

The shape and volume restoration of the mammary glands in postoperative deformations

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This article is dedicated to modern methods of reconstructive and plastic breast surgery in women with postoperative deformities. Reconstruction of the mammary glands in cases of postoperative deformities relies on a variety of surgical techniques. The selection of an appropriate method depends on the morphological characteristics of the defect, tissue condition, prior surgical history, and the patient's overall somatic status. The article highlights the anatomical and aesthetic parameters of the mammary glands, the classification of postoperative deformities, and modern approaches to secondary reconstruction (implants, autologous tissues, lipofilling), the importance of preserving or restoring the nipple-areolar complex, as well as methods for objective measurement of breast shape and volume, including 3D scanning, magnetic resonance imaging (MRI), and mathematical models. The main approaches to reconstruction are discussed: implants, tissue expanders, autologous flaps (DIEP, TRAM, TDAP, SGAP, LICAP), and lipofilling as an additional or independent option for minor defects. Their advantages, disadvantages, and indications are analyzed. Special attention is given to breast symmetry, the influence of individual anatomical features of the patient, and the staging of surgical interventions. It is emphasized that early reconstruction after mastectomy contributes to better psychological rehabilitation, and the restoration of the breast's aesthetic units improves patients' quality of life. MRI is identified as the most accurate method for assessing breast volume, although less invasive and more accessible methods are preferred in routine practice. The article summarizes current approaches to the planning and execution of secondary reconstructive surgery for restoring breast shape, volume, and symmetry. The importance of an individualized approach is emphasized to achieve optimal aesthetic and functional outcomes.

KEYWORDS

breast reconstruction, postoperative deformities, autologous flaps, breast symmetry, nipple-areolar complex, 3D breast imaging, MRI volumetry.

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According to official data from the American Society of Plastic and Reconstructive Surgeons, in 2019, 575,292 plastic surgeries were performed on the mammary glands (National Plastic Surgery Statistics 2022). The number of patients who underwent surgical intervention in the United States increased by 15% between 2014 and 2019. Consequently, the number of postoperative complications, including pathological deformations of the mammary gland shape and volume, also increased.

Surgical interventions on the mammary gland alter not only its proportions but also affect the overall body balance, which is related to symmetry and aesthetics. The consequences of surgical

intervention must consider all potential postoperative effects, including scars and distortion defects in the form of asymmetry due to tissue removal.

Research conducted by silicone implant manufacturers indicates that within a decade, 22% to 36% of patients may require secondary surgical correction for shape and volume deformations, with this rate expected to increase to 35%-47% over time. Pathological deformation of the mammary glands following surgery was most often attributed to capsular contracture, ptosis, and mammary gland asymmetry [36].

The pursuit of effective, minimally invasive, and standardized methods motivated this study.

Specific parameters may change naturally or through external intervention over a woman's life, such as weight changes, hormonal fluctuations during and after lactation, and the aging process. These physiological changes are generally symmetrical. However, surgical interventions for medical or aesthetic reasons can modify any of the three primary parameters that determine breast shape, either individually or in combination.

To restore symmetry, beauty, and harmony, it is essential to adhere to the proportionality principle during both surgical planning and the intervention itself. Proportionality restoring of anatomical structures requires considering blood supply, skin innervation, and glandular tissue quality while also paying attention to supporting structures, biomechanical characteristics, glandular tissue dynamics, and connections with axillary structures and the vasculature of the pectoralis major and latissimus dorsi muscles [25].

Three main parameters that influence the shape of the mammary gland are the contact area with the chest wall (base), the skin surface area, and the breast parenchyma volume. Additional factors include the base shape, the ratio of structural elements in the composition of the breast parenchyma (ratio of glandular, adipose tissue, and connective tissue), and skin elasticity. The base size and shape of the mammary gland are often referred to as the 'breast footprint' in literature. The breast shape can be altered by modifying one or more of these parameters through surgical intervention.

According to surveys, breast asymmetry occurs in 5%-50% of women. From a surgical perspective, the most challenging situations arise when the nipple-areolar complex is located above the highest projection point of the breast.

Studies indicate that lateral displacement is of more concern to women than height differences. High nipple placement is typically regarded as abnormal. A volume difference exceeding 100–150 grams between breasts is noticeable when unclothed and may raise concerns for patients when wearing undergarments. The position of the inframammary folds is imperceptible in the horizontal plane if the difference is less than 1 cm. However, a discrepancy exceeding 2 cm may cause concern in women and is often a reason for aesthetic surgical interventions.

Standards of mammary gland shape, size, and volume

The desire to describe an aesthetically acceptable mammary gland is not new. Defining aesthetic beauty becomes more feasible with measurable parameters and consideration of body proportions.

The female mammary gland is perceived as a spatial geometric shape resembling a hemisphere or a cone. Breast surgeries modify, reduce, or increase the breast volume, may reduce the skin surface area, and change the shape of the base. If the changes involve only one side, breast symmetry is disrupted, and the spatial relationships between the breasts change. A disproportionate increase or decrease in any measurable parameter leads to the loss of the aesthetic breast shape.

Aesthetic units and subunits of the breast are static. Functional anatomical landmarks, which border or overlap one another, are individually defined by the plastic surgeon. The shape and size of an aesthetic unit influence the surgical intervention goal, whether it is partial or complete breast removal, reconstructive or aesthetic surgery, including breast shaping, volume augmentation or reduction, or symmetry correction. Various interventions involve specific aesthetic units and subunits of the breast. Restoring an aesthetic unit is particularly relevant when it is located in an anatomically significant area. It is crucial to preserve or reconstruct the nipple-areolar complex, the lower pole profile, or the upper-inner quadrant of the breast. The complexity of a particular aesthetic unit is characterized by its blood supply, tissue structure, innervation, unit or subunit volume, surface profile, skin quality, and the proportion of incisions at unit borders to natural folds.

The aesthetic appearance of the breast is primarily determined by its proportion to the entire body. In human body proportions, the entire breast is an aesthetic unit from the anthropometric perspective. The aesthetic subunit of the breast is defined by the proportion of various anatomical landmarks. Aesthetic units can be divided into additional subunits: the nipple, areola and its immediate surroundings, the central chest area, and the upper, lower, inner, and outer poles of the breast. The upper-inner quadrant is a distinct aesthetic unit. This area, the *décolleté*, defines the visible attractiveness of the breast. Its preservation or restoration is one of the key challenges for surgeons practicing reconstructive plastic procedures. Significant discrepancies between body and breast size appear aesthetically unbalanced, such as an extremely large breast size in a slender woman or a small breast size in a woman with an endomorph body type. Breasts with proportions that differ from the norm, size mismatches, or asymmetry can affect a person's behavior, emotional well-being, and self-esteem.

An objective determination of individual breast beauty can be achieved by comparing the measurable parameters of its ideal shape and size. Plastic surgeons have attempted to define breast beauty, i.e., its ideal dimensions, based on clinical

experience, artistic canons, geometric and mathematical measurements. The proportions of an ideal breast and its measurable parameters include the ratio of the upper and lower breast poles, the nipple position on the breast meridian, the inframammary fold (IMF) and its distance from the nipple, the horizontal and vertical diameter of the breast base, and the angle of nipple deviation in the area of the greatest projection.

Proportions of the ideal breast

Arithmetic measurements and geometric rules determine the individual proportions of the breast, anatomical landmarks, and lines necessary for definition.

Parameters of a medium-sized breast

- Distance between the suprasternal notch and the nipple is 18–21 cm.
- Horizontal diameter of the breast base is 11–14 cm.
- Vertical diameter of the breast is 11–14 cm.
- Nipple-areolar complex diameter is 2.8–5 cm.
- Distance between the inner pole and the nipple is 8–11 cm.
- Distance between the outer pole and the nipple is 9–11 cm.
- Distance between the upper pole and the nipple is 6–7 cm.
- Distance between the lower pole and the nipple is 7–9 cm.

