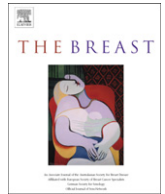




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Original article

Patient-subjective cosmetic outcomes following the varying stages of tissue expander breast reconstruction: *The importance of completion*

Donald W. Buck II, Deana Shenaq, Kamaldeep Heyer, Caroline Kato, John YS. Kim*

Division of Plastic and Reconstructive Surgery, Feinberg School of Medicine, Northwestern University, 675 North St. Clair Street, Galter Suite 19-250, Chicago, IL 60611, United States

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ABSTRACT

Introduction: Tissue expander breast reconstruction consists of three major surgical steps: placement of the expander after mastectomy, exchange of the expander for an implant, and nipple-areola complex reconstruction. The evolution of patient satisfaction throughout this process has not been evaluated. Here we performed a stratified analysis of patient-subjective cosmetic outcomes during the stages of breast reconstruction.

Methods: Twenty-eight consecutive tissue expander-implant reconstructions were performed by the senior author using human acellular dermis. Cosmetic outcomes were assessed after each reconstructive stage using a validated Breast Evaluation Questionnaire consisting of questions related to breast size, shape and firmness in three separate contexts: intimate or sexual activities, leisure or social activities, and professional or job-related activities.

Results: Eighteen patients underwent unilateral reconstruction, while 10 underwent bilateral reconstruction. Satisfaction scores were statistically higher following Stage I and II procedures for bilateral reconstructions. For unilateral reconstructions, there was a statistically significant elevation in scores following Stage II. The addition of nipple-areola reconstruction resulted in the highest scores for both unilateral and bilateral reconstructions. These score elevations were significant ($p < 0.05$) in nearly every measured context for unilateral reconstructions and as such, the significant differences in scores between unilateral and bilateral cohorts after stages I and II were nearly eliminated after completion of the entire reconstructive process.

Conclusion: Satisfaction with tissue expander reconstruction is significantly affected by the patients' stage during the reconstructive process. Completion of all three stages, including nipple-areolar complex reconstruction, achieves maximal patient satisfaction. For unilateral reconstructions, completion of the entire reconstructive process, including contralateral symmetry procedures and nipple-areolar complex reconstruction, results in cosmesis scores that are similar to those in bilateral cases.

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Introduction

Over 50,000 tissue expander-implant breast reconstructions were performed in 2008, representing the majority of post-mastectomy breast reconstructions.¹ Since 2005, there has been a steady increase in the percentage of surgeons electing to use acellular dermis to assist their expander-based reconstructions. Breuing was the first to report on the use of human acellular dermis in prosthetic breast reconstruction. Since then, several other reconstructive surgeons have demonstrated their respective reconstructive outcomes using this method.^{2–7}

Proposed advantages of acellular dermis include: improved definition of the mammary folds; increased resistance to capsular contracture; less implant displacement; better control of implant position, facilitating greater lower pole projection and potentially greater ptosis; reduced risk of implant exposure, extrusion, visibility, palpability; and greater intra-operative tissue expander fill volumes by creating a large sub-pectoral pocket.^{2–9} The process of tissue expander breast reconstruction encompasses three major surgical stages, the first of which involves placement of the tissue expander followed by serial expansion. The second stage entails removal of the expander in exchange for a permanent implant, as well as potential contralateral symmetry procedures in unilateral cases. And, the final stage includes the nipple-areola reconstruction.^{2,3,7}

While prior studies describe in detail the reconstructive benefits of acellular dermis in tissue expander-implant breast reconstruction,

* Corresponding author. Tel.: +1 312 695 6022; fax: +1 312 695 5672.
E-mail address: jokim@nmh.org (J.YS. Kim).

less is known about the aesthetic outcomes. Additionally, the impact of these stages on patient-subjective cosmetic outcomes has not previously been investigated. In this study, we explore patient-subjective cosmesis scores using an ad-hoc, validated breast evaluation questionnaire to ascertain the impact of stage within the reconstructive process on overall patient satisfaction.

Methods

Patients and study design

The Northwestern University Institutional Review Board approved this retrospective medical record review of a prospectively maintained database. Twenty-eight consecutive patients undergoing tissue expander breast reconstruction (18 unilateral, 10 bilateral) received the validated Breast Evaluation Questionnaire¹⁰ survey after each stage during the reconstructive process. All patients underwent unilateral or bilateral mastectomy by a breast surgeon. Each patient in this series either elected to have implant-based reconstruction, or were not candidates for autologous reconstruction based on expert clinical opinion. A single plastic surgeon (JYK) performed the procedures in all reconstructive stages. Patients scheduled to receive neo-adjuvant/adjuvant radiation therapy chemotherapy, as well as single stage nipple sparing procedures were excluded from the study.

