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Oncoplastic Surgery in Breast Cancer: Indications and Principles

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Abstract:

Breast-conserving surgery represents a cornerstone in the management of early-stage breast cancer; however, conventional techniques may result in suboptimal cosmetic outcomes, particularly in patients with large tumors, unfavorable tumor-to-breast ratios, or tumors located in cosmetically sensitive areas. Oncoplastic breast surgery (OBS) has emerged as an integrative approach that combines oncologic safety with plastic and reconstructive principles, allowing wider tumor excision while preserving or improving breast aesthetics. OBS enables optimal margin clearance, reduces re-excision rates, and enhances patient satisfaction and quality of life without compromising oncological outcomes. The appropriate application of OBS requires careful patient selection, accurate preoperative planning, and a thorough understanding of both oncologic and reconstructive principles. This review aims to highlight the main indications, classifications, and fundamental principles of oncoplastic surgery in breast cancer management, with emphasis on surgical planning, oncologic safety, and aesthetic outcomes.

Keywords: Oncoplastic surgery; Breast cancer; Breast-conserving surgery; Surgical margins; Cosmetic outcome.

Introduction:

Oncoplastic surgery (OPS) has emerged as a new approach to allow wide excision for BCS without compromising the natural shape of the breast. It is based upon integration of plastic surgery techniques for immediate breast reshaping after wide excision for breast cancer. The conceptual idea of OPS is not new, and its oncologic efficacy in terms of margin status and recurrence compare favorably with traditional BCS (**Youssef et al., 2018).**

Oncoplastic techniques for breast conservation range from simple reshaping and mobilization of breast tissue to more advanced mammoplasty techniques that allow resection of up to 50% of the breast volume. The goal is to develop a clear classification system of oncoplastic techniques and outline a systematic approach for all breast surgeons to follow when undertaking BCS (**van la Parra et al., 2019).**

Indications for Oncoplastic Surgery:

The main indication for OPS is large lesions for which a standard excision with safe margins would either seem impossible or lead to a major deformity. Extensive ductal carcinoma in situ (DCIS), lobular carcinoma, multifocality, and partial or poor responses to neoadjuvant treatment are all potential indications for OPS intervention. Standard BCS that results in positive margins constitutes an additional category of patients. Oncoplastic Validation Oncoplastic surgery is fully integrated into a multidisciplinary environment. Pre- and postoperative treatments are not modified. During surgery, the original tumor bed is clipped, allowing precise localization for postoperative radiotherapy (**Douvetzemis and Kovacs, 2020).**

Oncoplastic Principles: Selection Criteria:

Elements for Selection:

Rainsbury et al. (2007) identified three elements to select patients who would benefit from an oncoplastic approach for BCS. The two factors already recognized as major indications for OPS are excision volume and tumor location. The third additional element they evaluate is glandular density. When taken into consideration together, these three elements comprise a sound guideline for determining when and what type of OPS to perform and, more importantly, to reduce the guesswork in performing BCS.

Excision Volume:

The first element, excision volume, is the single most predictive factor of surgical outcome and potential for breast deformity. Studies have suggested that, once 20% of the breast volume is excised, there is a clear risk of deformity. Excision volume compared to the total breast volume is estimated preoperatively. Through systematic determination of specimen weights, accurate preoperative estimation of excision volume can be achieved. The average specimen from BCS weighs 20–40 g; as a general rule 80 g of breast tissue is the maximum weight that can be removed from a medium-sized breast without resulting in deformity (**Nemes et al., 2012).**

Tumor Location

The location of the tumor is the second factor in planning OPS. There are zones that are at high risk of deformity during BCS when compared with more forgiving locations. The upper outer quadrant of the breast is a favorable location for large-volume excisions. In this location, defects can readily be corrected by mobilization of adjacent tissue. Excision from less favorable locations, such as the lower pole or upper inner quadrants of the breast, often creates a major risk for deformity. For example, a bird‘s beak‘‘ deformity is classically seen on excision of tumors from the lower pole of the breast. Therefore, a key tool used in planning the appropriate surgical approach is evaluating the tumor location and the associated risk of deformity. For extensive resections, **Clough et al., (2010)** have developed an oncoplastic Atlas of surgical techniques based on tumor location. This Atlas provides a specific mammoplasty technique for each segment of the breast (**Clough et al., 2010).**

Glandular Density:

