Partial Breast Reconstruction With Mini Superficial Inferior Epigastric Artery and Mini Deep Inferior Epigastric Perforator Flaps

Aldona J. Spiegel, MD,† and Liron Eldor, MD*‡*

Abstract: In this study, partial breast reconstruction was undertaken after breast conservation therapy using mini abdominal free flaps on both an immediate and delayed basis.

Patient demographics, oncologic status, reconstructive data, and complications were collected from medical records.

Twelve patients (age range 39–60) were included in this study with a mean follow-up time of 5 years. Ten mini superficial inferior epigastric artery flaps and 2 mini deep inferior epigastric perforator flaps were used (7 immediate and 5 delayed reconstructions). No flap lost, 1 minor abdominal wound dehiscence, and no local or distant recurrences were noted. Good to excellent results were reported by 91% of the women.

In properly selected patients with high motivation toward breast conservation, tailored abdominal mini-free flaps can safely and satisfactorily be implemented for the reconstruction of partial mastectomy defects. Patients should be comprehensively educated on the potential future implications of using the abdominal donor site for partial breast reconstruction.

Key Words: breast conserving therapy, breast reconstruction, DIEP flap, SIEA flap, breast cancer

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Modern surgical treatment for early-stage breast cancer consists of breast conserving therapy (BCT) versus mastectomy. BCT integrates breast conserving surgery (BCS), radiation therapy (RT), and axillary node sampling as complimentary modalities. The principal intent of BCT is to remove only the required amount of breast tissue, leaving intact as much of the native breast tissue, skin, and nipple areola complex (NAC) as possible. BCT has become the preferred method of treatment for many women diagnosed with early-stage breast cancer. Oncoplastic breast conserving reconstruction has evolved to maximize treatment in the oncologic aspect of wide tumor-free resection, optimize the reconstructive strategy, and keep complication and recurrence rates to a minimum.[1]

From an oncologic standpoint, the accumulated data demonstrate that BCT compares favorably with traditional mastectomy protocols.[2] Current randomized prospective studies comparing mastectomy with BCT for the treatment of early-stage breast cancer (stages I and II) with follow-up periods of up to 20 years have demonstrated no significant differences in overall or disease free survival.[3–5] In recent trials (B-20, B-23 NSABP trials) in which all node negative patients were treated with adjuvant chemotherapy, the 10-year local recurrence rates were lower than 5%.[6]

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From the *Center for Breast Restoration, Institute for Reconstructive Surgery, The Methodist Hospital, Houston, TX; †Weill Cornell Medical College, New York City, NY; and ‡Department of Surgery, Division of Plastic Surgery, Baylor College of Medicine, Houston, TX.
Reprints: Aldona J. Spiegel, MD, The Methodist Hospital, Institute for Reconstructive Surgery, Center for Breast Restoration, 6560 Fannin St., Suite 2200, Houston, TX 77030. E-mail: Aspiegel@tmhs.org.

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Various techniques, guidelines, and classifications for partial breast reconstruction have been described since the acceptance of BCT as a pivotal alternative for breast cancer treatment. Reconstruction of these defects can be broadly categorized as being either a volume-replacement technique or volume-displacement technique.[7–13] The ratio between the excised breast mass to initial breast volume is useful in choosing between these two techniques; the higher the ratio the more likely volume replacement will be indicated.[14–17]

Hence, the smaller breasted women are best managed by volume-replacement techniques as, offered by autologous tissue transfer. These women may dislike the added scarring at the chest donor site that is inherent to local flaps and are thus more amenable to the abdominal donor site, which likens the tissue excision to a cosmetic abdominoplasty.

In this study, we present our initial experience with the use of mini abdominal free flaps for volume replacement. This was done in the setting of both immediate and delayed partial breast reconstruction. Although immediate reconstruction patients initially had their surgical reconstruction and then completed their RT, the reverse is true for the delayed reconstruction group. The mini superficial inferior epigastric artery (SIEA) flaps or mini deep inferior epigastric perforator (DIEP) flaps were chosen with the rationale of offering superior cosmetic results, minimal donor site morbidity, and a well-hidden donor site scar.

