30 Topics

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INTRODUCTION

The size, shape, and symmetry of a woman's breasts can have a profound effect on her mental and physical well-being. Many women with excessively small or large breasts have an altered self-image and suffer from poor self-esteem and other psychological ailments. In particular, women whose breasts are abnormally large relative to their body habitus are frequently limited in clothing choices and lifestyle. They might find it difficult to exercise, play sports, or participate in other normal daily activities. As a result, they avoid many of these activities, which are replaced by more sedentary ones that can in turn contribute further to their isolation. In short, a woman's breast size affects her attitudes, career choices, and personal and professional life in many ways.

Chronic headaches and pain in the neck, back, and shoulders are not uncommon presenting complaints of women with excessively large breasts. These symptoms are either eliminated or markedly improved by reduction mammoplasty. Typically, women who have undergone reduction mammoplasty are among the happiest patients in a plastic surgeon’s practice. After surgery, many of these women enjoy a totally new outlook on life and pursue activities that were previously unavailable to them. Reduction mammoplasty is certainly one of the operations from which we can significantly contribute to a woman's quality of life. This monograph contains a review of the anatomic basis for many of the breast-contouring operations, consideration of the surgical advances that have brought us to where we are in the field, and a summary of the current literature on reduction mammoplasty and mastopexy.

HISTORY

Breast reduction surgery continues to evolve and is being refined. Excellent reviews of the history of reduction mammoplasty and the progression of concepts in breast reduction and ptosis surgery can be found in chapters by Letterman and Schurter1 and Hinderer2 in the book Aesthetic Surgery of the Breast.

As early as the 6th century AD, Paulus Aegineta described details of reduction mammoplasty for the correction of gynecomastia.1 Hans Schaller was thought by German medical historians to have performed the first breast amputation early in the 19th century.1 Dieffenbach,3 in 1848, was likely the first to perform reduction mammoplasty in a female patient by reducing the lower two-thirds of the breasts and posterior segment, leaving the scar in the inframammary fold (IMF). Thomas4 and Guinard5 emphasized the IMF as the access route for surgical correction of excessive breast tissue inferiorly.

Most of the operations performed during the late 1800s and early 1900s were to correct ptosis. Various types of skin and glandular excision were involved, all of which attached or suspended the breasts into a higher position on the chest wall but without true nipple-areola complex (NAC) transposition.6 Between 1909 and 1925, the concept of NAC transposition was advanced. Morestin, in 1909, was probably the first to transpose the NAC,2
followed by Villandre in 1911,2 Lexer in 1912,6 and Thorek1 from 1921 to 1946.

The next stage in the evolution of breast reduction surgery focused on techniques to preserve blood supply to the skin, mammary gland, and NAC. The subdermal blood supply to the breast skin and gland was carefully considered, which led to operations that preserved the skin over the remaining gland during reduction mammoplasty. After publication of Aubert’s technique in 1923,7 most surgeons tried to prevent vascular complications by leaving the skin and gland attached through the subdermal plexus. When large reductions were involved, wide dissections were performed in either one or two stages.

Schwarzmann,8 in 1937, recommended leaving a periareolar dermal ring to enhance arterial and venous blood supply to the NAC. The maneuver seemed to improve the viability of the NAC, facilitated its transfer, and helped pave the way for techniques involving deepithelialized nipple pedicle flaps.

Subsequent refinements in breast reduction surgery concerned skin incisions and pedicle designs to further preserve vascularity to the operative field and to place the scars in more aesthetic sites. The importance of preoperatively marking the incisions and proposed areas of resection was emphasized by Bames9 in 1948. In 1949, Aufricht10 remarked that ultimate breast form is determined by the postsurgical “skin brassiere.” In a landmark paper published in 1956, Wise11 described a pattern for preoperatively marking the breast that produced accurate and reproducible resection of parenchymal tissue with minimal complications and satisfactory breast form. The Wise pattern was based on previous work by Bames,9 Aufricht,10 and Penn12 and continues to be popular today.

Strombeck,13 in 1960, described a horizontal dermal bipedicled flap for nipple transposition that helped maintain innervation to the NAC through lateral attachments. Many variations of that procedure based on different orientations of the dermal pedicles have been described.14−19 McKissock14,15 described a vertical bipedicled flap, Weiner et al.16 a superiorly based flap, Orlando and Guthrie17 a superomedially based flap, and Courtiss and Goldwyn18 and Georgiade et al.19 inferiorly based flaps. With the refinements, it became much easier to maintain a reliable blood supply and innervation to the breasts during reduction surgery.

Several authors have since described additional nerves to the breast in association with vertical and short-scar reduction techniques.20−22 Although some of those techniques were developed in the late 1960s and 1970s, they gained widespread popularity in the United States only during the last decade. Others have used suction-assisted lipectomy (SAL) for breast reduction, either alone or combined with scalp excision.

PATHOPHYSIOLOGY

The pathophysiology of breast hypertrophy is thought to be an abnormal end-organ response to circulating estrogens.23−25 Jabs et al.26 showed normal levels of estrogen and the usual number of estrogen receptors in women with mammary hypertrophy, evidence of some women’s hypersensitivity to the hormone. Hypermastia typically begins with the hormonal challenges associated with puberty and pregnancy. The breast enlargement consists primarily of fibrous tissue and fat, while the glandular elements remain small.9

With the increasing obesity epidemic in modern society, breast hypertrophy caused by excess adipose tissue rather than glandular hyperplasia is common. Studies have suggested that fat accounts for 48% to 61% of modern breast reduction specimens.27,28 Despite this, there are no data to support weight loss as effective treatment for breast hypertrophy, and outcome studies have shown excellent symptom relief for both obese and non-obese patients.29

Juvenile Gigantomastia

Massive breast enlargement or gigantomastia (juvenile virginal hypertrophy of the breast) was first described by Durston30 in 1970. Gigantomastia is much more severe than simple breast hypertrophy—at least 1800 g of tissue per side during reduction mammoplasty31,32—and seldom regresses spontaneously.33 The condition typically manifests in early puberty, often with the first menses.31,34

Kupfer et al.35 reviewed the literature of juvenile breast hypertrophy and presented their experience with two patients, mother and daughter, which suggested to them a familial pattern to the disease. The differential diagnosis of unilateral massive breast hypertrophy in
adolescent girls includes fibroadenoma, cystosarcoma phyllodes, virginal hypertrophy (unilateral), breast hamartoma, and trauma.\textsuperscript{31,36,37} The mainstay of treatment in gigantomastia is radical surgery. Free nipple grafting usually is required to obtain adequate reduction. Netscher et al.\textsuperscript{31} reported a case of massive, asymmetric, virginal breast hypertrophy requiring unilateral reduction mammoplasty despite an actively enlarging breast to relieve extreme discomfort.

Although early studies showed that hormone suppression was ineffective in the management of gynecomastia, Baker et al.\textsuperscript{38} reported successful experience with tamoxifen combined with reduction mammoplasty in the treatment of juvenile gigantomastia. The authors presented four cases and reviewed the literature. The patients were 10, 12, 14, and 17 years of age at the time of initial treatment; the gigantomastia was prone to recur and necessitated additional surgery. The 17-year-old patient in that series did not require secondary surgery, suggesting that the older subgroup might be successfully treated with breast reduction surgery alone.

Recurrence of gigantomastia is a recognized risk, particularly among pregnant women as circulating estrogens increase.\textsuperscript{33} Reoperation is the primary therapy for recurrence. A hormone assay is not indicated in a person who has normal secondary sex characteristics.\textsuperscript{31} Hoppe et al.\textsuperscript{39} conducted a meta-analysis of published case reports, including 65 cases and several reviews. The authors found a significantly greater risk of recurrence in patients who underwent reduction mammoplasty as opposed to mastectomy (odds ratio [OR], 7.0), and they noted that postoperative Tamoxifen therapy can decrease recurrence rate.

Eliasen et al.\textsuperscript{40} noted changes consistent with atypical ductal hyperplasia in the surgical specimens obtained from five of nine young women who underwent reduction mammoplasty for hypertrophy. At a mean of 39 months after surgery, none showed any signs of breast carcinoma. The study suggested that ductal hyperplasia might also play a role in the etiology of breast hypertrophy.

### Gynecomastia

Gynecomastia denotes enlargement of the male breast. The pathophysiological mechanisms involve a relative or absolute excess of estrogens, a decrease in circulating androgens, or a defect in androgen receptors.\textsuperscript{41} The condition is common during puberty secondary to proliferation of breast parenchyma but usually abates after progression for 3 to 18 months. Marijuana, opiates, multiple medications, hormonal imbalances, systemic conditions (e.g., obesity, hyperthyroidism, liver disease), and exogenous hormones have all been implicated in the development of gynecomastia. Although most cases of gynecomastia are idiopathic, a thorough history and physical examination should be performed at the time of initial consultation to exclude a testicular hormone-producing neoplasm.

### ANATOMY

#### Innervation

The breasts are richly innervated laterally from the anterior rami of the lateral cutaneous branches of the third to the sixth intercostal nerves and medially through anterior branches of the second through sixth intercostal nerves. The skin of the upper pole of the breast is innervated by supraclavicular branches of the cervical plexus. The NAC is innervated primarily from deep within the breast, usually by the third, fourth, and fifth anterior cutaneous nerves and by the fourth and fifth lateral cutaneous nerves.\textsuperscript{42} Courtiss and Goldwyn\textsuperscript{43} described the lateral cutaneous branch of the fourth intercostal nerve as a “unique nerve” to the NAC.