Glandular density is the final component of a complete OPS evaluation before surgery and is evaluated both clinically and radiographically. Although the clinical exam is reliable, mammographic evaluation is a more reproducible approach for breast density determination. Breast density predicts the fatty composition of the breast and determines the ability to perform extensive breast undermining and reshaping without complications. Breast density can be classified into four categories based on the Breast Imaging Reporting and Data System (BIRADS): fatty (1), scattered fibroglandular (2), heterogeneously dense (3) or extremely dense breast tissue (4) (**Douvetzemis and Kovacs, 2020).**

Undermining the breast from both the skin and pectoralis muscle (dual-plane undermining) is a major requirement to perform level I OPS.A dense glandular breast (BIRADS 3/4) can easily be mobilized by dual-plane undermining without risk of necrosis. Low-density breast tissue with a major fatty composition (BIRADS 1/2) has a higher risk of fat necrosis after extensive undermining. Low breast density should provoke the decision to either limit the amount of undermining during level I OPS or proceed to a level II OPS that requires only posterior undermining, leaving the skin attached (**van la Parra et al., 2019).**

Oncoplastic Classification System:

Kaufman and Calhoun, (2022) propose a new classification of OPS techniques into two levels based upon the amount of tissue excised and the relative level of surgical difficulty. A level I approach is based on dual-plane undermining, including the nipple areola complex (NAC), and NAC recentralization if nipple deviation is anticipated. No skin excision is required. Level II techniques allow major volume resection. They encompass more complex procedures derived from breast reduction techniques. These therapeutic mammoplasties‘‘ involve extensive skin excision and breast reshaping. They result in a significantly smaller, rounder breast.

Bilevel Classification:

Bilevel classification system leads to a practical guide of OPS techniques. This guide allows for selection of the most appropriate OPS procedure during surgical planning.

I- If less than 20% of the breast volume is excised, a level I procedure is often adequate. These procedures can be performed by all breast surgeons without specific training in plastic surgery.

II- Anticipation of 20–50% breast volume excision will require a level II procedure with excision of excess skin to reshape the breast. They are based upon mammoplasty techniques and require specific training in OPS. (**van la Parra et al., 2019).**

General Considerations for all OPS Techniques and Patient Counseling:

Although oncoplastic procedures can provide high satisfaction with the final breast shape and in some situations may avoid the need for mastectomy, OPS may result in longer and multiple scars. The patient should be aware of the possible asymmetry caused by level II OPS. Because of the extensive resection, an asymmetry in volume is expected compared with the contralateral breast. This asymmetry may require immediate symmetrization of the contralateral side if desired by the patient, or can be performed as a second-stage procedure (**Kaufman, 2019).**

All oncoplastic procedures begin with the preoperative marking of the patient sitting in the upright position prior to induction of anesthesia. Once marked, both breasts are draped into the operative field for comparison. The patient is centered on the operating room table to accommodate both the supine and upright position, as she will be transitioned between these positions to allow optimal reshaping and symmetry. The patient is then secured into place with either arms extended, for access to the axilla, or both arms at the sides if no axillary surgery is needed (**Carlson et al., 2010).**

Step-By-Step Approach For Level I OPS:

There are six steps for level I OPS (Figs. 1, 2). They begin with skin incision (1) followed by undermining of the skin (2) and NAC (3). After completion of undermining, a full-thickness glandular excision is performed from the subcutaneous fat to the pectoralis fascia . The glandular defect is closed with tissue reapproximation . If required, an area in the shape of a crescent bordering the areola is deepithelialized and the NAC is repositioned (**van la Parra et al., 2019)**.

Oncoplastic surgery is based upon allowing wide excisions with free margins, not on minimizing incision length. Short incisions limit mobilization of the gland and do not permit creation of adequate glandular flaps to fill in excision defects. This effective mobilization of the gland is a key component of breast reshaping after wide excisions (**Noguchi et al., 2016).**