The breast meridian is the vertical midline (from the inner third of the clavicle to the nipple, inframammary fold, descending toward the abdomen).

Horizontal breast lines are parallel circles between its base and the nipple.

The ideal ratio of the upper to lower breast poles is 45:55, and the optimal lower pole size from the nipple to the inframammary fold is 5.5–7.0 cm, averaging 6.8 cm according to Persichetti's studies.

Batik and Uzun have researched that the length of the lower pole is 5–7 cm from the lower edge of the areola to the inframammary fold when it is measured without skin tension. The distance between the inframammary fold and the nipple differs from the distance from the lower edge of the areola to the inframammary fold. The distance from the nipple to the inframammary fold is a more accurate measurement of the lower pole [22].

The significance of the nipple-areolar complex in aesthetic and reconstructive breast surgery

In the aesthetic evaluation of the breast, the position, shape, and size of the nipple are of great importance. It is located at the highest curvature point, on the breast meridian, between the upper and lower poles (45:55), slightly above the midline. The nipple is tilted upward

by 20 degrees. The areola's diameter is proportional to the breast size, ranging from 2.8 to 5.0 cm.

On average, the areola is round, with a diameter of 3.8 cm, while the nipple diameter ranges from 0.8 to 1.5 cm. These parameters can vary depending on breast volume.

The presence or absence of the nipple or areola significantly affects the overall aesthetic appearance of the breast. The absence of a nipple reduces the aesthetic appeal of the breast and is perceived by patients as an imperfection in reconstructive procedures. Psychological studies indicate that reconstructive breast surgery can be considered complete only after the restoration of the nipple-areolar complex.

Differences in the diameter and shape of the nipple-areolar complex must be taken into account in nearly every case involving reconstruction with an expander, breast hypertrophy, or gigantomastia. Typically, nipples are positioned at different levels in the horizontal or vertical plane.

Methods for measuring the mammary gland shape and volume

The measurement of breast volume has been a challenge for plastic surgeons for decades. Several methods have been developed to determine breast volume.

Direct mechanical measurements are based on **Archimedes' principle**. The simplest method involves submerging the breast in a container filled with liquid and measuring the volume of displaced fluid. However, this approach is inconvenient for the patient, and it is difficult to implement. Based on the same principle, an imprint of the breast is created using a thermoplastic material. Once it hardens, the mold is filled with liquid, which is then measured. A study published by Turkish authors described the use of a **ready-made device based on the fluid displacement principle**, which allowed measuring the difference in breast volume. However, these measurement methods did not gain popularity due to their inaccuracy and complexity in routine practice [34].

A group of Chinese authors attempted to develop a practical formula for calculating breast volume:

$$(\pi \cdot MP^2 \cdot (MR + LR + IR - MP))/3,$$

where: MR – medial radius (distance from the nipple to the medial border); LR – lateral radius (distance from the nipple to the lateral border); IR – nipple-inframammary fold length (distance from the nipple to the inframammary fold); MP – mammary projection.

The accuracy of such volume measurements is limited because the breast cannot be described using a simple geometric formula. Therefore, anthropometric measurement methods have not become widely adopted in daily practice.

Breast volume and ptosis can be accurately calculated using models described by B. Longo et al. The authors aimed to develop a unified predictive formula for assessing volume in both small and large breasts. Their study was based on anthropomorphic measurements and direct volume measurements of 108 mastectomy specimens received from 88 women. The authors performed multivariate regression analysis to develop a predictive volume assessment formula, which was then internally validated.

The mean breast weight was 527.9 ± 227.6 g (range: from 150 to 1250 g). The most significant predictive parameters were:

- Distance from the sternal notch to the nipple;
- Distance from the inframammary fold to the nipple;
- Distance between the folds' projections.

The resulting BREAST-V formula showed a corrected r-value of 0.73. The expected deviation in volume estimation was 89.7 g (95 % CI: 62.4–119.1 g), and the expected relative deviation was 18.4 % (95 % CI: 12.9 %–24.3 %). The authors stated that BREAST-V is a reliable tool for objectively assessing small and large breast volumes and can be used as an additional tool in surgical planning.

An app called BREAST-V is now available for iOS and Android devices for free download on the App Store and Google Play Store [4].

Other measurement methods

Similar anthropometric data can be obtained from breast and chest wall photographs or direct measurements.

The biostereometric measurement method is based on the same principle. Breast volume data can be obtained using computer calculations performed when studying images in standard projections.

Mammographic images have been used to determine breast volume, but due to inaccuracies, particularly related to compression, this method was deemed ineffective.

A more precise measurement of breast volume can be performed using a laser scanner. A laser beam scans the breast surface, and through computer processing, a model is created, followed by volume calculations.

Advantages of the laser scanning method:

- It allows scanning in a standing position, under physiological conditions.

Disadvantages:

- High device cost;
- It requires specialized laboratory and trained personnel;
- Inaccuracy in measuring ptotic breasts, as breast parenchyma casts a shadow, concealing part of the volume from the laser beam.

German and Japanese specialists have published several studies describing the practical application of this method.

MRI- and CT-based volume measurement

The idea of determining breast volume using MRI and CT scans originated from neurosurgical diagnostics. In neurosurgery, it is crucial to determine the precise spatial localization of a brain tumor, its size, and its relationship with surrounding structures. Advances in diagnostic imaging and virtual modeling have enabled the use of these methods in other medical fields.

Software used for volume determination:

- FreeForm Concept
- ANSYS
- Geomagic Studio
- Amira
- Mimics
- Osiris
- AMIDE
- Sundera Vie Personal
- OsiriX
- ConQuest
- Ginkgo CADx
- XMedCon
- Mango
- UniPACS DICOM viewer
- ImageVis3D
- DicomWorks
- Slicer

MRI and CT volume measurements are typically conducted using specialized software programs commonly utilized in industrial settings. Segmentation is performed manually, generally requiring 40–60 slices, depending on the scanner's resolution.

While the segmentation process can be partially automated, the similar density of subcutaneous fat in the breast and chest wall often results in poor contrast at the boundaries, complicating accurate delineation of breast tissue from adjacent structures.

During segmentation, breast boundaries are manually marked using fixed points, reducing measurement errors due to subjectivity [24].

The authors of this section propose defining the sternal midpoint as the medial boundary. The lateral boundary is defined as a plane along the lateral edge of the pectoralis major muscle, built perpendicularly to the chest wall. The distal boundary is the inframammary fold, and the upper boundary is the beginning of the breast projection.

Computer programs generate voxels (volume units) from selected pixels on slices, and the total volume is quantitatively assessed. A spatial model can then be obtained from the voxel distribution.

MRI as the most accurate measurement method

A variety of programs are available for MRI-based volumetric analysis. While some options are expensive, free online versions can be accessed at www.idoimaging.com.

MRI volume measurement is labor-intensive and expensive, making it less practical compared to other methods. However, it remains the most accurate measurement method according to the literature.

In 2015, H. Kim et al. published a study on MRI for breast reconstruction planning, including both autologous flap and implant-based reconstruction.

The study included 40 patients preparing for autologous reconstruction with DIEP flap and 30 patients preparing for implant reconstruction between 2011 and 2012.

In DIEP flap patients, the average weight of excised breast tissue after mastectomy had a stronger association with the MRI-estimated breast volume than with CT-estimated volume (Pearson's correlation: 0.928 vs. 0.782; $p = 0.001$). MRI had a stronger correlation with final flap weight than CT (Pearson's correlation: 0.959; $p = 0.001$).

For implant-based reconstruction patients, MRI-estimated volume closely correlated with the actual mean weight of removed breast specimens (0.937; $p = 0.001$).