Patient-subjective cosmetic outcomes were measured using the Breast Evaluation Questionnaire, a survey that was validated by Cogwell et al. in 2006, on a group of 1244 women seeking augmentation mammoplasty. The questionnaire uses a scale ranging from 1 (very dissatisfied) to 5 (very satisfied) with respect to breast size, shape and firmness in three separate clinical contexts: intimate or sexual activities, leisure or social activities, and professional or job-related activities. Implant firmness relates to how the implant feels to touch, with higher scores correlating to a more “natural feel” of the implant. It is important to recognize that a patient-subjective outcome questionnaire specifically directed toward breast reconstruction patients does not currently exist. The closest, validated correlate is the Breast Evaluation Questionnaire, described above, which was tailored toward the reconstructive population where possible.

Surgical technique

In the senior author's (JYK) preferred expander reconstruction technique, the pectoralis muscle is disinserted and either pre-hydrated human acellular dermal matrix (PHADM) (Flex HD[®], Musculoskeletal Transplant Foundation, Edison, New Jersey) or non-hydrated human acellular dermal matrix (NHADM) (AlloDerm[®], Lifecell, Branchburg, New Jersey) is attached to the inframammary fold using 3-0 vicryl suture. Laterally, the ADM is secured directly to the serratus muscle fascia. Additionally, the lateral border of the pectoralis major muscle is secured to the serratus muscle fascia to create the lateral border of the expander pocket. A textured expander (McGhan-Inamed, Santa Barbara, CA) is inserted into the newly created sub-pectoral/dual-plane pocket, and the superior border of the ADM is sutured to the cut edge of the pectoralis major muscle. The expander is then inflated judiciously according to the degree of skin excess. Post-operatively, serial expansions of the tissue expander are initiated after incisions have healed. Stage II reconstruction with tissue expander to implant exchange is performed after the desired volume of expansion is obtained. For unilateral cases, where indicated, a simultaneous symmetry procedure (mastopexy alone, mastopexy with augmentation, or reduction mammoplasty) is performed on the contralateral breast for symmetry at the same time as expander-implant

exchange. Stage III reconstruction of the nipple-areola complex (NAC) is performed after the stage II incisions have healed. The senior author's (JYK) preferred method of NAC reconstruction is through a modified C–V flap, which relies on local tissue to create two “V” flaps which wrap around the central plane of the new nipple with a “C” flap as a hinged cap.¹¹

Statistical analysis

All statistical analyses were performed using SPSS Statistical Analysis Software (SPSS, Version 17.0, Chicago, Illinois). A paired two-tailed Wilcoxon signed-rank test was utilized to compare scores after each stage. An independent Wilcoxon rank sum test was used to compare outcomes between unilateral and bilateral cohorts. Data is considered statistically significant with a *p*-value < 0.05 and is expressed as mean ± standard error of the mean.

Results

During the research period, the senior author completed 38 breast reconstructions (18 unilateral and 10 bilateral) in 28 patients. The mean age of the patients was 52.2 ± 2.6 years. Ten women (36%) in this study had a significant smoking history. Mean interval between Stage 1 and Stage 2 reconstruction was 136.2 ± 24.4 days with a total follow-up period of 153.7 ± 23.1 days. There were no reconstructive complications, including infection, mastectomy flap necrosis, hematoma, seroma, tissue expander migration, implant extrusion, or early capsular contracture, in the acute perioperative period or during short-term follow-up.

Cosmetic outcomes – stage I tissue expander placement

Patients completed the stage I questionnaire at the final expansion visit prior to expander/implant exchange. For unilateral reconstructions, overall mean cosmesis scores after Stage I were 2.36 ± .24, 2.40 ± .18, and 2.63 ± .23 for breast size, shape, and firmness, respectively. Individual scores for each of the contexts (intimate, social, and professional) can be found in Table 1. For bilateral reconstructions, scores were 3.7 ± .33, 3.5 ± .31, and 3.6 ± .35 for breast size, shape, and firmness, respectively. Stage I bilateral reconstruction scores were statistically higher than their unilateral counterparts across nearly all contexts in intimate, social, and professional settings (Table 1).

