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Oncoplastic breast surgery: comprehensive review

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Abstract. – Breast cancer is the most common female cancer in Western populations, affecting 12.5% of women, with 1.38 million patients per year. Breast-conserving surgery followed by postoperative radiotherapy replaced the radical and modified-radical procedures of Halsted and Patey as the standard of care for early-stage breast cancer once the overall and disease-free survival rates of breast-conserving surgery were demonstrated to be equivalent to those of mastectomy. However, excision of >20% of breast tissue, low or centrally located cancer, and large-sized breasts with various grades of breast ptosis, result a in unacceptable cosmetic outcomes.

Oncoplastic breast surgery evolved from the breast-conserving surgery by broadening its general indication to achieve wider excision margins without compromising on the cosmetic outcomes. Thus, oncoplastic breast surgery can be defined as a tumor-specific immediate breast reconstruction method that applies aesthetically derived breast reduction techniques to the field of breast cancer surgery and allows for higher volume excision with no aesthetic compromise. However, contralateral breast symmetrization should be regarded as an intrinsic component of the oncoplastic surgery. The main procedures involved are volume-displacement or volume-replacement techniques, which depend on breast size and cancer size/location. Volume-displacement or reshaping procedures apply the plastic surgery principles to transpose a dermo-glandular flap of breast tissue into the defect site, while volume-replacement techniques use autologous tissues to replace the volume loss that follows tumor resection. Furthermore, these procedures are more complex and time-consuming than those involved in breast-conserving surgery.

Based on current literature, the authors analyze the different techniques and indications of the oncoplastic breast surgery, determining its complication rate, in order to help both surgeons and their patients in the decision-making stage of breast reconstruction.

Key Words:
Reconstructive surgery, Breast cancer, Breast conservative therapy, Oncoplastic breast surgery.

Introduction

The term "oncoplasty" is derived from the Greek words "onco" (tumor) and "plastic" (to mold)[1]. It essentially merges tumor resection, which ensures oncological safety, with plastic surgery, which ensures the best cosmetic outcome. According to its original definition, oncoplastic breast surgery (OBS) focuses on favorable scar orientation/placement, significant soft tissue rearrangement, and reconstruction of the contralateral breast to achieve symmetry[1]. As stated in the Milanese Consensus Conference on Breast Conservation of 2006, the aim of OBS is to achieve wide excision and clear margins without compromising on the cosmetic outcomes; moreover, the procedure should be performed simultaneously with oncological excision[2].

The principles of oncoplastic procedures evolved in Europe in the 1990s, but it was only in 1993 that Dr. Audretsch, a German surgeon, introduced the term "oncoplastic surgery"[3]. It quickly spread through France, Italy, and the UK, where it quickly gained popularity: the rate of procedures performed increased from 40% in 1991 to 60% in 2002. OBS has more recently become popular in the USA and other countries worldwide[4,5].

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Background

Breast cancer (BC) is the most common female cancer in Western populations, affecting 12.5% of women, with 1.38 million patients per year[6,7]. The peak prevalence of BC is 61 years, and more than 65% of women affected are < 65 years old. Therefore, the affected population comprises many young women who expect the treatment to result in long-term survival and also to have good aesthetic and psychological outcomes[8].

Breast-conserving surgery (BCS) followed by postoperative radiotherapy replaced the radical and modified-radical procedures of Halsted[9] and Patey and Dyson[10] as the standard of care for early-stage BC once the overall and disease-free survival rates of BCS were demonstrated to be equivalent to those of mastectomy[11-13]. Indeed, BCS allows for removal of cancer along with a tumor-free margin. The optimal extent of this margin is still being determined, and it varies from a 2-mm negative microscopic margin to 1- to 2-cm macroscopic uninvolved tissue[14]. BCS, therefore, offers the advantages of preservation of body image, better quality of life, and reduction of psychological morbidities[11].

The standard BCS strategies are lumpectomy or quadrantectomy with or without axillary dissection and radiotherapy. The main indications for BCS are early-stage BC, ductal carcinoma *in-situ* (DCIS) and large BC preceded by neoadjuvant chemotherapy[15]. Up to 30% of patients who undergo BCS complain of residual deformities, mainly including a deficiency of glandular tissue, overlying skin retractions, delayed side effects of radiotherapy, retraction/displacement of the nipple-areola complex (NAC), reduction of mammary ptosis, and asymmetry of the breasts[16-18]. Tumor size and location, the tumor-to-breast ratio, breast shape, postoperative radiation, and liposubstitution are commonly accepted risk factors for poor cosmetic outcome[18,19].

