

Fat Grafting following Internal Tissue Expansion: An Option for Breast Reconstruction after Total Mastectomy

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Background: Breast reconstruction is currently performed as standard practice.

Methods: A prospective study was performed of patients after total mastectomy who underwent autologous breast reconstruction with fat grafting (FG) combined with internal tissue expansion between September 2015 and December 2020. The patients were classified into groups A to F depending on the steps of breast reconstruction. Groups A and B described patients with completed breast reconstruction with FG and expander removal, with or without nipple/areola complex reconstruction. C described patients during deflation of the expander combined with simultaneous FG. D described patients after expander implantation and refilling. E described patients after first FG, and F included patients who discontinued reconstruction with the described method and converted to reconstruction with a breast implant.

Results: Among 22 treated patients, two were after first FG (9.09%, group E), two were after expander implantation and refilling (9.09%, group D), three were during deflation of the expander combined with simultaneous FG (13.63%, group C), and four (18.18%) had completed breast reconstruction—two (9.09%) without NAC reconstruction and symmetrization (group B) and two (9.09%) with completed breast reconstruction (group A). In 11 patients (50%), breast reconstruction was abandoned after expander implantation and one to three FG procedures (group F), converting to breast reconstruction with a breast implant.

Conclusions: This study demonstrated successful breast reconstruction using FG and expander implantation. Breast reconstruction using this method is safe and enables possible abandonment at any treatment stage, as well as conversion to breast reconstruction with implants. (*Plast Reconstr Surg Glob Open* 2022;10:e4088; doi: 10.1097/GOX.0000000000004088; Published online 11 February 2022.)

INTRODUCTION

Breast reconstruction procedures are currently performed as standard practice and are an integral part of breast cancer treatment. They allow women with breast cancer to fully recover their physical, mental, and social health. According to statistics from the American Society of Plastic Surgeons in 2019, 107,238 breast reconstitution treatments were performed in the United States.¹ The advantages and disadvantages of particular types of reconstructions are well known. Some of them require

the woman to accept a different consistency of the reconstructed breast, as is in the case of implants,^{2,3} or to have extra scarring at the donor site and a cutaneous island with a different texture in the recipient site, as is the case with TRAM, DIEP, and other flaps.⁴ Breast reconstruction with BRAVA-assisted fat grafting (FG) is an interesting alternative.⁵ It undoubtedly sets a new direction in reconstructive surgery. Its disadvantage is the discomfort related to the use of the BRAVA system, which significantly limits the woman's normal functioning and thus reminds her of her traumatic disease.

We would like to propose a treatment based on a combination of the internal tissue expansion (ITE) method with FG. It allows for complete breast reconstruction in selected cases. The multistage nature of the described

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method makes it very safe for the patient, and in the case of withdrawal from the intended treatment during its course, it allows for conversion to reconstruction using a breast implant, achieving a very good aesthetic effect.

PATIENTS AND METHODS

An institutional review board-approved cohort study was performed using a prospectively maintained database of patients who underwent autologous breast reconstruction with FG combined with ITE between September of 2015 and December 2020 at two medical centers (Klinika Kolasinski, Swarzedz, Poland, and Oddzial Chirurgii Onkologicznej Szpital im. Dr. A.Sokołowskiego, Walbrzych, Poland). Patients who underwent a total mastectomy were included in the study. Exclusion criteria consisted of patients after a breast lumpectomy, and skin- and nipple-sparing mastectomy. The study was approved by the ethics committee of our institution and the patients gave informed consent for the documentation and publication of the reconstructive technique; the principles outlined in the 1964 Declaration of Helsinki have been followed.

Ideal Patient

The following criteria were assumed to qualify the patients for reconstruction according to the described method, not as an absolute condition for its performance, but only a recommendation:

1. Status post total mastectomy without previous radiotherapy;
2. Contralateral breast of moderate size;
3. Good fat tissue development in other body regions (abdomen, hips, and thighs);
4. Emotional stability, patience, and strong motivation.

Surgical Technique

The following reconstruction plan was assumed: in eligible patients, FG was performed in the subcutaneous tissue region of the reconstructed breast. The procedure was performed under local anesthesia by harvesting fat from the abdomen or hips. The fat tissue was collected using the Coleman technique,⁶ with a 3-mm multiperforated cannula featuring several sharp side holes 3 mm in diameter (Tulip Medical Products, San Diego, Calif.) at -0.75 atm of suction pressure. After centrifugation at 3000 rpm for periods ranging from 4 to 5 minutes, the fat tissue was injected subcutaneously using a 2- to 2.5-mm blunt-tip infusion cannula, with injection occurring in multiple passes in the area in front of the pectoralis major muscle (Fig. 1A). Next, an anatomical breast tissue expander with an integrated port (Mentor Worldwide LLC or Allergan plc, Ireland or Polytech GmbH, Germany) was implanted through an inframammary fold incision under general anesthesia and placed prepectoral or under the pectoralis major muscle. After wound closure, the expander was filled with saline up to a volume that did not create excessive tissue tension. Next, the expander was filled up to the expected volume in 1-week intervals (Fig. 1B). Next, every 2 months, FG procedures (as previously described) combined with the gradual

Takeaways

Question: The conducted study wanted to solve the problem of breast reconstruction using the patient's own fat tissue.