The average implant volume used for reconstruction was more closely related to the MRI-estimated breast volume than to the actual mastectomy tissue weight (0.893 vs. 0.880; $p = 0.001$).

The authors concluded that MRI provides reliable information for determining implant volume and autologous tissue flap volume, ensuring optimal symmetry in breast reconstruction [20].

Three-dimensional modeling based on surface scanning

In recent years, three-dimensional (3D) visualization based on surface scanning has gained popularity due to its advantages, such as:

- Fast and simple analysis;
- Minimally invasive procedure;
- Ability to examine the patient in an upright position;
- No ionizing radiation;
- Safety.

3D scanning systems are relatively new and were first described by SJJ Daly and Hartmann in 1995. The authors used Moire topography to obtain surface scans. However, this method was limited in its ability to capture images and assess volume only in women with well-defined breast shapes and sizes.

J. M. Yip et al. used the Cyberware WBX (Cyberware, USA) system, which captures images

through scanning with four laser heads. The scanning process took an average of 15 seconds.

A. Losken et al. and B. Mailey et al. implemented scanning technologies using camera-based systems. These systems measure distortion of a light beam projected from an integrated light source (3DMD system, GA, USA, Losken) or analyze reflected light patterns (Portrait 3D, Axis Three, FL, USA, Mailey) [6].

These systems usually have a very short capture time (for example, 3DMD captures in ~50 ms), which minimizes the effect of breathing and heart-beat movements during scanning.

Validation of 3D imaging techniques

In 2005, A. Losken et al. published a study evaluating the reliability of three-dimensional breast visualization methods. The authors emphasized that the potential for extrapolating precise data from 3D images to clinical practice is significant and that this method could greatly improve the accuracy of assessing shape, size, and volume in surgical planning.

Study Details:

- 19 three-dimensional images of breasts were obtained pre-mastectomy (14 patients).
- Breast tissue volume was determined intraoperatively using the water displacement method.
- Two independent studies calculated breast volume using 3D imaging and specialized software and compared the results with intraoperative volume measurements.
- The next step was to compare nipple-to-sternal notch distance measurements (20 breasts, 10 patients) in reality vs. on the 3D model.

Key Findings:

- Average breast volume is 500 ml.
- Measured volumes are 489 ml (first measurement) and 490 ml (second measurement).
- The relative difference between actual and calculated volume is ~2%.
- Standard deviation is ± 13 to 16%.
- Study agreement coefficients are 0.80 (first study) and 0.92 (second study).
- The measurement correlation coefficient is 0.975.
- Average nipple-to-sternal notch distance is 26.1 cm (actual), 25.1 cm (first calculation), and 26.1 cm (second calculation).
- Relative difference in distance measurements is 6% (standard deviation: 6–7%).

The authors concluded that objective breast volume assessment using 3D surface scanning is feasible and highly reproducible. Although subjectivity is always present in breast volume evaluation, 3D technology provides valuable information and is an extremely useful and convenient tool [23].

Postoperative monitoring and virtual planning

3D scanning is also applicable for postoperative monitoring. Another significant advantage is that it allows segmentation of breast volume in virtual surgical planning.

However, surface scanning does not capture the full thickness of the breast down to the chest wall. Additionally, for large breast sizes, measurements may be inaccurate.

Limitations of 3D Scanning:

- High cost of the technology;
- Limited availability due to expensive equipment;
- Challenges in measuring large or ptotic breasts accurately.

Systematic review of breast volume measurement accuracy

In 2016, S. B. Choppin published a systematic review to evaluate the accuracy of various methods for measuring breast volume and their clinical utility.

The review included 15 studies, each with more than 10 participants, where the accuracy of volume measurement was compared against breast volume and weight after mastectomy [7].

Evaluated methods:

- Anthropometric analysis;
- Water displacement (Archimedes' principle);
- Breast molds;
- The Grossman-Rudnev cone method;
- CT- and MRI-based modeling;
- Mammography-based volume estimation.

Key Findings:

- All methods showed significant measurement errors (> 200 ml).
- Measurement errors were likely due to method execution rather than inherent flaws in the methods themselves.

Reducing measurement errors

To minimize errors, researchers emphasized the importance of:

- Consistent patient positioning;
- Standardized examination conditions;
- Uniform segmentation techniques to separate breast volume from the chest wall.

Clinicians must define an acceptable margin of error in breast volume measurement, as inaccuracies can lead to incorrect clinical decisions.

- A. Losken et al. suggested an acceptable measurement error of $\pm 10\%$.
- H. Probst et al. established a precision threshold of $\pm 5\%$ and a volume tolerance of 25 ml.
- A 5–10% measurement error is considered clinically acceptable.

Most accurate methods

Among all imaging techniques, MRI scanning consistently demonstrated the highest accuracy.

Errors were less than 10% for different breast volumes:

- Small breasts (~250 ml);
- Medium breasts (~500 ml);
- Large breasts (~1000 ml).

Conclusions

- 3D surface scanning is an accurate, reproducible, and useful tool for breast volume assessment.
- MRI remains the most accurate method, but high costs and time-consuming analysis limit its widespread use.
- Acceptable measurement error for clinical decisions ranges from 5–10%.
- Standardized protocols for patient positioning and segmentation are necessary to improve accuracy [30].

Incision lines on the breast

Conscious preoperative planning of incisions on the breast skin surface is essential. Periareolar, vertical, L-shaped, or T-shaped incisions are necessary for reducing or increasing breast volume or creating symmetry.

For tumor removal, classical mastectomy, or reconstructive breast surgeries, the following incisions should be used:

- Incisions around the nipple-areolar complex;
- Parallel incisions along the breast meridians;
- Vertical incisions on the lower pole.

Making an incision in the décolleté area should be avoided. Whenever possible, the incision should be placed along the natural curvature of the breast, at the border between the inframammary fold and the nipple-areolar complex.

Radiation therapy's effect on scars

Post-reconstruction radiation therapy does not worsen scar quality, regardless of skin incision direction. However, tissue fibrosis may lead to structural displacement.

Preferred incision techniques

- Incisions along relaxed skin tension lines;
- Parallel incisions outside breast aesthetic units;
- Incisions around the areola;
- Central horizontal breast incision with semi-circular extensions above or below the areola;
- Periareolar and vertical incisions on the lower pole of the breast.

From the areola, oblique and vertical incision lines are acceptable. Among these, the most favorable incision follows the central breast line.

Optimal incision direction

The optimal incision direction is determined by:

- Relaxed skin tension line;
- Anatomical structure boundaries;
- Natural breast contours.

The goal of reconstructive or aesthetic breast surgery is not only to preserve the natural shape but also to achieve the best possible aesthetic result [28].

Incision placement impact on healing

Incision lines corresponding to the boundaries of aesthetic units promote:

- Ideal wound healing;
- Normotrophic, minimally visible scars.

Reconstructing the aesthetic units of the breast helps restore the shape, volume, and symmetry of the entire body's external appearance.

Reconstructive and plastic surgery methods

The goal of breast reconstruction is to correct the balance of three key measurable parameters:

- Partial or complete replacement of missing breast volume, achieved either by restoring volume on the affected side or reducing the volume of the contralateral breast.
- The missing volume can be restored using autologous tissue or implants.

One of the challenges in analyzing unsatisfactory surgical outcomes is the high variability among clinical cases, making it difficult to establish a universal treatment strategy for breast shape and volume deformities.

Modern oncoplastic approaches

In contemporary breast surgery, the primary oncoplastic approach involves surgical planning based on breast aesthetic units and subunits, which determines incision lines for tumor removal.

- Surgical plans should be individualized, allowing for method adjustments during the procedure.
- Autologous tissue reconstruction provides a natural breast structure, making it biologically superior to foreign-body implants; however, the surgery is more complex and time-consuming.

