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Preventing Bird's Beak Deformity: A Narrative Review of Innovations in Oncoplastic Surgery

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ABSTRACT

Background: In the field of breast surgery, breast conserving surgery (BCS) is widely valued for its ability to preserve the breast while also achieving cosmetically acceptable outcomes and an overall survival rate comparable to that of total mastectomy. However, BCS has not always managed to achieved satisfactory cosmetic results. Among its challenges is the "bird's beak" deformity, which is characterized by skin retraction and a downward deviation of the nipple areolar complex due to tissue excision from the lower pole of the breast.

Methods and Results: Various forms of oncoplastic surgery (OPS) have been developed to prevent bird's beak deformity. These include volume displacement operations (such as superior pedicle mammoplasty, rotation technique and downward-mobilization procedure), as well as volume replacement techniques, including the latissimus dorsi mini-flap, thoracodorsal artery perforator flap, lateral intercostal artery perforator flap, anterior intercostal artery perforator flap, inframammary adipofascial flap and lipofilling.

Conclusion: Choosing the most suitable approach for OPS depends on careful consideration of different factors, notably the size and location of the defect, the size of the breast, and the thickness of subcutaneous fatty tissue. Future studies are needed to firmly position these forms of OPS techniques in an evidence-based framework.

INTRODUCTION

Breast conserving surgery (BCS) is a well-established standard of care for patients with early breast cancer. The surgery is widely valued for its ability to preserve the breasts while still providing cosmetic outcomes that are acceptable to most patients and a general survival rate comparable to that of total mastectomy. However, BCS has not always achieved satisfactory cosmetic results : 20-30% of patients experience a breast deformity after BCS.1 In recent years, a large number of women are dissatisfied with the appearance of their breast after a traditional BCS.2 As the BCS procedure gained prevalence, breast surgeons began to recognize that BCS may cause breast deformities worse than those seen with total mastectomy with postoperative breast reconstruction.3 Two primary factors that influence the likelihood of unsatisfactory cosmetic results following BCS are tumor-to-breast volume ratio and tumor location.4 Specifically, the likelihood of breast deformity increases when 20% or more of the breast tissue is removed5 or when the tumor is in either the upper inner quadrant or lower pole of the breast.6 The lower pole of the breast, in particular, is known as a high-risk area for breast deformity, even in cases where less than 20% of the breast tissue is removed. One deformity that has posed significant challenges

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to obtaining satisfactory cosmetic results is known as "bird's beak" deformity. It is characterized by skin retraction and a downward deviation of the nipple-areolar complex (NAC) resulting from tissue excision in the lower pole of the breast.[6-8] In response, oncoplastic surgery (OPS) has been developed as an intermediary solution that bridges the gap between conventional BCS and mastectomy.[9-11] There are various forms of OPS to avoid bird's beak deformity occurring after BCS. The approach principally involves immediate partial reconstruction of the breast defect either through volume displacement or replacement procedures. This article reviews OPS techniques used for preventing bird's beak deformity and discusses the feasibility of volume displacement and replacement in achieving favorable cosmetic outcomes.

Volume displacement vs. volume replacement

The term "oncoplastic surgery (OPS)" was introduced and conceptualized in 1993 by a German Gynecologist, Audretsch *et al.*[9] as a procedure to avoid total mastectomy by combining wide excision with partial breast reconstruction. Thus, "OPS" initially focused on breast conservation. In 2019, the American Society of Breast Surgeons defined OPS as a form of BCS "incorporating an oncologic partial mastectomy with ipsilateral defect repair using volume displacement or replacement techniques with contralateral symmetry surgery as appropriate".[12] Immediate partial breast reconstruction through volume displacement entails using the patient's remaining breast tissue to fill in the area of defect caused by partial mastectomy, whereas volume replacement, involves transposing autologous tissue from other parts of the patient's body.[10] Interestingly, even before the formal introduction of the term "OPS" by Audretsch *et al.*[9], volume displacement was already in practice by French plastic surgeons[8] and volume replacement was being performed by Japanese breast surgeons.[13,14] Volume displacement techniques used to prevent bird's beak deformity include superior pedicle mammoplasty, rotation technique, and downward-moving procedure. Volume replacement options include the latissimus dorsi (LD) mini-flap, thoracodorsal artery perforator (TDAP) flap, lateral or anterior intercostal artery perforator (ICAP) flap, inframammary adipofascial flap, and lipofilling. Volume replacement is usually indicated when 20% or more of the breast tissue has been removed.

