



Autologous Breast Reconstruction Skin Paddle Designs: Classification and Aesthetic Outcomes

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Abstract

Objective Present study was conducted to identify common mastectomy patterns and autologous skin paddle designs, to identify patient characteristics that influence these patterns, and assess aesthetic outcomes associated with each pattern.

Methods Autologous breast reconstructions over 5 years were reviewed. Mastectomy type and resultant skin paddle were categorized into four mastectomy type/skin paddle design groups based on the amount of native “Skin Spared” after mastectomy and the resultant flap skin paddle designed. Groups were designated as skin-sparing mastectomy 1 (SS1)/large elliptical skin paddle, skin-sparing mastectomy 2 (SS2)/small elliptical skin paddle, skin-sparing mastectomy 3 (SS3)/areola skin paddle, and skin-sparing mastectomy 4 (nipple-sparing mastectomy, SS4)/no skin paddle. Surveys were performed to validate the classification system and critique aesthetic outcomes.

Results A total of 89 autologous breast reconstructions were included. Radiotherapy was used in 45.6% of SS1 patients versus 29.2% in SS2 and 12.5% in SS3/SS4. Mean body mass index (BMI) was 30 in SS1/SS2 and 26 in SS3/SS4 mastectomy types ($p = 0.045$). Delayed reconstruction was performed in 96.5% SS1 versus 62.5% in SS2 and only 25% of SS3/SS4 ($p < 0.0001$). Physicians and Non-MD personnel correctly categorized 85.8 and 76.1% of skin paddle designs, respectively. Over 75% of those surveyed rated the reconstruction aesthetic outcome as “good-excellent” regardless of the pattern group.

Conclusions Patients in SS1/SS2 groups had a higher incidence of radiotherapy, delayed reconstruction, and higher BMI compared with the SS3/SS4 groups. The classification system is recognizable and may provide improved patient education and communication between healthcare providers. All mastectomy type/skin paddle designs received high aesthetic ratings.

Keywords

- ▶ mastectomy
- ▶ autologous breast reconstruction
- ▶ free flap
- ▶ flap inset

Breast reconstruction following mastectomy is associated with a positive influence on a patient's breast appearance, psychosocial status, and sexual well-being.^{1,2} Use of autogenous soft tissues for breast reconstruction is increasing for several reasons. This reconstruction technique has an acceptable risk profile and produces a natural appearing breast.³ In addition, autologous tissue allows for improved symmetry with a contralateral native breast in unilateral mastectomy patients.⁴ Most recently, concerns regarding implant reconstruction have surfaced stimulating re-evaluation of surgical

interventions for implant complications including the occurrence of implant associated lymphomas.^{5,6}

Autologous breast reconstruction is distinct from implant reconstruction because it provides both breast volume and may add new skin to the breast in the form of a skin paddle. The skin paddle serves multiple purposes including replacing resected native skin and paddle examination is the most sensitive manner of flap perfusion monitoring. The balance of native skin envelope and newly added skin paddle varies and this ratio results in predictable patterns of the reconstructed

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breast. Several studies discuss techniques to improve the aesthetic outcomes of autologous breast reconstruction but, to our knowledge, none address the influence of the mastectomy pattern on autologous skin paddle design.^{7,8}

This study was conducted to identify common mastectomy patterns and define their effect on autologous flap skin paddle design in an attempt to create a standardized nomenclature to assist in communication amongst providers and with patients, to identify patient characteristics that influence which pattern is ultimately selected in autologous breast reconstruction, and to assess aesthetic outcomes associated with each pattern.

Methods

An institutional review board (IRB)-approved retrospective review of autologous breast reconstructions performed by a single surgeon over 5 years was completed. Patients ages 18 to 99 who underwent autologous breast reconstruction after mastectomy were included. Patients undergoing lumpectomy reconstruction, oncoplastic breast surgery, and latissimus dorsi myocutaneous (LDMC) flap reconstructions were excluded. Factors, including mastectomy technique, reconstruction technique, use of perioperative chemoradiation, timing of reconstruction, age at time of reconstruction, body mass index (BMI), smoking status, and comorbidities, were evaluated. The incidence of complications was examined and included partial or complete flap loss, hematoma/seroma, fat necrosis, and infection.

