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Breast

Local Flaps to Cover Skin Necrosis after Skin-sparing Mastectomy and Prepectoral Reconstruction from PreQ-20 Trial

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Background: In recent years, mastectomy has increasingly been indicated for women at high risk and those with breast cancer. Prepectoral reconstruction with polyurethane implant is an option for these patients. Nevertheless, this procedure can become complicated with exposure of the implant. The aim of this article is to describe the feasibility of local flaps to treat skin necrosis and dehiscence after prepectoral reconstruction and its impact on implant loss.

Methods: This study includes the women who met the inclusion/exclusion criteria of the PreQ-20 protocol (12), which assessed patients with exposed implant who required a local flap for its coverage. Three types of flaps were used: thoracoepigastric, lateral thoracic, and batwing.

Results: The study included 226 skin-sparing mastectomies and immediate reconstruction using prepectoral implants (52.7% bilateral mastectomies). Some 20.9% of the patients showed complications, with wound dehiscence the most frequent. Thirteen local flaps to cover the implant were performed. All flaps presented appropriate perfusion; however, the implant cover failed in six patients (46.2%).

Conclusions: The use of local flaps can be a low-morbidity option for preventing implant loss when skin dehiscence or necrosis occurs and delays in oncology treatments.
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INTRODUCTION

Breast-conserving surgery combined with radiation therapy is currently the standard treatment for women with breast cancer. In recent years, mastectomy has been increasingly indicated for women with early-stage carcinoma[1–3] and those with good response to primary systemic therapy,[4] and in the performance of bilateral mastectomies.[5] This increase is explained by three facts: first, the combination of sparing mastectomies and prepectoral reconstruction has provided a surgical procedure of low morbidity, good cosmetic quality, and high oncologic safety,[6,7] which approaches the results of breast-conserving surgery. Second, the progress in assessing the high risk for breast cancer, based on improved knowledge and a greater use of genetic studies, has raised awareness in practitioners and patients about the role of mastectomy in reducing the risk of this disease. Finally, the greater access to information by women with breast cancer is changing the shared decision-making process during the selection of surgical techniques. Thus, various studies have shown a greater preference for mastectomy among young patients, especially in the millennial generation,[8] for whom this prior information increases awareness of the high risk and the capacity for reducing the risk of mastectomy.

Various authors have confirmed the safety of prepectoral reconstruction in women with breast cancer.[6,7] However, this technique is not exempt from complications.[6,9–11] Recent studies have reported an incidence rate of total complications of up to 25%, including implant infection (2.6%–4.8%), skin necrosis (3.8%–7.8%), wound dehiscence (4.6%), and implant loss (3.3%–6.5%). Skin necrosis and wound dehiscence represent severe complications in women with prepectoral reconstruction because the absence of muscle coverage leads to rapid exposure of the implant and a high risk of loss of the reconstruction. For this reason, the safety of this type of

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reconstruction is increased by covering the implant with meshes or foam (polyurethane) and by training physicians in performing local flaps to restore the skin coverage after necrosis or dehiscence. The objectives of this article are to describe the use of local flaps in treating skin necrosis and dehiscence after prepectoral reconstruction and to assess their efficacy in preserving the reconstruction after these postoperative complications.

Takeaways

Question: How to treat skin necrosis or dehiscence after a mastectomy with prepectoral reconstruction?

Findings: This study includes women from the PreQ-20 prospective study who developed exposed implant and required a local flap for its coverage.

Meaning: The exposure of the implant after mastectomy is a catastrophic scenario which could involve the loss of the reconstruction. The use of local flaps can be a low-morbidity alternative for preventing implant loss with an acceptable success rate.