In both early and delayed breast reconstruction, breast implants can yield excellent aesthetic results, reduce patient stress, and shorten treatment duration.

However, achieving full reconstruction of all breast aesthetic units generally requires at least three surgical procedures.

Skin surface replacement

- Missing skin can be restored using flaps, which may be local or transferred from other anatomical areas.
- The most common and noticeable cause of asymmetry is a volume mismatch between the two breasts.

Recognizing and measuring this asymmetry is a key aspect of reconstructive plastic surgery [18].

Chest wall deformities or abnormal breast positioning can cause asymmetry without altering breast volume. Accurate volume discrepancy assessment is crucial for successful reconstruction.

Challenges in volume assessment

- During reconstructive or aesthetic surgery, breast volume differences are typically assessed subjectively by the surgeon.

- Accuracy depends on the surgeon's individual experience.

- Plastic surgeon Aufrecht (Hungarian by origin) stated in 1949:

«*Most surgeons rely solely on their eyes and hands during breast plastic surgeries.*» Unfortunately, this statement remains relevant today. Using objective volume measurement methods in reconstructive breast surgery provides significant advantages.

Runquist's formula for breast enlargement

- Implants of the same base width but different heights will maintain the same inframammary fold position.

- High-profile implants may misposition the nipples, placing them below the highest point of anterior projection.

- The optimal nipple-to-IMF (inframammary fold) distance depends on implant width and skin elasticity.

Calculation example:

- Implant width 11 cm → Nipple-to-IMF distance:
 - 8 cm (firm skin)
 - 7 cm (elastic skin)
- Implant width 12 cm → Nipple-to-IMF distance: 8–9 cm
- Implant width 13 cm → Nipple-to-IMF distance: 9–10 cm

If the nipple-to-IMF distance exceeds 10 cm, it may indicate:

- Nipple position is too high.
- The lower pole curve is excessively long.
- Unfavorable lower-to-upper pole ratio.

To correct the proportions, options include:

- Redistributing glandular tissue;
- Removing excess skin via L- or T-shaped incisions [34].

Projection and proportion enhancements

- Preserving glandular tissue in the central breast increases upper pole projection.

- Reducing breast footprint diameter while increasing projection improves upper-to-lower pole proportions.

- Upper pole volume can be enhanced through lipofilling.

Structural Considerations for Breast Reconstruction

- All aesthetic units of the breast may undergo reconstructive and aesthetic surgery.

- The foundation of breast aesthetics includes:
 - Breast base (footprint);
 - Glandular tissue (parenchyma);
 - Skin envelope.

The juvenile mammary gland spot is a perfect circle, while the ratio of glandular to fatty tissue defines breast size and consistency.

- Skin quality, thickness, and elasticity influence breast shape and firmness.

- Surgical planning focuses on modifying the breast footprint by increasing or decreasing its diameter.

Breast reshaping and lifting can be achieved with:

- Parenchymal modeling (increasing or reducing volume);
- Skin removal or tightening;
- Carefully planned incision and excision techniques.

With age, the vertical breast footprint diameter shortens, and the upper pole shifts closer to the inframammary fold. Horizontal diameter decreases after reductive surgery [12].

Techniques for breast volume and shape correction

- Parenchymal volume can be reduced (breast reduction) or increased (implants).

- Mastopexy procedures modify breast shape and roundness without changing upper pole volume.

- Common incision types for breast correction:
 - Periareolar incision;
 - Round-block vertical incision;
 - Inverted-T incision

Oncoplastic considerations

- During oncoplastic surgery, excised breast tissue volume is measured, and the defect is reconstructed.

- Volume deficits between the two breasts are calculated to guide augmentation or asymmetry correction.

The role of reconstruction in post-mastectomy recovery

- Comprehensive surgical expertise is required for selecting the optimal reconstructive approach.

- Breast reconstruction after mastectomy is now a standard practice, but it was controversial for a long time.

Early critics believed that «sick women should be left alone» and opposed integrating post-mastectomy

breast reconstruction into routine plastic surgery, citing concerns about oncological safety.

However, medical practice has shown that delayed breast reconstruction significantly improves psychological recovery in women post-mastectomy.

Breast restoration provides:

- A chance for complete rehabilitation;
- Restoration of a normal appearance;
- Optimism and improved post-mastectomy quality of life.

This approach enhances both cancer treatment and psychological well-being [13].

Breast reconstruction evolution since the 1980s

Since the 1980s, breast reconstruction has been an integral part of breast cancer treatment.

Proven oncological safety and continuous advancements in surgical techniques have enabled:

- Successful restoration of breast shape and size;
- Improved clinical outcomes.

Advancements in breast reconstruction techniques:

- Submuscular placement of silicone implants;
- Innovations in textured and silicone gel implants;
- Borosilicate microspheres in implant design;
- Introduction of myocutaneous and myofascial flaps;

- Refinement of microsurgical free tissue transfer techniques.

These methods apply to both primary and secondary breast reconstruction.

The timing of breast reconstruction

- Early reconstruction after mastectomy is preferred, as it helps avoid psychological trauma associated with breast loss.

- If early surgery is not possible, secondary reconstruction is performed after 6–12 months to allow tissue recovery [23].

Challenges in post-radiation reconstruction

- Fibrosis is common in post-radiation patients, complicating simple implant placement.

- Alternative reconstruction techniques (e.g., muscle or tissue flaps) may be required.

- The optimal time for post-radiation reconstruction is typically one year after therapy.

Achieving symmetry with contralateral breast adjustments

Reconstructive surgical choice depends on post-mastectomy local tissue conditions.

Reconstruction techniques:

1. Silicone implant placement
 - Simple procedure
 - It requires sufficient soft tissue coverage
 - It is best for small breasts with firm tissue

2. Tissue expander technique
 - Gradual skin expansion to match contralateral breast size
 - Final implant selection based on preoperative markings
 - Ideal for large-breasted patients [38].

Breast tissue expander

The technique involving tissue expansion and implant placement was primarily introduced into plastic and reconstructive surgery practice by Radovan in the 1980s, and it was further developed under the influence of Argenta's work. Today, this method is widely used in reconstructive breast plastic surgery. Earlier techniques required the mandatory use of skin (or musculocutaneous) flaps to replace the breast skin. Tissue expansion using expanders has significantly enhanced the capabilities of breast reconstructive surgery, particularly in early reconstruction procedures.

The tissue expanders used in the 1980s had a poor-quality surface. As a result, their displacement and even the formation of contractures that hindered proper tissue expansion were not uncommon. In the 1990s, Maxwell developed a new generation of textured expanders, which gave a significant boost to the development of reconstructive breast plastic surgery. The porous textured surface allows fibroblasts from the surrounding tissues to grow into the implant, providing the expander fixation in the desired position [25].

In general, tissue expansion with expanders is indicated for all women who have undergone mastectomy, where soft tissue quality is sufficiently good but its quantity is insufficient. From a technical standpoint, tissue expansion with expander usage is a less complex procedure than the alignment of a skin or muscle flap and is also not associated with scarring or deformational changes, which is an additional advantage for many women.

The use of expander tissue expansion tactics necessitates the need for secondary intervention aimed at the restoration of breast shape and size. Before the second stage of surgical correction can be performed, several preliminary check-ups are required, during which the expander must be gradually filled. This characteristic feature (the multi-stage nature of the correction) is inconvenient and even unacceptable for some women. Despite the advantages of reconstruction using autologous tissue, tissue expansion with expanders remains a standard method included in the set of breast reconstructive surgery procedures [18].

The size of the tissue defect after mastectomy is determined by measuring the horizontal and vertical dimensions of the healthy breast and projecting these

measurements onto the mastectomy area. When reconstructing the breast, it is important to take into account any interventions to eliminate damage and scar formation on the healthy side. This method allows for an accurate assessment of the amount of skin and tissue required for reconstructive surgery.

