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Breast

Three-dimensional Simulation on Patient-reported Outcomes Following Oncoplastic and Reconstructive Surgery of the Breast: A Randomized Trial

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Background: Three-dimensional (3D) imaging using computer simulations is an evolving technology. There is a lack of strong data on the use of this technology for oncoplastic (OP) and reconstructive surgery.

Methods: A prospective, randomized, single-center trial including breast cancer patients undergoing OP or mastectomy with immediate breast reconstruction with implant (IBR) enrolled from November 2019 to October 2021 at the Hospital Nossa Senhora das Graças, Breast Unit in Curitiba, Brazil. Both patients undergoing OP and those in the IBR group were randomized to undergo 3D imaging and simulation of postoperative results (intervention group) or 3D imaging without simulation (control group). All patients were invited to complete a patient-reported outcome (BREAST-Q) expectations module and breast reconstruction or reduction/mastopexy module before and 6 months after surgery.

Results: A total of 96 patients were enrolled. Sixty-nine patients (45 OP and 24 IBR) completed the pre- and postoperative questionnaires and were randomized for the simulation. Women in the OP group had higher expectations for breast appearance when clothed than those in the IBR implant group (93.4±16.3 versus 82.9±26.5; $P = 0.03$). The intervention group was more satisfied with information than the control group ($P = 0.021$). Both patients who underwent OP and IBR believed that the 3D simulation helped them understand the surgical process (86.6% and 75%, respectively).

Conclusions: Preoperative 3D simulation significantly improved patient's satisfaction with information and did not decrease postoperative satisfaction with the outcomes. The incorporation of preoperative 3D simulation may be a valuable tool in breast reconstruction. *(Plast Reconstr Surg Glob Open 2024; 12:e5804; doi: 10.1097/GOX.0000000000005804; Published online 15 May 2024.)*

INTRODUCTION

Breast cancer care involves highly complex procedures such as surgery in conjunction with oncoplastic (OP) techniques and breast reconstruction.[1] There is general agreement that breast reconstruction makes an important and positive contribution to the quality of life of breast cancer patients.[2–4] Patient satisfaction is one of the most important endpoints, where the overriding goal is to meet patient expectations and improve their quality of life. However, a large proportion of breast cancer survivors have unmet expectations regarding reconstruction after mastectomy, particularly in relation to appearance. Approximately 42% of the women who underwent breast reconstruction after mastectomy reported that their reconstruction was worse than expected.[5]

Several studies have already evaluated satisfaction, expectations, and quality of life in women treated surgically for breast cancer.[2–7] However, most of these are limited as they use generic measures and different surgical approaches.[2] The BREAST-Q is a validated patient-reported outcome (PRO) instrument designed specifically for patients who undergo breast surgery with a specific

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module for breast reconstruction and OP.[6,7] In 2012, a specific preoperative expectation of breast reconstruction module was added to the BREAST-Q set. The expectation module covers a thorough range of questions about how patients expect to feel in the first week, first year, and 10 years after breast reconstruction surgery.[2]

A preoperative assessment of quality of life, satisfaction, and expectation may aid the surgeon in an accurate clinical assessment and allow early identification of patients at a higher risk of regret.[8,9] Studies suggest that better preparedness may improve patient expectations, support decision-making, and alleviate anxiety.[10,11] Three-dimensional (3D) imaging with computer simulation is an evolving technology with the potential to enhance preoperative consultation for patients considering aesthetic surgery.[12] The novel application of 3D imaging is widely used in the cosmetic surgery industry, particularly in breast and facial surgery, and represents a significant advance in the decision-making process, surgical planning, and evaluation of outcomes, in addition to improving communication between multidisciplinary team and patients. Although many studies have previously reported successful clinical outcomes of 3D imaging simulation in aesthetic surgery,[12–17] there is a lack of strong data regarding the clinical application of this technology in breast reconstructive surgery.

Therefore, this study aimed to evaluate preoperative patient expectations and the impact of 3D simulation during preoperative consultation on PROs after breast reconstructive surgery. We believe that preoperative 3D image simulation for patients with breast cancer undergoing breast-conserving surgery (BCS) with OP or immediate breast reconstruction with implants (IBR) after mastectomy may affect patient satisfaction and the understanding of expected surgical outcomes. This is the first study to compare the changes in expected versus actual breasts in women with breast cancer who underwent IBR after mastectomy or OP using the breast-specific PRO measure (BREAST-Q).