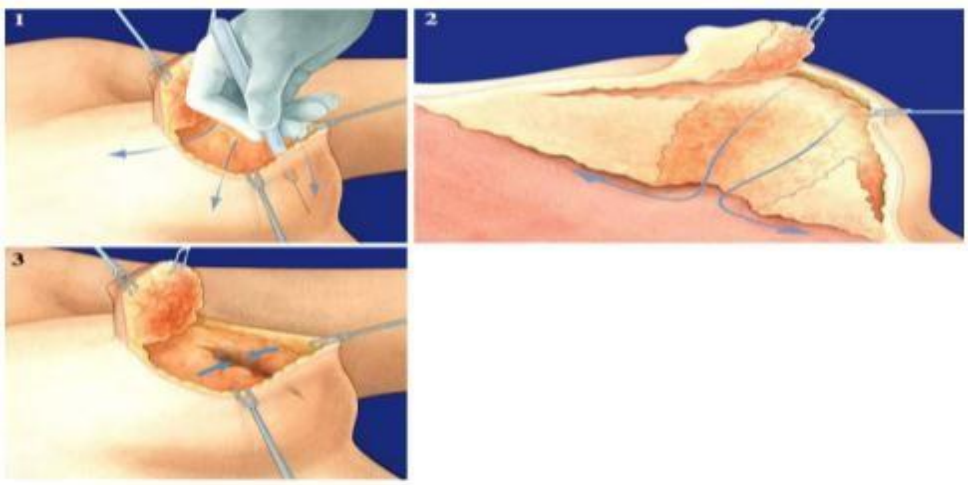

Figure (1): Level I OPS: surgical concept. 1 Initial extensive skin undermining. 2 Excision of the lesion from subcutaneous tissue to pectoralis fascia. 3 Reapproximation and suturing of the gland (**Clough et al., 2010).**

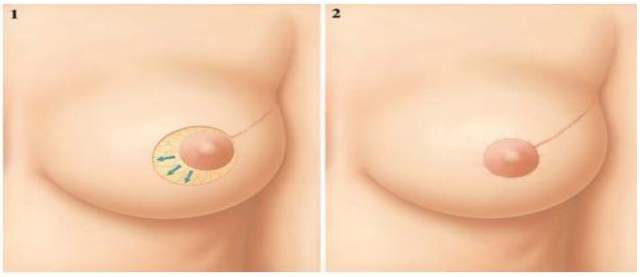

Figure (2): Level I OPS: nipple recentralization. 1 A skin crescent is deepithelialized opposite to the lumpectomy bed in the upper-outer quadrant. 2 NAC is recentralized to avoid NAC deviation post lumpectomy (**van la Parra et al., 2019).**

The location of the incision is at the discretion of the operating surgeon. All incisions should allow for both en bloc excision of the cancer, without causing fragmentation of the specimen, and extensive undermining to facilitate reshaping. For level I procedures, if a direct incision over the tumor is chosen, the general principle is to follow

Kraissl‘s lines of tension to limit visible scaring. However, in many cases an indirect incision along the areola border is possible and can be extended by a radial extension towards the tumor **(Clough et al., 2010).**

Skin Undermining

One of the key factors of level I OPS techniques is extensive subcutaneous undermining. It is easier to undermine the skin before excising the lesion. The undermining follows the mastectomy plane and extends anywhere from one-fourth to two-thirds of the surface area of the breast envelope. Extensive skin undermining facilitates both tumor resection and glandular redistribution after removal of the tumor. The area of undermining should be reduced if risk factors for fat necrosis are present. The two main risk factors are smoking history and fatty composition of the breast (**Barnea and Papa, 2020).**

NAC Undermining

Extensive resections lead to NAC deviation towards the excision area. NAC repositioning is easily performed with simple undermining: this is a key component of both level I and II OPS. The first step is to completely transect the terminal ducts and separate the NAC from the underlying breast tissue. A width of 0.5–1 cm of attached glandular tissue is maintained to ensure the integrity of the vascular supply. This appropriate amount of subareolar tissue prevents NAC necrosis and avoids venous congestion. Ultimately, the level of NAC sensitivity may be reduced after extensive mobilization and undermining (**Bertozzi et al., 2017).**

Glandular Resection:

The standard approach is to perform full-thickness excisions from the subcutaneous fat underlying the skin down to the pectoralis fascia. A full-thickness excision ensures free anterior and posterior margins, leaving only the lateral margins in question. The breast parenchyma itself is excised in a fusiform pattern oriented towards the NAC. This shape facilitates reapproximation of the remaining gland. Before closing the defect, metal clips are placed on the pectoralis muscle and lateral edges of the resection bed to guide future radiotherapy (**Cantürk et al., 2021).**

Defect Closure:

During standard BCS, breast tissue is either reapproximated or left open, allowing for the eventual formation of a hematoma or seroma. Seroma formation, however, does not always result in predictable longterm cosmetic results for larger-volume excisions. Once reabsorption of the seroma occurs, the excision cavity becomes prominent due to fibrosis and retraction of the surrounding tissue, creating a noticeable defect and causing NAC displacement towards the previous excision cavity. Extensive resections require closing the cavity and redistribution of the volume loss. Tissue can be mobilized from lateral positions of the remaining gland or recruited from the central portion of the breast. This allows creation of glandular flaps that are sutured together to close the defect (**Beddok et al., 2022).**

NAC Repositioning:

Avoiding NAC displacement is a key element for both levels I and II OPS. An unnatural position of the NAC deviated towards the excision site can be one of the major sources of patient dissatisfaction after BCS. This result should be expected after all extensive volume resections. NAC repositioning is difficult to attempt after radiotherapy; therefore, immediate recentralization is preferred and should be anticipated during initial resection (**van la Parra et al., 2019).**

An area of periareolar skin opposite the excision defect is deepithelialized in the shape of a crescent. For level I procedures, the width of deepithelialization can measure up to 6 cm. Deepithelization should be achieved sharply, using a scalpel blade or fine scissors. This technique is simple and safe, and is used systematically in aesthetic surgery of the breast. The vascular supply of the NAC after its separation from the gland and deepithelialization is based on the dermal vasculature (**Holmes et al., 2011).**

Level II oncoplastic surgery:

Level II techniques are reserved for situations that require major volume excisions of 20–50%. They are based upon different mammoplasty techniques. To simplify the selection of the appropriate technique, it was devised an Atlas based on tumor location. This Atlas does not contain an exhaustive list of options, but provides one or two surgical techniques for each tumor location. Existing mammoplasty techniques were initially adapted for OPS for specific tumor locations such as lower-pole cancers. In other locations, such as the lower inner and upper outer quadrants, a series of new mammoplasty techniques were created to serve for breast cancer treatment (**Vlajcic et al., 2004).**

The superior pedicle reduction mammoplasty will serve as a model for the technical description of all mammoplasty techniques. Schematically rotating the NAC pedicle opposite the site of tumor excision allows the application of this technique for a variety of tumor locations. These procedures are listed in a clockwise direction and described for the left breast. Because of the volume excised, level II OPS will generally result in a breast that is smaller, rounder, and higher than the contralateral breast. Thus, the need for contralateral symmetrization should be discussed in the preoperative setting. Either immediate or delayed symmetrization can be performed depending on the amount of tissue resection and the desire of the patient (**Pascone et al., 2016).**

Lower-Pole Location (5–7 O'clock)

General Principles The lower pole of the breast was the first recognized high-risk location for deformity. Retraction of the skin and downward deviation of the NAC resulting from excision of tissue from the 6 o'clock position became known as the __bird's beak'' deformity. A superior pedicle mammoplasty can allow for large-volume excision at the lower pole without causing NAC deviation with the added benefit of breast reshaping **(Clough et al., 2010).**

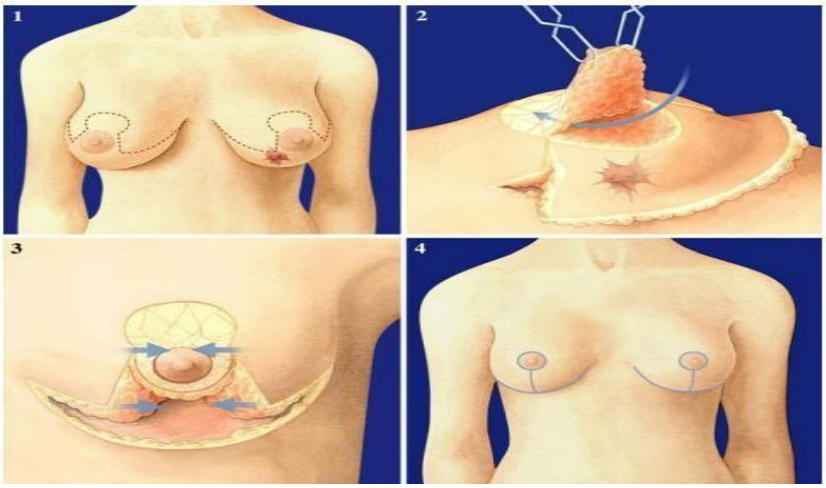

Figure (3): Level II OPS: **superior pedicle mammoplasty** for lower pole lesion (6 o'clock). 1 Preoperative drawings. 2 Superior pedicle deepithelialized and elevated. 3 Reapproximation of medial and lateral glandular

flaps after wide excision. 4 Final result after reshaping and contra lateral symmetrization (**Clough et al., 2010).**