Volume displacement

Superior pedicle mammoplasty

Developed by Clough *et al.*, superior pedicle mammoplasty with inverted T skin scar is a technique that can mitigate the risk of bird's beak deformity occurring.[7,8,15,16] The procedure involves a number of steps as follows.[16] It begins with deepithelialization of the area surrounding the nipple-areolar complex (NAC) and an inframammary skin incision (Figure 1a). Then, the breast tissue is detached from the pectoralis fascia through an inframammary incision (Figure 1b), and the NAC is raised on a superior based flap (Figure 1c). The tumor is removed *en bloc* with at least a 1-cm macroscopic margin of the normal tissue, the overlying skin, and the tissue excised for remodeling procedure (Figure 1d). After resection is completed, the breast tissue is reapproximated to repair the breast defect, followed by NAC recentralization (Figure 1e). The contralateral breast is made symmetrical during the procedure.

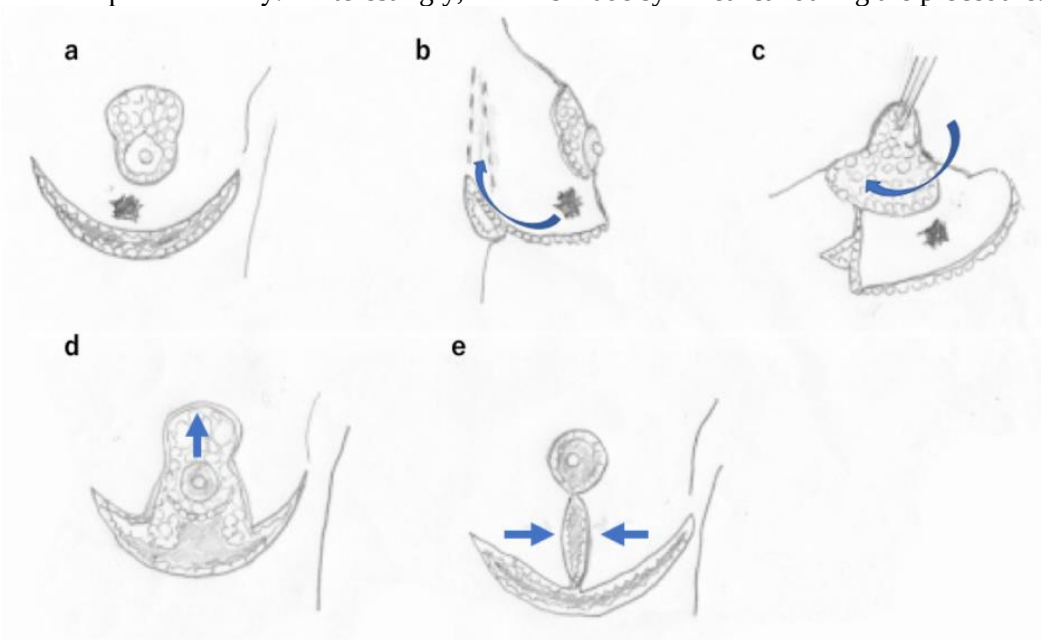

Figure 1. Superior pedicle mammoplasty

Superior pedicle mammoplasty is regarded as the standard method for performing volume displacement in OPS. However, it is important to note that this technique is less suitable for patients with small or medium-sized breasts due to the constraints posed by limited tissue availability.[17,18] Furthermore, the technique involves NAC transposition with a single dermal pedicle. This poses the risk of ischemia, potentially resulting in partial or total necrosis of the NAC.[19] Challenges may also arise when surgical margins are involved and require re-excision. In such cases, total mastectomy is usually unavoidable as the limited volume of remaining breast tissue precludes any further resection without causing major deformity.[15]

Rotation technique

Rotation flap using the Burow's triangle (Rotation technique) is a procedure that has been developed to improve cosmetic outcomes for patients with lower pole breast cancers.[20] The Rotation technique has been described as follows.[20] Following segmentectomy or quadrantectomy, a long S-shaped or reverse S-shaped incision is made from the axilla to the tumor site along the anterior axillary line and inframammary fold (IMF) (Figure 2a). A triangular section of the axillary skin (Burow's triangle) is removed along with the underlying axillary fat in order to reduce tension on the breast (Figure 2b). The breast tissue is then detached from the pectoralis muscle, allowing it to be positioned to close the breast defect. Arrows are drawn to indicate the direction of the skin movement along the long incision line (Figure 2b). Once the breast tissue and additional fatty tissue of the lateral chest wall have been appropriately mobilized, the breast defect is closed at the mid-point of the parenchymal thickness (Figure 2c). Although this procedure requires a relatively long skin incision, there is usually no deviation of the NAC. However, when the tumor is located near the NAC, this procedure may result in NAC displacement towards the tumor. Additionally, it is not easy to design a triangle above the mass that avoids invading the NAC.[21]

