mean difference of 5–10 is perceived as 'a little' change, 10–20 as 'a moderate' change and greater than 20 as 'very much' change.

Satisfaction with		AFT group	SD	Control group	SD	Difference	CI	AFT group (*n*)	Control group (*n*)	Change
Breasts	BL	40.8	9.2	42.9	16.9	–2.1	–10.4 – 6.2	24	22	No
	6 m	57.8	16.0	53.0	14.6	4.8	–5.0 – 14.5	20	21	No
	24 m	63.4	16.0	50.90	13.8	12.54	2.66 – 22.43	18	20	Moderate
Outcome	6 m	72.5	21.8	67.4	24.3	5.1	–9.7 – 19.9	20	20	Little
	24 m	74.8	21.5	61.6	26.3	13.2	–2.8 – 29.1	17	20	Moderate
Psychosocial well-being	BL	51.8	17.2	53.5	15.5	–1.6	–11.4 – 8.1	24	22	No
	6 m	72.8	21.7	65.4	18.5	7.4	–5.4 – 20.1	20	21	Little
	24 m	79.53	18.7	62.60	19.7	16.93	4.10 – 29.75	17	20	Moderate
Physical well-being chest	BL	73.2	16.0	79.7	14.6	–6.5	–15.6 – 2.6	24	22	Little
	6 m	70.90	14.9	75.81	15.2	–4.91	–14.43 – 4.61	20	21	No
	24 m	76.4	19.1	77.0	16.4	–0.5	–12.2 – 11.2	18	21	No
Sexual well-being	BL	34.3	17.3	33.7	11.7	0.6	–8.9 – 10.1	20	20	No
	6 m	50.6	27.8	49.9	19.3	0.7	–15.9 – 17.3	17	18	No
	24 m	59.8	31.9	46.9	16.2	12.9	–6.2 – 32.1	15	16	Moderate

SD: standard deviation, Diff: the difference between the two groups. BL: baseline, CI: confidence interval, m: months, n: number of patients included in the analyzes, Change: Q-scores' interpretation of change. Boldface indicates statistically significant result.

The change for baseline versus 24 in the intervention group was 32.8 (95% CI 18.9 to 46.7) and for the controls 11.1 units (95% CI 3.9 to 18.4). Physical well-being chest: Change was shown neither between the groups nor over time within the groups (Table 5).

Patient-related outcome – Satisfaction: Satisfaction of outcome: There was a 'little' difference after 6 months, 5.1 (95% CI –9.7 to 19.9), after 24 months it was 'moderate', 13.2 (95% CI –2.8 to 29.1), although one of them significant. Comparing 6 versus 24 showed no difference in the intervention group but the controls showed a 'little' decline, -8.5 (95% CI –15.7 to 1.3). Satisfaction with the breast: There was No difference between the groups at baseline, –2.1 (95% CI –10.4 to 6.2). After 24 months the difference was 'moderate' 12.54 (95% CI 2.66 to 22.43). In baseline versus 6 AFT had a 'moderate' change and the controls had a 'little' change that persisted in baseline versus 24 months 9.25 (95% CI 2.63 to 15.87). The intervention group had a 'very much' change in baseline versus 24, 21.33 (95% CI 11.92 to 30.75). Satisfaction with breast nipples after 24 months showed a non-significant difference of 14.9 (95% CI –3.8 to 33.6) between the groups (Table 6). There were no differences in satisfaction with nipples, surgeon, medical team, and information between the groups.

Harms: One patient had a pneumothorax that was conservatively treated, and one had a laryngospasm that led to a dental injury during the expander surgery. None of these adverse events was related to the intervention of the study.

Discussion

When conducting studies of this kind, power calculations are challenging and easily err. We aimed to include 10 patients more than we needed according to the calculation. Inclusion rate decreased over time, and we had more drop-outs than expected. The main reason of the decrease were increased availability of increased use of primary breast reconstruction. Nevertheless, the analyzes point in the same direction despite few patients. Not being able to blind the surgeon

Table 6. Results of the Breast-Q questionnaire and difference in the score at different time points after breast reconstruction within each group and for all patients given as mean scores (range 0–100). A mean change of 5–10 is perceived as 'a little' change, 10–20 as 'a moderate' change and greater than 20 as 'very much' change'.