Sarhadi et al.\textsuperscript{44} studied the nerve supply to the breast and confirmed that NAC innervation includes the third through fifth lateral cutaneous branches of the intercostal nerve and the second through fifth anteromedial cutaneous nerves off the intercostal nerve. Multiple nerves were found to supply the NAC. Most of them run on the superficial surface of the gland and coalesce under the NAC to form a plexus. The contribution by each of these nerves to the NAC varied among cadavers and within the same individual between the right and left sides. The lateral cutaneous branch of the fourth intercostal nerve contributed to the NAC in 11 of 12 cadavers. This nerve consistently showed two branches: a superficial branch supplying the NAC and a deep branch on top of the pectoralis muscle that loops around inferolaterally before passing superficially up to the NAC. This study also found
that nipple sensation was retained with either superior or medial pedicles. Nevertheless, dissection on the surface of the pectoralis fascia should be avoided to preserve as many nerve branches as possible.

It is important to document the status of nipple sensation preoperatively because many patients complain of diminished sensibility after reduction surgery. Curiously, some women claim to have increased nipple sensation after mammaplasty. This is difficult to explain on anatomic grounds and might be related to the psychological impact of improved breast contour, self-image, and self-esteem. Others conjecture that improved breast and NAC sensibility occurs because of relief from chronic nerve traction injury.45,46

**Blood Supply**

The breast tissue has a rich blood supply with contributions from the internal mammary artery medially, the thoracoacromial and thoracodorsal arteries superiorly, branches of the lateral thoracic artery, and multiple deep intercostal perforators through and below the pectoralis musculature (Fig. 1).47 Both a superficial and a deep periareolar vascular plexus are present.

As Aufricht10 noted, from a surgical standpoint, the entire breast is well vascularized and has sufficient blood supply from any direction. Nevertheless, Maliniac48 recommended preserving as many sources of perfusion as possible during reduction mammaplasty because of great individual variation in the dominant circulatory system.

le Roux et al.49 conducted an anatomic study of 16 fresh female cadaveric breast specimens to assess venous drainage of the breast. The authors found that the breast is drained by an extensive network of veins. The NAC is drained by a superficial subareolar ring of veins, which then empties into a medial and a lateral vein. Laterally, two deep veins (inferolateral and superolateral) drain into the subclavian veins. Medially, two superficial veins drain into the internal mammary system. One inferior vein drains the inferior pole at the meridian of the breast.

In a study of 28 cadaveric breasts, Würinger et al.50 showed the existence of a septum of dense fibrous tissue that connects the NAC to the pectoralis fascia at approximately the level of the fifth rib. The authors consistently found perforators from the thoracoacromial vessels, intercostals, and nerve supply to the nipple in close proximity to this septum, which also seemed to act as a suspensory sling. Excellent anatomic studies of the breast are those by Penn,12 Hester et al.,47 and Palmer and Taylor.51

**SYMPTOMATOLOGY AND INDICATIONS FOR SURGERY**

Breast size out of proportion to body habitus has a profound effect on the musculoskeletal system. Many patients complain of neck and shoulder strain, headaches, back pain, persistent rashes in the intertriginous areas, a heavy anterior chest, and occasionally paresthesias of the ulnar side of the hand. These women tend to show poor posture, with deep shoulder grooving from bra straps, stretch marks, and skin rashes and irritation beneath the breasts. In extreme cases, degenerative arthritis of the cervical and thoracic spine has been noted. Letterman and Schurter52 presented a discussion of the anatomic basis for these signs and symptoms and concurred with others that reduction mammaplasty can be curative. Findikcioglu et al.53 examined the effects of reduction mammaplasty on the thoracolumbar anatomy of 30 patients. They found that the thoracic kyphosis, lumbar lordosis, and sacral inclination angles were all significantly improved postoperatively.
The psychological benefits of restoring proportion between a woman’s breasts and her physique are difficult to quantify, but most surgeons think that they are considerable. Despite outcome studies of reduction mammoplasty documenting universally favorable results,\textsuperscript{54-62} the surgical indications for reduction mammoplasty remain unclear and subject to different interpretations by third-party payers. In the United States, this has created an environment in which detailed and specific documentation of a patient’s symptomatology is essential.

Recent studies have described the physical and psychosocial characteristics of patients with symptomatic hypermastia. Recommendations and guidelines ensuing from these studies should be adopted by the plastic surgery community and insurance carriers to dispel the current ambiguity and to standardize surgical indications.

Netscher et al.\textsuperscript{63} compared women with macromastia with age-matched normal controls and another cohort of women undergoing cosmetic breast procedures. The aim of the study was to determine whether breast size alone was responsible for the presenting complaints of neck and back pain in patients seeking breast reduction. The authors found that symptomatic hypermastia is better defined by a constellation of symptoms rather than by the volume of tissue removed. No correlation was shown between a woman’s weight and symptoms associated with large breast size. Overweight women had a symptom complex that was different from that of women with large breasts. The authors concluded that symptomatic hypermastia can be defined by a set of disease-specific physical and psychosocial symptoms not related to patient age or weight.

Gonzalez et al.\textsuperscript{61} proposed a definition of macromastia based not on the degree of breast hypertrophy but on the degree of associated upper body pain. According to that definition, a patient with bilateral breast hypertrophy who complains of chronic pain in at least three anatomic areas above the waist can be said to have macromastia. In a study of 39 patients who underwent reduction mammoplasty for symptomatic macromastia (average reduction, 753 g per breast), the authors submitted the same questionnaire to study participants and 40 female volunteers of similar age, height, and weight who had A-cup or B-cup breasts. Questions had to do with frequency and severity of discomfort and difficulty with posture, intertrigo, sleeping, breathing, and getting clothes to fit. Reduction mammoplasty diminished neck, back, and shoulder discomfort in all patients and totally eliminated pain in 25%. Improvement in symptoms after surgery was independent of patient height-to-weight ratios, casting doubt on weight loss as an effective therapy for macromastia.

Kerrigan et al.\textsuperscript{64,65} investigated the quality of life of women with breast hypertrophy. In the first study, the authors estimated a mean utility value for symptomatic hypermastia of 0.86. This was comparable to living with other health conditions such as moderate angina pectoris or a kidney transplant. In a companion study, the authors compared the health burden of women with breast hypertrophy who seek surgical treatment versus those who do not. A control group consisted of women without breast hypertrophy. The authors concluded that breast hypertrophy has a significant impact on women’s quality of life in both study subgroups. Symptoms are more important than breast volume in determining which women have the greater health burden.

In a third prospective study,\textsuperscript{66} the authors took the next logical step to assess the effectiveness of surgical breast reduction in the relief of established symptoms of macromastia. The study was prospectively designed with a surgical intervention group (179 participants) and two control groups, including a breast hypertrophy group with bra cup sizes D or larger (88 participants) and a normal control group with bra cup sizes <D (96 participants). The effectiveness of nonsurgical interventions in relieving the symptoms of macromastia was also evaluated in subgroups. Analysis showed that 50% of operative participants reported breast-centered pain all or most of the time in the upper back, shoulders, neck, and lower back preoperatively. This number decreased to less than 10% postoperatively. The operative participants and hypertrophied controls tried a variety of conservative treatments, including weight loss; however, none of the nonsurgical methods provided permanent relief of symptoms. Additionally, postoperative participants experienced significant improvement in a quality-of-life assessment. The authors concluded that breast hypertrophy has a significant impact on women’s health status and quality of life.
Additional prospective clinical studies\(^6^7\)−\(^6^9\) showed consistent benefits in health status, quality of life, and psychosocial function. Broad measurements of quality of life, health status, and individual symptoms improve significantly with surgery,\(^7^0\) including improvements in lung function after bilateral breast reduction.\(^7^1\),\(^7^2\)

Despite objective evidence that reduction mammoplasty significantly relieves symptoms of hypermastia in almost all patients, many third-party payers still consider the procedure to be of questionable medical necessity.\(^6^6\),\(^7^3\) Schnur et al.\(^7^4\) analyzed data obtained from 591 reduction mammoplasties by 92 plastic surgeons. The woman's age, height, weight, and expressed reasons for undergoing the procedure and the amount of breast tissue resected were collected for each patient. The weight of the specimen was plotted against the calculated body surface area, and the resulting relationship was expressed on a logarithmic scale. When the formula is applied, “if the woman's data plot above the 22nd percentile, her motivation is purely medical…. If her data plot below the 5th percentile, her motivation is purely cosmetic…. If her data plot between the two, her motivation is mixed and must be looked at individually.” In addition, 132 plastic surgeons were asked to provide their subjective impression of reasons for reduction mammoplasty among their patients, with the following results: 78% for symptomatic relief, 17% for mixed reasons, and 5% for cosmetic reasons.

Seitchik\(^7^5\) assessed criteria for insurance payment of reduction mammoplasty procedures and was unable to describe a single formula that could be applied to all patients. Although women of small build generally had less tissue removed than larger women, a direct correlation could not be established between specimen weight and increasing body weight. To predict which patients will receive symptomatic relief from reduction mammoplasty, it might be more appropriate to judge breast size versus body build. The author suggests a three-level, graduated scale of minimum-specimen-weight to patient-body-weight, as follows:

- 200 g/breast to <60 kg
- 350 g/breast to 61–79 kg
- 500 g/breast to >80 kg

These criteria are much less restrictive than those of most third-party payers.

Kerrigan et al.\(^6^5\) used multiple linear regression analysis to try to identify patient factors that affected outcome. None of the traditional predictors used in evaluating this patient population—height, weight, body mass index (BMI), bra size, or weight of breast tissue resected—had a statistically significant relationship with reported improvement. Subsequently, Kerrigan et al.\(^7^6\) designed a large, prospective cohort study in an attempt to test the usefulness of the formula presented by Schnur et al.\(^7^4\) and to determine whether another method for defining medical necessity was more valid. A total of 266 women requesting breast reduction and 184 nonsurgical control participants were followed prospectively. All women completed health-related quality-of-life questionnaires—such as the Short Form 36, EuroQol, McGill Pain Questionnaire, Multidimensional Body-Self Relations Questionnaire, and the Breast Related Symptom Questionnaire—both preoperatively and 6 to 9 months postoperatively. This more recent analysis established that women reporting at least two of seven physical symptoms (upper back pain, rashes, bra strap grooves, neck pain, shoulder pain, numbness, and arm pain) all or most of the time were improved to a greater extent than women reporting fewer than two symptoms all or most of the time. The authors noted that this criterion is more valid than the formula presented by Schnur et al. and current third-party payer reimbursement policies.