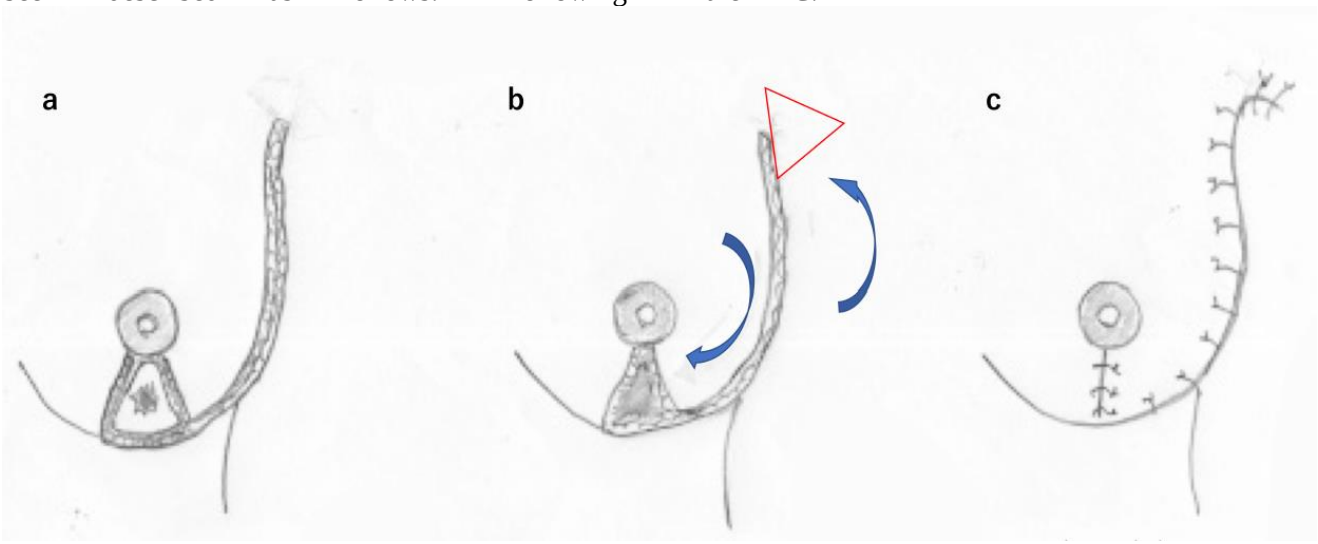

Figure 2. Rotation flap using the Burow's triangle (Rotation technique)

Downward-mobilization procedure

Developed by Noguchi *et al.*, the downward-mobilization procedure is specifically designed for patients with lower pole breast cancer.[22,23] In the literature, the procedure has been described as follows. First, a wide excision with a 1-cm macroscopic margin of normal margin is performed through an inframammary skin incision (Figure 3a). Next, a skin flap with a 0.5-cm thick layer of subcutaneous fat is carefully developed, and the retroareolar breast tissue is detached from the NAC to facilitate maximal mobilization of the breast tissue (Figure 3b). Breast tissue from the upper pole is then mobilized downward to fill in the breast defect, and is sutured to the inframammary fatty tissue (Figure 3c). Although the volume of the remaining breast tissue is limited in the lower pole after BCS, a substantial volume of breast tissue from the upper pole is still available to fill in the breast defect. In this procedure, parenchymal blood flow through perforators is maintained, as the breast tissue remains attached to the underlying pectoral fascia. Moreover, there is no deviation of the NAC, so neither NAC transposition nor contralateral symmetrization is required. However, it is important to recognize that the efficacy of the downward-mobilization procedure, as a volume displacement technique, depends on the availability of sufficient breast tissue in the upper pole, which can be limited. As a result, this approach is indicated in cases where less than 20% of the breast tissue is excised.

