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Breast Reduction and Mastopexy for Repair of Asymmetry After Breast Conservation Therapy: Lessons Learned

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Abstract

Background Breast conservation therapy (BCT) can cause breast distortion and asymmetry. Repair of this asymmetry by means of breast reduction or mastopexy procedures can be challenging and harbor considerably high rates of complications.

Methods In this retrospective study, we describe our experience in repairing post-BCT breast asymmetry by performing breast reduction or mastopexy. The surgical protocol we followed consisted of stringent patient selection, thorough surgical planning, basic surgical refinements, and patient education for enhancing the likelihood of achieving a good outcome with minimal surgical complications.

Results Our search of the departmental database identified 25 patients with breast asymmetry who had undergone breast reduction or mastopexy between 2009 and 2017. Corrective surgery was performed 4 years on average after the completion of radiotherapy, and those patients included eleven who had undergone breast reduction and fourteen who had undergone mastopexy on the radiated side. Two patients (8%) had major complications that required further surgery (major fat necrosis, wound infection, and breast deformation), and five patients (20%) had minor complications (infection, minor fat necrosis, wound dehiscence, and nipple congestion). All complications developed on the radiated breast. There was no correlation between the occurrence of complications and patients' demographics, tumor type, tumor location, and breast tissue resection ($p > 0.05$).

Conclusion Only two of our 25 patients had major complications following breast reduction and mastopexy for the repair of asymmetry post-BCT. Following our four-step protocol was instrumental in leading to the successful performance of these procedures.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Breast conservation therapy · Breast reduction · Mastopexy · Radiated breast

Introduction

Breast conservation therapy (BCT) involves tumor resection with clear margins followed by radiation therapy, and it is the current standard of care for isolated breast cancer. It has been shown to attain local oncological control with survival rates similar to those of mastectomy [1–3]. BCT allows sparing of the remaining breast tissue, thus leading to almost normal breast sensation and improved quality of life [4–8]. However, the combination of wide tumor resection and postoperative radiation-induced fibrosis may cause significant breast deformity, asymmetry, fat necrosis, and nipple–areolar complex (NAC) malposition [9, 10]. Improving the breast symmetry in these cases is surgically challenging due to the radiation-induced injury to the affected breast. Surgical options include local tissue rearrangement or tissue displacement by means of flaps of

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tissue and skin to reconstruct the volume, shape, and envelope of the affected breast [4, 11–15].

Patients who have breast ptosis and hypertrophy with significant asymmetry after undergoing BCT are potential candidates for local tissue rearrangement in the form of breast reduction or mastopexy, together with adjustment of the contralateral healthy breast. This procedure can improve the cosmetic result and the patient's quality of life. Nevertheless, breast reduction procedures in a previously operated and radiated breast raise concerns about wound healing complications, infection, NAC necrosis, fat necrosis, prolonged edema, and further breast deformation [16], leading many plastic surgeons to reject these high-risk cases. There has been an ongoing search for surgical modifications and refinements to achieve a good outcome with minimal complications for these challenging cases.

Recent studies have demonstrated acceptable complication rates for breast reductions in post-radiated patients when refined surgical techniques are used and comprehensive patient education is provided [17–22]. Surgical refinements described in the literature include avoiding skin undermining [17–22], planning a wide NAC pedicle [18–20], and dissecting thick skin flaps [18–20, 22]. A major limitation of these studies is the small number of patients in each series [17–22]. In the current retrospective study, we report the largest number of patients who underwent breast reduction and mastopexy in previously irradiated BCT deformities. We present our surgical approach for these cases, from patient selection and education to planning and refinements in the surgical technique—all of which are based on lessons learned. We believe that these cumulative data can serve to reduce the complication rate and ensure a better outcome in these challenging high-risk cases.

Patients and Methods

We reviewed all consecutive patients who underwent breast reduction and mastopexy for asymmetry repair after breast conservation therapy in our department between 2009 and 2017. Patients with previous breast reduction, bilateral tumors, or loss to follow-up were excluded from the study. All surgeries were performed in our institution and in a private clinic by the two senior authors (YB and AI) who used the same surgical approach. The study was approved by the institutional review board (IRB).