Only women who expressed very high motivation toward breast conservation and preservation of their NAC were included in this study after being extensively educated on the pros and cons of this procedure from both oncologic and reconstructive view points. The aim of this article is to share our gained knowledge and experience with this technique, examine its cosmetic outcome, and debate its applicability for BCT. The use of tailored mini abdominal free flaps for partial breast reconstruction is a novel technique.

PATIENTS AND METHODS

Patient Population

This study is a retrospective review of consecutive partial breast reconstructions using mini-SIEA and mini-DIEP flaps for BCT undertaken at our institute during a 17-month time period. The patient population consisted of 2 groups: immediate reconstruction before RT and delayed reconstruction after completion of the RT. Patient charts were reviewed for the following parameters: patient age, presurgical brassiere cup size, tumor size, tumor type, tumor location, tumor stage, lymph node involvement, RT, chemotherapy treatment, locoregional or distant tumor recurrence, time interval from BCT to reconstruction, type of flap used for reconstruction, and complications associated both with the flap and the donor site. Patients were also questioned regarding their satisfaction with the final results.

Patients were scheduled for immediate partial breast reconstruction after receiving the permanent pathology reports of both the breast tissue and axillary node sampling; thus tumor staging and planned oncologic treatment were known before the reconstructive procedure. In the delayed group, reconstruction was undertaken only after being satisfied with the completion of the oncologic treatment

protocol and after reviewing the previous pathology report for wide clear margins.

Surgical Technique

Before marking the flap outline, both the superficial and the deep abdominal vascular systems were mapped at bedside using a standard pencil-Doppler. In marking the flap, the lower incision was placed just above the pubic hair line and carried out laterally with a gentle sloping curve to the anterior superior iliac spine. When planning any SIEA flap, it is wise to keep a low incision line as the diameter of the SIEA increases proximally toward its origin. Because the relative majority of patients opting for partial reconstructions with these types of flaps were slim, the upper abdominal incision line was marked keeping in mind both the existing abdominal tissue laxity and the anticipated amount of tissue needed for reconstruction. Thus, in this slimmer patient group, the course of the upper incision line may lay caudal to the umbilicus, potentially necessitating relocation of the umbilicus, resulting in a small, low vertical scar. Patients should be informed and accepting of the possibility of such a scar.

At the commencement of surgery, attention is centered on recreating the lumpectomy defect (the reason being the tendency to underestimate the true size of the excisional defect) and choosing the recipient vessels for anastomoses. Careful dissection is imperative, so as not to transect any perforator vessels in the vicinity of the recreated defect. Preserving these perforators is particularly important when a mini-SIEA flap is chosen, because these perforators might be of adequate size match, and in preferable location, relative to the flap vessels. When attempting to recreate the excisional defect, any scarred and fibrosed tissues are removed in delayed cases, whereas any serous cavity lining encountered is excised in immediate cases. A template of the cavity was then drawn on sterile glove paper to be duplicated before flap inset.

Applying our previously published algorithm,[18] intraoperative assessment of the SIEA pedicle guided us in choosing between a mini-SIEA and a mini-DIEP. However, our originally described criteria for choosing an SIEA flap entailed a 1.5-mm arterial caliber for choosing an SIEA flap, but in partial reconstructions a caliber as narrow as 1.3 mm was acceptable for choosing a mini-SIEA. The rationale in allowing for a smaller arterial caliber for mini-SIEAs is both the smaller size of the flap needed to perfuse and the use of smaller recipient vessels for the anastomosis. Still, a palpable arterial pulse and good audible external Doppler signals had to coincide with an appropriate SIEA caliber. Dissection of a mini-DIEP was performed whenever these criteria were not met. In these instances, the mini-DIEP was preferentially anastomosed to the internal mammary vessels because of better vessel caliber match.

Surgically, dissection of the mini-SIEA or mini-DIEP was executed in the same manner as routine harvest of SIEA or DIEP flaps. In the mini-DIEP, one should remember the importance of including the lower lying perforators into the flap design because of the lower positioning of the superior incision line.

We were able to reduce the size of the flaps around the chosen vascular axis without damaging perfusion to the rest of the flap; hence, the terms mini-SIEA/mini-DIEP. These flaps enabled us to tailor the necessary amount of abdominal tissue according to the patient's need with considerably less donor site morbidity.