Stage II – tissue expander exchange

By the end of the research period, 13 women (72%) in the unilateral reconstruction group had completed Stage II procedures, while the remaining 5 women were scheduled to undergo stage II surgery at a future date. Mean overall scores following this procedure were 3.36 ± .29, 3.28 ± .28, and 3.33 ± .30 for breast size, shape, and firmness respectively. Within this cohort, there was a statistically significant improvement in cosmesis scores in all three contexts when compared to the previous stage (Table 2). The majority (69%) of women in the unilateral reconstruction cohort also underwent a contralateral symmetry procedure during stage II, including breast augmentation with mastopexy in 7 cases, mastopexy alone in 1 case, and reduction mammoplasty in 1 case.

At the end of the research period, 9 (90%) of the women in the bilateral reconstruction cohort had completed Stage II procedures, and 1 was awaiting surgery. Overall mean cosmesis scores were 4.23 ± .16, 4.16 ± .7, and 4.27 ± .20 for breast size, shape, and firmness, respectively. There was a statistically significant improvement in cosmesis scores in nearly all clinical contexts, especially with regard to shape and firmness, when compared to

Table 1

Mean cosmetic scores following Stage I tissue expander breast reconstruction with a direct comparison of bilateral versus unilateral cohorts.

	Size			Shape			Firmness		
	Intimate	Social	Professional	Intimate	Social	Professional	Intimate	Social	Professional
Unilateral – Stage I (N = 18)									
Mean	2.33	2.44	2.33	2.44	2.44	2.33	2.78	2.61	2.50
SEM	0.23	0.27	0.23	0.16	0.22	0.16	0.21	0.25	0.22
Bilateral – Stage I (N = 10)									
Mean	3.6	3.7	3.8	3.2	3.6	3.8	3.3	3.7	3.8
SEM	0.35	0.35	0.28	0.32	0.32	0.28	0.41	0.35	0.28
Bilateral vs. Unilateral – Stage I									
P-Value	0.002	0.009	0.001	0.038	0.018	0.001	0.239	0.028	0.006

the previous stage (Table 2). When compared to women in the unilateral group, scores for the bilateral group at stage II were statistically higher in 5 of the 9 contexts (Table 2).

Stage III – nipple-areola complex (NAC) reconstruction

At the end of the research period, 7 women (39%) in the unilateral cohort had completed all stages of the reconstruction, including NAC reconstruction. The remaining 6 women were scheduled for NAC at a future time point. Overall mean cosmesis scores after this final stage were $4.66 \pm .30$, $4.66 \pm .50$, and $4.25 \pm .50$ for breast size, shape, and firmness, respectively. Within this cohort, these scores were significantly improved from the stage II scores in 6 of the 9 contexts (Table 3).

Five women (56%) in the bilateral cohort completed the reconstructive process including NAC reconstruction. The remaining 4 women were scheduled for NAC reconstruction at a future time point. Overall mean cosmesis scores were 5.0 ± 0.0 , $4.73 \pm .33$, and 5.0 ± 0.0 for breast size, shape, and firmness respectively. These scores were increased across all contexts when compared to stage II; however, the scores were not statistically significant (Table 3). When compared to women in the unilateral group at the same stage, there was no statistically significant difference in scores within any of the clinical contexts.

Discussion

Over the last decade, technical options and surgical outcomes for breast reconstruction have improved. By the virtue of these enhanced outcomes, expectations of women with breast cancer have also increased.¹² The utility of acellular dermis as a soft tissue replacement has been demonstrated throughout the body.^{13–16} Several reports have shown its efficacy and relative safety in

breast reconstruction, but with limited emphasis on cosmetic outcomes.^{2–7}

With unilateral breast reconstruction, contralateral ancillary procedures aimed at achieving breast symmetry often play a significant role in optimizing aesthetic outcomes. Predicting the necessity of such procedures at the time of initial consultation is often difficult. The decision to perform ancillary work is not only based upon the position, contour and size of the reconstructed and natural breasts following primary reconstruction, but also on patient motivation and desire to undergo further surgery.¹⁷ This includes patient motivation to complete the often lengthy expander-implant reconstructive process in its entirety through NAC reconstruction. Currently, there is limited data examining patient-subjective satisfaction during the specific stages of expander-based breast reconstruction. To our knowledge, ours is the first known report of patient-based cosmetic analysis relative to each stage in the expander/implant reconstructive process. Through interval examination, the contribution of ancillary procedures and NAC reconstruction to patient satisfaction can be assessed. Likewise, it is possible to investigate any differences between patient-derived cosmetic outcomes among women undergoing bilateral or unilateral reconstructions, information which may have important implications for tailoring the reconstructive process and for encouraging completion of all stages.