Satisfaction with		BL	6 m	24 m	Difference	SD	CI	AFT group (*n*)	Control group (*n*)	Change
Breasts	BL versus 6, AFT	42.4	57.8		15.4	16.3	7.8 – 23.0	20		Moderate
	BL versus 6, C	43.9	53.1		9.1	18.9	0.5 – 17.8		21	Little
	BL versus 24, AFT	42.1		63.4	21.3	18.9	11.9 – 30.8	18		Very much
	BL versus 24, C	41.7		50.9	9.3	14.2	2.6 – 15.9		20	Little
Outcome	6 versus 24, AFT		71.6	74.8	3.2	16.8	–5.5 – 11.8	17		No
	6 versus 24, C		67.7	59.2	-8.5	14.4	–15.7 – 1.3		18	Little
	6 versus 24, All		69.6	66.7	-2.8	16.5	–8.5 – 2.8			No
Psychosocial well-being	BL versus 6, AFT	53.9	72.8		18.9	19.3	9.9 – 27.9	20		Moderate
	BL versus 6, C	54.0	65.4		11.4	21.1	1.8 – 21.0		21	Moderate
	BL versus 24, AFT	52.0		79.5	27.5	20.8	16.8 – 38.2	17		Very much
	BL versus 24, C	53.6		62.6	9.0	19.3	–0.04 – 18.0		20	Little
Physical well-being. chest	BL versus 6, AFT	73.6	70.9		-2.7	12.3	–8.5 – 3.1	20		no
	BL versus 6, C	81.0	75.8		-5.1	14.0	–11.5 – 1.2		21	Little
	BL versus 24, AFT	72.9		76.4	3.5	18.0	–5.4 – 12.4	18		No
	BL versus 24, C	80.0		77.0	-3.0	12.3	–8.6 – 2.6		21	No
	BL versus 24, All	76.7		76.7	0.0	15.3	–5.0 – 5.0			No
	6 versus 24, All		73.0	77.2	4.2	10.9	0.6 – 7.8			No
Sexual well-being	BL versus 6, AFT	32.7	53.8		21.1	19.6	10.3 – 33.0	15		Very much
	BL versus 6, C	36.0	49.9		13.9	20.8	3.5 – 24.3		18	Moderate
	BL versus 24, AFT	31.3		64.1	32.8	24.1	18.9 – 46.7	14		Very much
	BL versus 24, C	35.8		46.9	11.1	13.6	3.9 – 18.4		16	Moderate
	BL versus 24, All	33.7		54.9	21.2	21.8	13.1 – 29.4			Very much
	6 versus 24, All		51.4	55.6	4.1	18.7	–3.0 – 11.2			No

Diff: the difference between the two groups. BL: baseline. SD: standard deviation. CI: confidence interval, C: control group, AFT: AFT group, m: months, n: number of patients included in the analyzes, Change: Q-scores' interpretation of change. Boldface indicates statistically significant result.