The location of the recreated defect and the vessel caliber match were the key elements dictating the recipient vessels we chose for anastomoses. The internal mammary and its perforators, serratus branch of the thoracodorsal, and thoracoacromial perforators were used in this series. Arteries were anastomosed using interrupted 9/0 or 10/0 nylon sutures, veins were coupled with a coupler, and an implantable venous Doppler was used in all cases.

In choosing the final flap size, we intentionally used flaps roughly 20% larger than the recreated defect, as we anticipated shrinkage of the flaps from radiation or physiologic flap shrinkage (not related to radiation treatment). The breast and abdominal incisions were closed in standard layered fashion using absorbable sutures.

RESULTS

Patient Demographics

The study group included a total of 12 patients with a mean age of 50 years (range, 39–60) years. Seven patients underwent immediate partial reconstructions, whereas 5 had been referred for delayed reconstructions (data summarized in Table 1). The breast sizes before lumpectomies ranged from a 34A to a 38D. With 7 (58%) being a B cup, 3 (25%) a C cup, 1 an A cup, and 1 a D cup. The time frames from original lumpectomies to reconstructions were as follows: for the immediate group a mean of 10 days (range, 0–29 days) and for the delayed group a mean of 3.1 years (range, 10

TABLE 1. Patient Data

Patient	Age (yr)	Bra	Interval*	Flap	Flap Weight (g)	Recipient Vessels	LHS	FU	IRT
1	48	36B	0 d	SIEA	181	Internal mammary	3	66	16
2	45	38C	0 d	SIEA	152	Internal mammary	3	66	12
3	50	36B	29 d	DIEP (1)†	342	Internal mammary	4	62	14
4	45	36B	14 d	SIEA	164	Serratus branch	4	59	16
5	58	36B	9 d	SIEA	191	IM perforator	3	62	10
6	60	36B	8 d	DIEP (2)†	429	Internal mammary	3	53	10
7	58	38D	11 d	SIEA	180	Internal mammary	4	53	10
8	50	36C	10 mo	SIEA	333	Serratus branch	5	54	N/A
9	59	36B	7 yr	SIEA	263	Internal mammary	4	59	N/A
10	43	36C	3 yr	SIEA	301	Serratus branch	4	63	N/A
11	39	34A	3 yr	SIEA	244	IM perforator	5	68	N/A
12	43	34B	2 yr	SIEA	161	serratus branch	4	69	N/A

*Time interval from time of lumpectomy to reconstructive surgery.

†Number in parenthesis denotes the number of perforators used for the DIEP flap.

IM indicates internal mammary; LAH, length of hospital stay (days); IRT, time interval from reconstruction to start of radiation therapy (weeks); FU, follow-up time (months).

TABLE 2. Oncologic Data

Patient	Histology	Size (cm)	Location	TNM	Stage	Chemotherapy
1	IDC*	6.7	Supero-central	T3N1M0	IIIA	Neoadjuvant
2	IDC + DCIS†	1.1	Supero-lateral	T1N0M0	I	None
3	IDC + DCIS	5	Supero-medial	T2N0M0	IIA	Neoadjuvant
4	IDC	0.9	Lateral	T1N0M0	I	Neoadjuvant
5	IDC	0.3	Supero-central	T1N0M0	I	None
6	IDC	2.7	Supero-central	T2N0M0	IIB	None
7	IDC	2	Supero-lateral	T1N0M0	I	Neoadjuvant
8	DCIS	1	Infero-lateral	TisN0M0	0	None
9	IDC	2.5	Medial	T1N1M0	IIA	Adjuvant
10	IDC	1.5	Supero-lateral	T1N1M0	IIA	Adjuvant
11	IDC + DCIS	3.5	Supero-central	T2N1M0	IIB	Adjuvant
12	IDC	1.5	Supero-lateral	T1N0M0	IIA	Adjuvant

*IDC-Invasive ductal carcinoma.
†DCIS- Ductal carcinoma in situ.

months to 7 years). Mean follow-up time was 5 years (61 months) ranging from 53 to 69 months.