Standard patient photographs (preoperative and postoperative) were examined for each patient and their mastectomy type and resultant skin paddle design was categorized into one of four groups based on the amount of native skin present from the mastectomy and the resultant flap skin

paddle designed. The mastectomy type/skin paddle groups were designated as skin-sparing mastectomy 1 (SS1)/large elliptical skin paddle, skin-sparing mastectomy 2 (SS2)/small elliptical skin paddle, skin-sparing mastectomy 3 (SS3)/areola skin paddle, and skin-sparing mastectomy 4 (nipple-sparing mastectomy, SS4)/no skin paddle (→ Fig. 1).

Our first survey was performed to validate the classification system. Thirty medical doctors (MD) and 22 non-MD personnel (NMD) were asked to categorize randomized pictures of patients who had undergone mastectomy and autogenous reconstruction into their respective groups. Each survey participant was given a standardized explanation and cartoon image as well as example patient images of the mastectomy/skin paddle groups (→ Fig. 2), subsequently administered the survey, and their results recorded. These same participant groups were then administered a second survey to critique the aesthetic outcomes of each mastectomy group. The participants were administered a five question, Likert's scale survey that presented randomized pictures of patients following mastectomy and autogenous reconstruction and asked them to grade each on important aesthetic parameters of the reconstructed breast. This included rating the scar appearance on the final reconstructed breast, the overall size of the skin paddle, the influence of the skin paddle position on scar appearance and in relation to the nipple areolar complex (NAC), and the overall appearance of the reconstructed breast. Their results were recorded and analyzed for trends.

Statistical analysis was performed to evaluate trends and differences between groups. Continuous measures were compared with independent *t*-tests or analysis of variance (ANOVA) tests. For categorical measures, Fisher's exact tests were employed. A *p*-value of ≤ 0.05 was used to indicate statistical significance.

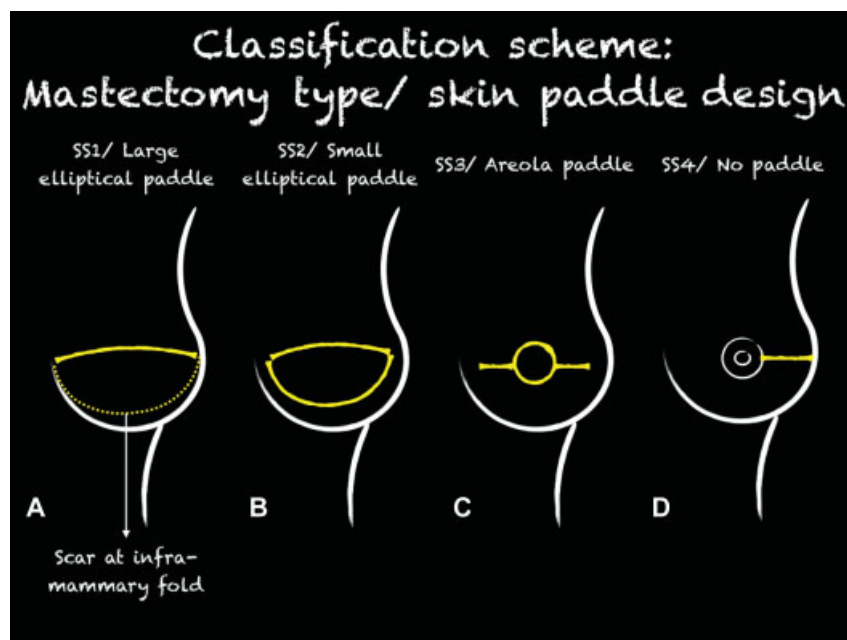


Fig. 1 Mastectomy type and their resultant skin paddle designs. (A) SS1/large elliptical paddle: large skin paddle with a transverse superior scar and an inferior scar hidden in the inframammary fold. (B) SS2/small elliptical paddle: central elliptical skin paddle on the anterior surface of the breast mound, all scars visible on the breast surface. (C) SS3/areola paddle: small central circular skin paddle located at the planned nipple areolar complex position. (D) SS4/no paddle: nipple sparing mastectomy with lateral radial and periareolar scar.