It is generally recommended to carry out the procedure in two stages. During the first stage, a tissue expander is implanted. In the second stage, after the soft tissue layer has been expanded, the expander is replaced with a standard implant. In some cases, reconstructive plastic surgery of small breasts is possible in one stage; after stretching the soft tissue layer, the expander is replaced with a standard implant.

In cases where the skin is too thin, it is advisable to attempt to increase the thickness of the covering layer over the expander using connective tissue from the chest wall or sections of surrounding muscles (such as the serratus anterior, rectus abdominis, or external oblique abdominal muscle).

The choice of expander depends on the size of the contralateral breast and must correspond to the dimensions of the chest wall. The volume of the expander should exceed the volume of the contralateral breast by approximately 100–200 ml. Expanders that are most commonly used are 12–16 cm in size with a volume of about 600 ml. Both single-chamber and dual-chamber expanders are available, with either integrated or external ports. The main advantages of an integrated port are that there is no need to form an additional pocket for the port, as well as it eliminates the risk of rotation after the expander is installed. The drawbacks include the risk of expander perforation due to improper needle insertion. Undoubtedly, a key aspect is that the textured surface of the expander ensures secure fixation to the surrounding tissues, preventing displacement once filled [19].

Before implantation, the expander is deflated and placed into the area of prior dissection (beneath the muscle layer). After restoring the integrity of the muscle layer by applying several interrupted sutures (using absorbable suture material), the expander is initially filled with 100–200 ml of sodium chloride physiological solution.

Application of flaps in various modifications for breast shaping and volume restoration (gluteal flap, thoracodorsal flap, and LICAP flap)

Reconstruction with autologous tissue usage offers numerous advantages over implant-based reconstruction, including better aesthetic outcomes, a more natural breast shape, improved appearance over time, and fewer overall complications. Most

autologous breast reconstructions are based on the use of abdominal tissue as a donor site for flaps, which has proven to be reliable and is associated with good results and high patient satisfaction [16].

There are several alternative donor sites for autologous breast reconstruction in patients whose abdominal tissue is not suitable, often due to a thin abdominal wall or previous abdominal surgeries. These alternatives include the back, thighs, and buttocks [33].

Breast reconstruction using autologous tissue allows for the creation of a naturally shaped breast that is elastic, exhibits natural ptosis, and maintains normal skin temperature, which is rarely possible when using synthetic materials [5].

When there is sufficient area suitable for reconstruction and the required quality of soft tissues, a fairly good cosmetic outcome can be achieved. The use of a transposed abdominal skin flap provides enough skin surface for performing plastic procedures; however, upward displacement of the flap usually results in the formation of folds in the lateral areas (such defects are quite difficult to correct). Generally, the use of tissue expanders is necessary to achieve good cosmetic results [39].

Autologous breast reconstruction with anterior abdominal wall tissue usage is one of the surgical methods that began its history quite some time ago. Over the past 50 years, techniques for breast reconstruction with anterior abdominal wall tissue usage have reached a significant level of advancement. Historically, pedicled TRAM (Transverse Rectus Abdominis Myocutaneous) flap breast reconstruction was first described in the 1980s. The evolution from pedicled TRAM to free TRAM and then to DIEP (Deep Inferior Epigastric Artery Perforator) flap reconstruction reflects a transition from musculocutaneous flaps to perforator flaps that preserve the muscle.

Surgeons typically choose between pedicled TRAM and DIEP flap procedures based on their personal experience, comfort level with each technique, and the capabilities of their surgical equipment. It is important to note that the DIEP flap requires additional technical expertise [21].

The TRAM is a flap of the anterior abdominal wall that includes skin, subcutaneous fat, fascia, and the rectus abdominis muscle.

There are two types: pedicled TRAM (p-TRAM) and free TRAM (f-TRAM) flap.

DIEP is a flap based on the perforating branches of the deep inferior epigastric artery that includes skin and subcutaneous fat [10].

In recent years, the study of microsurgical techniques and the peculiarities of the blood supply to the subcutaneous fat tissue has led to the understanding

that the use of the rectus abdominis muscle is not a necessary component of the abdominal flap; the primary goal is to preserve the perforating vessels within the flap. The development of the deep inferior epigastric perforator (DIEP) flap technique has changed the approach to the use of anterior abdominal wall flaps in autologous breast reconstruction [14].

However, a major issue with these flaps is the risk of fat necrosis in the tissues due to the peculiarities of the blood supply to different areas of the transplant. Fat necrosis is caused by ischemia of the subcutaneous fat that leads to necrosis of adipose cells and subsequent scarring, which may clinically and radiographically mimic disease recurrence. On mammography, such damage may appear as heterogeneous tissue density and microcalcifications. According to the literature, the risk of fat necrosis using tissue complexes from the lower abdominal wall ranges from 3.0% (with TRAM flap transplantation) to 42.9% (DIEP flap) [12].

A meta-analysis of 13 studies conducted by X.-L. Wang and colleagues in 2014, involving data received from 1,843 patients, did not find a statistically significant difference in the overall complication rates between MS-TRAM and DIEP flaps.

The ideal candidate for a DIEP flap is a young, non-smoking woman with a normosthenic body type and excess tissue in the lower third of the abdomen, as well as a contralateral breast of small to medium volume [40].

In summary, breast reconstruction using DIEP and MS-TRAM flaps is a reliable and safe procedure. With a careful, differentiated approach, both methods can provide high-quality breast reconstruction results.

Over time, breast volume replacement procedures have evolved from using the entire latissimus dorsi (LD) muscle to pedicled perforator flaps that are available in the thoracic region, such as the thoracodorsal artery perforator (TDAP) flap, intercostal artery perforator flap, lateral flap, thoracic artery perforator flap, and serratus anterior artery perforator flap. The muscle-sparing LD flap (MS-LD) consists of a TDAP flap including a portion of the LD muscle to protect the perforators while preserving the nerves that innervate the rest of the LD muscle [28].

The TDAP flap is an effective and versatile tool that expands the arsenal of oncoplastic surgeons, combining the advantages of a perforator flap (minimal donor site pain) with the benefits of a pedicled flap (safety) and delivering satisfactory cosmetic results.

Among alternative options, the use of the superior gluteal artery perforator (SGAP) flap in autologous breast reconstruction is becoming increasingly popular among plastic and reconstructive surgeons.

First introduced by Allen and Tucker in 1995, the SGAP flap has since been used by several teams as a first-line alternative when the abdominal area is unsuitable as a donor site [1].

The superior gluteal artery and vein supply blood to the skin and fat of the upper buttock, while the inferior gluteal artery and vein supply the lower buttock. These vessels can be used to create the SGAP flap from the upper buttock and the inferior gluteal artery perforator (IGAP) flap from the lower buttock tissue. Scars from SGAP and IGAP flap harvesting are typically well concealed by clothing. However, since harvesting these flaps may result in undesirable contour changes in the buttock, we rarely perform these procedures and instead prefer alternative methods, such as the lumbar artery perforator (LAP) flap [8].

A retrospective comparative study comparing SGAP, LAP, and DIEP flaps in autologous breast reconstruction using the BREAST-Q scale, conducted by Opsomer et al., showed that patients who underwent breast reconstruction with the SGAP flap had similar satisfaction with the appearance of their breasts and similar overall satisfaction with the result compared to those who underwent DIEP flap reconstruction. However, satisfaction with the appearance of the donor site in the SGAP group tended to be lower, although not statistically significant ($p = 0.061$), compared to the DIEP group. Commonly cited drawbacks of the SGAP flap include its technical complexity, due to prolonged intramuscular dissection of the pedicle and flap harvest, the need to change intraoperative position, and longer operation time [32].