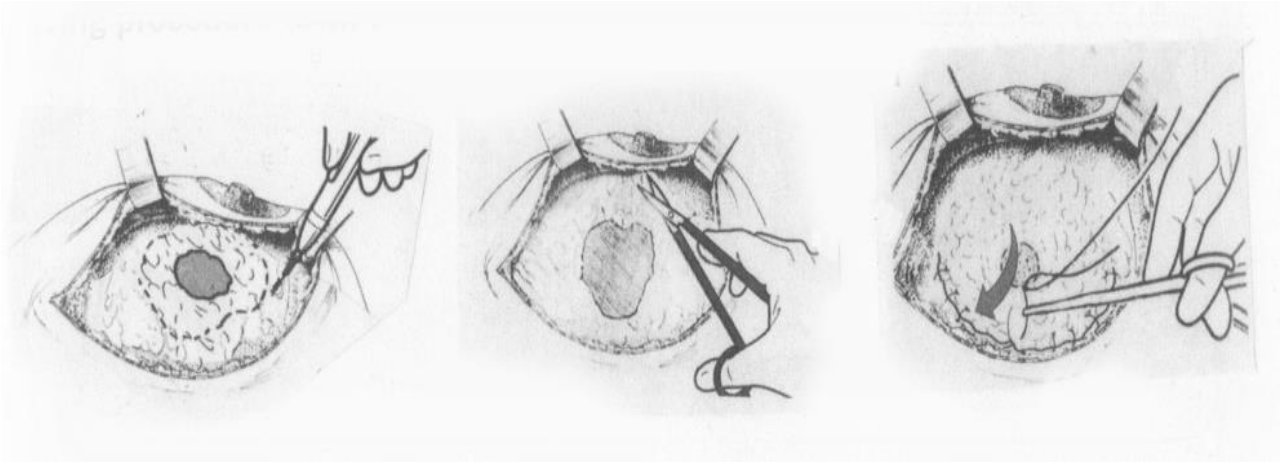

Figure 3. Downward-moving procedure

Volume replacement

Latissimus dorsi (LD) mini-flap

Quadrantectomy with immediate partial reconstruction using the LD myo-subcutaneous flap is a volume replacement procedure developed by Noguchi *et al.*[13,14,24] The procedure, initially detailed in a previous study[25], involves excising a small section of the skin and breast tissue overlying the tumor, and then extending the incision into the axilla for axillary lymph node dissection (ALND). After completing the quadrantectomy and ALND, a portion of the LD muscle and its subcutaneous adipose tissue is carefully dissected, preserving the thoracodorsal artery, vein, and nerve. This dissected section of the LD muscle and adipose tissue is then transposed to the anterior chest to fill in the space left by the excised breast tissue. This procedure marked the first instance of using volume replacement to prevent breast deformity post-quadrantectomy, as opposed to performing delayed breast reconstruction.[10] Raja *et al.*[26] and Rainsbury *et al.*[27,28] subsequently adapted the procedure, implementing a wide excision by a lazy S-shaped incision that extends from the apex of the axilla to the IMF, regardless of the tumor's location in the breast. The LD myo-subcutaneous flap (which they termed the "LD mini-flap") is transposed as reported by Noguchi *et al.*[13,14] This technique can be performed to reconstruct post-quadrantectomy defects in the breast's lower pole[26,29,30] (Figure 4a, b), but it obtains better results in cases where the tumor is located in the upper outer quadrant. The LD mini-flap allows for an excellent blood supply and provides sufficient fatty tissue and muscle to fill the breast defect. It suits patients with small-to-medium-sized breasts. In addition, transposition of the LD mini-flap does not complicate postoperative mammograms, as the transferred muscle and fatty tissue are radiolucent. However, it is recommended that the initial muscle harvest be approximately 30% greater than the volume of the resected breast tissue to account for some degree of expected muscle atrophy.[31] Despite its benefits, some practitioners suggest reserving the LD flap as a rescue option for cases where complications or recurrences arise.[15,32,33] Over time, volume replacement techniques have evolved from using the LD muscle to now also employing perforator flaps.