Attempts have been made to identify indications for breast reduction other than the classic musculoskeletal symptoms described above. Ducic et al.\(^7^7\) reviewed 84 consecutive patients who underwent reduction mammoplasty over a 5-year period. Fifty-eight patients preoperatively reported chronic headaches. Postoperatively, 53% of the 58 women reported >50% reduction in headache frequency and severity, with 21% stating that their headaches resolved completely. The authors proposed that excessive breast weight could result in tension on the trapezial and other posterior neck muscles, which in turn causes traction on the occipital fascia and leads to impingement of the occipital nerves. This is not yet an accepted indication for breast reduction but might be the focus of future investigations.

The above-mentioned studies represent the current information regarding indications for reduction
mammaplasty. These studies, in contrast with previously published data, are well-designed prospective analyses of randomized series that definitively show the disease process and medical indications for reduction mammaplasty and validate the effectiveness of reduction surgery in the treatment of symptomatic hypermastia. The key will be to disperse the data to third-party payers and have them adopt the guidelines as they are making determinations regarding coverage of breast reduction procedures.

GOALS OF SURGERY
The goals of reduction mammaplasty are as follows:

- improve symptomatology
- decrease the volume of breast tissue while maintaining the vascular and neural integrity of the NAC
- reposition the NAC in its anatomically correct position
- create a predictable, stable, and better breast shape
- provide parenchymal support to the breast for longevity
- discard excess skin while reducing tension on the closure (avoid using the skin to create the breast shape)
- minimize scars

OPERATIVE PLANNING AND AESTHETIC CONSIDERATIONS
Considering the different heights, weights, body shapes, and physical conditions of women seeking reduction mammaplasty, no single breast dimension will serve all. The surgeon should consider the patient's own desires regarding ultimate breast size and shape in light of her age, physique, and surgical limitations. Although all candidates for reduction mammaplasty want to have their breasts made smaller, most do not want their breast size to be out of proportion with their build. Aufricht, Penn, and Berry cautioned against trying to recreate a virginal appearing breast; the goal of reduction should be a smaller but slightly pendulous, mature-looking breast. It is not realistic to expect that reduction surgery can create a virginal-appearing breast. This is hardly likely or even possible. Most breast reduction techniques will naturally result in a pendulous, mature-looking breast without specific surgical manipulation.

The underlying principles of mastopexy and breast reduction surgery have evolved significantly in the past 10 years. Breast “bottoming out” occurs most frequently with inferior pedicle techniques in which much of the postoperative breast shape depends on skin tension. Modern techniques incorporate additional parenchymal support without relying on skin tension or skin shaping. With these modifications, bottoming out can be controlled for excellent long-term results.

Breast Size after Reduction
With changing and evolving reimbursement practices by health insurance companies, surgeons often are required to estimate the magnitude of anticipated reduction preoperatively. A minimum of 500 g per breast often is arbitrarily associated with medical necessity by third-party payers. To estimate the magnitude of the reduction that will be necessary to meet the surgical goal, patients are measured while sitting with arms by the side and wearing a bra. Regnault and Daniel stated that the amount of tissue that is to be removed during reduction mammaplasty depends on the ratio of breast girth to chest girth. Chest girth is determined first and equals the circumference of the chest measured under the arms. Breast girth is measured across the nipples and should encompass the fullest part of the breasts. If breast girth exceeds chest girth by 1 inch, the cup size is A; 2 inches, B; 3 inches, C; 4 inches, D; and 5 inches, DD. Regnault and Daniel offered the following rule-of-thumb for how much tissue will have to be resected to attain each cup size reduction:

<table>
<thead>
<tr>
<th>Chest circumference (inches)</th>
<th>resect (grams)</th>
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<tr>
<td>32–34</td>
<td>100</td>
</tr>
<tr>
<td>36–38</td>
<td>200</td>
</tr>
<tr>
<td>42–44</td>
<td>300</td>
</tr>
<tr>
<td>44–46</td>
<td>400</td>
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This technique was evaluated and modified by Turner and Dujon in 2005. The authors pre- and
postoperatively studied 75 patients who underwent bilateral reduction mammoplasty. They found that the formula suggested by Regnault and Daniel tended to underestimate the weight of reduction. To improve accuracy and precision, the authors changed the formula by measuring the chest girth at the level of the IMF (the manufacturers’ means of brassiere sizing). The following formula was then devised and validated for weight of tissue to be removed per cup size reduction desired (Table 1). Other authors have suggested formulae for calculating breast volume and predicting weight of reduction based on measurements of nipple position, breast mound dimensions, use of sizers, water displacement, and photobiostereometric analysis. Patients continue to voice desired outcomes in terms of cup size. Interestingly, mass media and scientific literature suggest that the vast majority of women wear the wrong size bra. In one study, only 13% of women being evaluated for reduction mammoplasty were wearing a cup size suggested by standard bra-fitting formulae. Thus, considering the lack of a universally standard brassiere size, these figures should be taken only as an estimate when formulating the surgical plan. Operator experience and surgical technique will have much more influence on final breast size than any of the above-mentioned resection guidelines.

Nipple Size and Position

Many women who have breast hypertrophy also have widening of the areola that can be a particular source of distress. Normal areolar diameters range between 38 and 45 mm. If indicated, areolar narrowing should be discussed with the patient preoperatively.

Much of the available information regarding breast aesthetics is based on finding the ideal position for the NAC. Penn attempted to define the ideal location based on a study of 150 healthy adult women, 20 of whom had “aesthetically perfect” breasts. He noted that the suprasternal notch and nipples form the corners of an equilateral triangle whose limbs are approximately 21 cm in length. This was also the distance from the midclavicular line to the nipple. The average nipple-to-IMF distance was 6.9 cm (Fig. 2). Tebbets argued that the ideal nipple-to-IMF measurement varies based on the base diameter of the breast, ranging from 7 cm (for base diameters of 11.5 cm or less) to as much as 10 cm for larger breasts (base diameter > 16 cm).

A useful maneuver for determining final nipple location is to measure from the level of the inframammary crease at the midclavicular line (Pitanguy’s point). With one hand under the breast and the other hand over it, pressure is applied until fingertips “touch” across the breast parenchyma. The point where the fingers would meet is the future site of the nipple. Placing the nipple at the level of the IMF will produce a breast with grade I ptosis. Final adjustments in position of the NAC can be made at the end of the procedure, after the breast volume has been reduced and the new breast contour has been established.

A number of studies have attempted to define the aesthetically perfect breast in terms of linear, angular, and volumetric parameters. A series of anthropomorphic breast measurements are obtained, analyzed, and correlated into a formula with which to calculate appropriate breast size based on torso parameters and to preoperatively predict desired breast shape and volume. This concept is not in widespread clinical use at the present time. Although anatomic landmarks and measurements are the starting point in planning reduction mammoplasty, no single formula, protocol, or technique is appropriate for every patient.

PERIOPERATIVE AND ANESTHETIC CONSIDERATIONS

Antibiotic Prophylaxis

Two recent meta-analyses examined the effectiveness of prophylactic antibiotics in reduction mammoplasty. Platt et al. conducted a meta-analysis of perioperative antibiotic prophylaxis and wound infection after breast surgery. A total of 2587 surgical procedures were tabulated, including excisional biopsy, lumpectomy, mastectomy, reduction mammoplasty, and axillary node dissection. The authors found that antibiotic prophylaxis significantly reduces the risk of postoperative wound infection after breast procedures (P = 0.03). Similarly, Hardwicke et al. analyzed 2971 patients who underwent reduction or augmentation mammoplasty and found that a single preoperative dose of antibiotics halved the rate of surgical site infection, which was a statistically significant
finding \( (P = 0.02) \).

In contrast, Serletti et al.\(^9\) reviewed 106 consecutive reduction mammaplasties. Forty-seven of the patients in that study received antibiotics, and 59 did not. The authors documented no decrease in wound infections when prophylactic antibiotics were administered. Individual risk factors of obesity, smoking, age older than 55 years, and large reductions were evaluated and found to be unaffected by antibiotics. Wound infections and delayed healing were statistically more common in obese patients and large reductions, respectively.

Veiga-Filho et al.\(^9\) conducted a prospective controlled study of the use of antibiotics in patients undergoing reduction mammaplasty. The authors sequentially assigned 100 patients to receive either no antibiotics or perioperative intravenously administered antibiotics and 6 days of orally administered antibiotics. Postoperative evaluations were blinded to the use of antibiotics. The authors found a statistically significant difference \( (P = 0.03) \) in the rate of surgical site infections between the two groups (2% versus 14%).

In a nationwide survey from the United Kingdom,\(^9\) 80% of the surgeons performing aesthetic breast surgery and 62% of the surgeons performing reduction mammaplasty routinely use prophylactic perioperative antibiotics. At the author's institution in the United States, perioperative antibiotics are routinely used in all breast cases.