Following Stage I reconstruction, cosmetic outcomes were statistically higher for the bilateral reconstruction cohort. These results may be explained by greater symmetry achieved through bilateral tissue expander placement with intra-operative volume adjustments to create the best illusion of symmetry (Fig. 1A). Though intra-operative fill volumes were not measured, the addition of PHADM or NHADM produced a larger pocket free from the confines of the pectoralis muscle insertion inferiorly, thereby maximizing intra-operative tissue expander fill volumes.² This early and ample fill volume may have improved the overall

Table 2

Mean cosmetic scores following Stage II breast reconstruction with direct comparison to the scores from the same cohort after stage I, and a comparison of bilateral vs. unilateral cohorts.

	Size			Shape			Firmness		
	Intimate	Social	Professional	Intimate	Social	Professional	Intimate	Social	Professional
Unilateral – Stage II (N = 13)									
Mean	3.46	3.38	3.23	3.31	3.31	3.23	3.38	3.31	3.31
SEM	0.28	0.31	0.28	0.25	0.28	0.3	0.3	0.3	0.3
P-Value vs. Stage I	0.003	0.008	0.005	0.015	0.030	0.008	0.036	0.043	0.025
Bilateral – Stage II (N = 9)									
Mean	4.4	4.1	4.2	4.2	4.1	4.2	4.4	4.2	4.2
SEM	0.16	0.16	0.16	0.23	0.13	0.16	0.16	0.23	0.2
P-Value vs. Stage I	0.068	0.068	0.043	0.028	0.043	0.043	0.018	0.043	0.068
Bilateral vs. Unilateral – Stage II									
P-value Bilateral vs. Unilateral	0.025	0.117	0.030	0.038	0.095	0.019	0.013	0.066	0.066

Table 3
Mean cosmetic scores following Nipple-areolar complex reconstruction with direct comparison to the scores from the same cohort after stage II, and a direct comparison of bilateral versus unilateral cohorts.

	Size			Shape			Firmness		
	Intimate	Social	Professional	Intimate	Social	Professional	Intimate	Social	Professional
Unilateral – Nipple Reconstruction (N = 7)									
Mean	5	4.5	4.5	4.75	4.75	4.5	4.5	4.25	4.25
SEM	0	0.3	0.3	0.25	0.25	0.3	0.3	0.25	0.25
P-Value vs. Stage II	0.028	0.068	0.043	0.028	0.043	0.043	0.043	0.068	0.068
Bilateral – Nipple Reconstruction (N = 5)									
Mean	5	5	5	4.6	4.6	4.6	5	5	5
SEM	0	0	0	0.2	0.2	0.2	0	0	0
P-Value vs. Stage II	0.180	0.068	0.068	0.593	0.273	0.273	0.109	0.109	0.109
Bilateral vs. Unilateral – NAC Reconstruction									
P-value	0.431	0.100	0.100	0.520	0.886	0.253	0.032	0.199	0.199

cosmetic outcome, as it preserved mastectomy skin for reconstruction.

After Stage II reconstruction, there was a statistically significant increase in average cosmetic scores within the unilateral reconstruction cohort. The majority of women (69%) in this cohort also underwent contralateral ancillary procedures including augmentation with mastopexy, mastopexy alone, or reduction mammoplasty during this stage of the procedure (Fig. 2A–B). Thus, the elevation in scores likely represents a reflection of improved symmetry achieved through work on the natural breast, as well as a reduced psychological burden given the time elapsed since mastectomy.¹⁸ Although differing symmetrization procedures could have varying effects on patient satisfaction, the overall result of contralateral breast procedures was an improvement in scores.

The literature is somewhat conflicted on the impact of breast mound revisions on overall patient aesthetic satisfaction.^{19–21} Andrade et al. concluded that revision procedures provided little added benefit; however, the revision procedures performed

in this series may not have been adequate, as 56.5% of patients unsatisfied with their reconstruction cited asymmetry as one of the main reasons.²² And Ramon et al. found that the achievement of breast symmetry was the main factor influencing patient aesthetic satisfaction post reconstruction.²³ In contradistinction to Andrade, results from Losken et al. suggested that contralateral symmetry procedures *are* important to implant-based reconstructions: specifically, of the 349 patients that underwent implant reconstruction, 66% required a contralateral symmetry procedure, whereas only 37% required them with autologous reconstruction.²⁴ Likewise, the results in this study highlight the importance of contralateral ancillary procedures during tissue expander breast reconstruction in optimizing overall patient satisfaction.