Previous studies have demonstrated that resection of parenchymal tissue greater than 70-100 cm^2 or a tumor-to-breast weight ratio exceeding 10:1 will probably result in unfavorable outcomes[20-22]. Indeed, excision of > 20% of breast tissue has unacceptable cosmetic outcomes as the tumor-to-breast ratio is more than the absolute tumor size, which is the strongest predictive factor for poor outcomes[1,23]. Tumor location has also been proven to affect the outcome. BC located within the lower and central quadrants has the worst cosmetic results after BCS, and only a 5% reduction in breast volume is allowed when the tumor is medially located, given the paucity of tissue[1,22]. Large breasts with various grades of breast ptosis are also not suitable for BCS, because of the higher incidence of complications and radiation-induced fibrosis, given the higher dosage of radiation required for patients with macromastia[24-26]. The other risk factors can be classified as patient-related (diabetes mellitus, tobacco use, and collagen diseases), and treatment-related (re-excision lumpectomy, postoperative seroma, and radiotherapy)[27].

General Principles

OBS broadened the general indication for BCT in order to reduce the risk of late deformities and asymmetry[28]. Tumors that are up to 3 cm in diameter can be safely removed if the resection procedure is followed by postoperative radiotherapy; however, mastectomy is still the gold standard of care for larger BCs[29-30]. Recently introduced neoadjuvant chemotherapies allow for a more conservative approach, even for advanced cancers[30].

OBS can be defined as a tumor-specific immediate breast reconstruction method that applies aesthetically derived breast reduction techniques to the field of breast cancer surgery and allows for higher volume excision with no aesthetic compromise[31]. The procedures involved are more complex and time-consuming than those involved in BCT[18]. The aim of OBS is to ensure better cosmetic outcomes and eliminate the need for surgical correction of defects resulting from BCT[33,34]. The average specimen for BCT weighs 20-40 g, compared to 200 g for OBS on average (though the specimen can weigh up to 1000 g or more)[15]. Studies have reported that breast resections of 20% to 40% breast volume (normally treated by mastectomy) ensure the removal of cancer with adequate tumor-free margins and retain enough tissue for good cosmetic outcomes[35,36]. Indeed, the oncological safety of breast surgery is determined by the status of the surgical margins. Residual carcinoma at the resection margins is regarded as one of the most important risk factors for local tumor recurrence with a relative risk that is almost 15-times higher than that in patients with tumor-free margins[37-39]. Focally positive margins may also be responsible for systemic spread and, eventually, disease-specific mortality[40]. Extensive DCIS, high-grade BC, infiltrating lobular carcinoma, previous neoadjuvant chemotherapy, Her2/neu-positivity, and lower age are all associated with a higher rate of tumor-positive margins[41-43]. The accepted definition of tumor-free

margins is at least a 1-mm distance between the cut edge of the specimen and the outer limit of the tumor[44]. However, a 1- to 2-mm distance between the resected edge of the specimen and the outer limit of the tumor is internationally defined as a close margin.

OBS provides the best results if the reconstruction is performed at the time of the resection (immediate reconstruction)[45,46]. The tissues surrounding the cancer should be healthy, non-irradiated and without scarring, which will result in lower complication rates and better cosmetic outcomes[47]. Moreover, the scars resulting from OBS improve after radiotherapy. Delayed reconstruction is performed at least 6 months to one year after the last radiotherapy session[48]. The techniques employed are similar to those of the immediate setting; however, the complication rate is almost double and the cosmetic outcome is usually poor. Delayed-immediate breast reconstruction has the same advantages as immediate reconstruction (the aesthetic outcomes and lower complication rates) as well as the delayed approach (oncologic safety). Delayed-immediate breast reconstruction is indicated in cases where final confirmation of a tumor-free resection margin is required prior to reconstruction; this procedure usually takes place 1-2 weeks after BC resection, prior to radiotherapy[49].