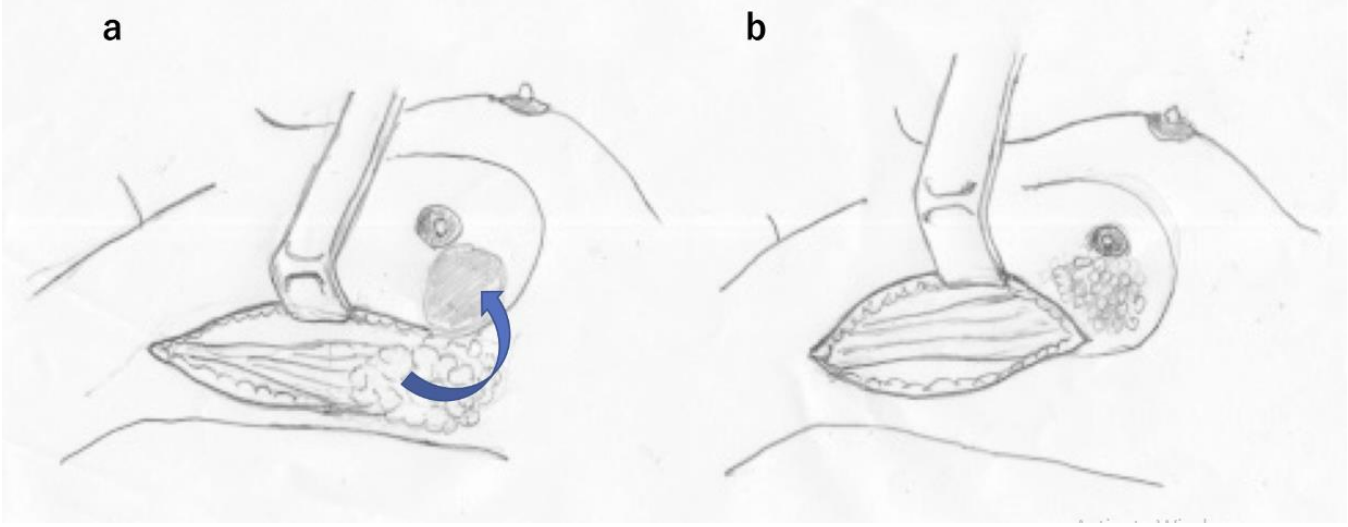

Figure 4. Latissimus dorsi (LD) mini-flap with adipose tissue

Perforator flaps

Perforator flaps use tissue supplied by perforating vessels stemming from a deep vascular system that extends through the underlying muscles or intermuscular septa. This form of reconstructive surgery includes the thoracodorsal artery perforator (TDAP) flap[34,35] and anterior intercostal artery perforator (AICAP) flap[34,36], both of which were initially introduced by Hamdi *et al.*[34] The use of perforator flaps has enhanced the range of indications for BCS, filling defects in all quadrants, reducing mastectomy rates and the associated revision and symmetrizing procedures.[37]

TDAP Flap

The TDAP flap utilizes perforators originating from the descending branch of the thoracodorsal artery. In the literature, the procedure has been described as follows.[38] Preoperatively, the TDAP is located and marked on the skin using Doppler ultrasonography. Donor skin markings are then made to delineate the permissible dimensions of the skin paddle based on the anticipated flap volume needed. The incision at the donor site is strategically performed to ensure that the resultant scar can be concealed under a bra strap (Figure 5a). A subcutaneous tunnel is then created between the anterior border of the LD muscle and the defect. The flap is passed through this tunnel and then transposed onto the lower pole breast defect (Figure 5b). As a surgical technique, the TDAP flap constitutes a minimally invasive evolution of the LD flap, enabling the preservation of the LD muscle and reduced donor site morbidity.[35,39] Nonetheless, complications with the procedure have been reported, the most common of which is partial flap necrosis, particularly at the edge farthest from the perforator vessel.[35] Due to its complexity, this technique requires the expertise of specialized plastic surgeons.