For the bilateral reconstruction cohort, elevations in scores following Stage II reconstruction were statistically significant in 6 of 9 contexts, particularly with regard to shape and firmness. Interestingly, there was only a statistically significant difference with

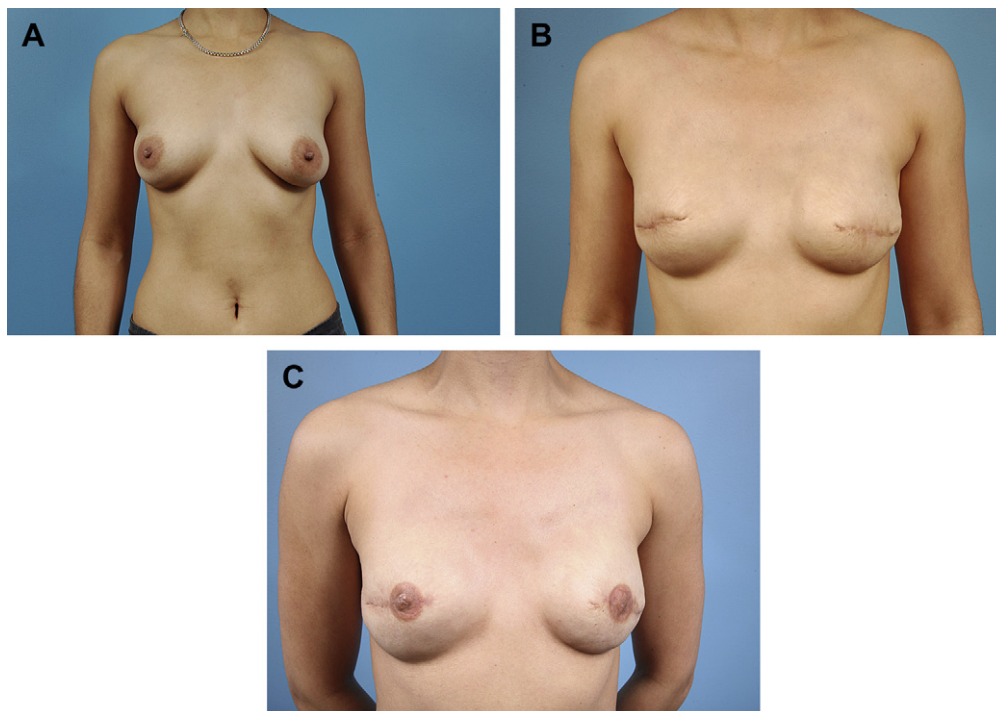


Fig. 1. Patient who underwent bilateral mastectomy with immediate tissue expander reconstruction. A. preoperative AP image. B. Same patient after Stage II (expander/implant exchange). C. Same patient following NAC reconstruction and tattooing.