Various authors[50-53] regard contralateral symmetrization as an intrinsic component of OBS that should be performed at the same time of the reconstruction. Indeed, simultaneous surgery on both breasts can eliminate the need for a second surgery. However, radiotherapy can have unpredictable effects on the treated breast, and hormonal and chemotherapy can significantly change the overall body weight of the patient. If the excision margins are positive and re-excision or mastectomy is required, the contralateral breast may require another reconstruction procedure to correct any asymmetry that arises[36]. Therefore, symmetrization surgery may be postponed until the third or sixth month after the last adjuvant therapy session[53]. The risks and benefits of both approaches should be extensively discussed with the patient before any procedures are performed[54].

Indications

High-volume breasts with severe ptosis may be particularly suited for OBS as the margins can be wider and the results are usually more satisfactory[18]. Furthermore, resection of over 20% of the breast volume with the need for large skin resections inside the mammoplasty area is also an indication for OBS[55]. When the tumor is located in the central, medial or inferior quadrant, the cosmetic outcomes are usually better, particularly if the BC is located within the resection area of the mammoplasty[56]. Conversely, cancers located close to the skin and outside this area may need to be treated with a combination of techniques, which may not always provide the desired results. In such cases, as well as in cases of previous plastic surgery of the breast, nipple- or skin-sparing mastectomy may be the best choice[57]. Small breasts without mammary ptosis and conical breasts can be regarded as absolute contradictions for OBS, and skin-sparing or nipple-sparing mastectomy may be a better option in such cases too[58,59]. Exaggerated patient's expectations of aesthetic results, youth and previously irradiated breast are relative contraindications to OBS. Associated clinical conditions, such as uncontrolled diabetes, tobacco use, collagen diseases, and older age are associated with higher complication rates, which may affect the aesthetic outcomes[18].

Preoperative Planning

Preoperative planning is important for optimizing the surgical resection technique without compromising the final breast shape. Indeed, performing tissue removal without proper planning can result in postoperative deformities that can prevent surgeons from achieving the ideal breast shape[60]. Computer-based software or imaging techniques, such as the recently introduced 3D surface imaging devices, which evaluate breast contour, shape, position, volume, and symmetry, are useful in this regard[61-64]. Such imaging information, when combined with the surgeon's experience, is useful in this decision-making stage.

However, the primary aim of OBS is oncological safety; therefore, a clear understanding of the location and spread of the cancer is required for optimal breast resection. The invasiveness and extent of BC can be reliably predicted by mammography complemented by ultrasound examination[36]. Conversely, non-invasive BC cannot be reliably predicted by these imaging techniques. DCIS usually presents with radiologically detectable microcalcifications. However, these calcifications are only centrally located and are absent in low-grade DCIS, so they may not be reliable for predicting the entire extent of the lesion[12,65,66]. Furthermore, DCIS is usually not associated with mass-like changes that are detectable

by ultrasonography, which is of little or no help in examining cancer distribution[36]. Contrast-enhanced magnetic resonance imaging (MRI) is the most feasible technique for determining the presence and size of BC as well as identifying additional invasive lesions[36]. MRI is particularly suitable for assessing invasive lobular carcinoma diffusion, as it has the lowest false-negative rate and highest accuracy[67]. However, the rate of false-positive results is high, and it is not always possible to determine the extent of non-invasive cancers. Therefore, MRI cannot be considered as the standard of care, and its use should be limited to restricted centers where MRI-guided biopsy is performed[68,69].

Technique

The OBS approach is based on two general principles: volume displacement and volume replacement, which depend on breast size, BC size, and location. Volume-displacement or reshaping procedures apply plastic surgery principles to transpose a dermo-glandular flap of breast tissue into the defect site, while volume-replacement techniques use autologous tissues to replace the volume loss that follows tumor resection[44].

There are no standardized protocols for these procedures, but there are a few basic rules[70]. Women with moderate-/large breasts, with or without ptosis, benefit from immediate breast reconstruction using of volume-replacement techniques. This is particularly true if the tumor is located within the breast resection pattern of the partial mastectomy[70]. Conversely, small breasts without ptosis usually need volume-replacement procedures, as the skin and tissue that are removed need to be replaced to ensure that the resected breast is similar in structure to the contralateral breast. BC of the upper or outer quadrant also usually requires volume-replacement techniques[49]. Before the closure of defects, metal clips must be placed on the pectoralis muscle and lateral edges of the resection bed for future radiotherapy[71].