Takeaways

Question: Is the use of three-dimensional (3D) imaging with computer simulation a useful technology for patients undergoing breast reconstructive surgery?

Findings: In this prospective study, we randomized 69 breast cancer patients undergoing breast-conserving surgery with oncoplastic or immediate-based reconstruction after mastectomy to receive 3D simulation of postoperative results (intervention group) or 3D imaging without simulation. The intervention group was more satisfied with preoperative information provided ($P = 0.021$).

Meaning: Preoperative 3D simulation significantly improved patient satisfaction with information and did not decrease postoperative satisfaction with results.

METHODS

Patients

This was a prospective, randomized, open-label, single-center trial including breast cancer patients undergoing oncological surgery (mastectomy or BCS) following IBR or OP between November 2019 and December 2021 at Hospital Nossa Senhora das Graças, Breast Unit in Curitiba, Brazil.

All patients had ductal carcinoma in situ or invasive carcinoma diagnosed by core biopsy or vacuum-assisted biopsy. Exclusion criteria were patients who had previous breast radiotherapy, underwent prophylactic mastectomy, had local recurrence or metastasis at the time of analysis, or refused or could not commit to 6-month follow-up.

This trial was approved by the internal review board of Positivo University, Curitiba, Brazil on September 19, 2019 (approval number 3.586.621) and registered in the Brazilian Registry of Clinical Trials (ReBEC)—RBR-62zs73b. Patients who agreed to participate were asked for their authorization through an informed consent document and were invited to complete a PRO (BREAST-Q) expectations module and preoperative breast reconstruction or reduction/mastopexy module already translated into Portuguese.

Intervention and Randomization

Two independent groups of patients who underwent oncological surgery were studied (Fig. 1). The first group included skin- or nipple-sparing mastectomy following IBR with prepectoral reconstruction with definitive anatomical form-stable implants. Contralateral symmetrizations were performed with different techniques according to the needs of each individualized case and the possibility of obtaining better symmetry with the reconstructed breast: reduction mammaplasty, mastopexy, augmentation mammaplasty or mastopexy associated with implant. The second group underwent BCS with level 2 OP (bilateral procedures with mammaplasty techniques).

In both groups, the patients were randomized to receive the computer simulation of the postoperative result. Thus, the intervention group consisted of patients who underwent 3D imaging and computer simulation of the postoperative result, whereas the control group consisted of patients who underwent 3D imaging without simulation. Randomization was performed using www.randomizer.org. Study details, including the availability of 3D imaging and simulation, were disclosed to all patients during the informed consent process.

Photographs were captured using Crisalix imaging software and analyzed using the Crisalix analysis module. To standardize the 3D images, photographs were obtained by the same photographer with the arms held 30 degrees from the side with palms forward. Images were oriented to ensure that the patients were facing directly into the camera without yaw, as gauged by the clavicle and shoulder alignment. Circular decals were placed on the sternal notch, mid clavicle, and nadir of the inframammary fold and confirmed using computer-generated landmarks placed at the sternal notch, clavicle midpoints, nipple, and lateral mammary fold.[12]

The intervention group underwent computer simulation with Crisalix in addition to the preoperative