Lower Inner Quadrant (7–9 O'clock):

General Principles Superior pedicle mammoplasty can be used for tumors located from 5 to 7 o'clock However, adaptation for tumors located more medially, between 7 and 9 o'clock, is more difficult and requires a novel level II technique (**Karanlik and Açar, 2021).**

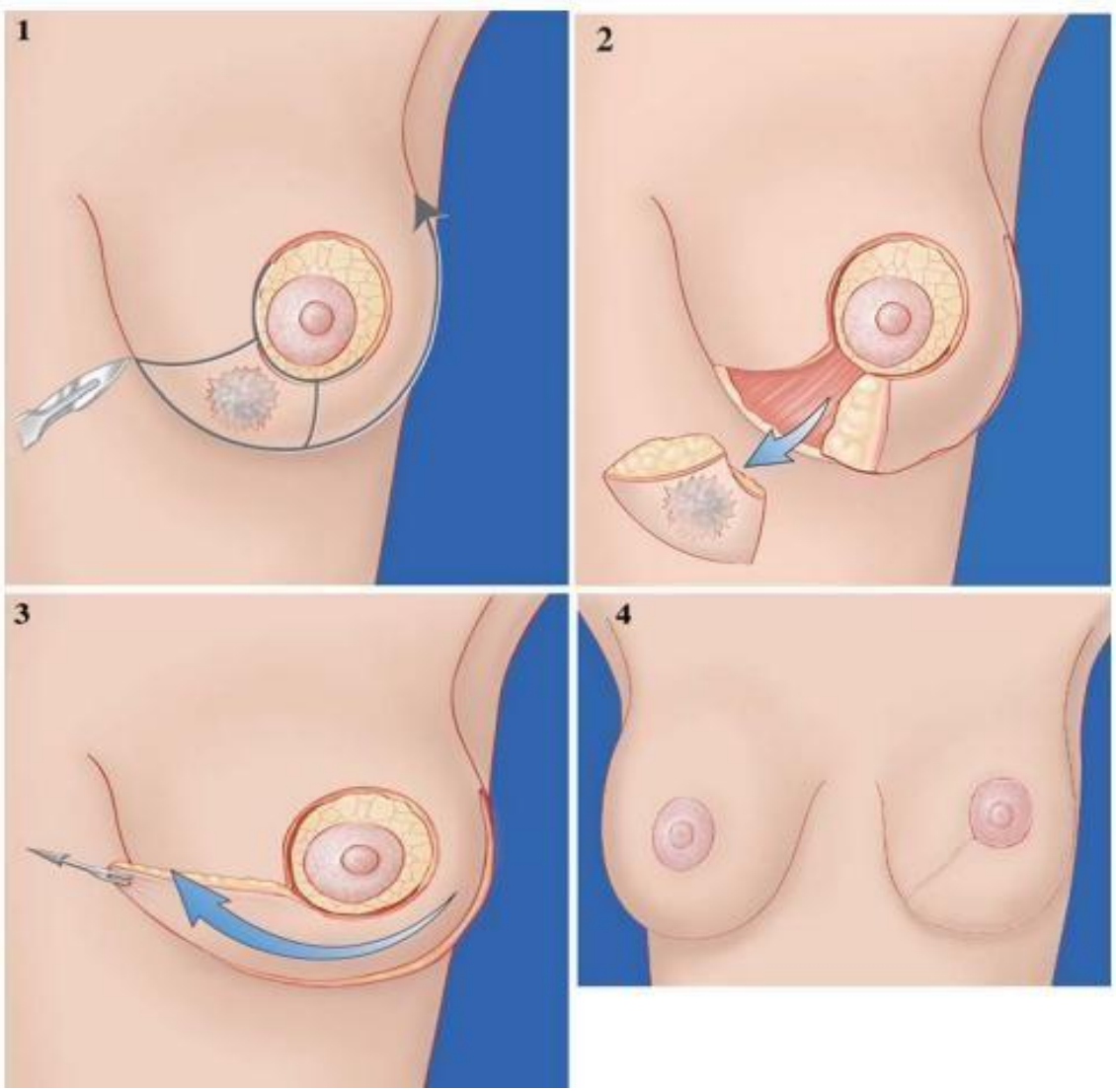

Figure (4): Level II OPS: **V mammoplasty** for lower inner quadrant (7–8 o'clock). 1 Preoperative drawings. 2 Full thickness excision and inframammary incision. 3 Medial rotation of lateral glandular flap to fill in the defect and reshape the breast.