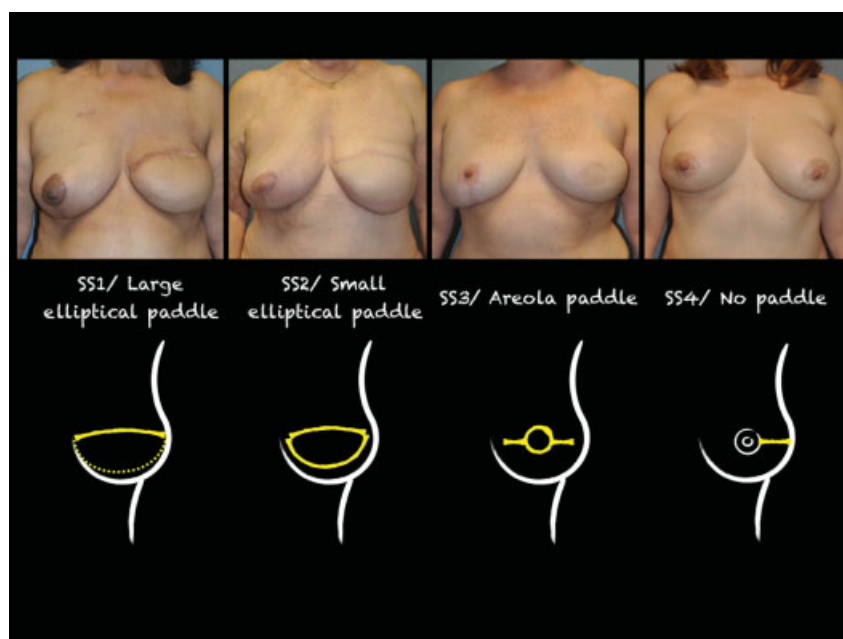


Fig. 2 Mastectomy pattern classification scheme. These classifications are based on final scar and skin paddle position in relationship to the reconstructed breast mound.

Results

A total of 89 autologous breast reconstructions were performed on 71 female patients. There were 57 breasts categorized as SS1 mastectomy/large elliptical skin paddle, 24 breasts as SS2 mastectomy/small elliptical skin paddle, seven breasts as SS3 mastectomy/areolar skin paddle, and one as SS4 mastectomy/no skin paddle. Flap types employed included four pedicled Transverse rectus abdominus myocutaneous (pTRAM) flaps, 49 muscle-sparing free TRAM (ms fTRAM) flaps, 32 deep inferior epigastric artery perforator (DIEP) flaps, three superficial inferior epigastric artery (SIEA) flaps, and one transverse upper gracilis (TUG) flap. The mean patient age at the time of surgery was 48.8 ± 9.1 years with a range of 29 to 73 years. One patient in our study underwent bilateral mastectomy for treatment of chronic mastitis. All other patients underwent mastectomy for treatment of breast cancer or cancer prophylaxis. Cancer diagnoses included 51 patients with invasive ductal carcinoma, eight with invasive lobular carcinoma, nine with ductal carcinoma in situ, one with Paget's disease with intraductal carcinoma, and one patient who underwent prophylactic mastectomy for BRCA gene positivity. Mastectomy types utilized were 17 modified radical, 53 simple/total, and one nipple-sparing mastectomy. Modified radical mastectomy was employed in 37% ($n = 21$) of breasts in the SS1 mastectomy group and 17% ($n = 4$) of breasts in the SS2 group. There was no significant difference in incidence of operative complication rates or incidence/type of medical comorbidities between all four mastectomy/skin paddle groups. Preconstruction radiation was employed in 38.2% ($n = 34$) of patients. Radiotherapy use in each of the mastectomy groups was 46% ($n = 26$) of SS1, 29% ($n = 7$) of SS2, and 13% ($n = 1$) of SS3/SS4 patients, which did not reach statistical significance

($p = 0.111$). Mean BMI was 30 ± 4 kg/m² in SS1, 30 ± 5 kg/m² in SS2, and 26 ± 2 kg/m² in SS3/SS4 mastectomy patients, respectively, and this difference was statistically significant ($p = 0.045$). Delayed reconstruction was performed in 96.5% ($n = 55$) of SS1 patients compared with 62.5% ($n = 15$) in SS2 patients. Immediate breast reconstruction was performed in 75% ($n = 6$) of SS3/SS4 mastectomy patients, and the difference in timing of reconstruction between groups reached statistical significance ($p < 0.0001$; **Table 1**).

A total of 30 MD and 22 non-MD personnel participated in the mastectomy group categorization and aesthetic surveys. Physicians correctly categorized patients into their respective mastectomy groups 85.8% of the time versus 76.14% correct answers from non-MD personnel.