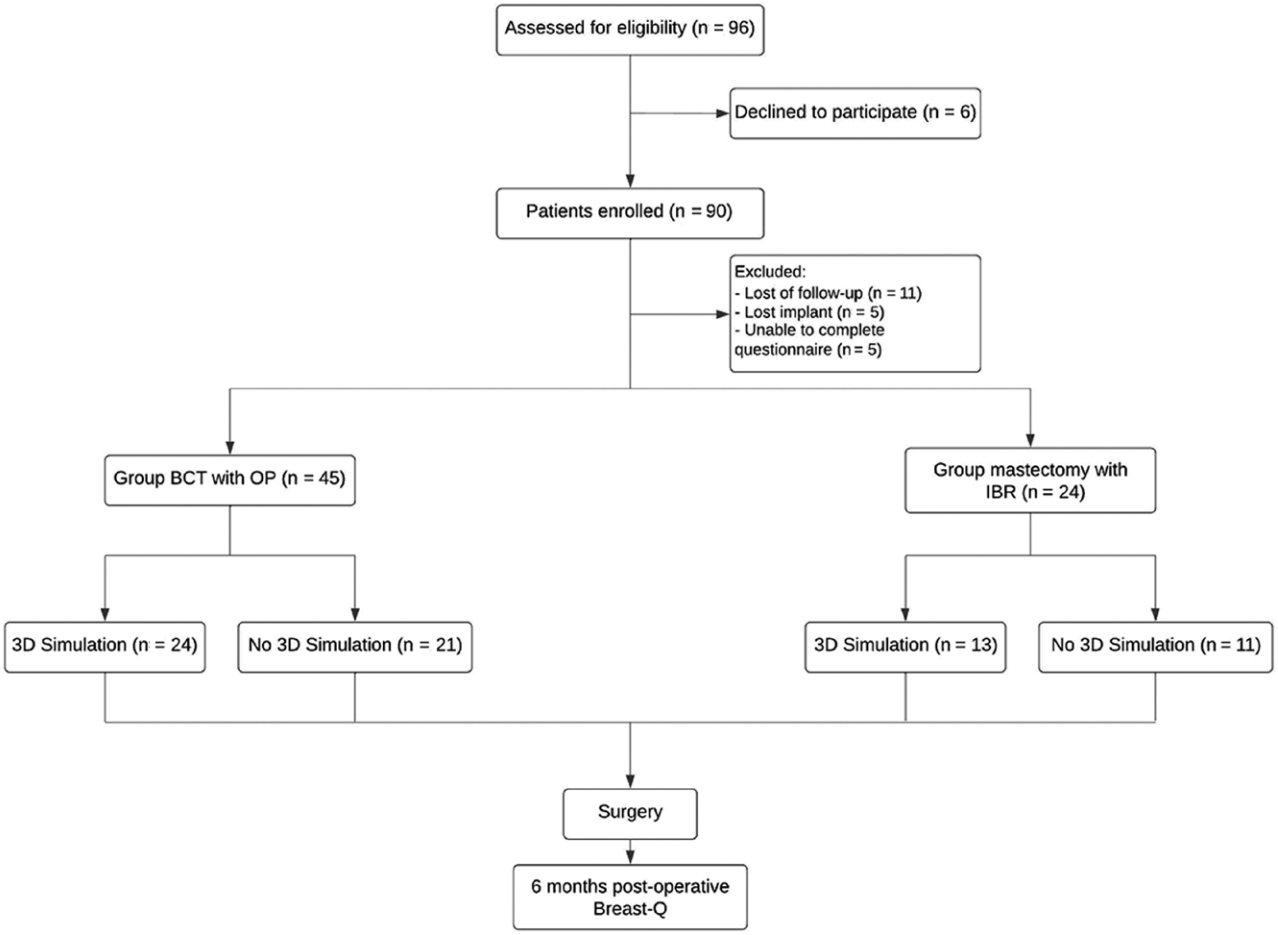

Fig. 1. Flowchart of the trial. BCT, breast conserving therapy.

evaluation of the control group. From the 3D images, the author was able to demonstrate simulated breast reconstruction outcomes with a variety of implant profiles and volumes and breast reduction according to the tumor size. The control group underwent 3D photography using the same system but was not simulated.

All the IBR and OP procedures were performed by the same breast OP surgeon. Six months postoperative, all patients were requested to answer the BREAST-Q postoperative module, and only the intervention group answered the following question: Did the 3D simulation help you understand the surgery process (yes, no, or indifference)?

PROs (BREAST-Q) including the expectations module and preoperative breast reconstruction module were recorded and compared preoperatively and 6 months postoperatively.

Statistical Analysis

Statistical analysis was performed using the IBM SPSS Statistics software (version 26.0). Quantitative variables are expressed as mean ± SD, and qualitative variables are expressed as numbers and percentages. The association between qualitative variables was analyzed using the chi-square or Fisher exact test. To compare the averages between the groups, the *t* test, analysis of variance, and the Mann–Whitney test were applied. The level of significance was set at 5% ($P < 0.05$).

RESULTS

A total of 96 patients were eligible for this study. Ninety patients were randomized as six declined to participate. After randomization, 21 patients were excluded: 11 were lost to follow-up, five lost the implant, and five were excluded because they were unable to understand and answer the entire questionnaire. Of the remaining 69 patients who completed the postoperative questionnaire, 45 were in the OP group and 24 were in the IBR group. In the OP group, 24 were simulated (Fig. 2), and 21 were not (control group). In the IBR, 13 patients were simulated (Fig. 3) and 11 were not.