4 Resulting scars (**van la Parra et al., 2019)**.

Technique: V-Mammoplasty This procedure involves excising a pyramidal section of gland, with its base located in the submammary fold and apex at the border of the areola. The section is removed enbloc, including the skin attached to the gland down to the pectoralis fascia. The submammary fold is then incised, from the resection site to the anterior axillary line. The incision is taken laterally as far as necessary to perform adequate rotation of the remaining gland into the defect. The lower pole of the breast is then entirely undermined off the pectoralis muscle and is transferred medially to fill the defect. The NAC is then recentralized on a deepithelialized superior-lateral pedicle (Fig. 4) (**Marco et al., 2018).**

Upper Inner Quadrant (10–11 O'clock):

Special caution is needed when considering BCS for lesions in the upper inner quadrant of the breast. A wide excision in this location can have a significant impact on the overall quality of the breast shape by distorting the visible breast line known as the de´collete´' (**Holmes et al., 2011).**

For moderate resections, level I techniques can be utilized safely. For more extensive excisions, **Lin et al. (2016)** currently have not developed a standard level II oncoplastic procedure that reliably addresses the limitations of BCS at this troublesome location. Silverstein has described an effective OPS procedure to address the upper inner quadrant. His approach utilizes a batwing excision pattern.

Upper Pole (11–1 O'clock):

General Principles Excision of lesions located at the 12 o'clock position rarely causes a deformity, as they can be excised widely followed by volume redistribution with tissue from the central location. For large excision volumes, repair of upper-pole resections can be accomplished through an inferior pedicle mammoplasty. This mammoplasty is commonly performed in the United States as a breast reduction technique and utilizes an inverted T-scar pattern. Another possible approach is a round block mammoplasty with a periareolar scar (**Cantürk et al., 2021).**

Techniques: Inferior Pedicle Mammoplasty The skin markings are identical to those described for the superior pedicle. The resection, however, is located in the upper pole; hence, the vascular supply of the NAC is based on its inferior and posterior glandular attachments. The inferior pedicle is deepithelialized and advanced upwards towards the excision defect to achieve volume redistribution. Complementary resection is performed in the inner and outer lower quadrants to optimize the breast shape (Fig. 5) (**Yilmaz, 2021).**

Round Block Mammoplasty The round block mammoplasty utilizes a periareolar incision. The procedure starts by making two concentric periareolar incisions, followed by deepithelialization of the intervening skin. The outer edge of deepithelialization is incised and the entire skin envelope is undermined in a similar manner to performing a mastectomy. The NAC remains vascularized by its posterior glandular base. Wide excision of the tumor and surrounding tissue is performed from the subcutaneous plane down to the pectoralis fascia. The medial and lateral glandular flap are then mobilized off the pectoralis muscle (**Knauer, 2020).**