Findings: The technique of breast reconstruction based on multiple FG directly after partial expander deflation was presented. The method was safe, convenient for patients, and conversion to direct-to-implant breast reconstruction was possible at every stage of the treatment maintaining the advantages of previous therapy.

Meaning: The study confirmed that FG combined with ITE could be a successful method of breast reconstruction in selected cases after total mastectomy.

emptying of the expander were performed under local anesthesia in an outpatient setting. During each course, 50 ml of fluid was removed and 70–100 ml of fat was injected into the subcutaneous tissue over the expander. The breast volume remained constant, but the consistency of the breast gradually changed (Fig. 1C). When the expander was almost emptied, it was removed through an incision in the inframammary fold. Often, this was accompanied by an additional FG procedure.

Two months later, the symmetrization procedure of the contralateral breast was performed if necessary. The final treatment stage was the reconstruction of the nipple/areola complex (NAC). The most frequently used techniques were nipple transplantation from the opposite nipple or from the labia minora, connected with micropigmentation (tattooing) of the areola.

A rule was adopted, according to which a conversion to reconstruction with a breast implant was performed by implanting it in place of the removed expander in case of ineffective transplantation of adipose tissue or the patient's withdrawal from continuing the breast reconstruction process with the described method. Depending on the subcutaneous fat thickness achieved, the implant was placed in the retropectoral or prepectoral space.

All treated patients were classified into groups A to F (Table 1).

The treatment results were assessed macroscopically one year after the last FG session, in terms of breast size and consistency, using a Vectra device (Canfield Scientific Europe, BV, Utrecht, Netherlands) for linear and volume symmetry, and using magnetic resonance imaging (MRI) or angio-computed tomography scan.

RESULTS

Overall, 22 patients underwent delayed breast reconstruction with FG combined with ITE during the study period. The average patient age was 44 years (from 30 to 63 years), average BMI 24.7 (from 20.6 to 30.1). All the patients had undergone a total mastectomy, 15 left-sided and seven right-sided. Postoperative radiotherapy was used in 12 patients (54.4%) and chemotherapy in two patients (9.09%). In two patients (9.09%), the treatment

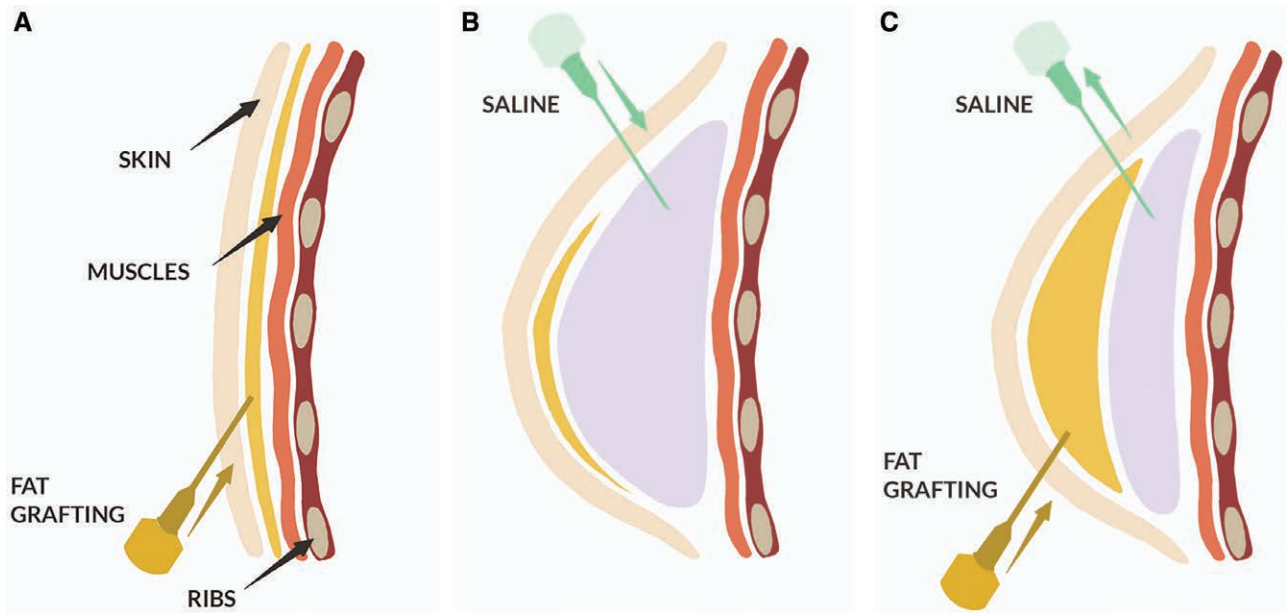


Fig. 1. The reconstruction plan: FG into the subcutaneous tissue in front of the pectoralis major muscle (A), filling expander with saline (B), and FG procedures combined with the gradual emptying of the expander (C).