Table 1 shows the demographic features of the study cohort. The mean age was 52.7 (±11.3) years, and the mean body mass index was 26.05 (±4.4). Most women had a high-school education level. The proportion of smokers was significantly higher in the IBR group than in the OP group (37.5% versus 4.4%, $P = 0.001$). No statistically significant differences were observed between the groups in terms of age, body mass index, menopausal status,

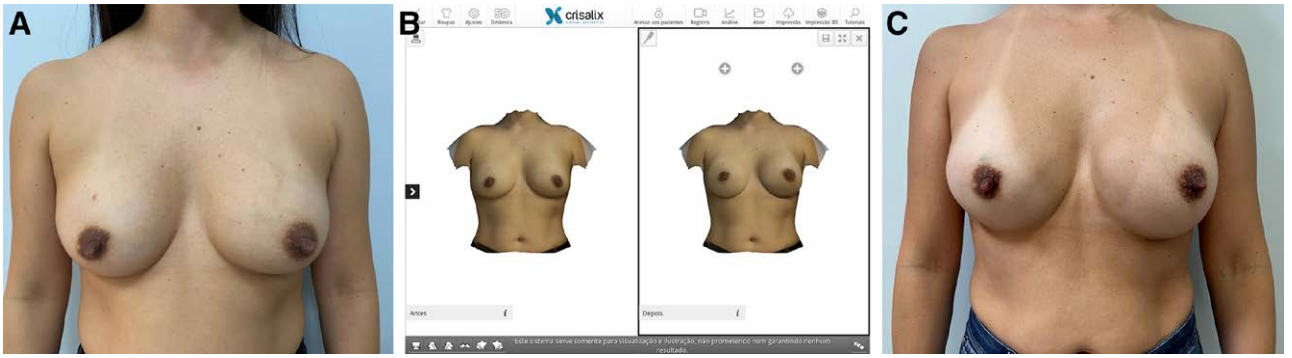

Fig. 2. Patient in the OP intervention group with preoperative simulation. A, Preoperative photograph, (B) 3D technology showing pre- and postoperative simulation, and (C) postoperative result.

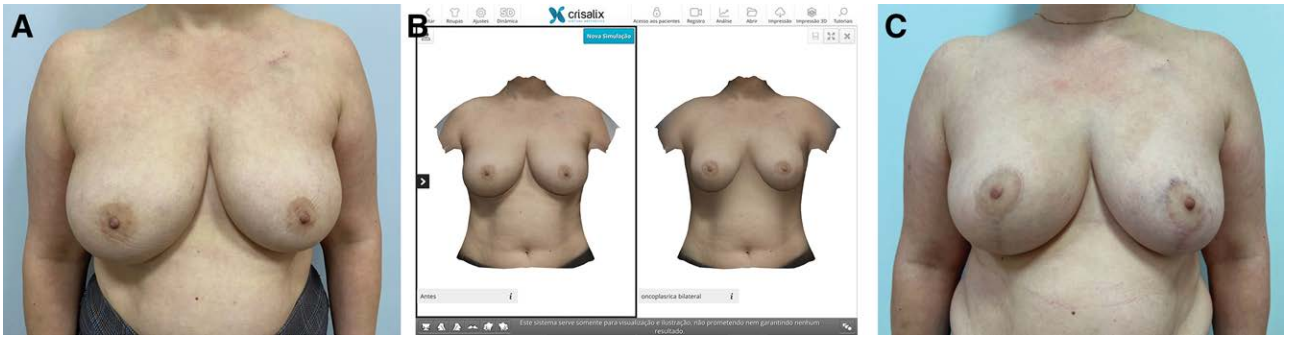

Fig. 3. Patient in the IBR intervention group with preoperative simulation. A, Preoperative photograph, (B) 3D technology showing pre- and postoperative simulation, and (C) postoperative result.

previous breast surgery, average implant size, or oncological data.

When we compared the BREAST-Q expectation rate (Table 2), patients demonstrated high expectations for breast appearance when clothed after reconstruction in both groups (93.4 ± 16.3 versus 82.9 ± 26.5; $P = 0.03$). Most patients expected that breast appearance when unclothed would look similar after 1 year (71.4% for OP and 80% for IBR). For breast appearance after 10 years, 42.9% of the OP group and 36.7% of the IBR group expected that breast appearance would match almost the same as that immediately after the reconstruction. In the OP group, 51% of the patients expected that the breast would have normal sensation after 1 year, whereas 43.3% of the women in the mastectomy with IBR group expected to have some sensation ($P = 0.001$).