### Autologous Blood Transfusion

Some surgeons advocate autologous blood transfusion to speed recovery after reduction mammaplasty.\(^9\) Clugston et al.\(^9\) assessed the justification for autologous blood use in reduction mammaplasty and found no objective benefit in terms of postoperative hemoglobin level, length of hospital stay, or economics. Considering the multiple techniques available to minimize blood loss intraoperatively,\(^9\)

#### Table 1

<table>
<thead>
<tr>
<th>Breast Cup Size</th>
<th>Chest Circumference (in)</th>
<th>Amount of Tissue to Resect (g)</th>
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<tbody>
<tr>
<td>A (breast = chest girth)</td>
<td>32–34</td>
<td>115</td>
</tr>
<tr>
<td>B (breast &gt; chest by 1 in)</td>
<td>36–38</td>
<td>215</td>
</tr>
<tr>
<td>C (breast &gt; chest by 2 in)</td>
<td>40–42</td>
<td>315</td>
</tr>
<tr>
<td>D (breast &gt; chest by 3 in)</td>
<td>44–46</td>
<td>415</td>
</tr>
</tbody>
</table>

#### Figure 2

Ideal breast measurements of the adult woman. \( MCP \), midclavicular point; \( SN \), sternal notch; \( MHP \), midhumeral plane; \( INP \), ideal nipple plane; \( IMF \), inframammary fold. \( Modified \text{ from} \ Penn.\(^9\)\)
autologous blood transfusion during breast reduction surgery does not seem warranted. The use of dilute epinephrine-containing wetting solutions for tissue resection at our institution has made blood transfusions a thing of the past and only a remote possibility in the face of a life-threatening complication.

**Local Anesthesia with Intravenously Administered Sedation**

Zukowski et al.\(^9\) presented a series of 50 patients who underwent reduction mammoplasty while under local anesthesia with bupivacaine, lidocaine, and epinephrine and sedation with midazolam and fentanyl. The average total resection was 1372 g. All except one patient tolerated the procedure well and did not recall any discomfort; 28 of 50 patients returned home the same day. No complications related to the anesthesia occurred, and the authors concluded that breast reduction can be safely performed using this anesthetic technique.

Patient selection should be based on whether a woman is a candidate for intravenously administered sedation, not on the amount of proposed resection. Bostwick\(^10\) recommended liposuction for patients whose breasts are heavy laterally, beyond the actual lateral breast margins. In such cases, a higher volume of local anesthesia might be needed for patient comfort.

Ample evidence indicates the feasibility of breast reduction surgery under local anesthesia with intravenously administered sedation. The author prefers to use general anesthesia for enhanced patient safety, especially regarding the airway when the patient is sitting up during intraoperative breast assessment. Which anesthesia technique to use is a decision made by the operating surgeon and the anesthesiologist.

**Outpatient Reduction Mammaplasty**

Several recent studies have assessed the feasibility of outpatient reduction mammoplasty. Buenaventura et al.\(^1\) reported a series of 338 patients who underwent reduction mammoplasty over a 3.5-year period. Two hundred eighty-six (85%) of the women were operated on as day-surgery patients, and the other 52 (15%) were inpatients. The inpatients were older (by an average of 8 years) and tended to need larger resections (7140 versus 6000 g) compared with the outpatients. No substantial differences in the incidence of complications were noted between the two groups, and satisfaction with the outpatient experience was universal. Outpatient surgery resulted in a savings of $1500 to $2500 per case.

Davies et al.\(^12\) and Short et al.\(^13\) also reported performing safe and cost-effective reduction mammoplasties in outpatient settings. Scott et al.\(^14\) described their transition to an efficient model for outpatient breast reduction, leading to high patient satisfaction and cost-effectiveness.

Outpatient breast reduction has almost become the rule rather than the exception. Despite multiple favorable reports, outpatient surgery is not indicated for all breast reduction candidates. A subset of patients at high risk of intraoperative and postoperative complications are best served by a 23-hour period of observation in the hospital.

**SURGICAL PROCEDURES**

**Minimally Invasive Techniques**

**SAL and Ultrasound-assisted Lipectomy (UAL)**

Originally proposed by Grazer\(^15\) in 1984 and Teimourian et al.\(^16\) in 1985, suction-assisted lipectomy (SAL) is now used either in combination with surgical excision or by itself for the correction of male and female breast hypertrophy. Teimourian et al. recommended SAL as an adjunct to conventional reduction mammoplasty. The authors particularly advocated suction lateral to the anterior axillary line to decrease fullness in the area without extending the incision. Lejour and Abboud\(^17\) reported the use of liposuction to limit the scar burden of excisional techniques.

**Liposuction Alone (Suction Mammaplasty)**

Matarasso\(^18\) stated that suction mammoplasty has the following advantages over traditional techniques:

1. Avoids pedicle and flap dissection
2. Leaves smaller scars
3. Minimally disturbs the supporting dermal and parenchymal structures
4. Does not interfere with the blood supply to the NAC
5. Preserves existing sensation
6. Facilitates small adjustments to achieve bilateral symmetry
7. Preserves lactation

Initial reports by Matarasso and Courtiss suggested that ideal candidates for suction mammaplasty are those who have a normally positioned NAC without significant widening, good skin quality, and predominantly fatty breasts. With continued experience, the authors expanded their indications for isolated SAL. Courtiss found that by using special cannulae, breast parenchyma itself could be removed. Additionally, he noted that when the weight of the breast is supported manually, the NAC rises and the areolar diameter decreases after SAL alone and does not require direct excision, as he had previously thought.

Matarasso expanded the original criteria to include patients with slightly ptotic and pseudoptotic breasts. He presented a 10-year follow-up on SAL in the treatment of large breasts and advocated SAL for breast hypertrophy caused by fatty tissue. However, he noted that it is often difficult to determine whether the cause of breast hypertrophy is fatty tissue or breast parenchyma based on preoperative examination. Subsequent experience has shown a need for more wetting solution than previously prescribed (1.5 mL of wetting solution per 1 mL of aspirate). Matarasso reported a preference to under-correct postmenopausal patients, but premenopausal patients are corrected to their desired size. Complications were minimal and consisted of a rare temporarily inverted nipple.

The liposuction reduction technique was even more broadly applied by Gray, who reported his 3-year experience with 204 patients. The maximum volume removed was 2250 mL. Reported complications were one seroma and one hematoma. Substantial skin retraction and satisfactory results in grades I, II, and III ptosis were achieved. The average improvement in nipple position (in relation to the sternal notch) was 6 cm. Gray concluded that SAL was an effective treatment that eliminated patient symptoms as effectively as conventional surgery with a lower risk of complications and a quick return to normal activities. Patients should not expect to go from grade II or III ptosis to a non-ptotic breast; nevertheless, in certain patients this technique has proved to be a useful option. Although static measurements often change, critical assessment of patient photographs indicates no change in the grade of ptosis from preoperative status in these patients.

Despite the increasing popularity of UAL techniques in body contouring, they have not been widely adopted for breast reduction surgery. No evidence suggests that ultrasound energy is a potential carcinogen, but concerns regarding postoperative monitoring and screening for malignancy might have slowed its clinical application. Surgeons who choose it should be well advised to obtain exhaustive informed consent from their patients, in which all unknown factors and potential risks of the UAL procedure are detailed.

Di Giuseppe reported his experience with UAL suction mammaplasty in 120 patients. He argued that ultrasound energy permits selective removal of fat cells while sparing local vessels, nerves, and supporting connecting tissue. Additionally, retraction of breast skin and parenchyma is attributed to low-frequency ultrasound treatment in the superficial layers of the subcutaneous tissue, contributing to ptosis correction.

The foremost concern about the traumatic removal of fat from the breast is whether it might potentially induce microcalcifications. No calcifications were shown by mammograms obtained as long as 2 years after suction mammaplasty and 4 years after UAL mammaplasty. Another caveat is the difficulty in obtaining an accurate histological diagnosis of the SL specimen. Because the suctioned tissue has been extracted under pressure and macerated in the process, it can be difficult for the pathologist to examine it microscopically. In an invited discussion, a pathologist argued that the process is unlikely to distort the tissue for histopathology but that localization of the lesion remains problematic. This should be discussed with the patient preoperatively, and if any suspected regions of breast tumor exist or if a strong family history of breast cancer is present, surgical reduction is deemed more appropriate. Separate pathological specimens should be sent from each breast so that findings can be localized to the right or left side.

In counterpoint, Lejour doubted whether ptosis can be accurately corrected with suction alone, and suggested that “liposuction as an isolated procedure should
be proposed to elderly women with heavy breasts who want a fast and safe operation without too much in the way of cosmetic considerations.” According to Lejour, the benefit of liposuction is in its ability to enhance the quality of the result by limiting the scars from excision.

SAL can play a role in breast reduction surgery in some patients. As always, patient selection is likely the most important factor in the eventual success of the procedure.113

**Gynecomastia**

Until recently, the mainstays of treatment in gynecomastia were direct excision of the hypertrophied breast tissue and/or SAL.116–118 The success of SAL was often limited by the dense fibrous parenchyma of the breast. Unlike conventional liposuction, however, UAL might be ideally suited to the treatment of gynecomastia because it effectively removes fibrous mammary tissue and maximizes skin retraction.41 In the event that UAL does not sufficiently remove all hypertrophied breast tissue, a surgical consent for direct excision should be obtained preoperatively and the patient should be appropriately counseled.

Rohrich et al.41 offered an algorithm for the clinical management of gynecomastia (Fig. 3). Gynecomastia is classified into four grades on the basis of breast volume and degree of ptosis. The authors recommended UAL as the first line of therapy for all grades. Secondary revision is most often needed for grades III and IV.

Rohrich et al.41 and Hodgson et al.119 separately reported their retrospective results with this technique. Both groups reported high patient satisfaction with chest contour and surgical scars, minimal complications (none), and rare need for reoperation.

**Endoscopic Reduction Mammaplasty**

Faria-Correa120 described his experience with endoscopic reduction mammaplasty/mastopexy in 56 women. Patients were chosen on the basis of having good skin elasticity without a large amount of excessive skin and first- or second-degree ptosis with or without hypertrophy. Breast tissue resection was accomplished through an arthroscopic shaving device from the base of the glandular cone. The shaver works like a punching aspirator. After appropriate excision, the gland is affixed to its new position with transcutaneous sutures and the patient is fitted with a continuous modulator bra that must be worn for at least 3 months. The endoscopic reduction technique is suitable only for very small reductions in young women who meet the author’s criteria of excellent skin elasticity and minimal ptosis.