was completed (group A); another two patients (9.09%) were qualified in group B, three in group C (13.63%), two in group D (9.09%), and two in group E (9.09%). In 11 patients (50%), breast reconstruction with the described method was abandoned after expander implantation and 1–3 FG procedures (group F), converting to breast reconstruction with a breast implant (Fig. 2). The reason was the unsatisfactory healing of the transplanted fat in seven cases, four of which had prior radiotherapy, and the patient’s resignation from reconstruction with the described method in four cases for personal reasons (inconvenience of the method). Two complications were noted. In one case, the expander was damaged during fat administration, requiring its replacement to continue the treatment. In the second case, skin necrosis occurred after nipple reconstruction with the triple-flap technique in a patient from group F after breast implant placement. This required the

removal of the implant, reimplantation of the expander and covering it with an LD flap, followed by replacement with an anatomic, polyurethane implant (Polytech GmbH) and reconstruction of the NAC with a graft from the other nipple and the micropigmentation technique. A satisfactory result of breast reconstruction was obtained (Fig. 3).

Example 1

A 33-year-old female patient admitted 20 months after left breast mastectomy due to breast cancer T2, N0, M0, had no radiation therapy. In the first stage, a breast tissue anatomical expander with an integrated port type 133MV12 (Allergan plc, Ireland) was implanted and refilled to a volume of 370 ml within 2 months. Over the next 12 months, five FGs were performed, combined with gradual deflation of the expander ranging from 80 to 140 ml. A total of 580 ml of fat was implanted, and 280 ml of the expander was deflated. Then, the expander was removed, and another 150-ml fat graft was performed. Reconstruction of the left NAC was performed using a star flap combined with micropigmentation (tattooing). One year after the end of the treatment, the final effect was stable and satisfactory for the patient (Fig. 4). The natural consistency was also restored (see Video 1 [online], which shows a 33-year-old female patient 1 year after the reconstructive treatment). MRI studies done at the same time demonstrated that the structure and vascularization of the reconstructed breast were comparable to the contralateral side (Fig. 5).

Example 2

A 44-year-old woman was admitted for a reconstructive procedure 1 year after total mastectomy for invasive carcinoma T1c, N0, M0 (IIB) of the right breast. Since there

Table 1. Patient’s Classification Depending on the Advancement of the Breast Reconstructive Treatment

Group A: Full treatment completion: full breast reconstruction after expander removal, reconstructed nipple/areola complex, completed symmetrization of the opposite breast
Group B: Treatment almost completed: full breast reconstruction after expander removal without reconstruction of the nipple/areola complex and without symmetrization of the opposite breast
Group C: Breast during deflation of the expander connected to the fat grafting
Group D: Breast during expander refilling
Group E: Breast after FG, before expander implantation
Group F: Patients who discontinued reconstruction with the described method and converted to reconstruction with a breast implant

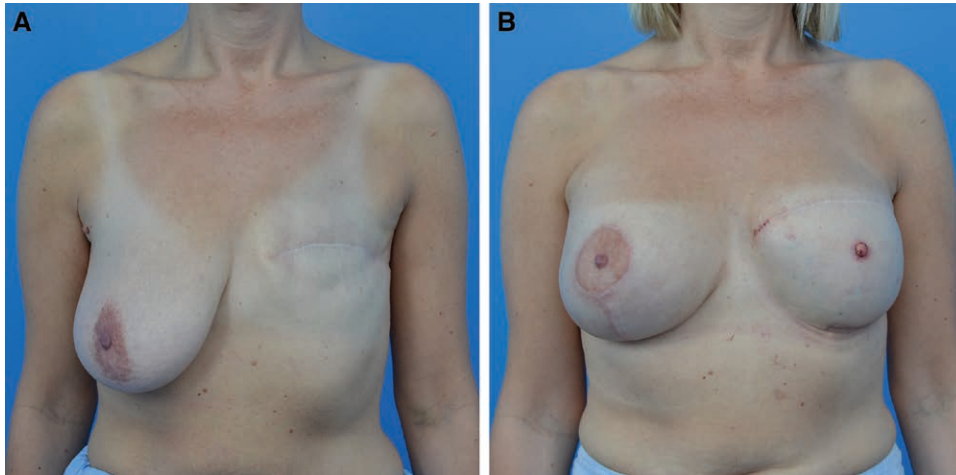


Fig. 2. A 46-year-old patient after total left mastectomy and right breast ptosis (A). The described method was abandoned after expander implantation and two FG procedures—70 ml (group F), converting to reconstruction with left breast implant and nipple transplantation and right mastopexy. The final result (B).