Table 3 shows comparison between the BREAST-Q satisfaction pre- and postoperative rates. In the preoperative set, the mastectomy with IBR implants group had more satisfaction with their breasts than the OP group ($P = 0.011$). On the other hand, after the surgery, the OP group was more satisfied with their breasts than the mastectomy with IBR implant group ($P = 0.047$). There was no statistically significant difference between the types of surgery in the other BREAST-Q domains.

When we compared the BREAST-Q score between groups who received 3D simulation and those who did not, the intervention group was more satisfied with information than the control group ($P = 0.021$) (Table 4). There were no statistically significant differences between the groups with respect to the other preoperative or postoperative Q-score domains. Most patients felt that the 3D simulation helped them understand the surgery process, regardless of the type of reconstruction performed (87.5% in the OP group and 92.3% in the IBR group) (Table 5). Although randomization was not stratified according to previous breast surgery, there was no imbalance in this regard: 10 patients with a history of breast surgery received 3D simulation, whereas eight were in the control group.

DISCUSSION

This prospective randomized trial showed that patients submitted to OP reconstruction have high expectations for breast appearance after surgery. Also, the use of 3D image simulation increased patient satisfaction with the information received preoperatively and helped them understand the surgery process.

To date, many studies evaluated the use of 3D surface imaging and have demonstrated that surgeons and/or patients find this technology useful.[12–18] In aesthetic surgery, the ability to simulate likely outcomes with implants of different volumes is an attractive patient education tool, and patients report that they find it helpful.[14,19] However, none of these studies included a control group; therefore, it is impossible to know how much value is added by the

Table 1. Demographic Features of the Study Cohort

	Overall, n (%)	BCS + OP Group (n = 45)	Mastectomy with IBR Group (n = 24)	*P*
Age, mean ± SD (y)	52.7 ± 11.3	52.6 ± 12.2	52.9 ± 9.4	0.919
BMI at surgery (kg/m²), mean ± SD	26.05 ± 4.4	26.8 ± 4.8	24.5 ± 3.1	0.032
Weight				
Normal	33 (47.8)	19 (42.2)	14 (58.4)	
Overweight	27 (39.1)	18 (40.0)	9 (37.5)	
Obese	9 (13.0)	8 (17.8)	1 (4.1)	0.212
Menopausal status				
Postmenopausal	37 (53.6)	24 (53.4)	13 (54.2)	
Premenopausal	32 (46.4)	21 (46.6)	11 (45.8)	0.575
HRT				
Yes	19 (27.5)	15 (33.3)	4 (16.7)	
No	50 (72.5)	30 (66.7)	20 (83.3)	0.115
Education level				
Unfinished primary school	5 (7.2)	4 (8.9)	1 (4.3)	
Full primary school	2 (2.9)	1 (2.2)	1 (4.3)	
High school	17 (24.6)	11 (24.5)	6 (25.0)	
College degree	22 (31.9)	16 (35.5)	6 (25.0)	
Specialization, postgraduate degree	23 (33.3)	13 (28.9)	10 (41.4)	0.735
Family history				
Yes	29 (42.0)	22 (48.9)	7 (29.2)	
No	40 (58.0)	23 (51.1)	17 (70.8)	0.092
Previous breast surgery				
Yes	18 (26.1)	9 (20.0)	9 (41.3)	
Breast augmentation	11 (61.1)	5 (55.6)	6 (66.7)	
Breast reduction	4 (22.2)	2 (22.2)	2 (22.2)	
Benign lesion	3 (16.7)	2 (22.2)	1 (11.1)	
No	51 (73.9)	36 (80.0)	15 (58.7)	0.100
Breast size				
Small	5 (7.2)	2 (4.4)	3 (12.5)	
Medium	19 (27.5)	8 (17.8)	11 (45.8)	
Large	31 (44.9)	22 (48.9)	9 (37.5)	
Very large	14 (20.3)	13 (28.9)	1 (4.2)	0.087
Smoking (%)				
Yes	11 (15.9)	2 (4.4)	9 (37.5)	
No	58 (84.1)	43 (95.6)	15 (62.5)	0.001
Histologic subtype				
Ductal carcinoma in situ	6	4 (8.9)	2 (8.4)	
Invasive ductal carcinoma	49	34 (75.6)	15 (6.5)	
Invasive lobular carcinoma	7	5 (11.2)	2 (8.4)	
Others	7	2 (4.5)	5 (20.9)	0.199
T stage				
Tis	6	4 (8.9)	2 (8.4)	
T1	35	24 (53.4)	11 (45.9)	
T2	27	17 (37.8)	10 (41.7)	
T3	0	0	0	
T4	1	0	1 (4.2)	0.549
N stage				
0	51	32 (71.2)	19 (79.2)	
1	15	11 (24.5)	4 (16.7)	
2	3	2 (4.5)	1 (4.2)	0.749
Axillary dissection				
No	56	41 (91.2)	15 (62.5)	
Yes	13	4 (8.9)	9 (37.5)	0.007
Molecular subtype				
Luminal A	14	9 (20.0)	5 (20.9)	
Luminal B	39	26 (57.8)	13 (54.2)	
Triple negative	5	4 (8.9)	1 (4.2)	
Her-2+/HR negative	7	4 (8.9)	3 (12.5)	
Her-2+/HR positive	4	2 (4.5)	2 (4.5)	0.889