One of the advantages in using free flaps for partial reconstruction is the freedom to reconstruct any quadrant of the breast because of the availability of a number of appropriate recipient vessels in the surrounding area. In this group, the recipient vessels used for anastomoses were as follows: in 50% of the cases, the internal mammary artery and vein were chosen, in 33% the serratus branch of the thoracodorsal vessels, the internal mammary perforators and thoracoacromial (pectoralis major) perforators were each used on one occasion.

Oncologic Data

Regarding tumor characteristics; in 11 patients (92%), the tumors were invasive ductal carcinoma, and only 1 patient had pure ductal carcinoma in situ (DCIS) with no invasive component (oncologic data are summarized in Table 2). Of note, in DCIS patients, we recommend that a delayed approach be adopted due to the multifocal nature of these tumors. Tumor size mean was 2.39 cm (range, 0.3–6.7 cm). In 9 patients (75%), the tumor was located at the superior half of the breast with each of the remaining 3 tumors located at the medial, lateral, or inferior aspect. Lymph node involvement was encountered in 4 patients (33%), with 3 being in the delayed reconstruction group and 1 in the immediate group. No local or distant recurrences were noted during the follow-up periods. Concerning tumor staging, 91.6% of the patients had a stage II or lesser tumor. Only 1 patient had a stage III tumor (see Discussion section).

As part of the routine protocol, all patients received a full course of RT in the range of 4500 to 5040 rads. Equal numbers of patients, 4 (33%), were treated with neoadjuvant chemotherapy, adjuvant chemotherapy, or no chemotherapy.

Complications

All flaps were successful, 1 required reexploration due to compression of the venous anastomosis by the adjacent pectoralis muscle, and the flap was salvaged in full. All flaps underwent some degree of volume shrinkage; still no cases of skin paddle contracture were noted even in the group receiving post reconstructive radiation.

No wound healing complications were encountered in the reconstructed breasts, but abdominal wound dehiscence occurred in 1 active smoker, necessitating minor surgical intervention. A small amount of fat necrosis (approximately 2 cm^2) was noted in 1 patient in the immediate reconstruction group after having her flap liposuctioned during flap revision surgery to achieve better symmetry. No local, regional, or distal tumor recurrences were evident throughout the follow-up period.

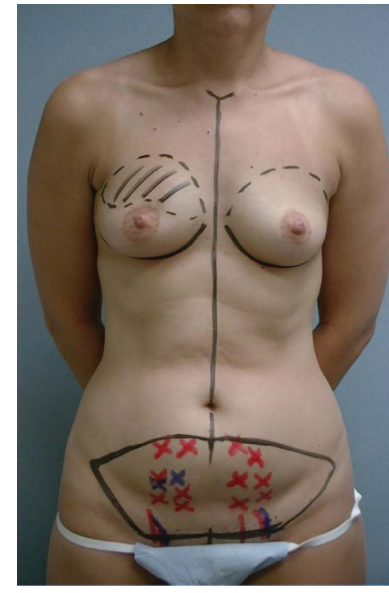

FIGURE 1. Patient 1—Markings for both the SIEA and DIEP mini flaps are made preoperatively, and the expected resection area is also marked (left).

Satisfaction

When polled regarding their esthetic results, 11 of 12 (91%) graded their result as good to excellent, whereas 1 patient graded her result as fair. This 1 patient was dissatisfied because of some intra flap fat necrosis that resulted from revision liposuction (as noted earlier).

Three representative cases are shown in Figures 1 to 7.

DISCUSSION

BCT offers women the hope of maintaining the overall breast cosmesis and functional and psychosocial advantages. Naturally, this should be accomplished without increasing the risk of leaving