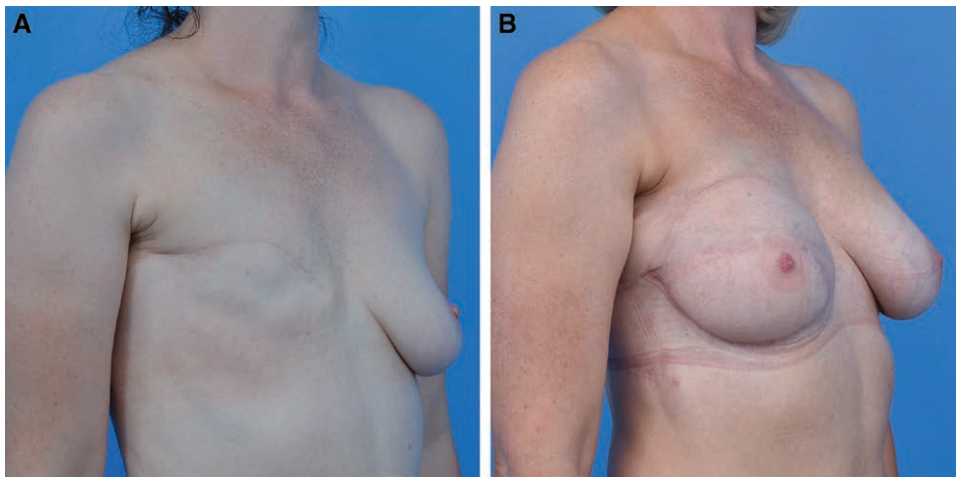


Fig. 3. A 34-year-old patient after total right mastectomy (A). The described method was abandoned after expander implantation and two FG procedures—90 ml (group F), converting to reconstruction with anatomical breast implant on the right site and left breast augmentation with anatomical implant. Because of skin necrosis after nipple reconstruction with the triple-flap technique the patient was treated with an LD flap, followed by replacement with anatomic, polyurethane implant (Polytech GmbH) and reconstruction of the NAC with a graft from the other nipple (B).

was no metastasis to the sentinel lymph node, the oncologic surgery was augmented by intraoperative radiotherapy. Complementary chemotherapy was also used.

Initially, the patient was qualified for reconstruction using the BRAVA system (Brava) and FG. Although a total of 280 ml fat was transplanted, the result was not satisfactory. Therefore, 350 ml breast tissue anatomical expander with an integrated port (Mentor Worldwide LLC) was implanted through an inframammary fold incision, under the pectoralis major muscle. In 2 weeks, the expander was filled up to 380 ml. Next, at 2-month intervals, five FG procedures combined with the gradual emptying of the expander were performed. During each course, 50 ml of fluid was removed and 70 ml of fat was injected into the subcutaneous tissue over the expander. In total, 415 ml fat

was transplanted. Next, the expander was removed and 110 ml fat was transplanted. A month later, the left breast was lifted using the vertical technique. After 3 months, reconstruction of the right nipple was performed using a star flap combined with micropigmentation (tattooing) of the NAC. Six months after the end of treatment, Vectra imaging (Canfield Scientific) confirmed satisfactory shape on both breasts (Fig. 6) with similar linear and volume symmetry (see Video 2 [online], which shows the animation of Vectra 3D imaging of a 44-year-old female patient six months after the reconstructive treatment). One year after the end of the treatment, the final effect was stable and satisfactory for the patient (Fig. 7). The natural consistency was also restored (see Video 3 [online], which shows a 44-year-old female patient one year after the