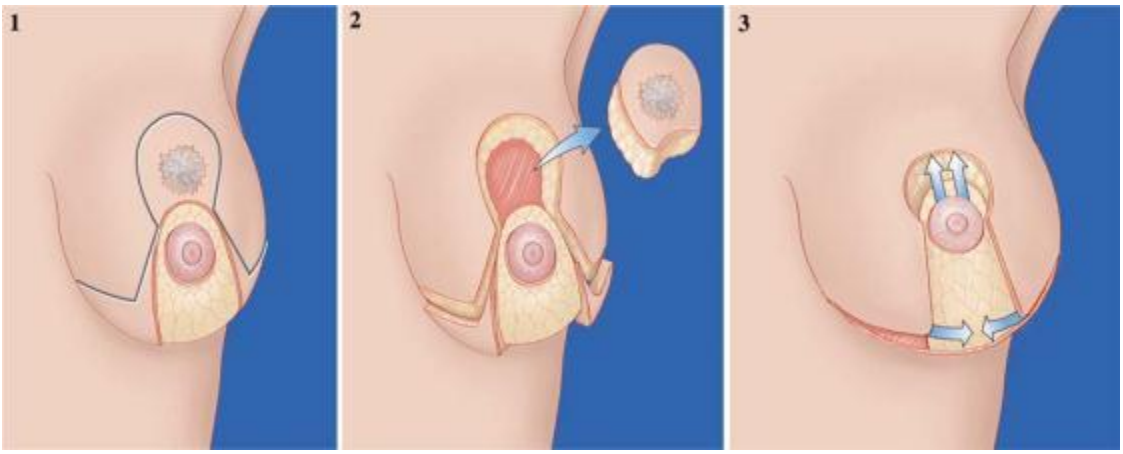

Figure (5): Level II OPS: Inferior pedicle mammoplasty for 12 o'clock tumors. 1 Preoperative drawings. Inferior pedicle deepithelialized. 2 Tumor resection. Complementary resection of medial and lateral pillars. 3 Advancement of inferior pedicle into the defect and skin closure (**Clough et al., 2010).**

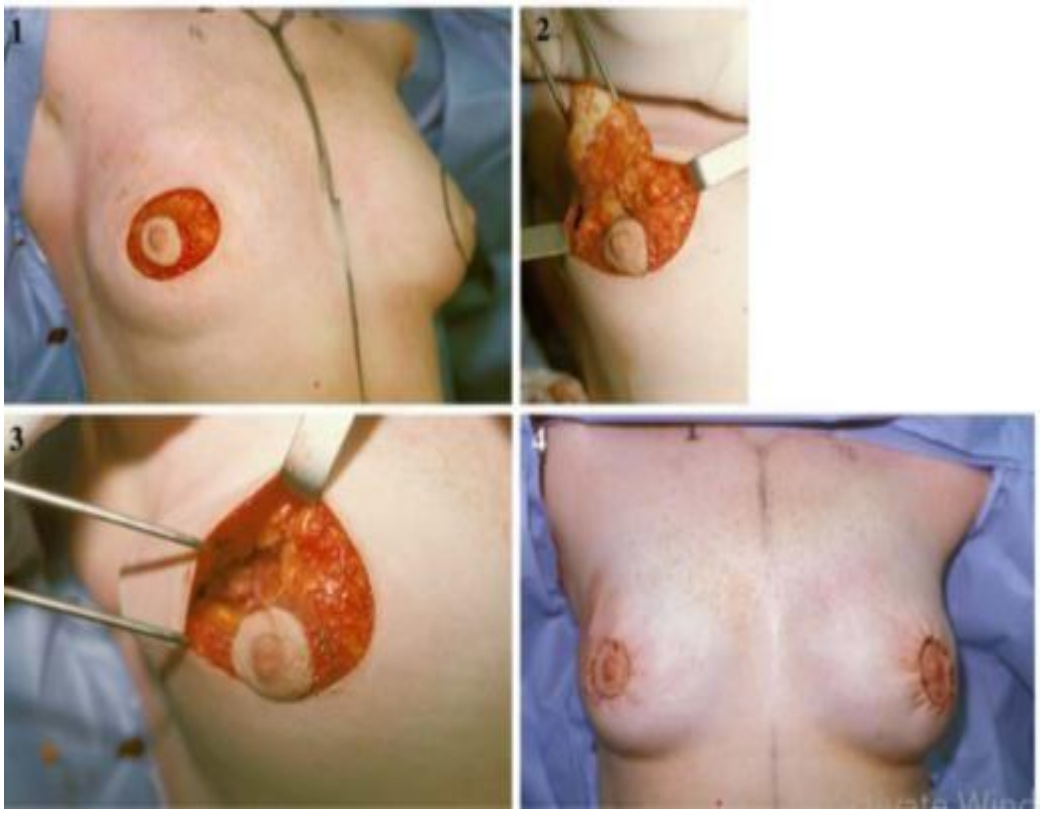

Figure (6): Round block: 3-cm invasive lobular cancer in the upper pole, patient undergoing round block. 1 Incision. 2 Tumor removal. 3 Excision cavity. 4 Final result (**van la Parra et al., 2019)**.

The periareolar incisions are then approximated, resulting only in a periareolar scar. Although **Barnea and Papa, (2020)** have used the round block mammoplasty initially for upper-pole tumors, it is a versatile technique that can be easily adapted for tumors in any location of the breast. It is a challenging technique as the reduced skin excision mandates sophisticated glandular reshaping (Fig. 6).