In our aesthetic survey, over 75% of NMDs and MDs rated the overall aesthetic outcomes of the reconstruction as "good-excellent" regardless of the mastectomy/skin paddle group. With regard to skin paddle size, the large and small elliptical paddle groups had three to five times higher rate of "somewhat to extremely large" rating compared with that of the areola- and no skin paddle groups, respectively, by both MD and non-MD personnel. Over 60% of MDs felt that the areola and no skin paddle groups were "perfect size" versus 56% and 46% by NMD, respectively. Sixty percent of MDs found that the elliptical skin paddles were "somewhat distracting to the nipple areolar complex" or "ideally positioned around the nipple areolar complex, but noticeable" while 55% of non-MD personnel found them "very good, blends in naturally with NAC/barely noticeable" to "excellent/native appearance around NAC." Overall, both MDs and NMDs found the no skin paddle group to have the highest rates of "excellent/native appearance around NAC." MDs marked this answer almost twice as often for the no skin paddle group compared with the large elliptical paddle and NMDs marked this answer over thrice more often

Table 1 Patient demographics, complication rates, and procedures performed

	Overall		SS1 (n = 57)		SS2 (n = 24)		SS3/SS4 (n = 8)		p-Value
Age at date of surgery (y)	48.83 ± 9.07		47.54 ± 9.09		52.17 ± 9.24		48.00 ± 6.44		1.07
Body mass index (kg/m ²)	29.92 ± 4.59		30.27 ± 4.26		30.35 ± 5.43		26.09 ± 2.01		0.045 ^a
	n	%	n	%	n	%	N	%	
Perioperative chemo therapy	27	30.34	19	33.33	6	25	2	25	0.7141
Perioperative radiation	34	38.2	26	45.61	7	29.17	1	12.5	0.1111
Prior history of smoking ^b	11	12.36	10	17.54	0	0	1	12.5	0.0908
Comorbidities									
Diabetes mellitus type 2	6	6.74	2	3.51	4	16.67	0	0	0.0711
Hypertension	28	32.18	16	28.07	10	45.45	2	25	0.3003
Peripheral vascular disease	0	0	0	0	0	0	0	0	–
Timing of reconstruction									
Delayed	72	80.9	55	96.49	15	62.5	2	25	< 0.0001 ^a
Immediate	17	19.1	2	3.51	9	37.5	6	75	
Procedure type									
DIEP	32	35.96	22	38.6	7	29.17	3	37.5	0.7273
SIEA or TUG	4	4.49	2	3.51	1	4.17	1	12.5	
TRAM	53	59.55	33	57.89	16	66.67	4	50	
Complication rates									
Hematoma	9	10.23	3	5.26	5	20.83	1	14.29	0.1005
Seroma	2	2.35	2	3.77	0	0	0	0	0.5388
Capsular Contracture	2	2.25	2	3.51	0	0	0	0	0.5631
Total flap loss	1	1.12	0	0	1	4.17	0	0	0.2542
Infection	7	7.95	5	8.77	2	8.7	0	0	0.6836
Fat necrosis	10	11.24	8	14.04	2	8.33	0	0	0.4354

Abbreviations: DIEP, deep inferior epigastric artery perforator; SIEA, superficial inferior epigastric artery; TUG, transverse upper gracilis; TRAM, transverse rectus abdominus myocutaneous.

^aStatistical significance.

^bPatients with prior history of smoking. No patients in this study endorsed active smoking at time of surgery.

for the no skin paddle group compared with the large elliptical skin paddle group. MDs and NMDs reported that the areola skin paddle and no skin paddle groups “significantly decrease the prominence of visible scars” compared with the large and small elliptical paddles. Both MDs and NMDs rated overall scar appearance for all groups as “good-excellent” greater than 30% of the time and “fair-good” greater than 55% of the time for the elliptical paddle groups. While “poor” scar ratings were overall low for all groups, NMDs rated the areola paddle and the no skin paddle appearances as “poor” twice as often as MDs. In addition, NMDs rated smaller skin paddles (areola and no skin paddle) as having “poor” scar appearances twice as often as larger skin paddles (large and small elliptical paddles).

Discussion

Advances in autogenous breast reconstruction techniques have improved their functional outcomes yet aesthetic outcomes remain largely dependent on the mastectomy and the quantity/quality of preserved breast soft tissues. Although

implicit in the process of breast reconstruction, factors that influence the mastectomy type and their effect on subsequent autologous skin paddle design remain largely undescribed.