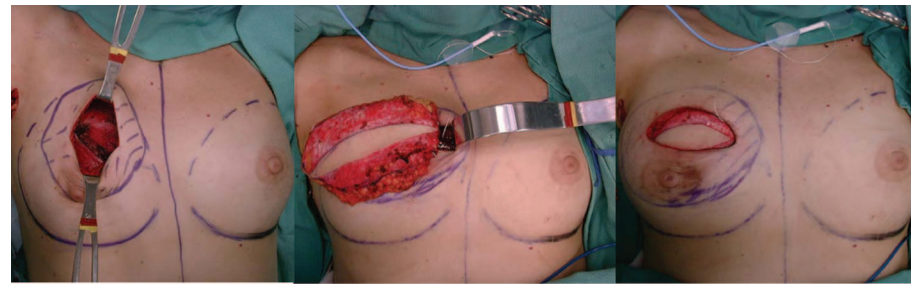

FIGURE 2. Patient 1—The right breast resection defect is demonstrated (left). Flap has been anastomosed to the internal mammary vessels, deepithelialized, and trimmed to be approximately 20% larger than defect (center). Flap after final inset before skin closure (right).

FIGURE 3. Patient 1—Immediate reconstruction with mini-SIEA flap. Preoperative (top) and 19-month postoperative and post-RT results are shown (bottom).

any cancerous cells. Several studies have shown that approximately 20% to 30% of women who undergo BCT will end up with unsatisfactory cosmetic results.[19–22] Multiple factors will add up to influence the final cosmesis of the breast including native breast shape, location of the tumor in the breast, the proportion of tissue resected from the breast, and RT.

As noted previously, the reconstructive techniques can be categorized into 2 groups as follows:

1. Volume displacement techniques are based on transposition, rotation, and/or reduction of the remaining breast tissue to achieve a more esthetic breast shape. These techniques are realistically more applicable to the larger breasted, ptotic patient (correlating to a D cup brassiere).[11,12]
2. Volume-replacement techniques involve the introduction of autologous tissue to replace the removed tissue and achieve symmetry and are useful in the small to medium breasted patients (cups A–C).[14,16,17]

Analyzing the data of both the location of the reconstructed area on the breast mound and the bra cup size of the patient population, it is evident that from a reconstructive point of view, the more challenging group of patients are the small to medium breasted women, which have a superior lumpectomy defect.

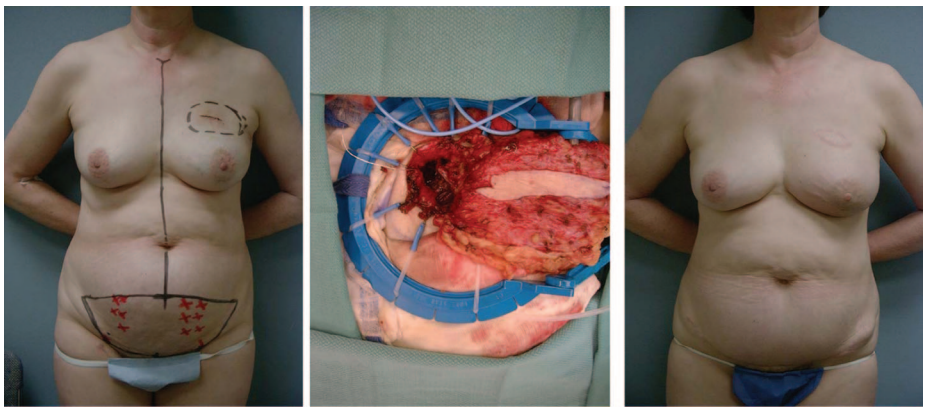

FIGURE 4. Patient 5—Preoperative marking, note the marking of the seroma-filled defect cavity in the left breast and the outline of the low positioned mini flaps (left). Initial tailoring of the flap tissue and skin paddle at inset (center). One-year postoperative result, after completion of RT before removal of the flap skin paddle (right).

FIGURE 5. Patient 5—Immediate reconstruction with mini-SIEA flap. Preoperative (top) and 4-year postoperative results are shown (bottom). The SIEA flap skin paddle was excised at just over 1 year from the reconstructive surgery. This patient's elongated lower abdominal habitus resulted in only minimal transposition of the umbilicus after the mini flap harvest.

Although it might be feasible in larger breasted women to reconstruct a partial defect with local tissue rearrangement (eg, reduction type procedure), a smaller breasted patient will most likely need transfer of distant tissue into the breast to recreate contour.