Volume-Displacement Techniques

Small- to medium-sized breasts are best suited for OBS when the defect does not lead to significant volume alteration and asymmetry. Dermo-glandular advancement and rotation or transposition flap placement are the main procedures used for filling the dead space with the surrounding remaining breast tissue. The mammary gland is usually dissected from the underlying pectoralis muscle, and a full-thickness fibro-glandular breast flap is advanced into the defect. Reconstruction of the contralateral breast to achieve symmetry of both breasts is usually not required[36]. However, the extensive dual-plane undermining of the breast gland may harness blood supply and should be performed cautiously, especially in low-density breasts with a high fatty composition[71]. In an optimal procedure, the location of the NAC is anticipated and it is relocated accordingly, as its position progresses in the infero-lateral direction with age, particularly in young patients[53].

The ideal technique for medium to large breasts with ptosis is probably mastopexy or reduction. The tumor is included within the breast resection pattern, while the remaining breast parenchyma is used for mound reshaping. The oncoplastic approach has been described by Masetti et al[52] as a four-step procedure where skin incisions and parenchymal excisions are first planned according to reduction/mastopexy templates; this is followed by parenchymal reshaping, repositioning of the NAC, and, finally, correction of the contralateral breast to achieve symmetry.

When the BC lies beyond the resection region of the mammoplasty, breast reshaping can be combined with complete tumor removal. The key step is the preoperative decision-making process: designing the pedicle, creating the skin/parenchymal resection pattern so as to preserve the viability of the NAC, reshaping the breast mound, and closing the dead space. If the expected volume of the breast to be removed is < 20%, the remaining breast mound can be satisfactorily reshaped with simple skin and glandular undermining. Skin undermining follows the mastectomy plane, and the target can be increased from 20% to 60% of overlying skin[71]. NAC can also be undermined by complete transection of the terminal ducts with a 0.5- to 1-cm glandular tissue left attached. NAC sensitivity may be reduced, but arterial supply and venous drainage are usually maintained[72,73]. Furthermore, NAC displacement can be prevented by de-epithelization of the periareolar skin in the shape of a crescent opposed to the defect site. Immediate recentralization guarantees a better cosmetic outcome than repositioning of the NAC after radiation therapy[74]. If the volume of the breast to be removed exceeds 20-50%, more complex OBS procedures are required, which ensure a wider resection margin while preserving the final breast shape from contour deformities and asymmetry. In addition, corrective surgery

for the contralateral breast to achieve symmetry should be discussed with the patient in the preoperative setting, as after OBS the breast usually appears smaller, higher, and rounder[71].

OBS is suitable for lower pole BC, since the use of BCT in these areas usually results in the "bird's beak" deformity with a downward deviation of the NAC, which can also worsen as a consequence of post-irradiation fibrosis[53,75]. Superior or superomedial pedicle inverted T or vertical scar mammoplasty allows for BC removal within the Wise pattern. The resulting cosmetic outcome is excellent in women with small-to-large breasts[76]. V-mammoplasty improves the aesthetic outcome of superior pedicle mammoplasty when the BC is located in the lower-inner quadrant. The tumor is excised *en bloc* with a pyramidal section of the gland, with its apex at the border of the areola and its base in the submammary fold. The incision is made laterally to the anterior axillary line in order to medially rotate a skin-glandular flap to fill the defect and reshape the breast. The resulting scar has a V-shape and is mainly hidden in the inframammary fold (IMF) [35] (Figure 1).

BC located in the upper inner quadrant needs to be treated with extra caution in the preoperative setting. It is an aesthetically relevant region as it is the most visible one, and, therefore, the scars are particularly difficult to hide and may distort the décolleté. Inferior medial pedicle mammoplasty provides satisfactory results and allows for safe tumor excision in the upper half of the breast while preserving the viability of the NAC[1]. Donut or round block mastopexy also allows for removal of segmentally distributed BC of the upper inner quadrant through a periareolar access point[77]. Furthermore, Clough et al[78] recently described the use of a rotation glandular flap for upper inner quadrant tumors, which can be also applied to all quadrants. However, their technique requires extensive undermining of the gland, and, therefore, should be reserved for glandular and not fatty breasts. According to Clough et al's technique, the NAC and the gland are extensively undermined through a semi-circular peri-areolar incision. Once the BC is completely resected, a wide V-shaped glandular flap is rotated medially towards the defect site via a full-thickness glandular incision created laterally from the lumpectomy cavity. Such remodeling techniques are not feasible if the skin in the upper half of the breast needs to be resected. In such cases, Silverstein's batwing mastopexy technique may be a solution[36]. According to this method, two similar half-circle incisions with angled wings are marked on either side of the NAC; the BC is located within this resection pattern and is excised at full thickness. The remaining fibroglandular tissue is advanced to close the defect; this results in the upward lift of the breast and nipple. This is a simple procedure that does not need extensive dual-plane undermining and also corrects breast ptosis[53]. A similar procedure is occasionally performed on the contralateral breast to achieve symmetry. When performing the batwing mastopexy, surgeons should not excessively reduce the sternal notch to nipple (SN-N) distance, as this could result in pseudoptosis. Indeed, undue up-