MATERIALS AND METHODS

PreQ-20 is a prospective study that evaluates the feasibility and safety of immediate breast reconstruction using prepectoral polyurethane implants in women with breast cancer and/or a high risk for breast cancer.[12] The study was assessed and approved by our hospital's healthcare ethics committee (PreQ-20 code; reference number 2020/295). The study protocol was subsequently registered in the ClinicalTrials.gov web site (code NCT04642508).[13]

This study includes the women who met the inclusion/exclusion criteria of the PreQ-20 protocol,[12] which assessed patients with exposed implant who required a local flap for its coverage. The main objective of the present analysis is to determine the technical feasibility of a local flap to prevent the loss of the implant in prepectoral reconstruction through the implantation of polyurethane (Microthane; POLYTECH Health & Aesthetics, Dieburg, Germany).

Preoperative Assessment

All patients were undergoing follow-up by the surgeon who performed the mastectomy and reconstruction. As defined in the PreQ-20 protocol, all patients with a mastectomy and reconstruction undergo the same infection prophylaxis protocol. This protocol includes perioperative antibiotic prophylaxis (24 h), cleaning the surgical area with betadine, washing the hands of the entire surgical team, changing gloves before placing the implant, and washing the implant and skin with antibiotic (amikacin 1 g). All patients presenting with an exposed implant after their reconstruction were evaluated by the unit's surgical team (one senior surgeon and four junior surgeons), after which surgery was planned with a local flap for implant coverage. The surgery was performed by the surgeon responsible for the patient, assisted by the senior surgeon. To those patients in whom infection was suspected, we prescribed oral antibiotic therapy (amoxicillin/clavulanic acid) at least 10 days. The antibiotic treatment was maintained between 10 and 15 days according to the surgeon's decision and the degree of infection and the clinical evolution. Infection was defined as those patients who presented local signs of phlogosis such as erythema, heat and/or induration, associated or not with fever. Microbiological confirmation was not awaited before initiating oral antibiotic therapy.

Surgery

On the day of the surgery, with the patient asleep in the operating room, the extent of the skin defect was determined. According to these measures, the most appropriate random pattern local flap was selected (thoracoepigastric flap, lateral thoracic flap, or batwing flap). Once the incision was performed, the local conditions of the surgical site and implant were assessed. In the event of infection of the cavity or partial absorption of the polyurethane, the implant was replaced with a new one of similar characteristics. In those cases with limited implant contamination or no signs of infection, the initial implant was left in place. In all patients, a drain was placed in the donor area. In those women whose implant was replaced or who had a cavity in the receptor area, another drain was placed in the implant cavity. Each patient underwent surgery by their surgeon, assisted by the unit's senior surgeon.

Thoracoepigastric Flap

The thoracoepigastric flap is a rotation advancement flap that allows for the ascension toward the chest of the skin and subcutaneous tissue located in the anterior part of the abdomen. A random pattern flap is performed, with vascular support based on the fifth or sixth perforator of the internal thoracic artery. Its design consists of making a rectangle with a line in the inframammary fold and another parallel line in the abdomen, with inframammary fold distance determined by the width of the defect to cover. The length of the flap is determined by the distance between the inframammary fold and the most distal portion of the defect to cover (Fig. 1).

Lateral Thoracic Flap

The lateral thoracic flap is a rotation advancement flap of the skin and subcutaneous tissue located in the anterolateral part of the abdomen. A random pattern flap is performed, with vascular support based on the anterolateral intercostal perforators that emerge in the anterior axillary line. Its design is similar to the thoracoepigastric flap; in the lateral thoracic flap, however, the axis of rotation, which remains anchored to the abdomen and allows for its irrigation, is located in the lateral part of the abdomen, at the anterior axillary line (Fig. 2).

Batwing Flap

The batwing flap is an advancement flap without rotation that allows for ascension toward the chest of the skin and subcutaneous tissue located in the part of the abdomen that is below the defect that requires coverage. The batwing flap is a random pattern flap irrigated by the

Fig. 1. Thoracoepigastric flap. A, Patient with exposure of implant. B, Design of the thoracoepigastric flap. C, Final results after performing the thoracoepigastric flap.

Fig. 2. Lateral thoracic flap. A, Patient with skin necrosis after mastectomy and reconstruction with prepectoral implant. B, Design of lateral thoracic flap. C, Result after performing the lateral thoracic flap.