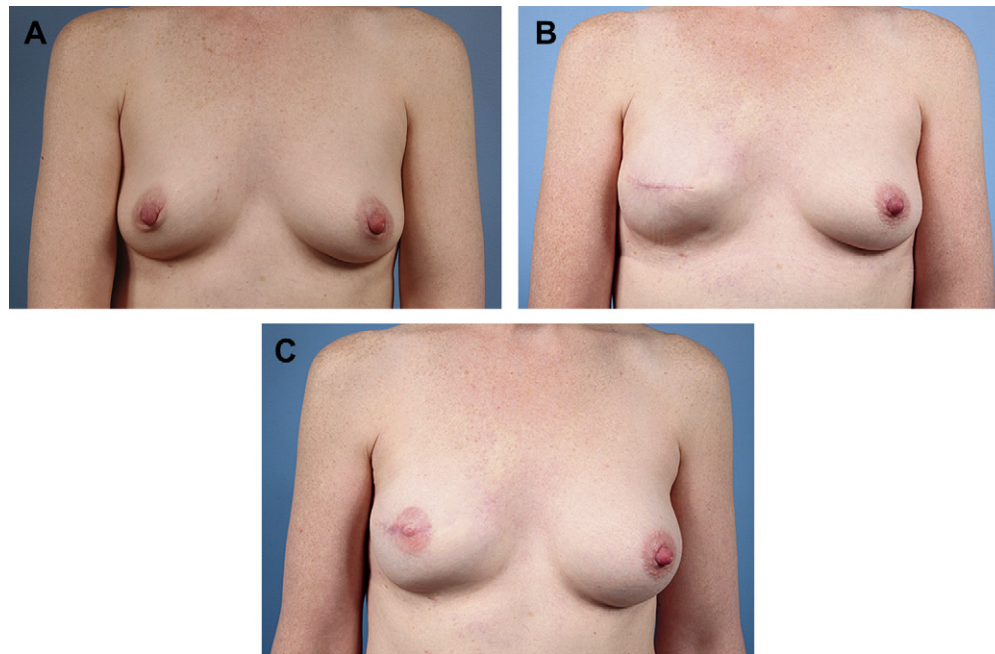


Fig. 2. patient who underwent unilateral mastectomy with immediate tissue expander reconstruction. A. Preoperative AP image. B. Same patient after Stage I. C. Same patient following NAC reconstruction and tattooing. Note contralateral augmentation for improved symmetry.

regard to size in the professional category. This nicely demonstrates the degree of expansion and symmetry that can be obtained by the use of acellular dermis along with appropriate intra-operative and post-operative expansion protocols (Fig. 1B). When compared to unilateral reconstructions there was a statistically significant increase in cosmesis scores in 5 of 9 clinical contexts at this stage. This, again, demonstrates the importance of symmetry in overall patient satisfaction.

In this study, the highest mean cosmesis scores were obtained for both unilateral and bilateral reconstructions after completion of NAC reconstruction (Figs. 1C and 2C). This finding provides a *patient-based* corroboration of prior studies that suggest nipple reconstruction is an important and “necessary” factor in cosmetically optimal reconstruction.^{25–27} In fact, despite unilateral scores being statistically lower at each stage when compared to their bilateral counterparts, this difference is almost entirely eliminated after NAC reconstruction.

The statistically significant difference among reported aesthetic outcomes, and the low discordance between reported scores helps validate the results of this study. It is worth noting, however, that the average follow-up period in this study is relatively short (approximately 6 months). Despite the relatively short follow-up, final cosmetic outcomes should be reasonably stable over the short-term because the NAC reconstruction has already been completed. Long-term cosmetic outcomes will require follow-up beyond 1–2 years. At this interval, accurate detection of subtle changes in degrees of symmetry can be obtained, especially for unilateral cases where a contralateral mastopexy or reduction mammoplasty has been performed such that any contralateral breast “settling” may create or accentuate any asymmetries. In addition, at the 1–2 year mark, detection of capsular contracture is more likely. While the above are potentially negative factors on long-term patient-subjective cosmesis scores, it is also possible that with time patients will adapt to their appearance and integrate the new image of their reconstructed breasts into their everyday lifestyle, thereby positively reinforcing their satisfaction with the overall outcome.

It is important to recognize that in a study regarding patient-subjective outcomes after breast reconstruction, the psychological effect of a cancer diagnosis cannot be under-appreciated. While this component could have an effect on cosmesis scores, it is unlikely that this contribution is large enough to outweigh the improvement from surgical reconstruction and symmetrization. Likewise, the validated questionnaire used in this study attempts to elucidate patient-subjective scores in a manner that is as objective as possible.

We did not include irradiated breasts in our study, which could present an additional confounding factor. The well-known implications of radiation on breast shape, skin texture, tone, and color can have significant impact on both autologous and tissue expander-based reconstruction.^{2,7,28,29} A separate analysis with reasonable sample size would be necessary to fully delineate the patterns of patient-based cosmetic outcomes in this specific population.

Conclusion

It is intuitive that optimal patient satisfaction with expander/implant reconstruction requires completion of the entire reconstructive process; however *patient-subjective* studies have not been performed to validate this assumption. In this study, we investigated patient-subjective cosmetic outcomes throughout the varying stages of the expander/implant reconstructive process and found that in unilateral reconstructions, there is a significant improvement in cosmesis with contralateral symmetry procedures. Likewise, there is a significant improvement in cosmesis when nipple-areolar complex reconstruction is performed, such that prior significant differences among cosmesis scores between bilateral and unilateral reconstructions are almost eliminated after completion of the entire reconstructive process. These findings highlight — from a patient’s perspective — the importance of completing the entire reconstructive processes, including NAC reconstruction, and the benefits of contralateral symmetry procedures on overall aesthetic outcomes.

Conflict of interest statement

The senior author (JYK) has received research funding from the Musculoskeletal Transplant Foundation.

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