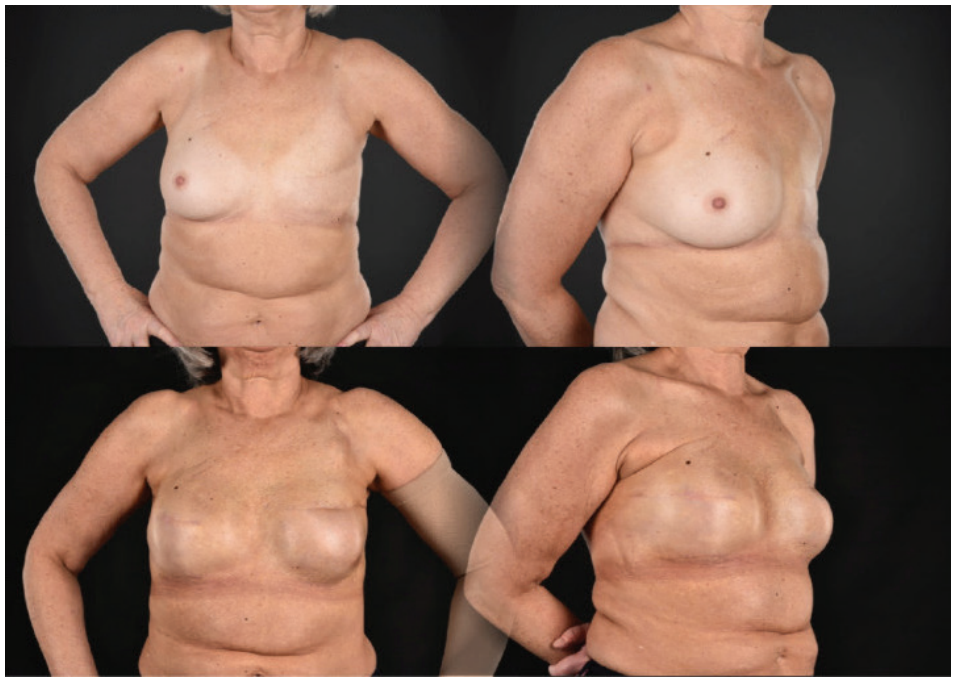

Figure 2. (A and B). Preoperative photo. A 61-year-old woman previously treated with mastectomy and radiotherapy due to breast cancer. Two-year postoperative photo. Autologous fat transplantation with 180 mL fat prior to expander surgery. She had one reoperation with change of implant and a capsulotomy during follow-up. Contralateral: risk-reducing mastectomy with immediate reconstruction.

and patient is a limitation. Both the patients and the surgeons are aware of the aim of the study, and this can bias especially the aesthetic indications for reoperations and results of PRO. A longer follow-up period for measuring PRO might provide clearer results, but concerning the primary outcomes it has previously been shown that 2 years follow-up are enough [25]. At the time of the study, Breast-Q was not validated for Swedish women. A limitation of this study is the study size. The generalizability for the primary outcomes is high due to randomization. Even if the complication and reoperation panorama in this cohort would differ from other cohorts, the differences shown between the two groups are most likely applicable in other settings. The inclusion criteria were wide meaning that the favorable study results may be applicable to many patients who undergo mastectomy and radiotherapy and where expander breast reconstruction then can be considered as an option. The results of PRO and numbers of appointments at the outpatient clinic should vary equally in both groups and not affect the generalizability. Primary outcomes were reoperations and complications. Since there were no comparable studies the power calculation had to be hypothetic and hence underestimated the number of patients needed to detect the effect size of AFT that can be seen in this study. The results are in favor of the AFT in the primary outcomes. Fewer patients who underwent AFT prior to breast reconstruction with expanders needed any reoperation. The patients who needed any reoperation underwent fewer operations. The AFT patients generally needed one operation whereas almost half of the controls underwent two operations. More than half of the patients in the AFT group did not have any complication, but more than half of the controls did have one or more complications, infection being the most common and treated with oral antibiotics. There was a tendency that AFT had a positive effect on the postoperative succession of events, even if it was not significant in other aspects than the number of appointments. The postoperative appointments were mostly to specialist nurses and the patients only met the surgeon at the scheduled follow-ups or if a nurse had medical doubts and therefore consulted the surgeon. Eighty-six per cent of the controls needed five or more appointments with nurse compared to 43% of the AFT group ($p = 0.002$), which demonstrate the need of fewer expansions with larger saline volumes and less general troubles. Comparing how many days the patients were hospitalized further supports the positive tendency in favor of AFT. Most of the AFT patients (33%) stayed 2 days in hospital after their expander surgery while most of the control patients (36%) stayed for 3 days. The analysis of total days in hospital showed no statistical difference but 32% of the patients in the control group stayed 10 or more days compared to 9.5% in the intervention group (Table 4). To summarize, there is a tendency that our hypothesis that AFT to the irradiated tissue prior to expander surgery reverses some of the negative effects of radiotherapy. All patients were satisfied with their reconstructed breasts and both the psychosocial and sexual well-being were improved at the follow-up. In all items the AFT patients had a better progression overtime than the controls. When comparing the two groups after 24 months the AFT patients were significantly more satisfied than the controls with both the reconstructed breasts and the psychosocial well-being. The same result was seen for outcome and sexual well-being, but we had to few observations for significance. Overall, the AFT patients scored higher, post- but not pre-operatively than the control patients (Figure 2). On the contrary the two groups scored uniformly in the items of satisfaction with information, surgeon, medical team, and office staff, which indicates that there is little bias associated with the intervention (Table 7). The intervention group was not more satisfied even though they were randomized to extra treatment. In conclusion we found that AFT decrease postoperative visits and increased satisfaction and well-being. We consider that AFT prior to breast reconstruction with expander may be a possible choice for irradiated women who are not suitable for or willing to undergo extensive surgery. With AFT as a part of the procedure, even more women may benefit from breast reconstruction, enhancing their psychosocial well-being.

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Disclosure statement

The authors report that there are no competing interests to declare. The funding bodies took no part in any of the stages in the research.

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