Losken et al[23] reported on their experience with immediate reconstruction of partial mastectomies based on initial gross or frozen section analysis, concluding that delaying the reconstruction until final pathologic examination of the specimens is complete, will maximize both the cosmetic results and oncologic safety. Two

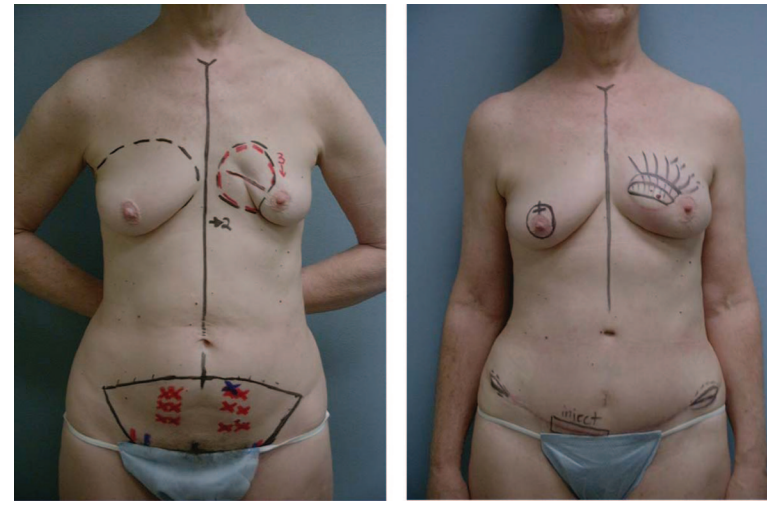

FIGURE 6. Patient 9—Markings for both the SIEA and DIEP mini flaps are made preoperatively, and the expected resection is also marked (left). Six months postoperative result with markings for revision surgery. Partial excision of the skin paddle, superior pole contouring, contralateral periareolar pexi, and abdominal scar revision are delineated (right).

FIGURE 7. Patient 9—Delayed reconstruction with mini-SIEA flap. Preoperative (top) and 4½ years postoperative results (bottom). After surgery, the patient no longer wears a compressive garment for left arm lymphedema, which she had worn for 6 years before her reconstructive surgery.

important points should be highlighted with respect to oncologic status in 2 patients in this study group. One of the first patients to undergo immediate reconstruction was a stage IIIA with a 6.7-cm tumor. This patient was very distressed with the high likelihood that she would need to sacrifice the NAC during a traditional mastectomy and was very highly motivated toward BCT. Thus, only after

an extensive discussion between the patient and her general surgeon regarding the risk of local recurrence, their decision was to opt for BCT, and the patient was referred to us for a partial reconstructive procedure. At present, only patients with stage II or less are candidates for this type of reconstruction. The second point in this regard is treatment for DCIS; as mentioned previously, we advise delayed reconstruction in DCIS patients because of the high tendency for multifocal tumors.

The mean time from lumpectomy to reconstruction was 10 days (range, 0–29) for the immediate reconstruction patients in this initial study. The first 2 immediate patients in this study were reconstructed on the day of lumpectomy after clear margins were confirmed on frozen section, whereas the rest of were done only after final permanent sections were reviewed. To date, in immediate reconstructions, we recommend postponing the reconstruction until final pathology reports confirm wide negative margins of at least 1 cm before reconstructive surgery.

We believe, this staged-immediate approach has many advantages over delayed reconstruction (post irradiation treatment) including less scarring encountered during surgery, relative ease of recreating the true excisional defect, better cosmetic outcome, and decreased psychologic distress for the patient.

Considering the patient's high motivation and desire for nipple preservation, the need for wide negative margins highlights two major advantages of free tissue transfer for BCT; first, the abundance of tissue available for reconstruction offers the oncologic surgeon the comfort of primarily performing wider margin excisions not being unnecessarily troubled by the resultant deformity. Second, women with larger tumors can still be candidates for BCT, despite the higher ratio of excised breast tissue to the remaining breast size. Although the need for systemic chemotherapy might be warranted in these cases, preserving a sensate NAC is still an option.