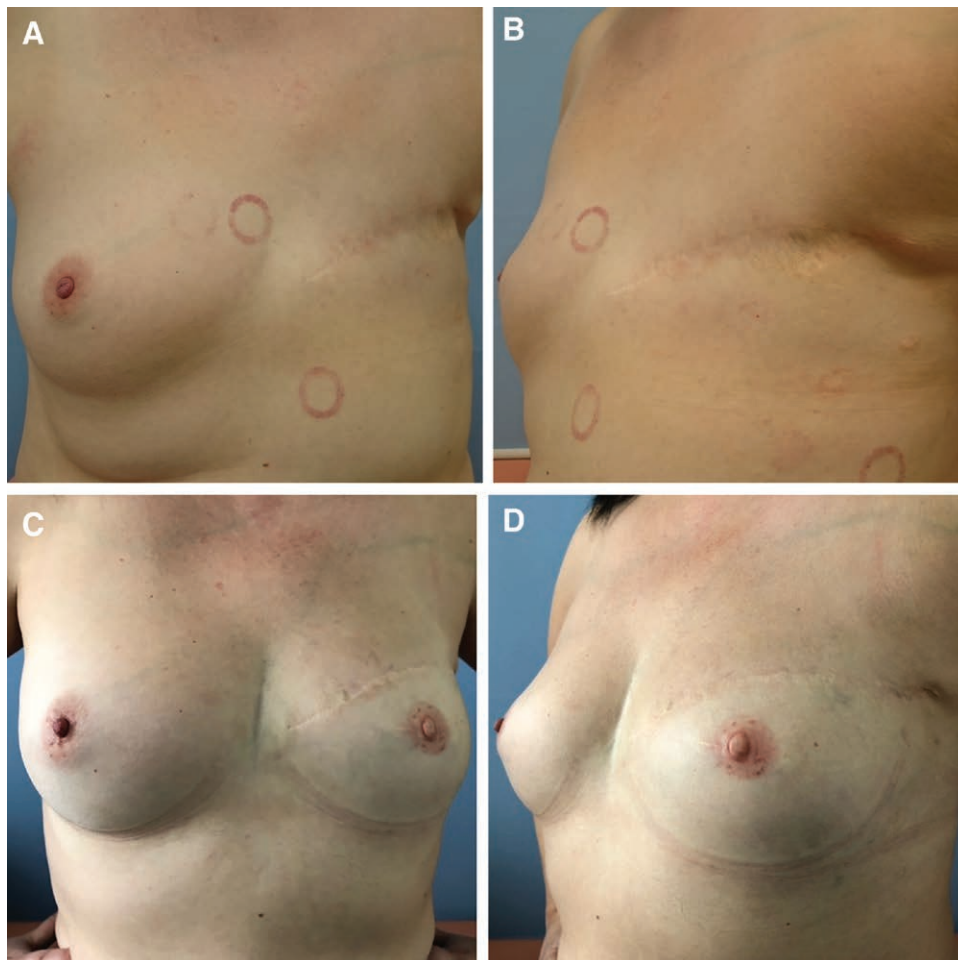


Fig. 4. A 33-year-old female patient (group A) after left breast mastectomy (A and B). Result one year after the treatment by FG combined with tissue expansion and NAC reconstruction (C and D).

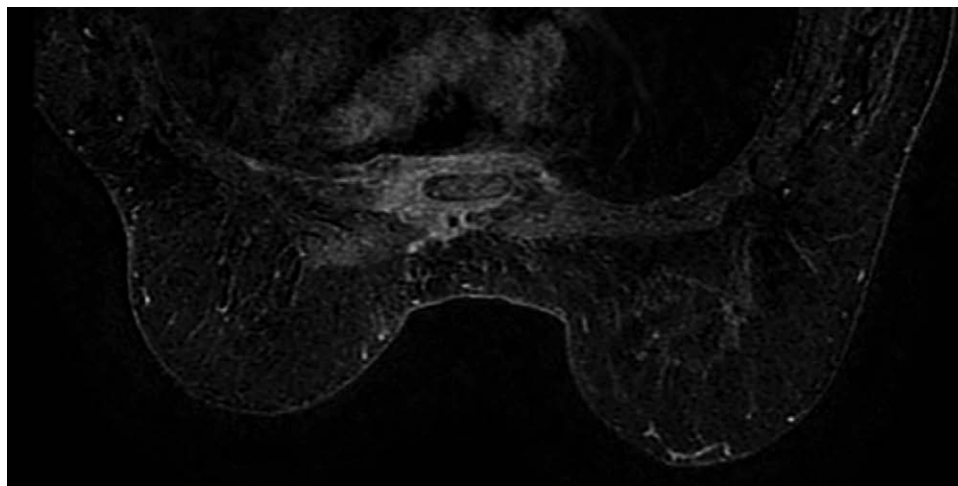


Fig. 5. MRI studies done in the same patient shown in [Figure 4](#) demonstrated natural structure and vascularization of the left treated breast.

reconstructive treatment). MRI studies done at the same time demonstrated that the structure and vascularization of the reconstructed breast were comparable to the contralateral side ([Fig. 8](#)).