Fig. 3. Batwing flap. A, Patient with dehiscence of the vertical incision after mastectomy and reconstruction with prepectoral implant. B, Design of batwing flap. C, Result after performing the batwing flap.

vascular anastomosis of the subcutaneous tissue, with no specific perforating artery. In this flap, the mobilization distance will depend on the vertical length of the skin defect, and the width of the skin defect will similarly determine the width of the flap (Fig. 3). This flap is indicated for defects close to the inframammary fold and for defects in the lower pole in small breasts. The flap can also be used to restore dehiscence or necrosis in the central region of the breast in type 1 skin-sparing mastectomies (Fig. 4).

Statistical Analysis

We performed a descriptive analysis of the variables included in the study. All quantitative variables are expressed as their mean and SD. The qualitative variables are expressed in proportions and their respective confidence intervals. The means were compared using Student *t* test or the Mann-Whitney *U* test and the Kruskal-Wallis test or ANOVA, as appropriate after determining the normality with the Kolmogorov-Smirnov test. The association of the qualitative variables was estimated using the chi-squared statistic. The statistical analysis was performed using version 24 of the statistical program IBM SPSS.

RESULTS

A total of 226 skin-sparing mastectomies and immediate reconstruction using prepectoral implants were performed on 148 women (52.7% bilateral

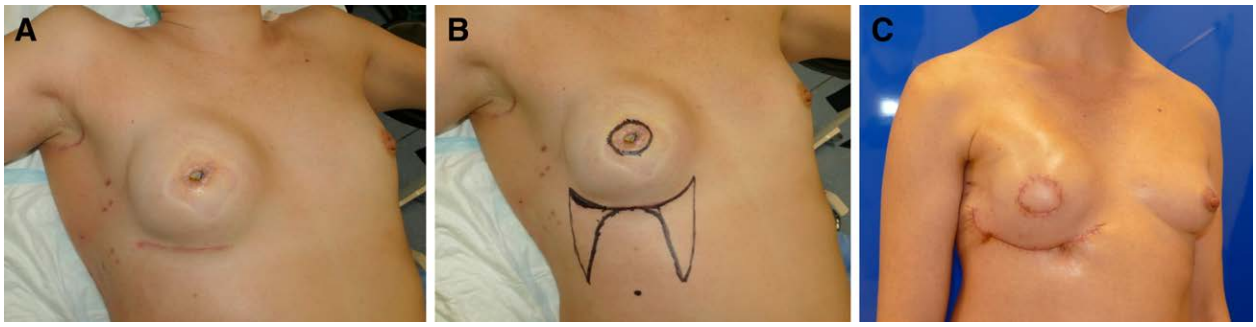

Fig. 4. Batwing flap. A, Patient with wound dehiscence after resection of the nipple-areolar complex. B, Design of the batwing flap. C, Result after performing the batwing flap.

mastectomies). Some 79.1% of the patients underwent surgery for a breast neoplasm, and the remaining 20.9% underwent surgery for high risk of breast cancer. The mean age of the series was 47.4 years (±9.2) (Table 1). Some 41.2% of the mastectomies were skin- and nipple-sparing, with an incision in the inframammary fold (Table 2).

The mean follow-up time was 20.8 months (±21.1), during which 31 patients (20.9%) presented surgery-related complications, representing 15% of the reconstructions (Table 3). Wound dehiscence was the most common complication, occurring in 11 patients (4.8% of the reconstructions), followed by periprosthetic seromas (2.7%) and skin necrosis (2.2%). Some 64.7% of the patients experienced a complication (14.9% of the series) that required at least one surgery. These complications created exposure of the implant in 14 patients. Eleven of these patients (78.6%) had a vertical incision (type IV mastectomy or vertical incision). In one of these patients, the implant was directly withdrawn because the patient had started radiotherapy; in the remaining patients, a local flap was performed for implant coverage.