(*Continued*)

Table 1. (*Continued*)

	Overall, n (%)	BCS + OP Group (n = 45)	Mastectomy with IBR Group (n = 24)	*P*
Chemotherapy				
No	29	22 (48.9)	7 (29.2)	
Neoadjuvant	20	13 (28.9)	7 (29.2)	
Adjuvant	20	10 (22.3)	10 (41.7)	0.174
Radiotherapy				
No	18	3 (6.7)	15 (62.5)	
Yes	51	42 (93.4)	9 (37.5)	0.001
Mastectomy				
Nipple-sparing			16 (66.7)	
Skin-sparing			8 (33.3)	
Implant size, cc				
≤300			3 (12.5)	
301–450			15 (62.5)	
>450			6 (25.0)	
Symmetrization				
Yes			18 (75.0)	
No			6 (25.0)	

BMI, body mass index; HR, hormonal receptor; HRT, hormone replacement therapy; N, nodal; T, tumor.

Table 2. BREAST-Q Expectation Preoperative Data

BREAST-Q Reconstruction Expectations				
		BCS + OP (N = 45)	Mastectomy with IBR implants (N = 24)	
		Mean ± SD	Mean ± SD	*P*
Expectations for pain		63.2 ± 18.9	56.7 ± 23.9	0.19
Expectations for breast appearance when clothed		**93.4 ± 16.3**	**82.9 ± 6.5**	0.03
		N (%)	N (%)	
Expectation for breast appearance when unclothed after 1 y	Will look very different	1 (2)	0 (0)	0.62
	Will look similar	**32 (71.4)**	**19 (80)**	
	Will look exactly the same	6 (12.2)	3 (13.3)	
	Do not know	6 (14.3)	2 (6.7)	
Expectations for breast sensation after 1 y	Almost no sensation	3 (6.1)	4 (20)	0.001
	Will have some sensation	8 (20.4)	11 (43.3)	
	Will have normal sensation	19 (51)	3 (10)	
	Do not know	15 (42.9)	6 (26.7)	
Expectation for breast appearance after 10 y	Will not match	9 (18.4)	5 (20)	0.72
	Will match almost	19 (42.9)	9 (36.7)	
	Will match exactly	3 (6.1)	4 (13.3)	
	Do not know	14 (32.7)	6 (30)	

3D assessment over what would be achieved by surgical acumen alone. Only one study has compared patient satisfaction after breast augmentation in women who did and did not have access to 3D simulation and demonstrated that the simulation did not significantly impact PROs or mammometric parameters.[12] Nonetheless, the number of patients evaluated in this study was small, which may have an impact on statistical significance. In addition, the authors report that significantly more patients refused randomization and chose simulation, which can influence the results found.

Up to now, there is on published randomized study evaluating 3D simulation in patients with breast cancer. This trial analyzed 117 breast cancer patients planning unilateral BCS and demonstrated that women who viewed an individualized 3D simulation of likely aesthetic outcomes for BCS were more confident in undergoing surgery than those who received standard care or who were shown 2D photographs of other women.[20] In our study, breast cancer patients were randomized into two groups: those who received 3D simulation versus those who did not. The incorporation of 3D simulation resulted in improved satisfaction with information based on PROs using the BREAST-Q. There was no statistically significant difference between the groups with respect to other preoperative or postoperative Q-score domains. Our hypothesis was that the 3D image simulation for oncological breast surgery would provide an artificially high level of expectation, and patients would be more dissatisfied with their outcome. Unexpectedly, we found no decrease in breast satisfaction parameters with the use of 3D image simulation.