Currently, there exists no standardized classification system or nomenclature for mastectomy type and their resultant skin paddle orientation. Several authors have discussed the importance of the mastectomy scar pattern on final breast outcome in both autologous and implant based breast reconstruction.⁹ Tan et al described a classification system for different mastectomy incisions and skin paddle designs specific to the Asian patient population.¹⁰ This classification consists of a “racquet handle” incision and a periareolar incision alone or with adjacent skin excision or distant skin paddle. While useful, this classification is not applicable to the general population. Bourne et al describes three incision patterns used in autologous breast reconstruction following skin-sparing mastectomies: racquet, wise, and vertical incisions. However, this does not address patients with more extensive mastectomies and larger skin deficits.¹¹

In performing autogenous breast reconstruction, the decision regarding native skin replacement and/or addition of new skin to the mastectomy defect is dependent on multiple factors. The general indications are for restorative and/or for monitoring purposes. For example, in nipple-sparing mastectomy, all native skin is preserved yet a small portion of transferred skin is maintained for perfusion monitoring in the immediate postoperative period and is typically excised in a subsequent procedure. In modified radical mastectomy, the nipple areolar complex and a portion of native breast skin is excised and a larger skin paddle is required. The need for a large restorative paddle was indeed identified in our study as all patients who underwent modified radical mastectomy received large or small elliptical skin paddles.

Presence of radiation injury or need for future radiotherapy is a critical consideration in autologous reconstruction. Radiation to the native breast skin results in microvascular circulatory changes, replacement of soft tissue with dense fibrotic tissue, and may lead to changes in skin quality and reconstruction success.¹²⁻¹⁴ Due to these changes, use of autologous reconstruction to replace radiation damaged soft tissues and performance of delayed breast reconstruction after completion of radiotherapy is becoming a more common practice.^{15,16} Despite the above, there has been controversy in the literature concerning the timing of breast reconstruction in patients receiving post mastectomy radiotherapy (PMRT). Several authors report that immediate breast reconstruction with subsequent radiotherapy has similar complication rates for reconstruction delayed until after radiotherapy is completed. However, current evidence suggests an aesthetic benefit to delayed breast reconstruction in the face of PMRT.¹⁷ For this reason, it is the practice of the senior author to delay autologous breast reconstruction until after PMRT has been completed.

In our study, patients with circumstances leading to increased scar tissue (radiation skin injury and delayed breast reconstruction) were more likely to require larger skin paddles. Delayed breast reconstruction was employed in 80.9% ($n = 72$) of the breasts in our study. Of these, 45.8% ($n = 33$) received prereconstruction radiation and 97.2% ($n = 70$) received large elliptical ($n = 55$) and small elliptical ($n = 15$) skin paddles. Approximately 20% of our patients underwent immediate breast reconstruction with only 64.7% ($n = 11$) receiving elliptical skin paddles and only 5.9% ($n = 1$) receiving prereconstruction radiation.

Patients with high BMI were also found to require larger skin paddles. These patients have larger breast volumes and, therefore, larger skin requirements. High BMI patients without radiation induced skin changes that receive immediate reconstruction often have macromastia and redundant skin, and it is counterintuitive that they would require a large skin paddle. However, this excess skin is often of poor quality and/or vascularity, and the surgeon has the decision to either apply reduction pattern excision techniques versus replacement of this skin with free tissue transfer. In the latter, there is a larger relative skin deficiency compared with those patients with lower BMI (and likely smaller breasts), thus requiring larger skin paddles. Our results support this as

patients who received large and small elliptical paddles had a mean BMI over 30 versus a mean BMI of 26 in those who received an areolar paddle or no paddle at all.

Our study is not without limitations. First, all but one of our patients received a variation of abdominal free tissue transfer. However, we do not predict that tissue transfers from other areas would change this classification system as the resulting skin paddle and scar pattern are primarily based on the health of the mastectomy flaps and various patient factors rather than the donor site. In addition, one physician at our institution performed all operations. Therefore, we cannot account for differences in technique that occur from surgeon to surgeon which may affect skin paddle size and design. Finally, specific limitations exist for the proposed SS3 group. There are several mastectomy flap incision designs possible in low BMI patients with large surface areas of healthy native breast skin following a mastectomy. This includes different orientations of the scars adjacent to the skin paddle. We have presented only transverse scars adjacent to the skin paddle in our SS3 group, as this is a common practice at our institution. In patients with excess skin, skin resection can be employed with resultant scar patterns similar to those in "wise" and vertical breast reductions. In addition, we did not include immediate oncoplastic reduction techniques, as these are already widely described in the literature and have standardized nomenclature. With regard to these scar patterns, Bourne et al showed no significant difference in shape or overall postoperative appearance in vertical skin resection pattern versus a transverse scar adjacent to the skin paddle.¹¹