Thirteen local flaps were performed for implant coverage: 10 patients with wound dehiscence and three with skin necrosis. Three types of local flaps were used: eight batwing, three lateral chest, and two thoracoepigastric flaps (Table 4). All of the flaps presented adequate perfusion during the operation and follow-up. In six patients (46.2%), however, the implant coverage failed; the reconstruction was preserved in 53.8% of the women with an extrusion. The factors associated with implant loss were a history of radiation therapy [two of the three previously irradiated patients lost the reconstruction (14.3% of 21 irradiated patients in the series)] and the association of implant infection (four of five patients with infection

Table 1. Characteristics of the Series

	Total Patients, N = 148
Age, y	
Mean ± SD	47.4 (±9.2)
Range	30–79
BMI, kg/m²	
Mean ± SD	24.1 (±4.5)
Range	17.8–42.3
Genetic mutation	
BRCA1	22 (14.9%)
BRCA2	14 (9.5%)
PALB2	4 (2.7%)
RAD51	1 (0.7%)
BRIP1	1 (0.7%)
Panel of genes without mutation	30 (20.3%)
Results pending	18 (12.2%)
Not requested	58 (39.2%)
Cause of the mastectomy	
Oncologic	117 (79.1%)
Risk-reducing	31 (20.9%)
Bilateral mastectomy	78 (52.7%)
Bilateral carcinoma	3 (2.0%)

BMI, body mass index.

Table 2. Characteristics of the Reconstruction

	Reconstructions, N = 226
Cause of the mastectomy	
Oncologic	122 (53.9%)
Risk-reducing	104 (46.1%)
Type of mastectomy	
SSM I	22 (9.7%)
SSM II	1 (0.4%)
SSM IV	43 (19.0%)
NSSM inframammary fold incision	93 (41.2%)
NSSM reduction pattern/vertical incision	67 (29.6%)

NSSM, nipple-skin-sparing mastectomy; SSM, skin-sparing mastectomy.

Table 3. Complications

	Reconstructions, N = 226	Reoperated Patients, N = 148
Hematoma/bleeding	5 (2.2%)*	2/5 (40%)
Infection	4 (1.8%)†	4/4 (100%)
Seroma	6 (2.7%)‡	2/6 (33.3%)
Skin necrosis	5 (2.2%)	3/5 (60%)
Wound dehiscence	11 (4.8%)	10/11 (90.9%)
Partial necrosis of the NAC	2 (0.9%)	1/2 (50%)
Skin rash	1 (0.4%)	0/1 (0%)
Total	34 (15%)	22 (14.9%)

*A patient with hematoma subsequently showed wound dehiscence.
†Two patients had seroma that subsequently superinfected.
‡A patient with periprosthetic seroma was reoperated to place a drain, subsequently showing wound dehiscence.

Table 4. Patients with Local Flap

	Type of Mastectomy	Cause of the Flap	Type of Local Flap	No. Procedures	Associated Infection	Previous Radiation Therapy	Loss of Implant
Patient 1	SSM IV	Skin necrosis	Batwing flap	2	Yes	No	Yes
Patient 2	NSSM IF	Skin necrosis	Lateral thoracic	3	Yes	No	Yes
Patient 3	SSM IV	Wound dehiscence	Batwing flap	3	Yes	No	Yes
Patient 4	NSSM IF	Skin necrosis	Lateral thoracic	2	No	Yes	Yes
Patient 5	SSM IV	Wound dehiscence	Batwing flap	1	No	No	No
Patient 6	SSM IV	Wound dehiscence	Batwing flap	1	No	No	No
Patient 7	NSSM vertical incision	Wound dehiscence	Thoracoepigastric	3	yes	No	Yes
Patient 8	NSSM vertical incision	Wound dehiscence	Batwing flap	1	No	No	No
Patient 9	SSM IV	Seroma + dehiscence	Batwing flap	3	No	Yes	Yes
Patient 10	NSSM IF	Wound dehiscence of the NAC	Lateral thoracic	1	No	No	No
Patient 11	NSSM vertical incision	Wound dehiscence	Thoracoepigastric	1	yes	No	No
Patient 12	SSM IV	Wound dehiscence	Batwing flap	1	No	No	No
Patient 13	SSM IV	Wound dehiscence	Batwing flap	1	No	Yes	No

IF, inframammary fold; NAC, nipple-areolar complex; NSSM, nipple-skin-sparing mastectomy; SSM, skin-sparing mastectomy.

lost the implant). In the overall series, 10 women lost the implant, representing 4.4% of all the reconstructions.