Upper Outer Quadrant (1–3 O'clock):

General Principles This is the most forgiving‘‘ of all quadrants. In this quadrant, large lesions can often be excised with standard BCS without causing deformity. However, resection of greater then 20% of the breast volume will result in retraction of the overlying skin with NAC displacement towards the excision site. Level II OPS can be utilized to increase resection possibilities while limiting the risk of postoperative deformities (**Dobke, 2012).**

Technique: **Racquet Mammoplasty** A large portion of the upper outer quadrant can be excised utilizing a direct incision over the tumor, from the NAC towards the axilla, similar to a quadrantectomy. After wide excision, the reshaping is performed by mobilizing lateral and central gland into the cavity and suturing it together. Central gland advancement is easily accomplished through NAC undermining. Complete detachment of the retroareolar gland from the NAC enables maximal mobility of the central gland for volume redistribution. Once the defect is eliminated, the NAC is placed in its optimal position, at the center of the new breast mound. This mammoplasty results in a long radial scar over the original tumor site with a periareolar extension (Fig. 7) (**Cantürk et al., 2021).**

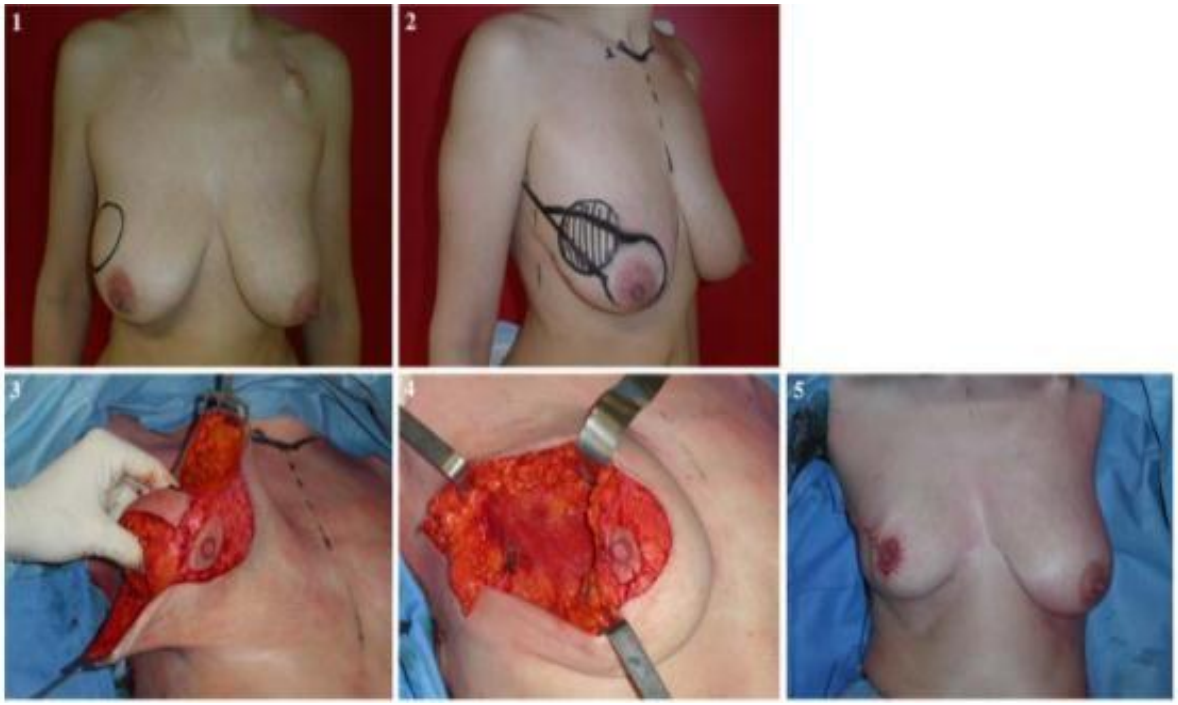

Figure (7): Racquet mammoplasty. Patient underwent neoadjuvant treatment with poor response and large residual tumor. 1 Upper outer quadrant tumor. 2 Skin markings. 3 Excision of tumor. 4 Excision cavity. 5 Final result prior to contralateral symmetrization (**Clough et al., 2010).**

Parallelogram Mastopexy Lumpectomy

This technique involves removal of the island of skin that is located directly superficial to the area of known disease. The parallelogram shape, when properly proportioned, guarantees that the two skin edges that are reapproximated at closure will be equidistant. This approach is most commonly used for superior pole or lateral cancers, with the skin incision lines designed to follow Kraissl lines, which follow the natural skin wrinkles and are generally oriented horizontally on the skin **(Munhoz et al., 2014).**

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