**EXCISIONAL TECHNIQUES**

All excisional reduction mammaplasty techniques involve three basic maneuvers: 1) removal of excessive breast tissue, 2) resection of redundant (or extra) skin to accommodate a reduced glandular volume, and 3) repositioning of the NAC.

**Transposing the NAC with Various Pedicles**

Ideally, the NAC is relocated with its intact neurovascular supply. The three common ways to do this are as follows: 1) on a parenchymal pedicle; 2) on a dermal pedicle; 3) on a dermal-parenchymal pedicle, which is the most common. When a dermal-parenchymal pedicle is used, the NAC is left attached to its surrounding dermis and underlying parenchyma to preserve the subdermal plexus that nourishes the areola. The true benefit of the dermis is probably improving venous drainage rather than providing arterial perfusion.

In some instances, it is not practical or possible to relocate the NAC on a neurovascular pedicle. Instead, the complex is removed from the breast and replaced in its new location as a free graft. This technique is described in more detail below.

Many variations of pedicle design have been conceived. Pedicles can be based superiorly, superomedially, medially, superolaterally, laterally, inferiorly, and on dual bases running horizontally or vertically. All these pedicles maintain adequate vascularity to the NAC regardless of how different the parenchymal resection patterns are.

Although the pedicles are variable, the majority of these parenchymal resection techniques are paired with a Wise pattern11 (“keyhole”) skin excision in the lower pole, resulting in “inverted T” incisional scars. Short-scar
techniques use different skin excision patterns and are discussed in the section called Short-Scar Techniques later in this monograph.

**Horizontal Bipedicle Techniques**

In 1960, Strömbeck\textsuperscript{13} described a technique of breast reduction that involves horizontal and vertical resection of glandular tissue from the lower pole, transposing the nipple to its new location on a horizontal bipedicled flap of dermis. When operating on fatty breasts (more difficult), or when the nipple was inverted or under traction, Strömbeck\textsuperscript{121} divided the lateral pedicle to create a single, medial, dermal-pedicle transposition flap. The author warned against wide undermining of the skin and breast parenchyma, advocated preoperative markings following the Wise pattern, and used the IMF to guide nipple placement. The Strömbeck reduction mammoplasty procedure has been criticized on the basis of a difficult nipple inset, awkward maneuvering of the pedicle intraoperatively, and a high incidence of nipple insensitivity postoperatively.

**Lateral Pedicle Techniques**

Skoog\textsuperscript{122} described an operation in which the NAC was elevated on a lateral dermal pedicle. The procedure was essentially a modified Strombeck resection, with most of the reduction in the inferior and medial quadrants.

Nicolle\textsuperscript{123} modified the Skoog procedure by tilting the keyhole resection obliquely toward the lower lateral
quadrant of the breast and carrying the nipple on a lateral dermoparenchymal pedicle, instead of a purely dermal pedicle as originally described by Skoog.122

Botta and Rifai124 detailed their refinements of the Skoog lateral pedicle technique for reduction mammoplasty. Of note is that they limited nipple transposition to a maximum of 15 cm to lessen the risk of nipple necrosis. The new nipple position is 20 to 23 cm from the suprasternal notch, and the angle of divergence between the vertical limbs of the skin excision is 90 to 110 degrees depending on the width of the breast (Fig. 4). The complication rate reported by Botta and Rifai is similar to that reported by other authors.

Superior Pedicle Techniques

In 1973, Weiner et al.16 described reduction mammoplasty with inferior pole parenchymal resection of the Arie-Pitanguy type125,126 and nipple transposition on a superiorly based dermal flap. Many refinements in the superior pedicle technique have since been published.17,127–132 Robbins and Hoffman133 presented the results of 193 breast reductions accomplished with a superior dermoglandular pedicle technique. The operation they used is based on procedures presented by Weiner et al. and Hugo and McClellan,127 except that the nipple is transposed on a pedicle containing not only dermis but also the entire underlying breast parenchyma. Major nipple-areola slough developed in 1.4% of patients and minor slough or epidermolysis in 4.3%, primarily after large-volume reductions. Postoperatively, nipple sensation was subjectively judged as good. Six patients (eight breasts) were converted from a planned superior pedicle technique to amputation with free nipple-areola graft because of circulatory compromise detected intraoperatively. Should a graft become necessary, healthy dermis at the proposed site for the NAC is a bonus. Complications were reported as minimal. Nipple sensation was measured by subjective expression of the patient after cotton swab (crude touch) and needle prick and was uniformly rated as good.

Abramo135 described his results with breast reduction in 25 patients (50 breasts) using a modified superior dermal pedicle technique and a specifically designed keyhole pattern. The amount of tissue removed ranged from 300 to 900 g per breast. Conversion to a free graft was necessary in one case because of circulatory compromise. Complications were reported as minimal. Nipple sensation was measured by subjective expression of the patient after cotton swab (crude touch) and needle prick and was uniformly rated as good.

Matarasso and Pitanguy136 reviewed the classic Arie-Pitanguy and Pitanguy reduction techniques, which involve a superiorly based pedicle. Depending on the degree of breast hypertrophy and ptosis, the patient can be left with a periareolar vertical scar (of the Arie-Pitanguy type) or inverted T scar (after Pitanguy). Superior pedicle techniques have proved to be reliable, but the superior pedicle is limited by its inability to move the nipple longer distances, particularly in patients with significant breast hypertrophy. Further details are discussed in the short-scar section.

Vertical Bipedicle Techniques

In 1976, McKissock15 described a vertical bipedicle mammoplasty in which the inferior limb, including the NAC, contained a dermoparenchymal component. The superior flap is thinned of underlying parenchyma, and the area above the nipple is left with only dermis. The maximum pedicle length recommended for this technique is 40 cm. The inferior pedicle base is tapered laterally to recruit blood supply and help preserve sensory innervation to the nipple.

This technique has been criticized on the basis of long-term loss of projection and secondary ptosis from “bottoming out” of the dermoglandular pedicle. Additionally, the procedure often results in long inframammary scars and wide breasts.

Inferior Pedicle Techniques

Many authors—including Ribeiro,137 Robbins,138 Courtiss and Goldwyn,18 and Georgiade et al.,19,139—have described reduction mammoplasty with nipple transposition on an inferior dermoparenchymal pedicle. Breast volumes
of 300 to 2500 g can be removed safely. Mandrekas et al.\textsuperscript{140} reported a large (371 cases) and largely favorable experience with the inferior pedicle technique for reduction mammoplasty. The authors found the technique to be versatile and associated with few complications: 11.4\% overall. Of patients who became pregnant postoperatively, 72\% were able to secrete milk. Nipple insensitivity was recorded in five (1.3\%) patients. The low rate was attributed to retaining 0.5 to 1 cm of fat and breast tissue on the pectoralis major, which spared the perforating branches of the third to fifth intercostals nerves that course along the muscle surface before entering the gland.

Courtiss and Goldwyn\textsuperscript{18} described tilting the keyhole laterally to preserve the lateral cutaneous branches of the fourth and fifth intercostal nerves. Patients who had normal nipple sensation before surgery showed no change after surgery. The authors recommended a relatively short medial limb of the keyhole, no more than 4 to 5 cm long, to prevent the nipple from ending up too high on the breast.

Inferior pedicle techniques have a tendency to result in breasts with a boxy shape, hypertrophic scarring, and poor long-term projection with bottoming out. Hidalgo\textsuperscript{141} reviewed his series of 251 patients followed for more than 12 years. He emphasized the importance of sitting the patient upright on the operating table for final shaping of the skin envelope. To prevent a boxy breast, adjustments are made at the inframammary crease by analyzing the vertical breast meridians and creating the ideal inferior

Figure 4. New nipple position is 20 to 23 cm from the suprasternal notch, 9 to 13 cm from the midline. The flap for nipple transposition is based superolaterally and measures 6 to 7 cm at its base. A 2-cm margin around the areola serves to preserve the venous plexus of Haller. (Modified from Botta and Rifai.\textsuperscript{124})
pole breast shape (Fig. 5). The shape of the NAC is also evaluated with the patient upright, and the surrounding skin is excised as necessary to produce a circular contour. Hidalgo emphasized the importance of intraoperative patient positioning, hemostasis, skin flap elevation, and glandular resection in the proper planes to improve patient safety and limit complications.

In a 2002 American Society for Aesthetic Plastic Surgery survey with 554 respondents, 56% of surgeons reported using only an inferior pedicle and Wise pattern excisional technique. The inferior pedicle technique has been used extensively in the United States. Although the overall results have been satisfactory, conventional inferior pedicle techniques lack parenchymal support, and the breast will eventually bottom out. Although shortening the nipple–IMF distance can help counteract this tendency, it must be balanced against excessively tight closure and the risk of wound healing complications.

**Medial Pedicle Techniques**

The NAC can also be translocated on a medial dermoglandular pedicle. Nahabedian et al. reported their experience with medial pedicle breast reduction for severe mammary hypertrophy; 44 of 45 breasts were successfully reduced with this technique. One case involved conversion to a free nipple graft because the distal pedicle was hypoxic. The mean resection was 1604 g. NAC sensation was retained in 43 (98%) breasts. Breast and nipple projection was satisfactorily achieved in all patients.

Hall-Findlay used a medial pedicle in a vertical short-scar technique. The technique is discussed in the section Vertical Mammaplasty.

The dilemma of how to maximize vascularity of the long pedicle (by keeping it wide) while ensuring adequate tissue resection is pervasive. The alternative of free nipple graft also has specific limitations. Nevertheless, most practitioners of medial pedicle reduction techniques declare themselves and their patients to be satisfied with the results.

**Parenchymal Pedicles and Central Mound Techniques**

Parenchymal pedicle techniques have had many advocates, beginning with Biesenberger in 1931. The NAC is carried on a pedicle composed solely of the breast’s glandular tissue, without dermis. In the 1960s, Climo and Alexander suggested removing the dermal bridge while preserving the attachments of the anterior branches of the fourth through sixth intercostal arteries to the inferior parenchymal tissue. Like others, they felt that the primary circulation to the nipple originated in the chest wall. A series presented by Kaplan of 165 breast reductions using parenchymal pedicles for nipple transposition showed the versatility and reliability of this concept. The author reported few complications and excellent viability of the NAC.