DISCUSSION

In 2020, the European Commission published the breast cancer burden in EU-27 countries with an estimated incidence of 355,457 new cases and 91,826 deaths.⁷ Both

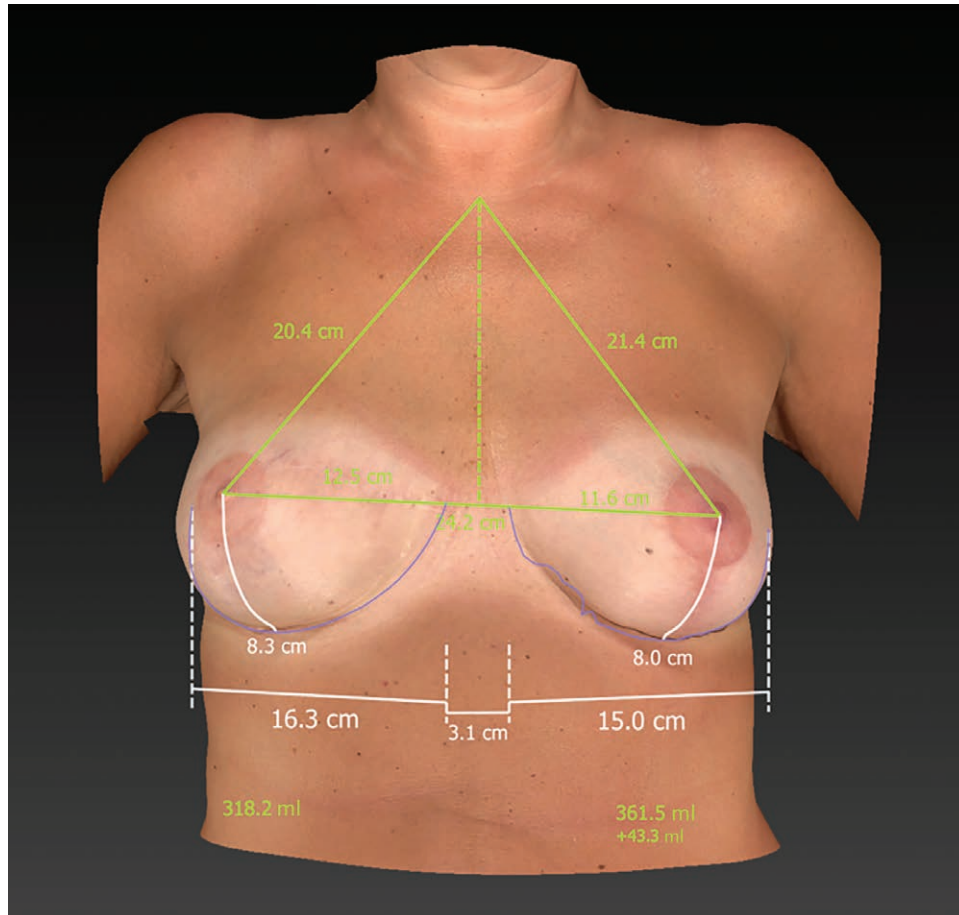


Fig. 6. Vectra imaging (Canfield Scientific) confirmed satisfactory shape on both breasts six months after the reconstructive treatment in a 44-year-old female patient after total right mastectomy (group A).

in Poland and in Europe, there are no statistics on reconstructive procedures, but the presented data demonstrates a relatively low number of immediate and delayed breast reconstructions in Europe in comparison to the total numbers of mastectomies.⁸ According to European Society of Breast Cancer Specialists (EUSOMA) data, immediate breast reconstruction is performed only in 40% of mastectomies.⁸

Breast reconstruction is an integral part of breast cancer treatment,²⁻⁵ although all of the currently available techniques have some disadvantages.

Reconstruction with implants allows for a quick volume and shape restoration but at the expense of differing consistency.^{2,3,9,10}

FG over the implant significantly improved this state.^{11,12} However, leaving the implant in the reconstructed area of the breast is always associated with the risk of capsule formation around the implant.^{13,14}

LD, TRAM, or DIEP flaps are methods of choice in some cases,¹⁵ although these extensive procedures require microsurgical skills and longer hospitalization times.

Reconstruction with FG in conjunction with the BRAVA system became popular in recent years, although the use of the external expansion is burdensome, and requires

strong motivation.⁵ Although concerns exist regarding graft viability, especially in patients after radiotherapy,^{16,17} some reports demonstrated good fat viability in poorly vascularized areas.¹⁸

The oncological safety of autologous FG and its effect on potential cancer recurrence is a separate issue. Although the transplanted fat does not induce tumor formation, its effect on small foci of breast cancer that may remain in the tissues after treatment completion is questionable. It is therefore natural that questions concerning the oncological safety of this procedure arise all the time.

Experimental work on adipocytes and adipose stem cells demonstrate that they can act to promote cancer through the cytokines they produce,¹⁹ or by creating a multifactorial microenvironment that promotes migration and increases the invasive potential of cancer.¹⁹⁻²¹ At the same time, there are published results of works that indicate the lack of such effect,^{19,20} or clearly indicate that only adipose stem cells accelerate the growth of residual cancer cells.¹⁹

The interaction between breast cancer cells and surrounding tissues, including fat cells, is so complex that no laboratory model can reliably represent them.