Measuring and managing patient expectations for breast reconstruction may improve patient perceptions of outcomes.[21] When we compared the two different types of surgery, 51% of patients of the OP group expected

Table 3. BREAST-Q Satisfaction Rate between the Two Groups

BREAST-Q Satisfaction	BCS + OP, Mean ± SD	Mastectomy with IBR Implants, Mean ± SD	*P*
Preoperative data			
Psychosocial well-being	69.1	73.2	0.378
Sexual well-being	60.5 ± 19.5	62.4 ± 18.5	0.703
Physical well-being	71.3 ± 16.1	70.8 ± 20.5	0.915
Satisfaction with breast	58.1 ± 18.7	71.5 ± 23.3	0.011
Postoperative data			
Psychosocial well-being	79.6 ± 17.3	71.0 ± 22.2	0.079
Sexual well-being	64.8 ± 19.8	63.5 ± 23.8	0.804
Physical well-being	70.2 ± 12.6	72.5 ± 19.9	0.527
Satisfaction with breast	74.2 ± 14.8	64.5 ± 24.7	0.047
Change in Q-score			
Satisfaction with breast	16.1 ± 19.0	-7.1 ± 28.6	<0.001
Psychosocial well-being	10.6 ± 15.9	-2.2 ± 20.8	<0.01
Sexual well-being	4.7 ± 17.2	0.9 ± 25.2	0.466

Table 4. Comparison of BREAST-Q Satisfaction Rate between the Intervention versus Control Group

	Simulated (n = 37), Mean ± SD	Nonsimulated (n = 32), Mean ± SD	*P*
Preoperative data			
Sexual well-being	59.0 ± 19.6	63.6 ± 18.4	0.318
Physical well-being	72.2 ± 17.8	69.9 ± 17.5	0.597
Satisfaction with breast	63.5 ± 23.3	61.9 ± 18.9	0.762
Psychosocial well-being	59.0 ± 19.6	63.6 ± 18.4	0.318
Postoperative data			
Sexual well-being	62.5 ± 22.5	66.6 ± 19.4	0.429
Physical well-being	72.1 ± 13.2	69.9 ± 17.9	0.572
Satisfaction with breast	70.2 ± 21.0	71.6 ± 17.3	0.765
Psychosocial well-being	75.0 ± 19.6	78.5 ± 19.3	0.449
Satisfaction with information	81.2 ± 17.6	70.0 ± 13.7	0.021
Satisfaction with surgeon	97.5 ± 5.4	96.8 ± 8.1	0.658
Satisfaction with medical staff	95.7 ± 12.2	98.9 ± 4.6	0.161
Satisfaction with office staff	99.7 ± 1.8	99.6 ± 1.9	0.918
Satisfaction with outcome	83.4 ± 16.2	81.8 ± 13.4	0.721
Change in Q-score			
Satisfaction with breast	6.64 ± 28.17	9.62 ± 21.66	0.628
Psychosocial well-being	5.24 ± 21.79	7.06 ± 14.43	0.689
Sexual well-being	4.16 ± 21.07	2.43 ± 19.44	0.726

Table 5. Impact of 3D Simulation on the Surgery Process

Did the 3D Simulation Help You Understand the Surgery Process?	Yes	No	Indifference	Total
OP group	21 (87.5%)	0 (0%)	3 (12.5%)	24
IBR group	12 (92.3%)	1 (7.7%)	0 (0%)	13
Total	34	1	3	37

P = 0.087.

that the breast would have a normal sensation after 1 year, whereas 43.3% of women in the mastectomy with IBR group expected to have some sensation ($P = 0{,}001$). A review by Sisco and Yao[22] reported that sensory outcomes in nipple-sparing mastectomy varied greatly, with self-reported normal sensation ranging from 10% to 43%. However, it is now clear that nipple sensation is largely or completely lost in most cases, as demonstrated by the Swedish prospective study that quantitatively examined tactile, thermal, and nociceptive cutaneous sensitivity before and after nipple-sparing mastectomy.[23] This study reported a total loss of touch sensation in the nipple in 62% of patients, whereas touch sensation was impaired in the remaining 38%.