The patients' demographics, comorbidities, smoking history, oncological staging, treatment, radiation therapy, and surgical data were retrospectively collected from our database (Tables 1, 2). Removal of $\geq$ 100 g of breast tissue was defined as breast reduction, while removal of $<$ 100 g was defined as mastopexy. Patients who were current smokers were required to stop smoking at least 1 month prior to surgery. The postoperative outcome and complications are summarized in Table 3.

Table 1 Patient demographics (n = 25)

Age, *mean* (*range*)	60.8 (42–74)
BMI, *mean* (*range*)	27.7 (21–35)
Comorbidities	*n* (%)
Hypertension	7 (28%)
Hyperlipidemia	6 (24%)
Diabetes mellitus	4 (16%)
Hypothyroidism	3 (12%)
Hyperthyroidism	3 (12%)
Asthma	2 (8%)
Anemia	1 (4%)
IHD	1 (4%)
Other malignancy	1 (4%)
Smokers	5 (20%)
Previous breast surgery	2 (8%)
BRCA gene mutation	0 (0%)
BSO	0 (0%)

BMI body mass index; *IHD* ischemic heart disease; *BSO* bilateral salpingo-oophorectomy

All the study patients were approved for surgery and followed up by the multidisciplinary breast team, including mandatory recent breast imaging before surgery (breast ultrasound, mammography and/or magnetic resonance imaging). Surgery was scheduled at least 6 months after completing the radiation therapy. The surgery planned for patients with significant skin damage or substantial fat necrosis following radiation therapy was postponed in the anticipation of future improvement and softening of the breast tissue. All patients signed an informed consent, after the limitations of surgery in a radiated field, including postoperative breast asymmetry and complications, had been clearly explained in detail.

Surgical Technique

Preoperative marking was done after photographing the chest with the patient standing. Each breast was assessed for volume, shape, and nipple position in order to strategize the reduction technique and volume. The radiated breast was further assessed for skin and soft tissue quality and the location of the previous scar and tissue deficit. The new nipple position was drawn on the central meridian of the breast, typically 1–2 cm below the projected inframammary fold (IMF). Nipple position of the radiated breast was drawn 1 cm below that of the healthy breast, because of

Table 2 Oncologic data ($n = 25$)

Characteristics	Number (%)
Tumor type	
DCIS	3 (12%)
IDC	16 (64%)
LCIS	1 (4%)
ILC	4 (16%)
Unknown	1 (4%)
Lymph node surgery	
Sentinel lymph node biopsy	13 (52%)
Axillary lymph node dissection	12 (48%)
Chemotherapy	
Neoadjuvant	2 (8%)
Neoadjuvant + biologic	3 (12%)
Adjuvant	3 (12%)
Adjuvant + biologic	6 (24%)
Biologic	8 (32%)
No chemotherapy	3 (12%)
Radiation therapy	25 (100%)
Tumor location	
Superior-lateral	6 (24%)
Lateral	5 (20%)
Superior-medial	2 (8%)
Medial	1 (4%)
Central (NAC)	4 (16%)
Inferior-lateral	5 (20%)
Inferior-medial	2 (8%)

NAC nipple–areola complex; *DCIS* ductal carcinoma in situ; *IDC* invasive ductal carcinoma; *LCIS* lobular carcinoma in situ; *ILC* invasive lobular carcinoma

anticipated sagging of the healthy breast which has more skin laxity compared to the radiated breast.

The skin resection was drawn in a dome-mosque configuration, with the vertical limbs marked by displacement of the breast medially and laterally along the breast meridian (the Lassus maneuver). Skin resection marking was more conservative on the radiated breast, with roughly 1 cm less for each limb. In cases of previous lower-pole lumpectomy and scars, the skin resection was even more conservative, and the skin was only de-epithelialized and sutured in a vest-over-pants fashion, to add volume to the lower pole in selected cases. The skin resection marking was adjusted to incorporate the previous lower-pole scar, even if the vertical scar turned out oblique, off the meridian line.

The vascular pedicle of the NAC was based on the opposing side of the previous lumpectomy. The pedicle was based superiorly for inferior-pole lumpectomies, medially for lateral lumpectomies, superior-medial for superior-lateral lumpectomies, and inferiorly for superior lumpectomies. As a rule of thumb, nipple position that is included in the dome-mosque perimeter was considered for superior NAC pedicle, while lower nipple position outside the dome-mosque perimeter was considered for superior-medial NAC pedicle. Tissue deficit requiring local tissue rotation was usually based on a medial or lateral pedicle. The pedicle base was marked wide (i.e., between 8 and 10 cm), and its length planned as short as possible. The NAC diameter was set at 40 mm.