DISCUSSION

The use of prepectoral reconstructions began in the 1960s through the placement of subcutaneous implants but was quickly abandoned due to the poor cosmetic results due to contracture and the visibility of the implant. Prepectoral reconstructions were therefore replaced by retromuscular procedures to decrease the frequency of these incidents.[10] Nevertheless, retropectoral reconstruction is not exempt from complications and is associated with animation deformity in up to 75%–100% of cases.[14–16] In recent years, this situation has fostered a return of prepectoral reconstruction, based on greater precision of the mastectomy technique, greater preservation of the anatomical elements of the breast and the improvements in implants with new surfaces compatible with a subcutaneous position.

Despite this progress in reconstructive techniques, there are various complications that affect the results of prepectoral reconstruction.[6,9–11] In a meta-analysis that included 654 mastectomies with prepectoral reconstruction, Chatterjee et al[9] showed a 7.8% rate of skin flap necrosis, a 4.2% rate of wound dehiscence, and a 4.6% rate of implant extrusion. Similar findings were reported by Wagner et al[6] in their systematic review, with an incidence rate of complications greater than 20% and a rate of implant loss of 3.3%. Most of these complications (infection, skin necrosis, or wound dehiscence) appeared in the patients with breast cancer and entailed three main problems. First, these complications required hospitalization, antibiotics, or even surgical interventions, which delayed the start of adjuvant therapies. Second, the complications negatively affected the psychological state of the women who were in a vulnerable state due to their oncologic process. Most patients experience complications such as treatment failure, added obstacles in the process, and even the loss of the implant, which results in double mourning, first for the loss of the implant and then for the loss of their breast.[17] Finally, the failure of the immediate reconstruction creates problems for the surgeon, given that they have to offer a deferred reconstruction on a chest wall in inferior local conditions and, in many cases, irradiated, which entails a reconstruction with a flap. Early detection of these complications is therefore necessary, and the use of surgical procedures that can help resolve these complications and prevent the loss of the reconstruction.

Muscle flaps were used originally for skin coverage after large resections of locally advanced tumors or severe radiodermatitis and subsequently for breast reconstruction after breast cancer.[18,19] In recent years, the use of local flaps has been developed as an alternative to muscle flaps thanks to progress in the understanding of the perforating arteries of the chest wall and their angiosomes.[20,21] This knowledge has helped develop the design of various local flaps, the main advantage of which is reducing the morbidity of the donor area and maintaining muscle function.[18] Local flaps have been used mainly to resolve the complications of breast-conservative surgery[19] and have recently been implemented as a volume replacement technique in oncoplastic surgery.[22–25]

These skin flaps are classified as axial and random according to the origin of their vascular supply. Axial flaps depend on an arterial pedicle at its base, and their design depends on the direction and length of the vessel, requiring identification and dissection of the pedicle. Random flaps lack a specific arterial pedicle, and their viability depends on a perforating artery and the vascular connections of the subdermal plexus.[21] The vascular principle of these local flaps is that their length should not exceed twice that of the base,[26] although a number of authors have disagreed with this axiom. In our case studies, flaps measuring more than twice the length of the base have been viable, without complications. The likely explanation is the linking vessels described by Saint-Cyr et al,[20] who studied 217 perforator flaps in 40 cadavers and described three fundamental principles for designing local flaps. First, the flow of each perforator is multidirectional, and each perforator has its own territory known as the perforasome. Second, each perforasome is joined to

the adjacent one through direct and indirect linking vessels. The flow in these vessels is bidirectional, allowing for the recruitment of more than one perforasome in a flap. Third, the flaps should be designed in the direction of the linking vessels, which in the chest are perpendicular to the midline. Our group uses the batwing flap, which breaks with this last principle. However, there were no cases of necrosis in these flaps in the presented series.