In the context of autologous flap transplantation, it is also worth describing the LICAP (Lateral Intercostal Artery Perforator) flap. The lateral intercostal artery perforator (LICAP) flap is a versatile second-tier option in breast reconstruction. The flap is rotated from the redundant lateral thoracic fold on a pedicle that is easily dissected through a skin bridge without microsurgical intervention, often in an outpatient setting. It illustrates the safety and effectiveness of the LICAP flap for implant coverage when a muscle flap is unavailable or undesirable. In some cases, it is even possible to obtain sufficient soft tissue to reconstruct the breast mound without an implant [15].

A study by S. Hakakian and A. Ryan demonstrates the advantages of the LICAP flap in addressing various breast reconstruction challenges, including outpatient procedures, the absence of muscle damage, flap reliability, and a low risk of pathological changes at the donor site. These studies confirm that the LICAP flap reliably forms

a large skin-fat flap from the redundant tissue of the lateral chest fold with minimal complications, even after radiation therapy. The LICAP flap deserves close attention in breast reconstruction [29].

Using implants for breast shaping and volume restoration

All women undergoing mastectomy should receive counseling regarding breast reconstruction options [9].

Subcutaneous mastectomy is becoming a standard procedure in many major centers, favoring surgical interventions that minimize additional skin incisions. Oncological indications for nipple removal include nipple involvement detected through clinical or radiological examination. From a plastic surgery perspective, nipple preservation is considered viable if the nipple can be positioned correctly anatomically after surgery. Previous breast incisions are not a contraindication to nipple-sparing mastectomy. The most common incisions include the inferolateral inframammary fold incision for better cosmetic outcomes. Full-thickness periareolar incisions are largely avoided to minimize nipple ischemia. Patients with grade I breast ptosis are universal candidates for subcutaneous mastectomy. Most patients with grade II breast ptosis are also excellent candidates; however, if they desire smaller, more elevated breasts, skin or areola adjustments may be preferred. In cases of severe grade II and III ptosis, several options for nipple preservation exist, depending on the surgical indications – whether for tumor removal with volume restoration or aesthetic procedures aimed at correcting breast volume and shape [35].

Implant-based reconstruction can be performed in one or two stages. In single-stage reconstruction, the final implant is placed during mastectomy, whereas in the two-stage approach, a tissue expander is initially placed and later replaced with the final implant during a second surgical procedure (tissue expander/implant).

According to the experience of M. Scheflan and A. Colwell, there is no difference in complication rates or revision frequencies between direct-to-implant and tissue expander/implant reconstructions [35].

Reconstruction directly with implants is considered for patients who wish to obtain an unchanged size of the mammary glands after the primary surgical intervention. Generally, these patients are healthy, with relatively symmetrical breasts and a volume of less than 900 cm³. The most critical component of successful single-stage silicone implant placement is the patient's health status and the vascularization of the skin flap post-mastectomy. Authors S. Colwell and M. Taylor note that

physical examination alone is sufficient to assess the flap; however, devices measuring tissue perfusion can also be used. To safely increase size in direct-to-implant reconstruction, the mastectomy technique must be precise in its ability to remove all breast tissue while leaving a well-perfused flap [35].

When using silicone implants for breast reconstruction, attention must be paid to options for soft tissue support and implant coverage. A meta-analysis of additional soft tissue coverage methods indicates that the ideal material should be flexible and soft yet durable for long-term soft tissue support. Moreover, the use of the material should not increase the risk of capsular contracture. Acellular dermal matrix is the most commonly used for breast implant coverage and meets the aforementioned requirements.

For successful implant interventions, a number of conditions must be met. Specifically, the contralateral breast should not be too large (maximum 300–400 g), the chest wall skin should be undamaged and capable of mobilization, and the pectoralis major muscle should be preserved. The maximum target breast sizes for which implant reconstruction can still be used are an average of 400–500 ml [26].

Lipofilling in breast reconstruction surgery

The application of lipofilling in reconstructive plastic surgery for the rehabilitation of patients after the surgical stage of breast cancer treatment has been studied by the Institute of Pediatrics, Obstetrics, and Gynecology named after Academician O. M. Lukyanov of the National Academy of Medical Sciences of Ukraine and the Verum Medical Center. This meta-analysis did not demonstrate an increased recurrence rate in patients who underwent lipofilling after the surgical stage of breast cancer treatment compared to the group of patients without lipofilling, among more than 6,121 unique patients within 10 studies. The results confirm that this procedure can be performed safely on patients after the surgical stage of breast cancer treatment [29].

Lipofilling is an effective method for correcting aesthetic defects and improving the quality of life for patients who have undergone the surgical stage of breast cancer treatment. This method is also effective for correcting aesthetic defects and enhancing the quality of life of patients who have undergone subcutaneous mastectomies with simultaneous endoprosthesis placement [2].

According to scientific publications, lipofilling can be performed on elderly patients [3]. This method does not increase the risk of breast cancer development in patients undergoing surgery for aesthetic correction, regardless of the presence or absence of benign mammary gland pathology [11].

Conclusions

The recent literature analysis underscores the unresolved challenges in the surgical restoration of breast shape and volume.

Essential components of secondary breast reconstruction surgery encompass skin repositioning, volume restoration at the breast defect site, inframammary fold restoration, reconstruction of the nipple-areolar complex, and simultaneous symmetry correction.

The application of flaps in the restoration of breast shape and volume provides an acceptable aesthetic outcome without the reliance on artificial substitute materials. However, these methods prolong surgical time and leave scarring at the donor site. These methods are widely used in routine reconstructive plastic surgery practice and require clear indications.

The issue of surgical restoration of breast shape and volume remains relevant and necessitates effective solutions. Potential avenues for research include the post-primary surgery analysis of breast deformation and the development of an updated algorithm for selecting a minimally invasive method during secondary surgery planning, aimed at optimizing outcomes related to aesthetic restoration and the psychological well-being of patients.

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

AUTHORS CONTRIBUTIONS

The authors have contributed equally to conception and design, acquisition and interpretation of data, drafting the article.

REFERENCES

1. Avashia YJ, Desrosiers AE 3rd, Flores JL. A second superior gluteal artery perforator flap with previous liposuction to the same breast after resection of initial SGAP breast reconstruction due to cancer recurrence. *Microsurgery*. 2012 Sep;32(6):482-4. doi: 10.1002/micr.21989. Epub 2012 Jun 20. PMID: 22718270.
2. Bayti T, Panouilleres M, Tropet Y, Bonnetain F, Pauchot J. [Fat grafting in breast reconstruction. Retrospective study of satisfaction and quality of life about 68 patients]. *Ann Chir Plast Esthet*. 2016 Jun;61(3):190-9. French. doi: 10.1016/j.anpl.2015.09.004. Epub 2015 Oct 23. PMID: 26603209.
3. Biazus JV, Falcão CC, Parizotto AC, Stumpf CC, Cavalheiro JA, Schuh F, Cericatto R, Zucatto AE, Melo MP. Immediate Reconstruction with Autologous fat Transfer Following Breast-Conserving Surgery. *Breast J*. 2015 May-Jun;21(3):268-75. doi: 10.1111/tbj.12397. Epub 2015 Mar 17. PMID: 25783210.
4. Bitik O, Uzun H. Analysis of Lower Breast Pole Length and Nipple-Areola Complex Position Following Superior Pedicle, Short Horizontal Scar Breast Reduction. *Aesthetic Plast Surg*. 2016 Oct;40(5):690-8. doi: 10.1007/s00266-016-0663-4. Epub 2016 Jun 29. PMID: 27357632.
5. Bresser PJ, Seynaeve C, Van Gool AR, Brekelmans CT, Meijers-Heijboer H, van Geel AN, Menke-Pluijmers MB, Duivenvoorden HJ, Klijn JG, Tibben A. Satisfaction with prophylactic mastectomy and breast reconstruction in genetically predisposed women. *Plast Reconstr Surg*. 2006 May;117(6):1675-82; discussion 1683-4. doi: 10.1097/01.prs.0000217383.99038.f5. PMID: 16651934.