During the dermoglandular resection of the radiated breast, we favored wedge resection, trying to avoid undermining of breast tissue from the skin and from the

Table 3 Surgical outcome ($n = 25$)

Variable	
Time from radiation to surgery, months	48 (range 6–180)
Type of operation on the radiated breast, n (%)	
Breast reduction	11 (44%)
Mastopexy	14 (56%)
The average weight of breast tissue resected (*g*)	
Radiated breast	175 (range 0–670)
Contralateral healthy breast	451 (range 40–1255)
Follow-up, months	8.5 (range 6–24)
Complications—minor ($n = 5$)	
Wound infection	2 (8%)
Fat necrosis	2 (8%)
Wound dehiscence	2 (8%)
Nipple congestion	1 (4%)
Complications—Major ($n = 2$)	
Fat necrosis	2 (8%)
Wound infection	1 (4%)

pectoralis muscle, thus preserving the perforator vessel blood supply. The area of the previous lumpectomy was inspected, and the tethering scar bands were directly released. Both the pedicle and the breast pillars were minimally undermined, only to ensure rotational ease of the pedicle.

We favored de-epithelialization and minimal breast tissue excision over wide and aggressive tissue undermining in mastopexy cases. Mastopexy included periareolar or circum-vertical patterns, depending upon the degree of nipple elevation and excess of skin. In cases of minor nipple elevation and mild skin excess, we chose the periareolar mastopexy. For superior-based pedicles, we favored minimal dissection of the pillars, leaving the deep tissue attached to the muscle. Intraoperatively, the patient was positioned in a 90-degree sitting position for additional breast contouring to achieve good breast symmetry and proportional reduction. A drain was placed before closure in each breast. Closure of the vertical incision was done using an inverted "T" type skin closure, keeping the horizontal scar as short as possible. At the end of the surgery, the patient was dressed with an elastic sports bra (Figs. 1, 2, 3).

Statistical Analysis

Patient demographics, tumor data, and complications were initially evaluated using descriptive statistics. Due to the study sample size, we assessed our data for a non-normal distribution. Spearman correlation statistics or Chi-square tests were applied to assess relationship between complications and demographics, tumor type, tumor location, and breast tissue resection. All statistical analysis was performed using p value < 0.05 for significance. Statistical analysis was performed by SAS for Windows, version 9.4 (SAS Institute Inc., Cary, NC, USA) and R Core Team 2017 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Twenty-five patients were reviewed for this study. Their average age was 60.8 (range 42–74 years), and their average body mass index was 27.7 (range 21–35 kg/m^2). Their comorbidities are listed in Table 1. Hypertension (28%) was the most common comorbidity, followed by hyperlipidemia (24%) and diabetes mellitus (16%). Five patients (20%) were active smokers who stopped smoking at least 1 month prior to their scheduled surgery in order to be eligible for surgery. None of the patients had a BRCA gene mutation. The average preoperative bra cup size was D (range B–F).

Oncological data (Table 2) demonstrated that 20 patients (80%) had invasive cancer and that all of the patients underwent axillary lymph node surgery (sentinel biopsy or axillary dissection). Most (n = 22, 88%) of the patients received either chemotherapy or biologic therapy. Tumor location was predominantly in the lateral aspect of the breast (n = 16, 64%), whereas 20% of the tumors were on the medial aspect of the breast, and the remaining 16% were in the central NAC location (Table 2).

All patients received radiation therapy after undergoing lumpectomy. Corrective surgery was performed 4 years on average after completion of radiotherapy, with a minimum time lapse of 6 months. Corrective surgery on the radiated breast included reduction in 11 patients and mastopexy in 14 patients. The average weight of breast tissue resected was 175 g (range 0–670 g) on the radiated side and 451 g (range 40–1255 g) on the contralateral healthy side. Follow-up after corrective surgery averaged 8.5 months (range 6–24 months) (Table 3).