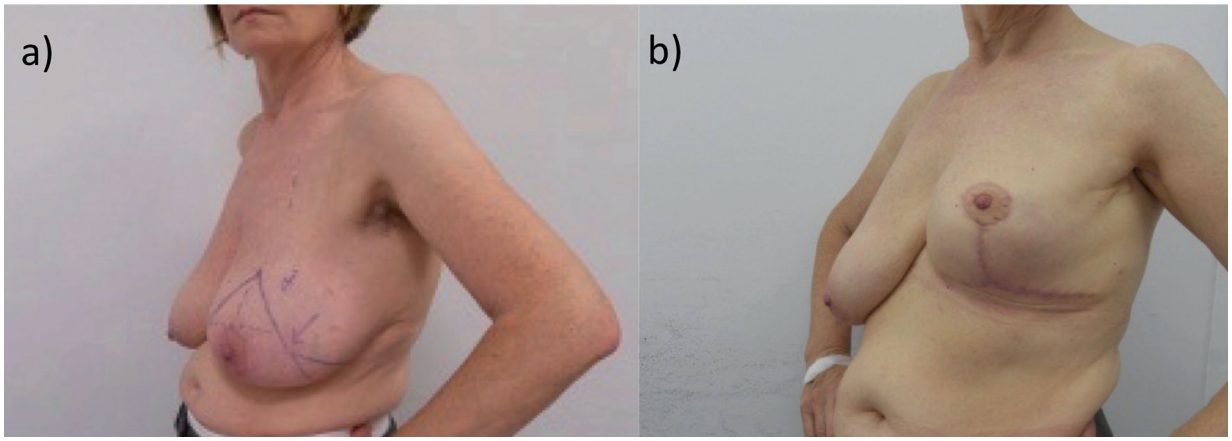

Figure 1. Picture ***a)*** shows the preoperative marking for an inverted-T wise pattern mastoplasty as the patient had a centrally located cancer of the left breast, which determined the excision of the nipple-areola complex too. Picture ***b)*** shows the patient in the ninth postoperative month after having undergone reconstruction of the nipple and areola tattooing.

ward displacement of the NAC would make the breast appear highly unnatural, and, therefore, the SN-N distance should never be less than 16 cm[79]. Both batwing and donut mastopexy also provide outstanding results for BC located in the upper and lateral quadrants. Round-block mastopexy can easily be performed on tumors in any location; however, it is most suitable for upper-pole tumors that are close to the areola and mildly ptotic breasts that can be aesthetically improved after a mastopexy[48]. Indeed, once the two concentric periareolar incisions are made and the intervening skin is de-epithelized, the skin envelope can be undermined starting from the outer incision line in any direction, in the same fashion as a subcutaneous mastectomy. The tumor and the surrounding tissue are excised from the subcutaneous plane to the pectoralis fascia, while the glandular flap from both sides is mobilized and advanced into the defect. The viability of the NAC is ensured as it is derived from the posterior glandular base. Moreover, the resulting periareolar scar stretching is lessened by a dual-layer closure with absorbable sutures, thus eliminating the need for a purse-string closure[66].

BC of the upper outer quadrant is associated with the best cosmetic outcome, since this is the most forgiving location; luckily, up to 60% of tumors occur in this region[71,80]. Racquet mammoplasty can be used to resect large sections of BC with a quadrantectomy-type incision made over the tumor from the NAC toward the axilla[81,82]. The periareolar skin is de-epithelized and the NAC is extensively undermined to relocate it to the center of the breast mound.