After presenting the possible donor sites available for reconstruction, this patient group selected the abdominal area as the most suitable volume-replacement source for them. When questioned, the explanations given were: an easily hidden scar, avoidance of adding scarring on the breast and chest wall, avoiding back scars (allowing for specific attire), and benefit from an improved abdominal contour. A small vertical midline scar is at times unavoidable because of the necessary umbilical transposition. This is discussed with the patients before surgery. In the cases where this occurred, the resulting scar was acceptable and easily hidden under higher waist attire.

In our hands, defects of the superior and medial poles are not easily reconstructed with pedicled perforator flaps because of limitations in pedicle reach and amount of tissue available. The tailored mini flap can be contoured to conform to the shape of the defect leaving only a small superficial skin paddle for monitoring and anastomosed to a local recipient vessel without disturbing adjacent breast tissue. The lattissimus dorsi is also a useful tool in these scenarios; however, we find that in certain instances, the lateral part of the breast is disrupted unnecessarily. The use of the mini abdominal-free flaps allows for a more direct and customized approach to the defect.

Others have suggested sparing the abdominal tissue in the event that the patient later needs to undergo a full mastectomy and subsequent reconstruction.[10] This rationale is challenged by both the current lower recurrence rates encountered after BCT,[24] which compare favorably with local recurrence rates after mastectomies,[2] and the logic that we would then have to stop performing elective abdominoplasties because 1 in 8 women (12%) have a lifetime risk of developing breast cancer and might require autologous breast reconstruction.

Using the abdominal tissue in partial reconstructions does burn the bridge of using this donor site in the case of local recurrence or if the need for a contralateral mastectomy reconstruction arises. The same dilemma arises when using the abdominal tissue for unilateral reconstructions after total mastectomy or undergoing a cosmetic abdominoplasty. We do not recommend using the abdominal donor site for partial reconstructions in the following situations: advanced stage breast cancer, *BRCA-1*- and *BRCA-2*-positive patients, strong family history, suspicious magnetic resonance imaging findings on contralateral breast, and unfavorable cancer oncotype.

In the adverse event of cancer recurrence necessitating completion mastectomy, other free flaps are available for reconstruction such as the superior or inferior gluteal artery perforator flaps and the transverse upper gracilis flap. These can usually be anastomosed to existing vessels. A pedicled latissimus dorsi flap with or without an implant is also a valid reconstructive option as the thoracodorsal pedicle was spared during the initial reconstruction.

In immediate reconstructions, we advise waiting at least 6 months postcompletion of RT before attempting any revisional surgery on the reconstructed breast. Any flap volume shrinkage or contracture secondary to RT should become apparent during this time frame. As anticipated, some degree of flap volume decrease was noticed in all the cases, which did not truly manifest in the final result because we intentionally designed flaps slightly bigger than the recreated defect to compensate for this scenario. In some cases, we have revised the flap size at a later date, but in our experience irradiated flaps are much less tolerant of liposuction; hence, we recommend mainly excisional revisions with minimal judicious liposuction. In this study, liposuction of the reconstructed breast was performed in 5 patients. If indicated, we offer the patient partial or even total excision of the skin paddle leaving a smaller skin island or only a linear scar. In this study, 4 patients had partial excision of the skin paddle, and 1 underwent total removal of the skin paddle. Breast asymmetry requiring contralateral mastopexy is also addressed at the time of revisional surgery. Three patients underwent contralateral mastopexy in this study to achieve better symmetry.

Life-long oncologic surveillance is mandatory in patients who undergo BCT. The patient must be highly motivated to preserve the remaining breast and NAC and to commit to this demanding life-long monitoring. We recommend the use of magnetic resonance imaging as the standard for subsequent breast surveillance.

CONCLUSION

We recognize the fact that our study involves a small sample size, and larger studies with even longer follow-up will be needed to corroborate our findings. We intentionally collected long-term follow-up data on this group of patients from both an oncologic and an esthetic perspective before publishing our results.

Still, we believe that the mini-SIEA and mini-DIEP flaps are a welcome addition to the reconstructive surgeon's arsenal. Future creative approaches will broaden the application of these and other free flaps in partial breast reconstruction. The use of free flaps for partial breast reconstruction should be considered for a select group of patients with early stage of cancer, low risk of recurrence, no family history of breast cancer, and negative genetic markers.

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