Five (20%) of the patients experienced a total of seven minor complications, including infection (n = 2), minor fat necrosis (n = 2), wound dehiscence (n = 2), and nipple congestion (n = 1). In the 2 cases of wound dehiscence, one case was at the "T" junction and the other was in the junction of the vertical and the periareolar incisions. None

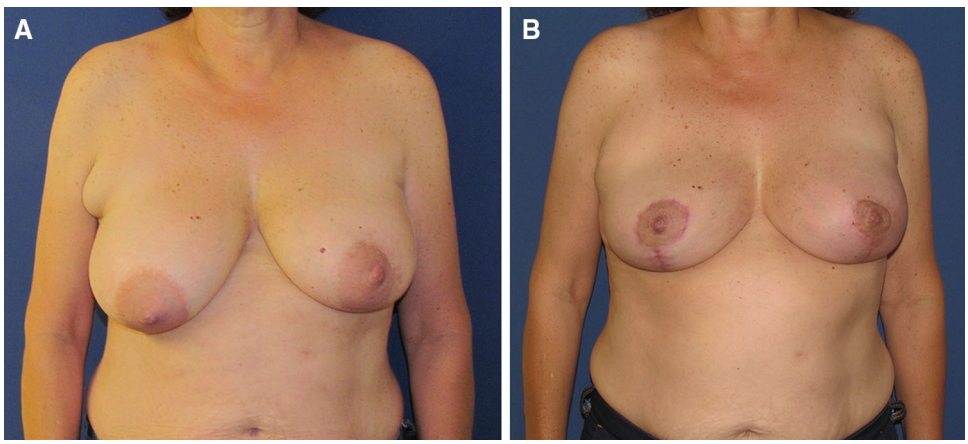

Fig. 1 A 58-year-old patient 6 years after left breast conservation therapy (BCT) with breast asymmetry and a left breast periareolar scar (**a**). She underwent right breast reduction and left breast mastopexy. Six months after surgery (**b**)

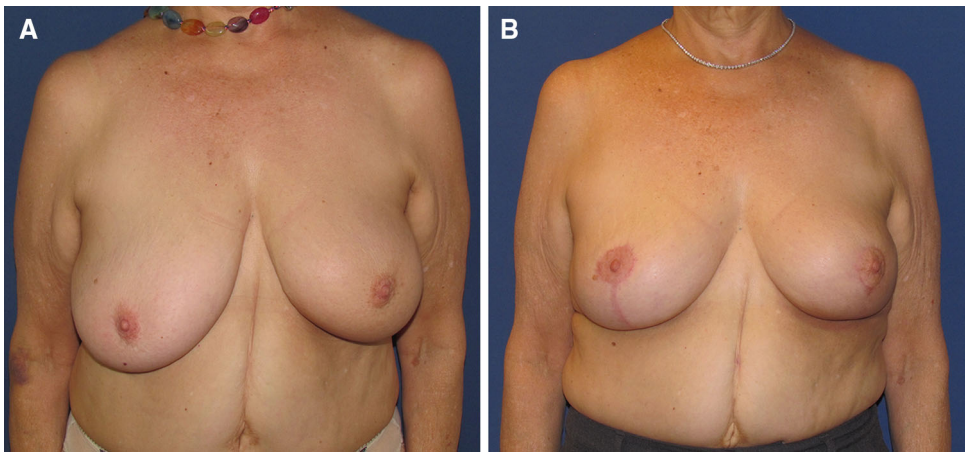

Fig. 2 A 72-year-old patient 2.5 years after left breast conservation therapy (BCT) with breast asymmetry and an upper-lateral breast scar (**a**). She underwent bilateral breast reduction using a superior-medial-based pedicle. One year after surgery (**b**)