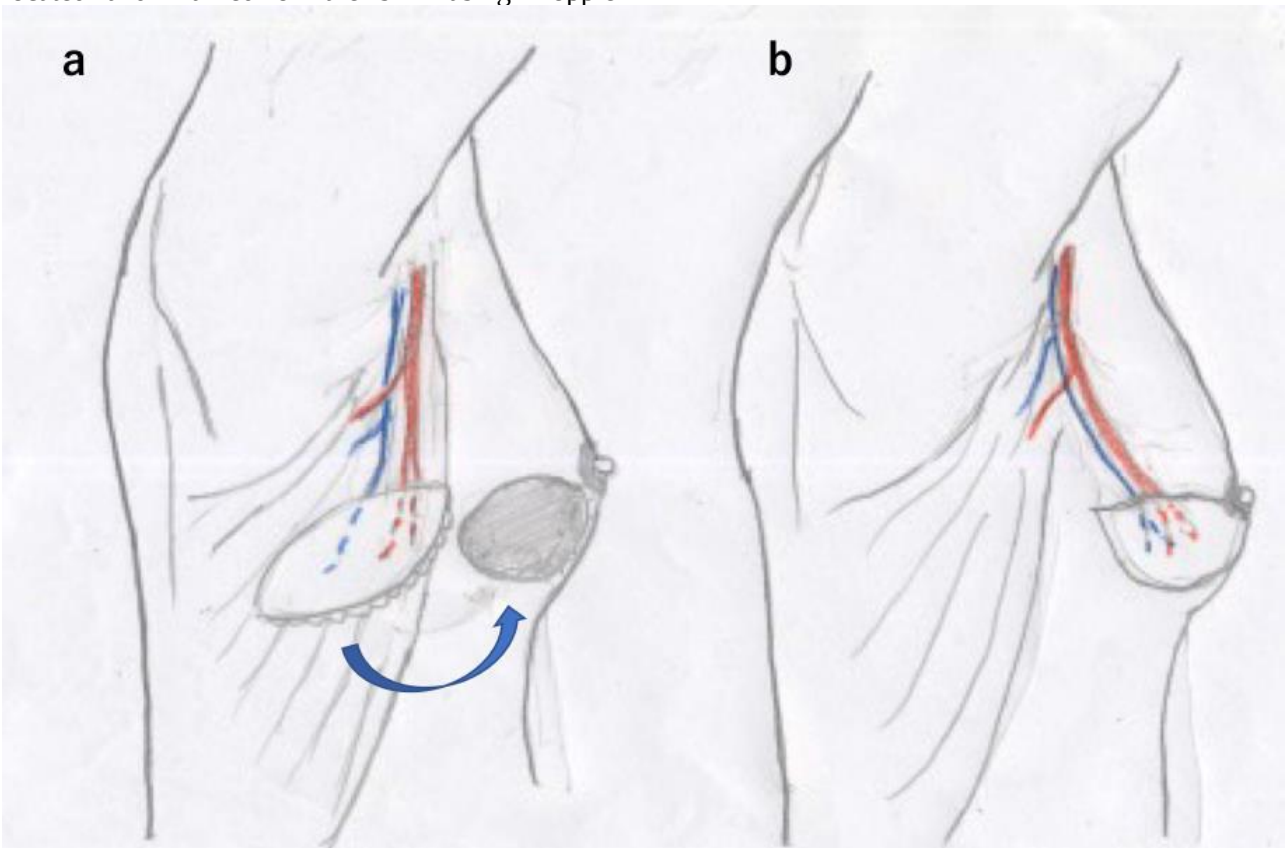

Figure 5. Thoracodorsal artery perforator (TDAP) flap

AICAP Flap

The AICAP flap is based on a perforator from the anterior intercostal artery. While it is a versatile flap, the use of AICAP is limited by the size of the defect. Recently, however, a modified crescenteric AICAP flap has been developed to better address breast reconstruction in patients with lower pole breast cancer and small to medium-sized, minimally ptotic breasts. The procedure has been described as follows.[36] The IMF is identified and marked, and Doppler ultrasonography is used to identify the appropriate perforator located within a 1-3cm lateral to the sternal border. The flap is then marked with the patient in an upright position, with the pedicle forming the center of the 3 limbs of the flap (medial extension, lateral extension and inferior extension). A crescent is marked in the same manner as is done for a traditional crescenteric AICAP flap. The superior

border is delineated by the curvature of the IMF (Figure 6a). Intraoperatively, the crescenteric section is de-epithelialized. The inferior extension is crafted from subcutaneous fat. The medial and lateral limbs of the crescent and inferior tongue are then raised, maintaining the pedicle (Figure 6b). Then, all three limbs of the flap are brought together and sutured to form a single body of tissue (Figure 6c). A new IMF is created and fixed at the level of the pedicle, slightly lower than the previous IMF position (Figure 6d). The inferior extension is a key aspect of the modified technique.