Interestingly, we found that most women in both groups expected that breast appearance (symmetry) when unclothed would look similar after 1 year (71.4% for the OP group and 80% for the IBR group) and after 10 years would match almost the same as that immediately after reconstruction in 42.9% of the OP group and in 36.7% of the IBR group. In breast-conserving therapy, a prospective study by Hennigs et al[24] showed that the change in aesthetic outcome is still measurable for 4 years after the surgical procedure with a subjective evaluation. In breast reconstruction with implants, several authors have described that the results tend to deteriorate over time, with a decline in aesthetic outcomes, an increase in capsular contracture, and an overall decrease in patient satisfaction.[25,26] Overall, aesthetic outcomes decline over time, especially when chemotherapy and radiotherapy are required. Furthermore, breast cancer patients using adjuvant endocrine therapy can vary in weight, resulting in asymmetry and impact on PROs. These findings highlight the importance of managing patient expectations of breast and nipple sensation after mastectomy and aesthetic outcomes over time due to the risk of dissatisfaction with surgery.

Improving patient communication regarding expectations and outcomes may lead to higher satisfaction after surgery. De Runz et al[13] evaluated 38 patients' attitudes regarding 3D simulation for breast augmentation and found that 93% of the patients believed that the 3D simulation helped them choose their prosthesis. The patients estimated that 3D simulation was necessary for 21%, very useful for 32%, useful for 45%, or unnecessary for 3%. Regarding prosthesis choice, an equal number of women preferred the 3D simulation as preferred using different sizes of implants in the bra. This demonstrated that 3D simulation is useful for patients, but it should be used as a complement to the classic method for trying different-sized breast implants in the bra.[13]

The available simulation software uses predefined algorithms to model outcomes from aesthetic surgery (implant augmentation, lipofilling, and mastopexy). Currently, there is no software available to model breast reconstruction or BCS using 3D surface imaging.[21] Predicting aesthetic outcomes for oncological resections presents additional due to the degree of uncertainty about the breast volume or skin to be resected, in addition to the effect of adjuvant treatments.[21] Furthermore, the available software does not allow breast simulation without the nipple-areola complex, which is a common situation in the surgical treatment of breast cancer. Despite these limitations, we found that 3D simulation helped breast cancer patients understand the process

of surgery, as 87.5% of the OP group and 92.3% of the IBR group considered it to be a valuable tool for breast reconstruction.

It is important to consider that most of the data were collected during the 2019 coronavirus (COVID-19) pandemic, first reported in Wuhan, China, in December 2019. The COVID-19 pandemic has become one of the main international concerns regarding its impact on mental health.[27] A study that included 3000 Brazilians from 25 states showed that almost half of the participants expressed symptoms of depression (46.4%), anxiety (30.7%), and stress (42.2%) during this period.[27] Pandemic-related symptoms of mental illness likely affected our study results.

There are some limitations to the present study. First, our population was restricted to a single center, limiting the generalizability of the information. Second, the randomization in the IBR group was underpowered, as the randomized arm consisted of 13 simulated patients. Although this weakens the study from a statistical point of view, our primary endpoint was to prove the impact of 3D simulation in oncological surgery, regardless of the type of surgery. Third, as a cross-sectional study, there is an important element of selection bias to consider: patients who answered the questionnaires could have been those who were more satisfied with their outcomes or with the staff. Moreover, it is important to consider that we did not include patients whose reconstruction failed. Therefore, the generalizability of our study results is limited to patients who successfully completed reconstruction. Further studies should be based on our findings and should include a larger number of patients.

Our study has several strengths. To the best of our knowledge, this is the first prospective and randomized trial that used 3D simulation in patients with breast cancer undergoing breast reconstruction. Additionally, our study is one of the few prospective publications of the BREAST-Q, including a baseline dataset to evaluate the changes in women with breast cancer from their diagnosis to the completion of 6 months follow-up after breast surgery. These findings suggest that viewing 3D images may increase preparedness before surgery by allowing patients to understand the process of their surgery, despite all breast reconstruction limitations and risks.

CONCLUSIONS

Patients demonstrated to have high expectations for breast appearance after reconstruction and expected to have normal sensations and not change over time. These results highlight the need to improve education and informed decision-making regarding breast reconstruction to reduce the risk of dissatisfaction with surgery. The incorporation of preoperative 3D simulation in breast cancer patients resulted in greater satisfaction with information based on PROs using BREAST. The results of our study showed that the 3D simulation may improve the understanding of the patient's expectations regarding the outcomes. Despite being designed for the cosmetic surgery market, we believe that 3D simulation could be a valuable tool in the breast reconstruction set, as it improves patient communication regarding expectations and results, reducing the gap between possibilities (what is possible in each case) and expectation (how they expect the outcome). More robust evidence of its superiority is required before it can be used in conventional clinical practice.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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