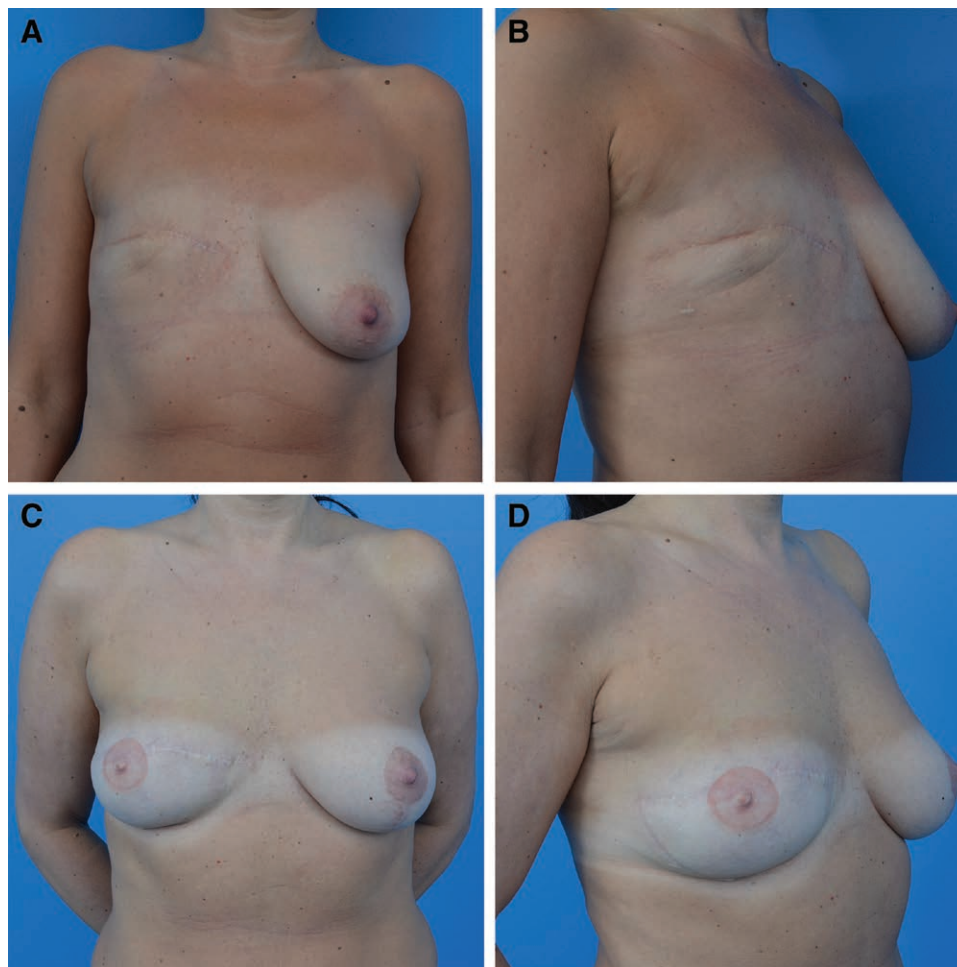


Fig. 7. A 44-year-old female patient (group A) after right breast mastectomy (A and B). Result 1 year after the treatment by FG combined with tissue expansion and NAC reconstruction (C and D).

At the moment, it seems that only clinical trials can provide us with an answer as to whether FG in patients after breast cancer removal is safe. There have been many reports in recent years, including a meta-analysis involving 11 original papers and 2382 patients,²² showing that this method does not increase the risk of locoregional recurrence or distant metastases.²³⁻²⁵

Over the last years, there have been several articles published, indicating not only the safety, but also very good results of breast reconstruction after skin- and nipple-sparing mastectomy, using autologous FG.²⁶⁻²⁸ The first reports of cases of breast reconstruction with FG after total mastectomy are equally optimistic.²⁹ The effectiveness of the method is greater after the sparing operations. On the other hand, the use of breast reconstruction after total mastectomy is more spectacular and, at the same time, radiotherapy is used less frequently in these patients than after conserving procedures, which makes FG more effective after total mastectomy.