BC of the lower outer pole can be resected using a J-type mammoplasty that avoids lateral retraction of the breast and deviation of the NAC, which are usually associated with an inverted-T mammoplasty[83]. Similar to the V-mammoplasty, the J-type method uses a lateral and central glandular flap that is rotated towards the defect to redistribute the remaining tissue. The NAC is repositioned with a de-epithelialized superior pedicle. The final scar is in the shape of the letter J from the periareolar down to the inframammary crease.

Central and subareolar BC can be contraindications for BCT, since the NAC is involved in 50% of the cases[84]. Retro-areolar tumors or those closer than 2 cm to the nipple do not allow for preservation of the NAC that are usually removed *en bloc* with the tumor[85]. However, an inverted T, a modified Lejour or a J-closure pattern, similar to breast amputation reduction techniques, can all provide good aesthetic outcomes[85-87]. The NAC is eventually reconstructed using a local flap of choice and subsequently tattooed[88]. When the cancer is located superiorly or laterally, an elliptical skin excision centered on the NAC can also be performed, and similar surgery may be required for the contralateral breast. However, the inverted-T Wise pattern mastectomy tends to have better cosmetic outcomes as some amount of breast projection is retained; in contrast, the purse-string and transverse-scar techniques tend to flatten the breast mound[85,87] (Figure 2).

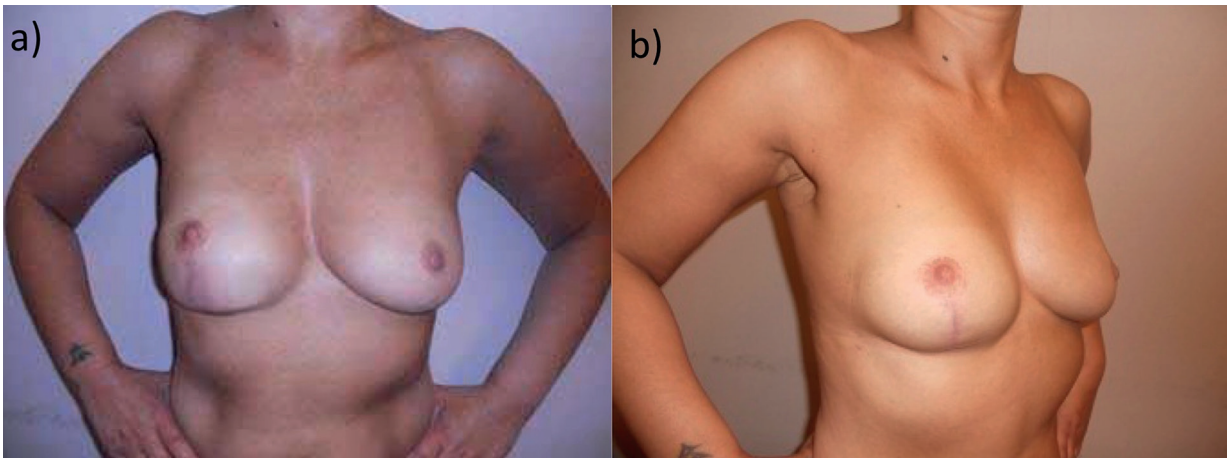

Figure 2. Postoperative picture after 6 months of a patient that has undergone inverted-T wise pattern mastoplasty for a lower pole cancer of the right breast.

Volume-Replacement Technique

Large tumors, high tumor/breast volume ratio and small breasts are often associated with defects that are difficult to reconstruct with volume-displacement techniques[89]. Indeed, in such cases the residual breast tissue is usually insufficient for proper rearrangement after a partial mastectomy, and the patient may require reconstruction using autologous local or distant flaps. Thus, volume-replacement techniques are used for the reconstruction of relatively small breasts with a large resection volume[44]. Furthermore, with the volume-replacement technique, remodeling of the contralateral breast is usually not required to achieve symmetry. The use of fascio-cutaneous flaps, myo-cutaneous local flaps, pedicled perforator flaps and even free flaps has been described for partial breast reconstruction[48].

Local fascio-cutaneous flaps can be employed in the case of small lateral defects (<10% of the breast size). The use of transposition flaps from the subaxillary area was first reported by Clough et al[16]. Munhoz et al[90] have described the placement of the lateral thoracodorsal flap (LTDF), which is ideal for lateral defects, especially in obese patients. These are essentially fascio-cutaneous flaps that rotate or transfer the skin and the subcutaneous fat of the subaxillary area to fill the breast parenchyma into the defect. Lower quadrant resection near the IMF in small-/moderate-sized breasts can be filled with a fascio-cutaneous flap harvested from below the IMF and then rotated to fill the defect created by the segmental excision[91].