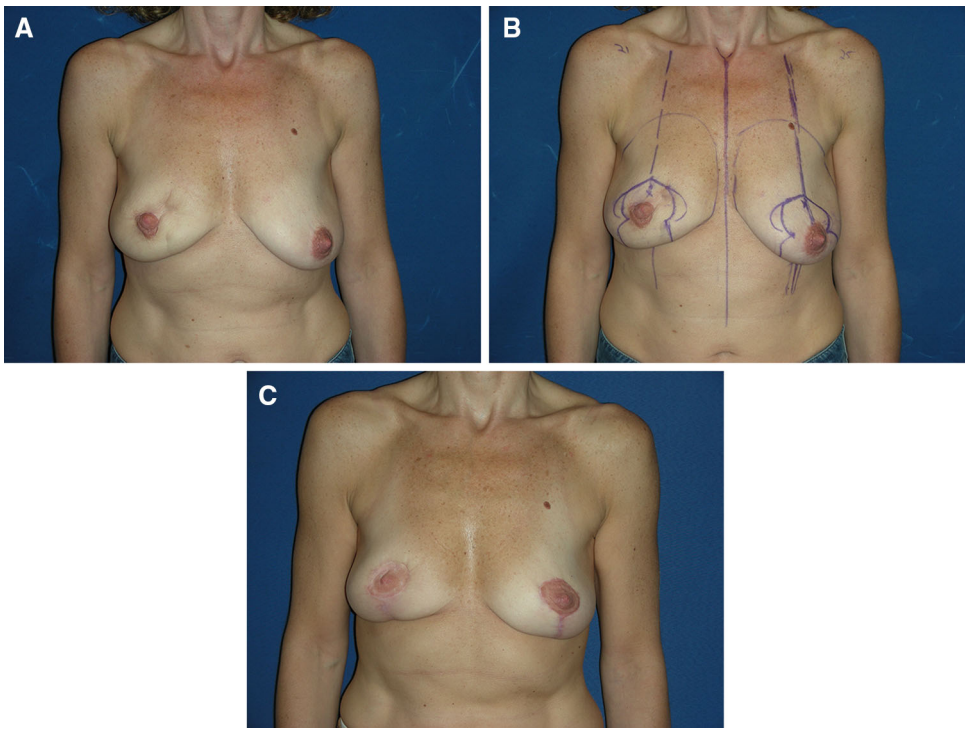

Fig. 3 A 55-year-old patient 3 years after right breast conservation therapy (BCT) with breast asymmetry and right upper-medial scar and breast distortion (**a**). Preoperative markings of the patient (**b**). She underwent bilateral mastopexy, using a lateral-based pedicle on the right breast. One year after surgery (**c**)

of these complications required a return to the operation room or caused major breast asymmetry. Two patients (8%) had major complications, requiring further surgery: one patient with wound infection and major fat necrosis required debridement and primary closure, and a second patient with major fat necrosis and breast deformation required further reconstruction with an autologous deep inferior epigastric perforator (DIEP) flap. One patient was diagnosed after surgery with recurrent breast cancer that required mastectomy and reconstruction with autologous tissue (DIEP flap).

There was no correlation between the complications and the patients' BMI ($p = 0.09$), comorbidities ($p = 0.67$), smoking history ($p = 0.48$), or chemotherapy ($p = 0.58$). There was also no correlation between the complications and tumor type (ductal carcinoma in situ, lobular carcinoma in situ, invasive lobular carcinoma, or invasive ductal carcinoma: $p = 0.26$, 0.11, 0.88, and 0.64, respectively), or tumor location (lateral, medial, lower pole, upper pole, or central: $p = 0.75$, 0.52, 0.18, 0.64, and 0.18, respectively). There was no correlation between the complications and the amount of breast tissue resected ($p = 0.607$).

Discussion

Breast-conserving therapy (BCT) is the leading oncological treatment for breast cancer, but it can cause significant breast asymmetry and distortion [23–31]. The risk of developing asymmetry and breast distortion is multifactorial, with one of the major factors being the ratio of lumpectomy volume versus total breast volume [23–31]. We currently offer patients with ptotic and hypertrophic breasts with a relatively large lumpectomy volume, immediate oncoplastic reconstruction by means of reduction or mastopexy pattern techniques, at the time of the lumpectomy. The aim is to obliterate the lumpectomy dead space and reduce the potential breast asymmetry and distortion that will follow after radiation therapy [32].

Many patients who had already undergone BCT without immediate oncoplastic reconstruction seek to improve the aesthetic outcome after completion of the oncologic treatment. Correction of the breast deformity and asymmetry in the form of breast reduction or mastopexy on previously irradiated and operated breasts is a surgical challenge, and there can be untoward postoperative sequelae, as noted by Dal Cin. [17] who described a fourfold–tenfold higher risk of delayed wound healing, infection, and scarring in breast reduction after BCT.