6. Cevik J, Rostek M, Rozen WM. Anomalous anatomic variation of an absent deep inferior epigastric artery: implications for autologous breast reconstruction. *Surg Radiol Anat.* 2024 Oct;46(10):1683-1686. doi: 10.1007/s00276-024-03441-7. Epub 2024 Aug 6. PMID: 39105777.
7. Choppin SB, Wheat JS, Gee M, Goyal A. The accuracy of breast volume measurement methods: A systematic review. *Breast.* 2016 Aug;28:121-9. doi: 10.1016/j.breast.2016.05.010. Epub 2016 Jun 9. PMID: 27288864.
8. Chrelias T, Berkane Y, Rousson E, Uygun K, Meunier B, Kartheuser A, Watier E, Duisit J, Bertheuil N. Gluteal Propeller Perforator Flaps: A Paradigm Shift in Abdominoperineal Amputation Reconstruction. *J Clin Med.* 2023 Jun 13;12(12):4014. doi: 10.3390/jcm12124014. PMID: 37373707; PMCID: PMC10299709.
9. Colwell AS, Taylor EM. Recent Advances in Implant-Based Breast Reconstruction. *Plast Reconstr Surg.* 2020 Feb;145(2):421e-432e. doi: 10.1097/PRS.00000000000006510. PMID: 31985660.
10. Damin AP, Tiellet BQ, de Melo MP, Zucatto AE, Cericcato R, Biazus JV. Case report of the combination of a TRAM flap, lipofilling, and 3D tattooing after failed implant-based reconstruction: improving aesthetic results. *J Surg Case Rep.* 2024 Sep 11;2024(9):rjae581. doi: 10.1093/jscr/rjae581. PMID: 39262576; PMCID: PMC11388521.
11. Eterno V, Zambelli A, Pavesi L, Villani L, Zanini V, Petrolo G, Manera S, Tusciano A, Amato A. Adipose-derived Mesenchymal Stem Cells (ASCs) may favour breast cancer recurrence via HGF/c-Met signaling. *Oncotarget.* 2014 Feb 15;5(3):613-33. doi: 10.18632/oncotarget.1359. PMID: 24327602; PMCID: PMC3996669.
12. Fong A, Park HS, Ross DA, Rozen WM. Preoperative planning of unilateral breast reconstruction with pedicled transverse rectus abdominis myocutaneous (TRAM) flaps: a pilot study of perforator mapping. *Gland Surg.* 2023 Mar 31;12(3):366-373. doi: 10.21037/gs-22-529. Epub 2023 Mar 13. PMID: 37057040; PMCID: PMC10086775.
13. Gabka CJ, Bohmert H. *Plastic and Reconstructive Surgery of the Breast.* 2nd ed. Stuttgart: Thieme; 2009.
14. Galych SP, Smolanka II, Dabizha OY, et al. Breast reconstruction by using free transplantation of TRAM-flap in various modifications in breast cancer: analysis of results and complications. *Clinical Oncology.* 2017;4(28): 42-47. Available from: <https://www.clinicaloncology.com.ua/article/20289/rekonstrukciya-grudi-s-ispolzovaniem-svobodnoj-peresadki-tram-loskuta-v-razlichnyx-modifikacijax-pri-rake-grudnoj-zhelezy-analiz-rezultatov-i-oslozhnenij>. Ukrainian.
15. Hakakian CS, Lockhart RA, Kulber DA, Aronowitz JA. Lateral Intercostal Artery Perforator Flap in Breast Reconstruction: A Simplified Pedicle Permits an Expanded Role. *Ann Plast Surg.* 2016 May;76 Suppl 3:S184-90. doi: 10.1097/SAP0000000000000752. PMID: 26914351.
16. Hamdi M, Van Landuyt K, Van Hedent E, Duyck P. Advances in autogenous breast reconstruction: the role of preoperative perforator mapping. *Ann Plast Surg.* 2007 Jan;58(1):18-26. doi: 10.1097/01.sap.0000250710.79113.e2. PMID: 17197937.
17. Han WY, Kim DJ, Lee YS, Eom JS, Kim EK, Han HH. Acellular Dermal Matrix without Basement Membrane in Immediate Prepectoral Breast Reconstruction: A Randomized Controlled Trial. *Plast Reconstr Surg.* 2024 Oct 1;154(4):649e-655e. doi: 10.1097/PRS.0000000000001117. Epub 2023 Oct 3. PMID: 39314097.
18. Jurševičs K, Jurševičs E, Krasliņikova J, Šķesters A, Lece A, Skadiņš I. Antioxidant Status in Patients after Breast Mastopexy and Augmentation. *Medicina (Kaunas).* 2024 Jun 26;60(7):1046. doi: 10.3390/medicina60071046. PMID: 39064475; PMCID: PMC11278537.
19. Keane AM, Chiang SN, Tao Y, Pierce A, Gagne J, Margenthaler JA, Tenenbaum MM, Myckatyn TM. Cortiva versus AlloDerm in Prepectoral and Partial Submuscular Implant-Based Breast Reconstruction: A Randomized Clinical Trial. *Plast Reconstr Surg.* 2024 Oct 1;154(4S):13S-26S. doi: 10.1097/PRS.00000000000011244. Epub 2024 Sep 20. PMID: 38085977; PMCID: PMC11412571.
20. Kim H, Kang BJ, Kim SH, Kim HS, Cha ES. What we should know in mammography after reduction mammoplasty and mastopexy? *Breast Cancer.* 2015 Jul;22(4):391-8. doi: 10.1007/s12282-013-0494-y. Epub 2013 Sep 3. PMID: 24000038.
21. Lee BT, Agarwal JP, Ascherman JA, Caterson SA, Gray DD, Hollenbeck ST, Khan SA, Loeding LD, Mahabir RC, Miller AS, Perdakis G, Schwartz JS, Sieling BA, Thoma A, Wolfman JA, Wright JL. Evidence-Based Clinical Practice Guideline: Autologous Breast Reconstruction with DIEP or Pedicled TRAM Abdominal Flaps. *Plast Reconstr Surg.* 2017 Nov;140(5):651e-664e. doi: 10.1097/PRS.0000000000003768. PMID: 29068921.
22. Longo B, Farcomeni A, Ferri G, Campanale A, Sorotos M, Santanelli F. The BREAST-V: a unifying predictive formula for volume assessment in small, medium, and large breasts. *Plast Reconstr Surg.* 2013 Jul;132(1):1e-7e. doi: 10.1097/PRS.0b013e318290f6bd. PMID: 23806950.
23. Losken A, Seify H, Denson DD, Paredes AA Jr, Carlson GW. Validating three-dimensional imaging of the breast. *Ann Plast Surg.* 2005 May;54(5):471-6; discussion 477-8. doi: 10.1097/01.sap.0000155278.87790.a1. PMID: 15838205.
24. Markiewicz E, Fan X, Mustafi D, Zamora M, Roman BB, Jansen SA, Macleod K, Conzen SD, Karczmar GS. High resolution 3D MRI of mouse mammary glands with intraductal injection of contrast media. *Magn Reson Imaging.* 2015 Jan;33(1):161-5. doi: 10.1016/j.mri.2014.08.035. Epub 2014 Aug 29. PMID: 25179139; PMCID: PMC4267960.
25. Mátrai Z, Gulyas G, Kovacs T, Kásler M. *Principles and Practice of Oncoplastic Breast Surgery.* Budapest: Medicina Publishing House Co., 2019.
26. Millen JC, Sibia U, Jackson K, Stern SL, Orozco JIJ, Fancher CE, Grumley J. Comparing Costs: Does Extreme Oncoplastic Breast-Conserving Surgery Confer a Cost Benefit When Compared with Mastectomy and Reconstruction? *Ann Surg Oncol.* 2024 Oct;31(11):7463-7470. doi: 10.1245/s10434-024-15711-0. Epub 2024 Jul 10. Erratum in: *Ann Surg Oncol.* 2024 Oct;31(11):7473. doi: 10.1245/s10434-024-15887-5. PMID: 38987370.
27. Moyer HR, Carlson GW, Styblo TM, Losken A. Three-dimensional digital evaluation of breast symmetry after breast conservation therapy. *J Am Coll Surg.* 2008 Aug;207(2):227-32. doi: 10.1016/j.jamcollsurg.2008.02.012. Epub 2008 May 12. PMID: 18656051.
28. Oku K. Vectorized facial skin tightening: A study on the Thermal Thread Technique™ utilizing high-intensity, high-frequency, parallel ultrasound beam. *Lasers Surg Med.* 2024 Apr;56(4):355-360. doi: 10.1002/lsm.23771. Epub 2024 Feb 27. PMID: 38411259.
29. Pominchuk DV, Lashchenko MV, Lashchenko VA. Use of lipofilling in reconstructive and plastic surgery for rehabilitation of patients after surgery for breast cancer. *International Medical Journal.* 2021;27(3):24-29. <http://jnas.nbuvgov.ua/article/UJRN-0001269722>. Ukrainian.
30. Probst H, Choppin SB, Wheat JS, Harrison M, Goyal A. The development of a low cost 3D surface imaging system to measure breast volume: Defining minimum standards using an adapted Delphi consensus study. *J Plast Reconstr Aesthet Surg.* 2015 Dec;68(12):1770-2. doi: 10.1016/j.bjps.2015.09.014. Epub 2015 Oct 9. PMID: 26454415.
31. Ribuffo D, Mosiello L, Abbaticchio D, Marcasciano M, Lo Tòrto F. Autologous breast augmentation combining the harvesting of the Anterior Intercostal Artery Perforator (AICAP) and Lateral Intercostal Artery Perforator (LICAP) flaps in massive weight loss patient: A case report. *JPRAS Open.* 2024 Jun 6;41:110-115. doi: 10.1016/j.jprra.2024.05.013. PMID: 38984324; PMCID: PMC11231510.
32. Schülein S, Taylor KJ, Braun B, Heyl V, Zoche H, Peek A, Solbach C, Schott S, Blettner M, Klug SJ. Evaluation of the methodological quality of articles on autologous breast reconstruction. *J Plast Reconstr Aesthet Surg.* 2018 Sep;71(9):1286-1294. doi: 10.1016/j.bjps.2018.05.010. Epub 2018 Jun 8. PMID: 30173715.
33. Shim S, Unkelbach J, Landsmann A, Boss A. Quantitative Study on the Breast Density and the Volume of the Mammary Gland According to the Patient's Age and Breast Quadrant. *Diagnostics (Basel).* 2023 Oct 30;13(21):3343. doi: 10.3390/diagnostics13213343. PMID: 37958239; PMCID: PMC10648521.
34. Smit JM, Plat VD, van Est MLQ, van der Velde S, Daams F, Negenborn VL. Clinical outcomes of breast reconstruction using omental flaps: A systematic review. *JPRAS Open.* 2024 Jul 31;42:10-21. doi: 10.1016/j.jprra.2024.07.010. PMID: 39279848; PMCID: PMC11399463.
35. Steiner MN, Boone LH, Hayden L, Schumacher J, Arnold CE. Mastectomy in ten mares: indications, surgical technique, complications, and long-term outcome. *J Am Vet Med Assoc.* 2024 Jul 31;262(10):1397-1404. doi: 10.2460/javma.24.05.0350. PMID: 39084242.
36. Stevens WG, Calobrace MB, Alizadeh K, Zeidler KR, Harrington JL, d'Incelli RC. Ten-year Core Study Data for Sientra's Food and Drug Administration-Approved Round and Shaped Breast Implants with Cohesive Silicone Gel. *Plast Reconstr Surg.* 2018 Apr;141(4S) Sientra Shaped and Round Cohesive Gel Implants):7S-19S. doi: 10.1097/PRS.0000000000004350. PMID: 29595714.
37. Swanson E. Is There a Role for Textured Tissue Expanders in Breast Reconstruction? *Ann Plast Surg.* 2024 May 1;92(5):489-490. doi: 10.1097/SAP0000000000003782. Epub 2024 Jan 4. PMID: 38289010.