This study describes the use of local flaps for covering implants as part of the PreQ-20 prospective study.[12] This technique has low complexity and morbidity and preserves the reconstruction in a high percentage of cases (53.8% of the women in our series with implant extrusion). The use of these flaps to resolve reconstruction complications was previously described by other authors. Spear et al[27] performed a retrospective review of 38 women with implant infection or exposure with a mastectomy due to breast cancer or risk reduction. The authors successfully used a local flap for coverage of a dehiscence in one patient with retropectoral reconstruction with expander after a type IV mastectomy. Similarly, Peeters et al[28] describe the use of local flaps for implant coverage in two patients: one with augmentation surgery and the other with a mastectomy and retropectoral reconstruction. As in the present study, the series of these authors is small.[27,28] Contrary to our series, these authors describe the use of these flaps in retropectoral reconstruction. This series is the first in the literature to describe the use of local flaps for implant coverage after mastectomy and prepectoral reconstruction.

In the presented series, all flaps were viable; however, there were six implant losses, all of them with associated infection or radiodermatitis. Therefore, the coverage failure is determined by problems in the receptor area and not by flap complications. Therefore, it is sometimes necessary to change the design of the initial flap, change the implant, or even assess not performing the flap and removing the implant. The authors recommend assessing the receptor area and the viability of the same before performing incisions on the donor area. The batwing flap is the flap that best allows for redesigning the flap's dimensions, because its length can be increased once the incision has been performed. The use of local flaps for covering the implant after extrusion in mastectomy with prepectoral reconstruction is a low-morbidity technique that can be the last attempt to preserve a reconstruction that has experienced a complication.

This study has several limitations. First, the low incidence of complications after a mastectomy and prepectoral reconstruction with polyurethane implant precludes identifying modifiable risk factors. Second, the case studies presented of local flaps are too few to state solid conclusions. Finally, the actual follow-up was too short to determine the long-term cosmetic results and patient satisfaction.

CONCLUSIONS

In conclusion, the exposure of the implant by dehiscence or necrosis after mastectomy is a catastrophic scenario, which, in most cases, involves the loss of the reconstruction. However, the use of local flaps to treat skin dehiscence or necrosis can be a low-morbidity alternative for preventing implant loss and delays in oncology treatments. The presented series is small, and there are no other series in the literature; more extensive studies are therefore needed to validate their use.