Flap survival and aesthetic outcome are ensured by a careful flap design. When the defect ranges from 10% to 30% of the breast volume, a pedicled musculocutaneous flap can be harvested. The latissimus dorsi (LD) musculocutaneous flap represents a common local option[92,93]. This flap uses the LD muscle and overlying skin to fill lateral, central, inferior and even medial defects. The LD is separated from its insertions and pivoted under the axilla while preserving excellent blood supply via its vascular pedicle[94]. An LD myo-subcutaneous flap can be harvested with the help of an endoscope when the skin overlying the tumor needs to be preserved in order to avoid a scar on the back[95]. An LD musculocutaneous flap should have larger dimensions than the defect it is used to fill. Indeed, the LD muscle usually undergoes postoperative atrophy as a consequence of the surgical de-innervation and radiotherapy. Therefore, a much larger flap than needed must be harvested in order to avoid unsatisfactory results caused by the expected loss of muscle volume (Figure 3).

The pedicled perforator flap technique has an advantage over other methods of autologous breast reconstruction, as it uses well-vascularized tissues and spares the underlying muscles, which results in lower donor site morbidity in terms of muscle function and seroma formation[96]. According to the pedicle length, perforator flaps can be used to manage defects in almost every quadrant. Intercostal, thoracodorsal and superior epigastric arteries are the main pedicles that the perforator flaps can be based on[97]. The fascio-cutaneous skin paddle of the classical LD musculocutaneous flap can be raised as a pedicled perforator flap from either the thoracodorsal or intercostal vessels and used to cover lateral, central, inferior defects[98].

The thoraco-dorsal artery perforator (TDAP) flap is based on the vertical branch of the thoracodorsal artery; it can be easily used for filling in lateral, superolateral and central defects of the breast. If no suitable perforators are found, the flap can be easily converted to a muscle-sparing TDAP or muscle-sparing LD flap[99]. Either the anterior or the lateral branches of the intercostal arteries are suitable for harvesting local perforator flaps. Lateral and inferior defects of the breast can be reconstructed with the lateral intercostal artery perforator (LICAP) flap, while inferior or medial defects can be reconstructed with the anterior intercostal artery perforator (AICAP) flap[1]. Perforators of the LICAP flap are usually found 2.7-3.5 cm from the anterior border of the

Figure 3. Latissimus dorsi musculocutaneous flap elevated on its main supplying pedicle: thoracodorsal nerve, thoracodorsal artery (branch of the subscapular artery) and vein.

LD muscle, while those of the AICAP flap pierce through the rectus abdominis or the external oblique muscles[100]. The superior epigastric artery perforator (SEAP) flap can be harvested as an alternative to the AICAP flap since both share the same indications[101]. However, the SEAP flap can cover more remote defects in the breast as it has a longer pedicle provided by perforators arising from the superior epigastric artery or its superficial branch.

If the defect is large and medially located or the residual breast tissue after a partial mastectomy is minimal, mastectomy and subsequent autologous free-flap breast reconstruction may have the best cosmetic and oncological outcomes[102,103]. Other less common volume-replacement techniques are adipofascial flap placement, omental flap placement, and autologous fat graft (AFG)[104-107]. Autologous fat grafting (AFG) is also a secondary procedure that can ameliorate any residual contour deformities and asymmetry with the contralateral breast[108]. Owing to the presence of the so-called adipose-derived stem cells (ASCs), AFG displays regenerative and therapeutic properties[109,110]. ASCs can differentiate into multiple cell lineages and secrete paracrine factors[111-115]. Thus, angiogenesis and wound healing are strongly enhanced, leading to higher fat graft survival as well as dermal and subcutaneous tissue regeneration[116,117]. Moreover, AFG has positive effects in radio-induced damage of the soft tissues in reconstructed breasts[118,119]. Indeed, ASCs can thicken the subcutaneous tissue, and improve the texture of the irradiated skin by enhancing its vascular supply through the ASCs regenerative potential[104].