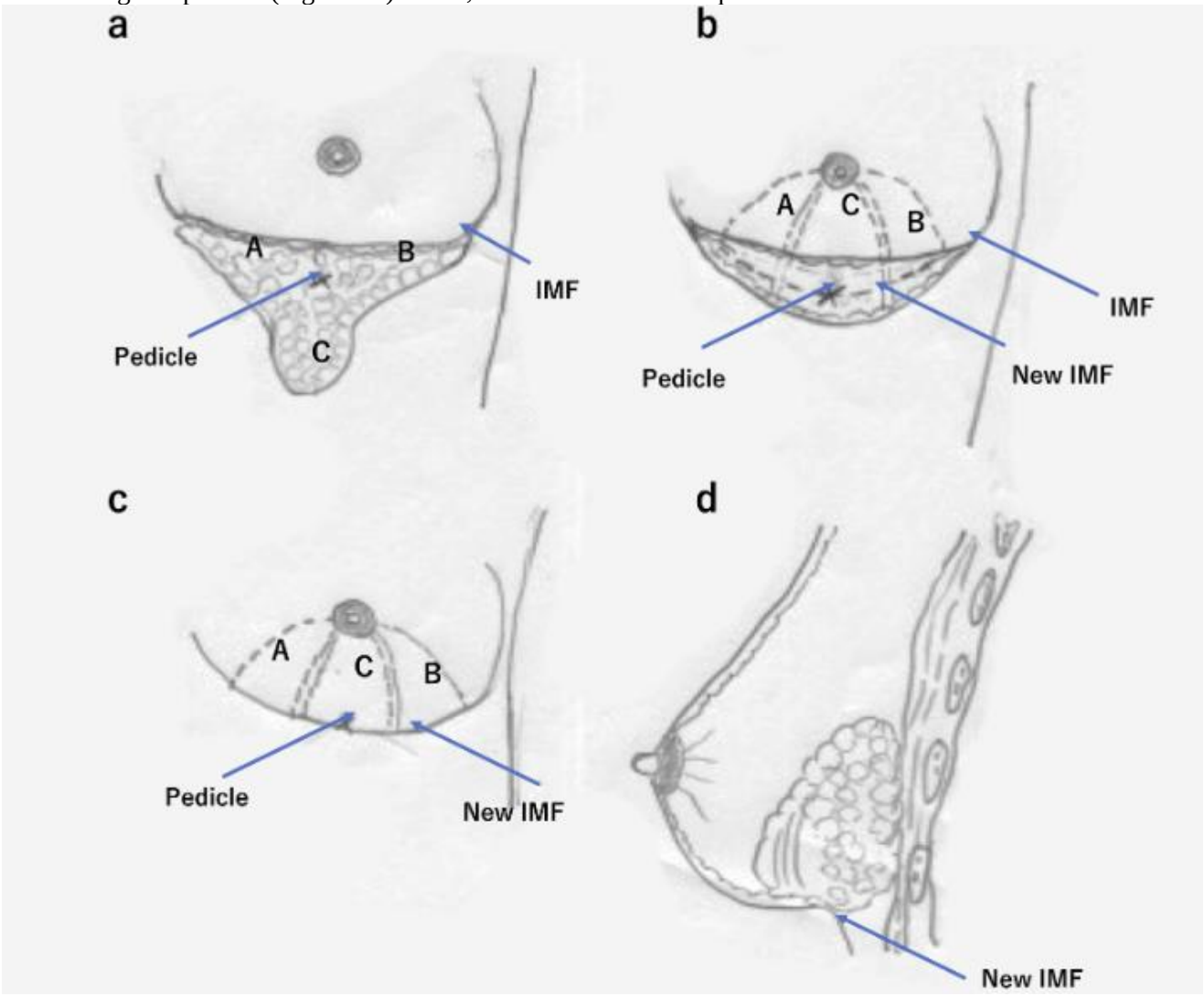

Figure 6. Anterior intercostal artery perforator (AICAP) flap

A: Medial extension, B: Lateral extension, C: Inferior extension, IMF: Inframammary fold

Inframammary adipofascial flap

The inframammary adipofascial (anterior rectus sheath) flap, conceived by Sakai *et al.*, was originally developed for breast reconstruction after a subcutaneous mastectomy.[40] The technique was later adapted to repair defects in the lower pole of the breast following BCS.[41,42] The procedure has been described as follows.[41] First, a skin incision is made along the inframammary line. Following BCS, the skin of the intended inframammary area is undermined in the subcutaneous fat plane at a depth of 3 or 4mm (Figure 7a). This undermining extends down along the chest to a length of 7 cm from the original IMF skin incision, preparing the area for the creation of a flap. The subcutaneous fatty tissue and the anterior sheath of the rectus abdominis muscle are then cut following a parabolic contour to form a tongue-shaped flap. Using forceps, the tip of the tongue-shaped flap is lifted, and the edge adjoining the anterior sheath is cut, releasing the flap from the rectus abdominis muscle. Then, the flap is folded back and placed in the cavity left by the surgery. The elevated flap is positioned and adjusted further to adequately fill the size and shape of the defect (Figure 7b). It is recommended that the flap be approximately 30% greater in volume than the defect to account for the atrophy of the flap that will occur over time. While the technique has demonstrated success, it is still constrained by the availability of fatty tissue in

the target area. For some patients, it may be difficult to harvest a sufficient volume of fatty tissue to refill the breast defect.[43,44] The technique may also carry a risk of fat necrosis as a delayed complication.[44,45]