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DISCLOSURE

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

REFERENCES

1. Kummerow KL, Du L, Penson DF, et al. Nationwide trends in mastectomy for early-stage breast cancer. *JAMA Surg.* 2015;150:9–16.
2. Mahmood U, Hanlon AL, Koshy M, et al. Increasing national mastectomy rates for the treatment of early stage breast cancer. *Ann Surg Oncol.* 2013;20:1436–1443.
3. Dragun AE, Huang B, Tucker TC, et al. Increasing mastectomy rates among all age groups for early stage breast cancer: a 10-year study of surgical choice. *Breast J.* 2012;18:318–325.
4. Erqi L, Qian Y, Chin A, et al. Rising rates of bilateral mastectomy with reconstruction following neoadjuvant chemotherapy. *Int J Cancer.* 2018;143:3262–3272.
5. Kurian A, Lichtensztajn D, Keegan T, et al. Use of and mortality after bilateral mastectomy compared with other surgical treatments for breast cancer in California, 1998-2011. *JAMA.* 2014;312:902–914.
6. Wagner RD, Braun TL, Zhu H, et al. A systematic review of complications in prepectoral breast reconstruction. *J Plast Reconstr Aesthet Surg.* 2019;72:1051–1059.
7. Sigalove S. Prepectoral breast reconstruction and radiotherapy-a closer look. *Gland Surg.* 2019;8:67–74.
8. Rohrich RJ, Dayan E. Improving communication with millennial patients. *Plast Reconstr Surg.* 2019;144:533–535.
9. Chatterjee A, Nahabedian MY, Gabriel A, et al. Early assessment of post-surgical outcomes with pre-pectoral breast reconstruction: a literature review and meta-analysis. *J Surg Oncol.* 2018;117:1119–1130.
10. Bloom JA, Patel K, Cohen S, et al. Prepectoral breast reconstruction: an overview of the history, technique, and reported complications. *Open Access Surg.* 2020;13:1–9.
11. Masiá J, Working group IBAG. The largest multicentre data collection on prepectoral breast reconstruction: the iBAG study. *J Surg Oncol.* 2020;122:848–860.
12. Acea-Nebril A, García-Novoa A, García L. The PreQ-20 TRIAL: a prospective cohort study of the oncologic safety, quality of life and cosmetic outcomes of patients undergoing prepectoral breast reconstruction. *PLoS One.* 2022;17:e0269426.
13. Clinicaltrials.gov. Available at https://clinicaltrials.gov/ct2/show/NCT04642508?term=NCT04642508&draw=2&rank=1. Accessed March 2023.
14. Nigro LC, Blanchet NP. Animation deformity in postmastectomy implant-based reconstruction. *Plast Reconstr Surg Glob Open.* 2017;5:e1407.
15. Becker H, Fregosi N. The impact of animation deformity on quality of life in post-mastectomy reconstruction patients. *Aesthet Surg J.* 2017;37:531–536.
16. Dyrberg DL, Bille C, Gunnarsson GL, et al. Breast animation deformity. *Arch Plast Surg.* 2019;46:7–15.
17. Weicka L, Ericson A, Sandman L, et al. research article health care for women international patient experience of implant loss after immediate breast reconstruction: an interpretative phenomenological analysis. *Health Care Women Int.* 2021;57:263–270.

18. Fujioka M. Surgical reconstruction of radiation injuries. *Adv Wound Care (New Rochelle)*. 2014;3:25–37.
19. Acea B, Builes S, García A, et al. Colgajos por rotación en la cirugía oncológica de la mama Fundamentos anatómicos y técnicos para su planificación quirúrgica. *Cir Esp*. 2016;94:372–378.
20. Saint-Cyr M, Wong C, Schaverien M, et al. The perforasome theory: vascular anatomy and clinical implications. *Plast Reconstr Surg*. 2009;124:1529–1544.
21. McGregor IA, Morgan G. Axial and random pattern flaps. *Br J Plast Surg*. 1973;26:202–213.
22. Agrawal SK, Shakya SR, Nigam S, et al. Chest wall perforator flaps in partial breast reconstruction after breast conservation surgery: an additional oncoplastic surgical option. *Ecancermedicalscience*. 2020;14:1073.
23. Carrasco-López C, Ibañez JFJ, Vilá J, et al. Anterior intercostal artery perforator flap in immediate breast reconstruction: anatomical study and clinical application. *Microsurgery*. 2017;37:603–610.
24. Losken A, Hamdi M. Partial breast reconstruction: current perspectives. *Plast Reconstr Surg*. 2009;124:722–736.
25. Retrouvey H, Mahoney MH, Pinchuk B, et al. The versatility of lateral chest wall perforator flaps in immediate and delayed breast reconstruction: retrospective study of clinical experience with 26 patients. *Plast Surg (Oakv)*. 2021;31:261–269.
26. Stell PM. The viability of skin flaps. *Ann R Coll Surg Engl*. 1977;59:236–241.
27. Spear SL, Howard MA, Boehmler JH, et al. The infected or exposed breast implant: management and treatment strategies. *Plast Reconstr Surg*. 2004;113:1634–1644.
28. Peeters G, Cambier B, Stasch T, et al. The exposed breast prosthesis at the infra-mammary region: treatment by local flaps. *Eur J Plast Surg*. 2011;34:513–516.