Many of the parenchymal pedicle techniques involve resection of the inferior pole of the breast in a Kiel pattern, leaving the NAC to be supported by a central parenchymal pillar. These procedures are often referred to as “central mound techniques.” Closure of the lower incision molds the residual gland into a conical shape and tightens the dermal brassiere. Variations of the basic Lexer-Kraske operation have been described by Penn, Arie, Pitanguy, Rohrich et al., and Hester et al. The relevant points of the central mound technique presented by Hester et al. are schematically illustrated in Figure 6.

Other breast reduction operations that use parenchymal pedicles for nipple transposition are the Dufourmentel-Mouly mammaplasty and the Regnault B technique. Dufourmentel and Mouly described a lateral wedge mammaplasty that involves lateral excision of skin and parenchyma and nipple transposition on a superomedial parenchymal pedicle. The skin over the inferior pole of the gland is lightly undermined to allow rotation, and the nipple is placed in its new position, usually 2 to 3 cm higher and more medial than before. Excellent results can be obtained with this technique in small to moderate reductions.

Because of a propensity for under-resection, Schatten et al. added some technical details for the correction of moderate breast hypertrophy, in which case excision of parenchyma deep to the pedicle is almost always required to make the breast small enough. The nipple should be located 5 to 6 cm above the IMF, slightly lower and more lateral than expected, to compensate for postoperative settling of breast tissue in the inferior outer quadrant.
Hamdi et al. and van Deventer and Graewe described parenchymal pedicles based on preservation of Wuringer’s septum, with good results, while achieving nipple elevation as much as 17 cm and resections as large as 1980 g.

Short-Scar Techniques

Reduction mammoplasty, like many other surgical procedures, has benefited from the trend toward smaller, less conspicuous incisions. In Europe and Brazil, many well-known surgeons have performed short-scar reduction procedures since the 1960s, but only recently have these techniques become popular in the United States. Technical modifications aim to minimize the vertical and horizontal limbs of the traditional reduction operation. In general, these small-incision operations are best suited to young women who have modest to moderate hypertrophy and good skin quality.

Short-scar techniques fall into one of six categories: 1) periareolar mammoplasty, 2) vertical mammoplasty, 3) vertical mammoplasty with short horizontal extension, 4) L scar mammoplasty, 5) circumvertical mammoplasty, and 6) horizontal mammoplasty. It must be emphasized that these procedures are grouped according to the pattern of the postoperative incisional scars. A variety of pedicles and parenchymal resection methods are used, and close attention to individual technical descriptions is necessary to recognize these particulars.

Periareolar Reduction Techniques

Many clinicians attempt to camouflage the scar from the reduction procedure in the areola-skin junction. These so-called periareolar reductions, whether concentric or excentric in relation to the areola, result in a bunching of skin around the perimeter of the new areola, the diameter of which can be trimmed to match the reduced dimensions of the gland. In most cases, the visible irregularities created by the skin gatherings disappear with time. These concepts have their origin in mastopexy (for more on this topic, see the sections “MASTOPEXY” and “Periareolar Techniques”), and they transitioned easily into reduction with resection of variable amounts of breast parenchyma.

Felicio described his experience with a modified concentric periareolar reduction technique in 380 patients. The complication rate in his series was similar to those associated with other reduction techniques. The procedure works best in patients requiring small to moderate reductions of 210 to 300 g but is of limited benefit in patients who have severe breast ptosis, who have considerable amounts of redundant or lax skin, or who require large reductions.

Góes recounted the development of his current periareolar mammoplasty procedure, called the double skin technique. The operation is founded on the principle that the skin alone will not prevent early ptosis and must be supplemented by application of absorbable polyglactin or mixed mesh. The need for parenchymal support for better and longer lasting results is pervasive in the surgery performed by Góes. The basic operation involves an extensive subcutaneous dissection of the breast gland raising relatively thin skin flaps. A conservative periareolar design is drawn, being careful not to remove too much skin so that breast flattening can be prevented. The intervening skin is deepithelialized, and the breast gland is dissected. The breast parenchyma is supported with...
anterior pectoral suspension sutures, and the dermal flap is sutured to the anterior pectoral fascia. In cases with only the dermal flap, Góes fashions a “double skin sandwich” to produce a scar that will support the parenchyma for the long term. Partially absorbable mesh is placed circumferentially on top of the dermal layer to produce a skin–mesh–dermis sandwich and further reinforce long-term parenchymal support through fibrosis. The remaining gland and nipple are transposed on a central pedicle (Fig. 7).

A maximum resection of 500 g is recommended. Góes\textsuperscript{20} chronicled his 7-year experience with this technique in 254 patients, most of whom were treated for ptosis or mild hypertrophy with or without ptosis. The mesh does not interfere with mammography, and the illustrated results are excellent.

Advantages of the periareolar reduction mammoplasty include minimal scarring and shorter operating times. Critics claim that it produces a flat, under-projecting breast, primarily in the nipple-areola area. A marked tendency has been shown for the areola to widen considerably afterward from tension in the periareolar closure, which is unavoidable.

As with other short-scar techniques, periareolar mammoplasty is probably best suited to small and moderate reductions with limited skin resection and to mastopexy. In our experience, periareolar abnormalities secondary to the purse-string closure can be frequent and are more prevalent in larger reductions.
Vertical Mammaplasty

In 1964, Lassus\textsuperscript{158} began using a vertical mammaplasty without an inframammary-fold scar for all breast reductions. The technique is characterized by resection en bloc of skin, fat, and gland; transposition of the areola on a superiorly based flap; no undermining; and a vertical scar (Fig. 8).\textsuperscript{159}

Although Lassus\textsuperscript{159} most commonly used a superior pedicle for preserving NAC vascularity, he frequently used either a lateral (Skoog type) or medial (“inner flap”) pedicle if the NAC required more than 10 cm of elevation. Lassus cautioned against marking the nipple too high (based on a point 2 cm below the bisected distance between the olecranon and acromion) and emphasized that the lowermost aspect of the vertical resection should be at least 3 to 4 cm (in smaller, ptotic breasts) and up to 6 to 7 cm (in hypertrophic, ptotic breasts) above the IMF to avoid migration of the vertical scar down onto the chest wall.

With the technique described by Lassus\textsuperscript{159} the patient is placed in a near-sitting position on the operating table and breast volume and shape are checked repeatedly throughout the procedure. The inferior resection is an en bloc excision of skin, fat, and glandular tissue. Superiorly only fat and glandular tissue are resected. Re-resection and breast shaping with stitches are performed as needed. If the vertical scar is too long at the end of a case, a small triangular skin excision producing a very short horizontal scar will correct the problem. Lassus\textsuperscript{22} typically waited 3 to 4 months before performing the revision.

Reviewing his 30-year experience with the vertical mammaplasty technique in 710 patients, Lassus\textsuperscript{159} reported zero necrosis when the nipple was transposed no more than 9 cm. The long-term stability of the surgical results was attributed to vertical wedge resection of the breast parenchyma, which simultaneously eliminated the ptotic volume and increased projection. This is in marked contrast to a horizontal amputation, which can produce a flat breast. The main complication associated with the procedure is scarring: 20 hypertrophic scars developed among the patients presented by Lassus, and four of them were severe, distorting the breast and marring the aesthetic result. The author did not comment on postoperative nipple sensitivity.
The vertical mammaplasty presented by Lejour and Abboud\textsuperscript{107} is a modification of the technique presented by Lassus\textsuperscript{159} involving wide skin undermining and often combined with liposuction. In a review of her results in 100 patients (192 breasts), Lejour\textsuperscript{160} described wide undermining of the skin of the lower pole to allow gathering of the skin along the vertical closure. After resection of glandular tissue inferiorly, medial and lateral breast pillars are closed with internal sutures. It is this parenchymal support that Lejour suggests leads to a stable and long-term breast shape with adequate projection. The skin excess is incorporated in fine wrinkles between sutures (Fig. 9), and the single scar is kept short. Adjunctive liposuction decreases the breast volume and facilitates transposition of the superior dermal-parenchymal pedicle. As with the technique presented by Lassus, the initial postoperative result is overcorrection with pronounced superior pole fullness that settles inferiorly into the final shape.

Lejour\textsuperscript{21} reviewed the complication rate in a series of 250 consecutive patients (476 breasts) who underwent breast reduction by the vertical mammaplasty technique between 1990 and 1998. Relatively few complications occurred, seroma being one of the most common (5%). Delayed wound healing was observed in 5.4% and was directly related to size and fat content of the breasts. The author recommended a simpler operation for obese patients—liposuction with skin reduction alone or free nipple graft.

A number of authors described variations of the Lejour vertical mammaplasty.\textsuperscript{161-164} Pickford and Boorman\textsuperscript{163} recounted their experience with breast reduction by vertical mammaplasty in 25 patients. The average reduction was 624 g per breast (range, 205–1180 g). The mean follow-up duration was 12 months. Minor complications occurred in 40% of the patients and included delayed wound healing, fat necrosis, and wound infection. In a similar group of patients treated with inferior pedicle reduction, the minor complication rate was 41%. Revision surgery for persistent inframammary skin folds was needed in 20% of cases. Sensation of the NAC was poorly preserved in most patients. Favorable features of the technique were no skin or nipple necrosis, applicability to all degrees of mammary hypertrophy, very good aesthetic results, and high patient satisfaction.