We present our experience in 25 patients (11 breast reduction and 14 mastopexy), which is the largest reported series on this topic to date. We demonstrated that these procedures can usually be performed safely following a basic surgical protocol. In our series, two patients (8%) had major complications that required further surgical interventions and five patients (20%) had minor complications, an outcome that is similar to the series described by Spear et al. [18]. There was no correlation between the complications and patients' demographics, tumor type, tumor location, and breast resection volume ($p > 0.05$).

Post-BCT Surgical Protocol

The first step is meticulous patient selection, which is key to successful outcome in these cases. All the candidates were presented and discussed at the institutional multidisciplinary breast team meetings regarding their oncologic status and the optimal timing for the procedure. Interventions for patients with significant radiation damage to the breast skin and/or parenchyma (mainly fat necrosis) were postponed, or they were offered only contralateral breast adjustment. Preoperative breast imaging was essential for baseline status as well as postoperative correlation and follow-up.

The second step is careful planning of the reduction or mastopexy. Tissue elasticity in radiated breasts is often lost, and there is less "give" for tissue manipulation. Moreover, with time, the healthy breast tends to sag with fullness of the lower pole (pseudoptosis), while the radiate breast has limited elasticity and less "bottoming out" of the lower pole. With this in mind, skin resection on the radiated side was minimalized, especially for lower-pole lumpectomies, to allow the descent of breast tissue to the lower pole and to avoid skin tethering and tension on the scars. Furthermore, for lower-pole lumpectomies, the vertical scar was adjusted to the previous lumpectomy scar. The nipple position on the radiated breast was set lower compared to the healthy breast, and the pedicle was planned in opposition to the previous lumpectomy scar, and marked as short and broad as possible, as described in the "Surgical Technique" section.

The third step is basic surgical refinements. Radiated tissue has reduced vascular supply and a higher tendency for ischemia and necrosis [33–37]. During surgery, undermining of the skin and breast tissue was avoided to preserve maximal blood supply (by means of perforating vessels) to the tissue. Wedge resection of breast tissue and de-epithelialization was favored over undermining, and in some cases mastopexy was performed using de-epithelialization only. The scarring in the previous lumpectomy area was released, and areas of significant fat necrosis were excised.

The final step is meticulous patient education. This elective breast surgery is performed in a high-risk irradiated tissue environment, with potential for major complications. All issues regarding expectations and complications should be raised with the patient, including postoperative breast asymmetry, wound dehiscence, scars, loss of nipple sensation, nipple necrosis, infection, and fat necrosis. Minor breast asymmetry after the corrective surgery (breast volume, shape, and NAC position) is the rule, since the skin and soft tissue behave differently in radiated and healthy breasts. These aspects should be discussed in detail with the patients, and the surgeon should be confident that the patient has understood them. Patient education is indispensable, since some patients will need further secondary procedures to improve their aesthetic outcome. For example, fat grafting can be offered in a second stage to fill in breast defects and to improve symmetry in breast volume and shape.

Oncoplastic breast reduction and mastopexy can be performed safely with high patient satisfaction and good aesthetic outcome in patients with breast cancer [4–6, 11–21, 32, 38]. This procedure can be done both immediately, at the time of the lumpectomy or delayed, after the completion of radiation therapy [4–6, 11–21, 32, 38]. Each technique has its pros and cons regarding tumor margins, secondary procedures, surgical complications (radiated tissue), and aesthetic outcome [38].

The goal is to consult the patients before the lumpectomy surgery and to decide on the best timing for the oncoplastic procedure. Multidisciplinary breast teams can facilitate in coordinating the patients in receiving a comprehensive consult before the oncological surgery.

This study has a number of limitations. Its retrospective nature bears potential bias in patient selection and outcome measures. The main outcome measure of the study was surgical success, complications, and reoperations, but no data on patient satisfaction and objective breast symmetry and aesthetic outcome were provided. The relatively low number of complications in the study can potentially under-power it to detect significance.

Conclusion

Breast reduction and mastopexy for the repair of asymmetry after BCT should be approached with caution. These procedures can be safely and successfully performed following a protocol of stringent patient selection, thorough surgical planning, basic surgical refinements, and patient education.

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Compliance with Ethical Standards

Conflict of interest Dr. Barnea is a speaker for Johnson Medical. None of the other authors have financial interest, conflict of interest or personal relationship to declare in relation to the content of this article.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed Consent For this study informed consent is not required

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