38. Tehranchi S, Karagiannis P, Oezdogan Y. Innovative Reuse of Breast Expander Capsules for Parietal Pleura Repair in DIEP Flap Surgeries. *Aesthetic Plast Surg.* 2025 Jun;49(11):3296-3297. doi: 10.1007/s00266-024-04432-0. Epub 2024 Oct 1. PMID: 39354228.
39. Vanschoonbeek A, Fabre G, Nanhekhan L, Vandevort M. Outcome after urgent microvascular revision of free DIEP, SIEA and SGAP flaps for autologous breast reconstruction. *J Plast Reconstr Aesthet Surg.* 2016 Dec;69(12):1598-1608. doi: 10.1016/j.bjps.2016.09.017. Epub 2016 Sep 28. PMID: 27771262.
40. Wang XL, Liu LB, Song FM, Wang QY. Meta-analysis of the safety and factors contributing to complications of MS-TRAM, DIEP, and SIEA flaps for breast reconstruction. *Aesthetic Plast Surg.* 2014 Aug;38(4):681-91. doi: 10.1007/s00266-014-0333-3. Epub 2014 Jun 6. PMID: 24902911.

Відновлення форми та об'єму молочних залоз після операційних деформацій

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Огляд присвячено сучасним методам реконструктивної та пластичної хірургії молочних залоз у жінок з післяопераційними деформаціями. Реконструкція молочних залоз при післяопераційних деформаціях ґрунтується на використанні різноманітних хірургічних технологій, вибір яких детермінується морфологічними характеристиками дефекту, станом тканин, історією попередніх втручань та загальним соматичним станом пацієнтки. У статті висвітлено анатомічно-естетичні параметри молочних залоз, класифікацію післяопераційних деформацій, сучасні підходи до вторинної реконструкції (використання імплантатів, аутологічних тканин, ліпофілінгу), важливість збереження або відновлення сосково-ареолярного комплексу, а також методи об'єктивного вимірювання форми та об'єму молочних залоз, включаючи 3D-сканування, магнітно-резонансну томографію (МРТ) та математичні моделі. Обговорено основні підходи до реконструкції: використання імплантатів, тканинних експандерів, аутологічних клаптів (DI-EP, TRAM, TDAP, SGAP, LICAP), а також ліпофілінгу як додаткового або самостійного варіанта при незначних дефектах. Проаналізовано їхні переваги, недоліки та показання. Особливу увагу приділено симетрії грудей, впливу індивідуальних анатомічних особливостей пацієнтки та етапам хірургічних втручань. Підкреслено, що рання реконструкція після мастектомії сприяє кращій психологічній реабілітації, а відновлення естетичних одиниць грудей покращує якість життя пацієнток. МРТ визнано найточнішим методом оцінки об'єму грудей, хоча в повсякденній практиці перевагу надають менш інвазивним і більш доступним методам. У статті узагальнено сучасні підходи до планування та виконання вторинної реконструктивної хірургії для відновлення форми, об'єму та симетрії грудей. Підкреслено важливість індивідуального підходу для досягнення оптимальних естетичних та функціональних результатів.

Ключові слова: реконструкція молочної залози, післяопераційні деформації, аутологічні клапті, симетрія грудей, сосково-ареолярний комплекс, 3D-візуалізація грудей, об'ємне МРТ-дослідження.

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