Tapia et al.\textsuperscript{164} presented a report of 54 cases of vertical reduction mammaplasty/mastopexy. The average resection was 421 g per breast. Complications occurred in 10% of cases and were considered minor: seroma, hematoma, abscess, wound dehiscence, and puckered nipples. There was no instance of NAC necrosis. A steep learning curve for preoperative marking was noted, with a 21% asymmetry rate. The most likely cause of secondary revisional procedures was a tendency for skin folds to form along the vertical scar. The scar and any cutaneous folds and puckers improved considerably over time in patients younger than 45 years. The most favorable results were obtained in cases of severe ptosis and moderate to severe hypertrophy.

Asplund and Davies\textsuperscript{162} reported a modification of the vertical mammaplasty with which the nipple was transposed on a medially based flap (Fig. 10A) for average reductions (mean, 608 g) and on a parenchymal pedicle (Fig. 10B) for smaller reductions (mean, 380 g). The rationale is that transposing the nipple on these pedicles minimizes tension around the areola and results in a more cosmetically acceptable scar.

Hall-Findlay\textsuperscript{144} reported a simplified vertical reduction mammaplasty based on the Lejour technique. The author’s goal was to shorten the learning curve with the procedure and make it more reliable for large breast reductions. The modifications include a medial or lateral
Figure 9. Preoperative markings and dissection in a combined vertical mammoplasty and liposuction procedure. (Reprinted with permission from Lejour.160)
Figure 10. A, markings for medial flap transposition of the NAC in breast reduction with a vertical scar. B, markings for parenchymal flap transposition of the NAC in breast reduction with a vertical scar. (Modified from Asplund and Davies.162)

dermoglandular pedicle, no skin undermining, rare liposuction, and no pectoralis fascia sutures (Fig. 11).

In further discussion, Hall-Findlay165 reported her preference for a medial pedicle because it improves sensibility and facilitates more glandular resection laterally—one of the heaviest regions of the breast. Medial and lateral breast pillars are closed inferiorly to cone the breast and the skin is redraped over restructured parenchyma rather than relying on skin tension to support the gland. Hall-Findlay credits parenchymal support for the longevity of the result. The outcome in 400 breasts—average reduction per breast of 525 g—was excellent in terms of breast shape and projection and lasting improvement.

Other studies134,166–169 confirmed similar rates of postoperative complications and satisfaction between Wise pattern (inverted T) and vertical scar techniques, but secondary revisions are more common with vertical scar techniques. In a single-surgeon, prospective, randomized trial comparing Wise pattern with vertical scar reductions (>100 patients in each group), patient satisfaction with postoperative scars and overall aesthetic results was significantly greater in the vertical mammaplasty group even though 11% required subsequent revisions, compared with 0% in the Wise pattern group.168 Of note, Akyurek170 presented his experience with the use of liposuction to contour the tissue at the IMF, thereby reducing his revision rate from 22% to 5%.

Vertical Reduction with Short Horizontal Scar

Shin et al.171 described their “short submammary scar” (S-S-S) technique of reduction mammaplasty and reported their results in 15 patients who underwent
reduction of 150 to 750 g per breast. The operation is a modification of the vertical mammaplasty presented by Lassus,\textsuperscript{172} which transposes the nipple on a superiorly based dermoglandular pedicle. Parenchymal resection is performed at the inferior, medial, and lateral poles of the breast. A portion of the inferior pole is stripped of all subcutaneous tissue and tacked up at the new IMF, effectively converting breast skin to chest-wall skin. The elongated keyhole pattern, corresponding to the vertical limb of the incision, is closed after NAC transposition.

The horizontal limb of the scar is 3 to 11 cm in length. After vertical closure, the dog-ear formed at the new submammary fold is corrected by converting it to a short, inverted T-shaped scar. Patients are fitted with compression bras postoperatively to flatten any wrinkles along the vertical and horizontal limbs of the incisions; the bras are to be worn for approximately 2 months. The authors report one case of partial fat necrosis, one epidermal cyst, and one patient with drug fever. All responded to treatment without further sequela. Nipple sensitivity was not addressed.

Many (≤20%) vertical mammaplasty techniques require transverse excision in delayed or immediate fashion.\textsuperscript{144,163} The difference lies in the initial approach, whether the transverse excision is a part of the preoperative plan.

**L. Scar Reduction Mammaplasty**

Bozola\textsuperscript{173} described a reduction operation similar to the B technique presented by Regnault\textsuperscript{150,151} that eliminates the medial horizontal limb of the usual inverted T closure, creating an L-shaped scar instead. The patients presented in the report by Bozola were all relatively young women who required mild to moderate reductions and needed <7 cm of nipple transposition.

Chiari\textsuperscript{174} described a modification of the L short-scar mammaplasty in 178 patients (355 breasts). The average amount of reduction was 380 g per breast (≤1300 g), and the average follow-up duration was 3 years. The technique presented by Chiari entails a series of fairly complex preoperative markings based on a woman’s chest and breast size rather than a predefined pattern. The results illustrated in the article are excellent, with good residual breast shape and a relatively short L scar. The author reported only one partial areolar slough, no hematomas, and “consistently preserved” sensation to the NAC. Four patients required secondary liposuction for residual fullness or asymmetry.

Born\textsuperscript{175} modified the L reduction mammaplasty and reported his results in 1994. His technique involves two inferiorly based skin flaps, a medial triangular flap, and a lateral rectangular flap. After reduction of the inferior pole of the breast, the flaps are interdigitated to leave an L-shaped scar with the horizontal component extending laterally. The author presented his results in a series of

![Figure 11. Modified vertical reduction mammaplasty technique (medial pedicle). (Reprinted with permission from Hall-Findlay.)\textsuperscript{140}](image-url)
275 patients (524 breasts) whose average reduction was 775 g per breast. Most operations were performed on an outpatient basis. Complications included three hematomas requiring surgical evacuation, eight seromas requiring drainage, and seven instances of scar hypertrophy, six of which proved to be temporary. Preoperative nipple sensation was retained or subsequently returned “in the majority of cases.” Before-and-after photographs show excellent cosmetic results, with good breast shape and short scars. Patient satisfaction was reported to be high.

Chiari recounted his 12-year, 887-patient experience with the L scar mammaplasty, which has been overwhelmingly favorable. He reported achieving good breast shape and excellent breast projection with the technique. Since 1999, he has tried to emphasize the vertical variant of the procedure, which has simplified markings and involves a larger transposition pedicle. This produces slightly larger breasts, shorter L scars, and no surplus skin in the inferior pole.

### Circumvertical Mammaplasty

“Short scar” techniques often can be difficult in patients requiring large reductions. Several authors combine the principles of vertical and periareolar techniques to produce shorter scars when performing larger reductions.

Mottura reported his experience with a circumvertical technique in 96 patients over 10 years. The technique repositions the NAC on a parenchymal pedicle. A wedge-shaped inferior glandular resection allows for medial and lateral breast pillar closure inferiorly to cone the breast. A periareolar excision removes skin excess and is closed in purse-string fashion. Mottura reported favoring this technique for breasts requiring 400 to 1000 g of reduction. Approximately 10% of patients required revision of the vertical scar, and 7% needed revision of the circumareolar scar. The aesthetic results are reported to be acceptable.

Hammond described the short-scar periareolar inferior pedicle reduction (SPAIR) mammaplasty. This technique consists of an inferior pedicle with medial, superior, and lateral glandular resection, parenchymal suspension sutures, permanent periareolar purse-string suture, and inferior pole skin resection with “tailor tacking” intraoperative adjustments. Hammond reported his results in 98 patients. The average resection was 632 g, and the average follow-up duration was 7.6 months.

The preoperative markings for the SPAIR mammaplasty are relatively straightforward. The technique shares many attributes with the inverted T, Wise pattern, inferior pedicle reduction but produces a more aesthetic breast shape and better scars. The ideal candidate for the SPAIR mammaplasty needs a unilateral mastopexy or a second-stage breast reconstruction. Breast reductions of <800 g are preferable early in a surgeon’s learning curve. The overall experience with the procedure has been extremely positive, and Hammond continues to use it for reduction mammaplasty and mastopexy.

Spear et al. described their preferred technique in an excellent review of vertical mammaplasty techniques. The technique is a modification of the SPAIR mammaplasty presented by Hammond, which uses a superomedial dermoglandular pedicle to carry the NAC, as does the Hall-Findlay technique. Intraoperative adjustments and tailor tacking allow for inferior skin excision and a purse-string periareolar closure. Occasionally, a small horizontal excision is necessary to remove a large inframammary dog ear.

### Horizontal Mammaplasty

Other reduction mammaplasty techniques have been developed to eliminate the vertical scar in favor of periareolar and horizontal IMF scars. Yousif et al. based the NAC on either a central parenchymal mound or an inferior pedicle, moved it superiorly to its new position, and inset it through a circular incision. The standard Wise pattern markings were made preoperatively only to estimate the degree of horizontal tightening of the skin envelope that was needed to increase projection. The skin of the vertical limbs was gathered at the inferior pole. Most of the resulting “standing cones” disappeared during the first few months after surgery, although four of 20 patients had to undergo revision under local anesthesia. The authors noted that this technique works best in patients requiring moderate to large reductions and vertical repositioning of the NAC of at least 7.1 cm.

Savaci reported a horizontal reduction mammaplasty technique that transposes the nipple on a central cone of breast parenchyma. In 13 patients who
underwent this technique, no complications occurred except for a single instance of “ecchymosis” of the skin flap. Nipple sensitivity was retained in all patients, and one patient was able to subsequently breast-feed her infant. The short-term aesthetic results were good.

Lalonde et al.\textsuperscript{182} described a modification of the traditional “inferior pedicle, inverted T” breast reduction that does away with the vertical scar by eliminating resection of the central wedge of skin and tissue between the native areola and the site for the new areola. The glandular resection is performed normally, and the breast flap is redraped over the inferior pedicle and closed in the inframammary crease. The areola is inset tension-free with a circumareolar closure. The authors stated that this technique is best suited to breasts with significant ptosis (>5 cm of skin between the lower edge of the new areolar hole and the superior edge of the pigmented areola). Photographic results from 10 consecutive patients are presented and depict moderate reduction and aesthetic final breast shape. To date, the horizontal mammaplasty technique has not become widely popular.