Outcome

The aesthetic outcome of BCT is unsatisfactory in 30% of patients, while the cosmetic failure rate of OBS is 0-18%[120]. Moreover, when BCT is implemented with the OBS technique, the failure rate drops to < 7% at 2 years[121]. Losken et al reported that the aesthetic results were good at 1 year (97.7%) and at 5 years (90.3%) in a series of 540 consecutive cases of patients with high tumor/breast volume ratios[122]. Age, BMI, size and location of the tumor, breast size, and the adjuvant treatment applied can affect the final cosmetic outcome[28]. The aesthetic results in a reported study were analyzed by means of patients' self-evaluated questionnaires or subjective scales completed by specialists[123,124]. It emerged that young patients at high social and economic levels have lower satisfaction rates[125,126]. Moreover, it appears that patients' evaluations are usually better than those of the specialists, and the interobserver agreement rate of specialists is often very low[28,127].

Studies have reported that the average complication rates (16%) associated with OBS are acceptable[28]. The common complications following volume-displacement techniques are delayed wound healing (3-15%), fat necrosis (3-10%), and infection (1-5%), which are similar to the complications associated with volume-replacement techniques, although the overall rate is slightly higher (range, 2-77%)[41,47,90]. This is probably due to additional donor site complications and potential flap loss issues[92,128]. Nevertheless, both volume-displacement and volume-replacement approaches share the same delayed complications: breast fibrosis and asymmetry.

Safety

Given the wider excision margin with OBS, the local control and oncological safety of OBS should be better than that of BCT. Based on reports in the literature, in OBS, the tumor size is usually larger (2.7 *vs*. 1.2 cm) and the specimen weight is four times higher than that with BCT[129]. Accordingly, the tumor-positive margin rate is significantly lower after OBS (12% *vs*. 21%) and the re-excision is more common when only BCT is performed (14.6% *vs*. 4%). Despite this, completion mastectomy is more common after OBS than after BCT (6.5% *vs*. 3.79%). The local recurrence rate after OBS and BCT is 4% and 7%, respectively, while the average follow-up period is reported to be longer in BCT (64 *vs*. 37 months). Losken et al[122] reported that the overall survival rate and 5-year recurrence rate after OBS are 92.9% and 6.8%, respectively.

One of the main concerns with OBS is that parenchymal manipulation, scar tissue and fat necrosis, which are a consequence of surgery, may impair the ability to adequately screen for tumor recurrence[122]. However, physical examination, radiologic imaging, and tissue sampling can overcome this issue. Indeed, mammographic sensitivity does not seem to be affected, and the qualitative changes observed are similar to those observed after BCT. However, the time required to achieve mammographic stability after OBS tends to be longer (25.6 months *vs*. 21.2 months)[130,131]. Changes and mammograms

should be compared carefully over time, while ultrasound and MRI can be used to complete the diagnostic process. Fine-needle aspiration, core-needle biopsy, or surgical biopsy can be performed to rule out malignancy. Of the patients who have undergone OBS, 53% require tissue sampling procedures, while only 13% of patients who have undergone BCT require these investigations[122].

Conclusions

The primary aim of OBS is oncological safety, which is always more important than the aesthetic outcome, although the main purpose of OBS stems from a desire to improve the cosmetic outcome of BCT. Besides ameliorating the aesthetic outcomes, OBS allows for wider resections (even involving 50% of the breast volume without causing deformity), which should ensure better local control of the disease. Furthermore, the breast size is usually smaller after OBS; thus, it has a positive impact on radiotherapy planning by reducing the dosage required[54]. OBS has been defined as an oncologic-aesthetic-functional individualized surgical approach because it can improve the general indications for BCT without compromising on the aesthetics or the oncological outcomes[18].

Patients are more worried about deformities than a mismatch in the size of their breasts or scar length[132]. Therefore, the aim of OBS is to reshape the remaining breast gland while maintaining an aesthetically pleasant shape and contours. Indeed, contralateral surgeries are often performed to achieve symmetry. OBS can also prevent NAC displacement by anticipating possible NAC deviation and repositioning it at the center of the breast mound. Future studies need to further validate the oncological safety of OBS and provide surgeons with adequate preoperative tools to better plan the resection and reconstructive steps. Although OBS is more complicated and time-consuming than the conventional BCT approach and has better oncological outcomes and satisfaction rates, breast surgeons should be also trained in plastic surgery or should at least collaborate with plastic surgeons when performing OBS.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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