Several subsets of patients were excluded from this classification system. Patients who received regional autologous flaps, such as the pedicled latissimus dorsi myocutaneous flap (LDMC) were not included in this study, as this flap does not frequently have a sufficient skin component to allow near total breast skin replacement. Despite this, in lower BMI patients with smaller breast size, the skin paddle of the LDMC flap may assume a configuration similar to that described in our classification system (► **Fig. 3**). Autologous flaps following lumpectomies were not included since scar patterns following these procedures can vary widely based on tumor location or radiation injury. In addition, there are several incisions employed in nipple-sparing mastectomy (inframammary, vertical, and periareolar incisions) that were not used in this classification system. This is accounted for by the fact that the inferior periareolar scar with lateral extension is the preferred approach of our surgical oncologists due to improved visualization during the mastectomy.¹⁸ From the reconstructive standpoint, this incision allows for easy access to the internal mammary vessels while maintaining a satisfactory aesthetic outcome. Variations of the areola skin paddle (including circumareolar mastectomy incisions) and nipple-sparing mastectomy incisions not utilized in our classification system may be easily added to the classification system based on local practice preferences.

The survey validation of the classification system demonstrated both MDs and non-MDs could correctly categorize randomized patient pictures into their correct group over 75%



Fig. 3 Forty-year-old female patient who underwent right skin-sparing mastectomy and radiotherapy followed by delayed right breast reconstruction with latissimus dorsi myocutaneous (LDMC) flap. (A) Preoperative images following initial biopsy. (B) Postoperative images following right mastectomy/radiation. Note hyperpigmentation and soft tissue contraction of the right chest soft tissues. (C) Six-month postoperative images following LDMC and implant reconstruction. Note the skin paddle of the flap may assume an elliptical configuration similar to that described in Mastectomy type/skin paddle design scheme.

of the time. This suggests that the classification system is understood by and applicable to those with and without medical degrees. Physicians had an exceptionally high success rate in recognizing these common patterns, with 85.8% correct answers. This further suggests that this would be a particularly useful tool for communication between practitioners involved in treating breast disease that may require reconstruction (i.e., family practice, internal medicine, obstetrics and gynecology, general surgery, surgical oncology, etc.).

In our aesthetic survey, elliptical skin paddles were found to be too large three to five times more often than the areola paddle or no skin paddle groups, and most MDs found the areola and no skin paddle groups to be perfectly sized. This is no surprise as the areola skin paddle is positioned in the future location of nipple areolar complex reconstruction and the skin

paddle maintained for monitoring in nipple-sparing mastectomy is usually small and removed in subsequent revision procedures.

There was discordance between MDs and NMDs on several important aesthetic components between groups. In addition to rating the elliptical skin paddles as too large, MDs also found them distracting to the NAC, while NMDs found that the elliptical skin paddles lead to a very natural NAC appearance. Overall, the no skin paddle group was rated the most natural around the NAC, which one would expect given these patients have preservation of their natural NAC. In contrast, NMDs rated results from the areola paddle and no skin paddle groups as poor more often than MDs. While the areola paddle and no skin paddle groups have less scar burden, it is not surprising that NMDs are less tolerant to scars adjacent to the NAC than

those with more experience with common breast surgery scars patterns. Overall, all mastectomy patterns had high aesthetic ratings despite medical background of the observer. This is encouraging, and in instances where a patient is a good candidate for all options, physicians can be confident that no matter the decision, they have the opportunity to provide an acceptable, aesthetically pleasing result to their patient.

Standardized nomenclature for common results of autologous breast reconstruction will allow better communication amongst surgeons and will assist in counseling prospective reconstruction patients. Moreover, understanding patient factors that lead to certain scar/skin paddle patterns may allow for results that are more predictable for surgeons who perform autologous breast reconstruction. Patients may be better educated regarding their anticipated reconstruction result and potentially aid in the planning of their reconstruction based on their preferred scar pattern, if operative conditions allow. We predict this will improve overall patient outcomes and satisfaction with their reconstructed breast.

Conclusion

Patients with elevated BMI, delayed breast reconstruction or radiotherapy more commonly require larger skin paddles when autologous breast reconstruction is employed. This likely is due to the need for creation of larger breasts in the higher BMI patient population, as well as the need for more skin replacement, in the irradiated and/or scarred operative field. The mastectomy type/skin paddle patterns presented can be correctly utilized by both medical doctors and those without a medical degree and can provide a simple scheme to allow for improved patient education and communication among practitioners. All mastectomy pattern/skin paddle designs received high overall aesthetic ratings by both medical and nonmedical personnel.

Conflict of Interest

The authors have no conflicts of interest or source of funding to declare.

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