These types of clinical experience and literature data have been the inspiration to use FG combined with ITE for breast reconstruction after total mastectomy. Injecting fat directly after reducing the expander's pressure on the recipient site is conducive to its integration,

as was the case in the experimental study.^{18,30} In contrast to FG augmented with BRAVA system, this protocol is less demanding for the patient. Rapid restoration of breast volume after the implantation of the expander and the subsequent gradual change of the breast consistency and shape encourage the patients' return to professional and intimate life, which seem to motivate them to continue the treatment. A stable effect 1 year after the end of the treatment, completely natural breast texture, full range of sensation in its area, and clear revascularization of adipose tissue visible in angio tomography and MRI scans allow the conclusion that this method enables complete breast regeneration. We did not measure the fat reabsorption rate exactly, but if we compare the total volume of FG with the breast volume measured one year after reconstruction with Vectra 3D, we can conclude that fat reabsorption rate varies from 40% to 60%. Importantly, FG combined with ITE is a very safe method, and could be a new option for breast reconstruction after total and skin-sparing mastectomy. According to our calculation, in Poland the cost of the reconstruction using this method is 40,000 PLN (US 10,000), which is comparable to the cost of the expander-to-implant method, and is three times lower than the cost of reconstruction with the DIEP flap (120,000

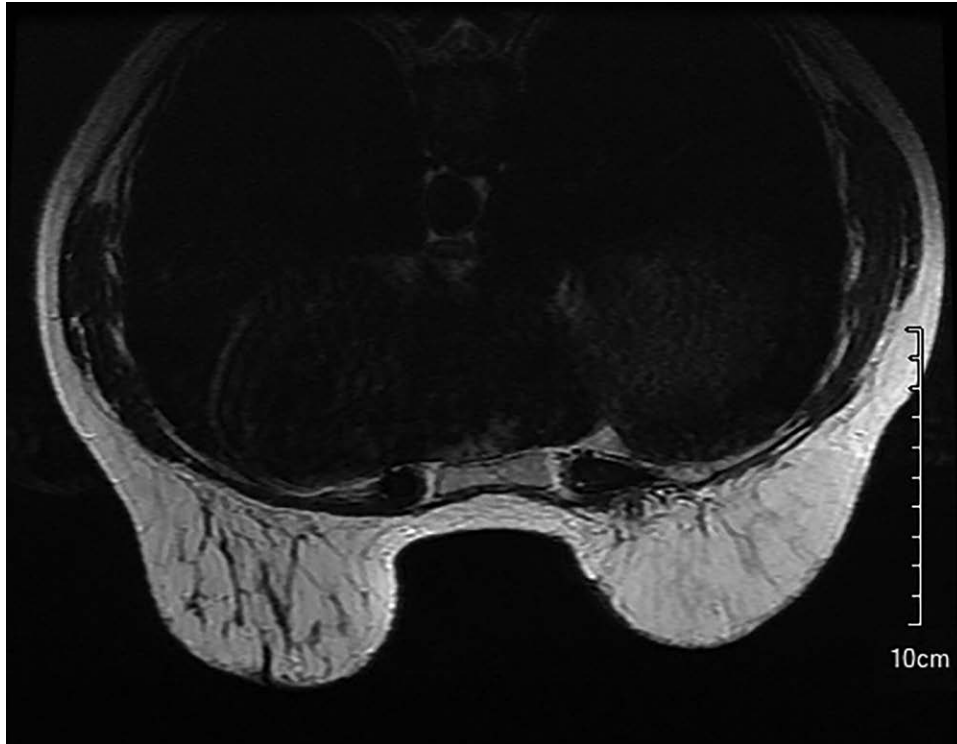


Fig. 8. MRI studies done in the same patient shown in Figure 7 demonstrated natural structure and vascularization of the right treated breast.

PLN, US 30,000). It is hoped that its main disadvantage, which is the time-consuming nature of the method and necessity of multiple operations, can be resolved by further studies on fat physiology. The difficulty of injecting fat without damaging the expander should be taken into account as well. The other limitation of the study is a small number of cases with completed reconstruction, so more studies are needed with more cases involved. The relatively high number of conversions to implant based reconstruction (50%) may be discouraging, but considering that the hybrid method of direct-to-implant breast reconstruction combined with FG³¹ is gaining popularity allows us to look at the described method another way. Both the described method and hybrid method begin with implantation of the expander and filling it up with saline. FG is also an integral part of both these methods. If the healing of transplanted fat is unsatisfactory, conversion to hybrid reconstruction is done without losing the benefits of FG. From this point of view, the method does not increase the cost of breast reconstruction significantly and could be acceptable. Radiotherapy was the leading cause of failure, and in the future reconstruction with the described method should be avoided in these patients. On the other hand, the effectiveness of autologous FG after breast radiotherapy cannot be underestimated.³²

CONCLUSIONS

This study demonstrated successful breast reconstruction using FG and expander implantation. This simple, inexpensive technique does not require microsurgical skills. It allows restoring natural breast consistency and

volume with minimal scarring. Breast reconstruction using this method enables possible abandonment at any treatment stage, as well as conversion to breast reconstruction with other techniques, while retaining the advantages of this therapy. Although this protocol may be an interesting alternative for many patients, subsequent studies are needed to verify all its potential benefits and complications.

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The study was approved by the ethics committee of our institution and the patient gave informed consent for documentation and publication of the reconstructive technique; principles outlined in the Declaration of Helsinki have been followed.

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