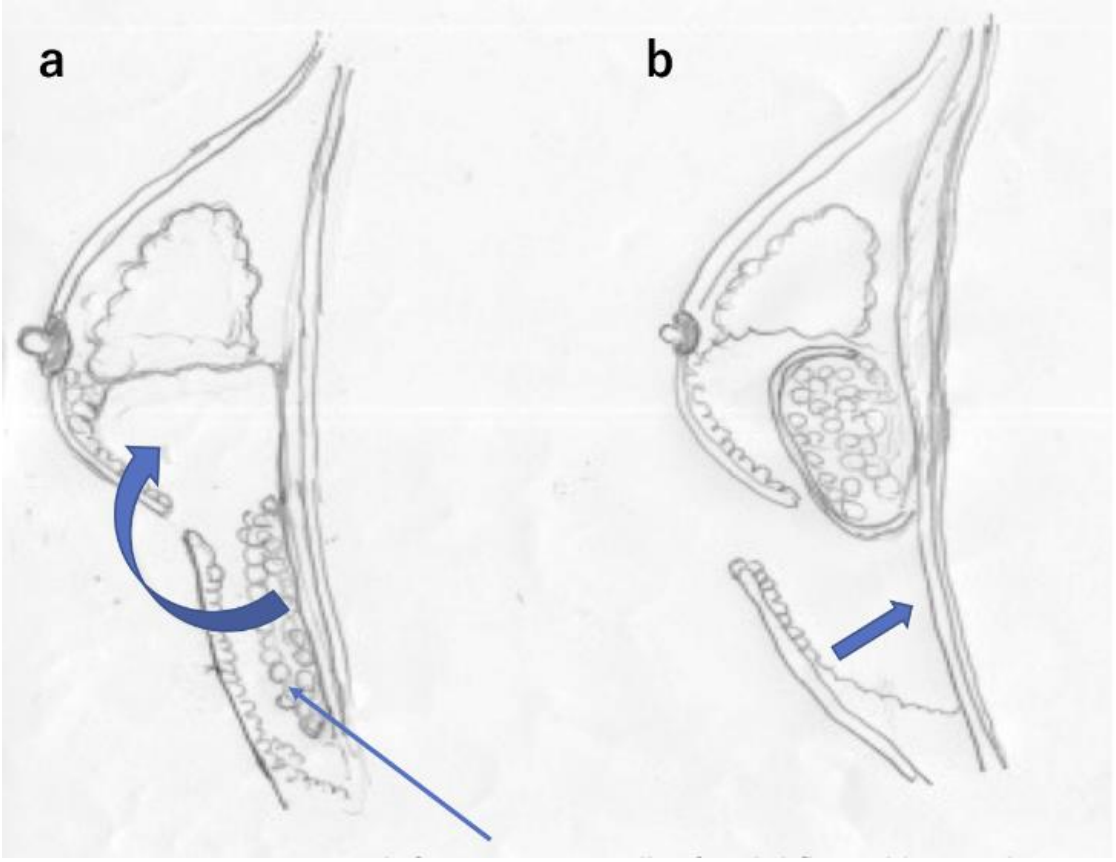

Figure 7. Inframammary adipofascial flap

Lipofilling

Lipofilling has been used for immediate reconstruction to improve poor cosmetic results after BCS. However, performing lipofilling directly into the cavity resulting from the lumpectomy or quadrantectomy is not recommended due to the risk of abscess formation, reabsorption of fat, or the need for external drainage. Immediately injecting fat into a lumpectomy cavity without proven negative margins is also not recommended as stem cells from the injected fat could interact with residual cancerous cells at the positive margins, posing a significant oncological risk.[46] Consequently, it is recommended that lipofilling be performed in the subcutaneous and intraglandular breast tissue around the breast defect rather than directly into the post-surgical cavity.[47] In their matched retrospective cohort study, Stumpf *et al.*[43] reported no significant differences in locoregional recurrence rates or disease-free survival rates between patients who received immediate autologous lipofilling post-BCS and those who underwent BCS alone. However, it should be noted that tumor location was not specified in their study. In fact, there have been few reports of BCS with immediate lipofilling in lower pole breast cancer.[48]

The OPS is originally an oncoplastic breast conserving surgery: partial mastectomy followed by immediate partial breast reconstruction.[9]

CONCLUSION

An indication of OPS has been decided during BCS by breast surgeons or gynecologists. In practice, breast or gynecologic surgeons have performed BCS, and plastic surgeon have subsequently performed plastic surgery. Alternatively, specially trained oncoplastic surgeons have performed OPS. Choosing the most suitable approach for OPS requires careful consideration of various factors, notably the size and location of the defect, the size of the breast, and the thickness of subcutaneous fatty tissue. Moreover, the affected breast may need to undergo adjuvant breast radiotherapy which could affect the final post radiotherapy shape and volume. At present, however, there are few studies comparing the results of the techniques for preventing Bird's Beak deformity. Further studies are required to firmly position these forms of OPS techniques in an evidence-based framework.

CONFLICT OF INTEREST

The authors have no potential conflicts of interest.

ETHICAL CONSIDERATIONS

Not applicable.

DATA AVAILABILITY

The data is available from the corresponding author on request.

FUNDING

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CONFLICT OF INTEREST

The authors declare no confilict of interest for this article.

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