**Large-Volume Reduction Mammaplasty**

Most currently available surgical techniques for dealing with large-volume breast reductions require free grafts of the nipple. In an effort to leave the neurovascular pedicle to the nipple undisturbed, Saccomanno\textsuperscript{183} described a technique for the correction of moderate to large mammary hypertrophy that involves an equatorial pattern of glandular resection. The preoperative markings are simple and straightforward, and the surgical technique involves creation of a retromammary pocket, vertical resection of the entire lower pole, and horizontal glandular resection of the upper breast. After the skin edges are approximated, the nipple is transposed upward on infolded subareolar tissue. Final skin closure creates vertical and IMF scars. In the 35 cases reported, the amount of tissue removed per breast ranged from 500 to 1950 g. No NAC necrosis or loss of sensation was reported, and the illustrated aesthetic results were very good.

**Free Nipple Grafting**

In women who have gigantomastia or severe hypertrophy, attempts to preserve the blood supply and nerves to the nipple during reduction mammaplasty are often limited by the length of the pedicle that would be needed to carry the NAC. Such a large pedicle is impractical, and these patients are probably better served by breast reduction with free nipple transplantation.

Amputation of excessive breast tissue and free nipple grafting significantly shorten the surgery time and decrease morbidity and mortality from the procedure.\textsuperscript{184} For this reason, other candidates for free nipple graft are women 1) who have a systemic disease that could affect vascularity of the skin flaps or impair wound healing, 2) who have had previous operations on or irradiation to the anterior chest that might have injured the vessels to the skin flaps or pedicle, and 3) for whom a long period of anesthesia might be detrimental.

Thorek\textsuperscript{185} originally described free nipple graft reduction mammaplasty in 1922. The technique has been criticized for producing a poorly projecting breast.\textsuperscript{186} Oneal et al.\textsuperscript{187} reported their experience with breast amputation and nipple graft in 11 women who had pronounced macromastia and a variety of medical disorders. With the authors’ method, a standard keyhole pattern is used and the circumscribed area is deepithelialized. Everything below the horizontal limbs of the keyhole is resected down to pectoralis fascia and removed en bloc down to the IMF, leaving a superior rise of tissue along the breast meridian. The conical shape of the breast is restored by reapproximating the vertical limbs of the keyhole while imbricating the dermis, and the nipple is grafted into its new position. In their series, no perioperative medical complications and no surgical complications occurred except for one partial skin slough at a distal papule; graft take was otherwise good. The authors recommended amputation of overprojecting papules to minimize this complication. Universal mild to moderate hypopigmentation of the areola was noted and was particularly severe in dark-skinned patients; nipple-areola tattooing was recommended. Two years and 9 months after surgery, the aesthetic results were good and patient satisfaction was high. Advantages of this technique are a shorter operating time, reduced blood loss, and less risk of wound healing complications, because it involves no skin undermining that might threaten flap viability.

Koger et al.\textsuperscript{188} reported a case of gigantomastia treated with reduction mammaplasty combining free
nipple transplantation and an inferiorly based parenchymal flap to enhance nipple projection. The patient had >2200 g resected from each breast. An inferiorly based inverted pyramid of glandular tissue was carefully dissected and transferred superiorly to fill the central void of the breast. Good mound projection and contour were obtained.

Casas et al.\textsuperscript{189} attempted to maximize breast projection after reduction mammaplasty with free nipple graft. The hallmark of their technique is an inverted T, Wise pattern reduction with 7-cm vertical limbs. After inferior pole resection, medial and lateral breast pillars remain and are sutured together, recruiting tissue centrally. The intersecting point of the inverted T is secured to the fascia of the pectoralis major muscle with a three-point suture. If more projection is desired, the vertical limb is lengthened and the distal portion is deepithelialized and tucked under the central mound (Fig. 12). Suction-assisted lipectomy is used to contour the excess medial and lateral breast parenchyma. This further improves the conical shape and minimizes resection of excess skin. The upper end of the vertical limb is closed with a superior dog-ear flap, contributing to nipple projection. A tie-over bolster relieves pressure over the papule of the nipple graft, which is defatted at the deep dermal level. The authors reviewed a 7-year, 25-patient experience with this technique. Mean follow-up duration was 36 months. They reported excellent projection and contour and better longevity of results than achieved with other nipple-grafting techniques.

Of particular importance for all free nipple grafting techniques is inevitable nipple depigmentation, especially in dark-skinned women. Depigmentation can be minimized by thinning the nipple graft in the periphery. With time, repigmentation will occur to variable degrees, although a central pale area will remain in most patients. Tattooing may help somewhat, but pigment fading is to be expected.

All potential problems should be discussed with the patient preoperatively. Despite these drawbacks, nipple grafting remains an excellent option for women with gross hypermastia. Patients with severe symptomatology are seldom bothered by nipple hypopigmentation and claim marked improvement in their quality of life after breast reduction.

Another option is reduction mammaplasty with immediate or delayed reconstruction of the NAC by techniques used in postmastectomy reconstruction. This eliminates depigmentation and can provide a symmetric, aesthetic result.

**TECHNICAL NOTES**

Reduction mammaplasty is an operation for which the fine technical details of planning and execution are the most important variables in determining the outcome of the surgery. Until recently, most published reports focused on the orientation of the circulation to the nipple and omitted the specific details that make the difference between an average result and an aesthetically superior one. The following suggestions for improving postoperative breast shape have been drawn from the experience of many authors.

**General Pearls**

- The nipple should be centered on the future breast, not on the existing one.
- When inferior pedicles are used, the nipple–IMF distance will lengthen with time, so the preoperative nipple–IMF distance at 3 and 9 o’clock should equal the postoperative nipple–IMF distance at 6 o’clock—approximately 8 to 12 cm.
- The lateral IMF incision must define the lateral border of the new mound. A common mistake of the young surgeon is to follow the IMF where the existing redundancy is, which places it too low and lateral. This results in a postoperative incisional scar located on the chest wall rather than within the fold of the breast and/or a boxy appearance to the breast. The lateral IMF incision should therefore rise out of the existing fold to form the new breast border.
- In planning an inferior pedicle reduction, one should remember that the medial and lateral radius of the breast will not change much. It is most efficient to fashion the pedicle first and to remember that
symmetry in final breast shape and size relates to what is left behind, not what is removed.

- Once the pedicle has been fashioned, nipple viability should be checked before thinning of the breast flaps. If there is a question about nipple viability, the operation can be converted to a free nipple graft and the pedicle can undergo débridement to the appropriate level without compromising breast volume. If the breast flaps are thinned first and nipple viability subsequently becomes questionable, particularly on the second breast, postoperative volume discrepancy is inevitable.

- Closure should include parenchymal sutures. The initial deep closure must establish the lateral extent of the mound to ensure appropriate inframammary scar location. Deep parenchymal tacking sutures fix the lateral part of the breast precisely and permanently and help avoid a boxy breast afterwards. Short vertical limbs do
not prevent superior nipple migration and bottoming out, but parenchymal support does.

- Fast-absorbing barbed sutures have been shown to reduce closure time without increasing the complication profile.  

- Similarly, topical skin adhesives have been shown to reduce closure time without compromising safety, although it is unclear whether they are cost-effective.

- Any axillary fullness must be addressed by either direct excision or liposuction. Failure to deal aggressively with this area will spoil the aesthetic result.

Nipple Position

- Most surgeons recommend placing the nipple 18 to 23 cm from the suprasternal notch, which postoperatively will result in a nipple at the level of the IMF (Pitanguy’s point). The nipple should probably be placed slightly lower in mature, fatty breasts, and higher in young patients with firm, glandular breasts.

One of the most difficult problems to correct is a nipple that is too high. In addition, the surgeon should fight a natural tendency to place the nipple slightly lateral to the apex of the newly formed breast cone.

Wise Pattern Pearls

- As the angle of the Wise pattern keyhole widens, the skin margins at the inferior aspect of the T become increasingly difficult to approximate. Wide angles might be appropriate in older patients with largely fatty breasts that can be relatively easy to mold and shape into a cone. They are not indicated in young women with primarily fibrous breasts. Wide angles in the young patient population result in high-tension closures with frequent wound healing complications and widening of the incisional scars.

- McKissock warned that an excessively wide angle produces a tight closure and a flat-bottomed appearance to the breast. He advised narrowing the keyhole to produce lower pole fullness postoperatively.

- The amount of parenchymal resection is not affected by the angle of the keyhole but by how far the nipple is moved.

- The concept of using the skin to shape the breast is now outdated. Sagging at the inferior pole in an inferior pedicle breast reduction is a function of parenchymal support, not tightness of the skin closure.

- As with a wide vertical limb angle, short vertical limbs lead to tension at the scar and higher risk of wound healing complications at the T region. Although Crepeau and Klein reported favoring a 4.5-cm medial limb, noting that it lengthens to 5.5 cm (an “appropriate” areola–IMF distance) within a year, this dogma should be questioned. The notion of keeping the vertical limb of an inferior pedicle breast reduction short (<7 cm) to minimize inferior parenchymal descent should be abandoned. In young patients, vertical limbs of 8 to 10 cm might be required to accommodate a safe closure and limit wound healing problems or cosmetic detriment.

- Several authors described leaving a small dog-ear at the three-cornered closure of the inverted T (Fig. 13), reasoning that this extra bit of skin places healthy tissue at the “corner of ischemia” and tends to decrease the cranial pull of short lower limbs by anchoring the closure to the chest wall.

Axillary Fullness

- Hypertrophic breasts typically are wider than normal, primarily laterally. The breast tissue appears to extend upward into the axilla without a well-defined IMF. Excision of subcutaneous tissue in the lateral
quadrant of the breast (Fig. 14) and re-tacking the skin to the chest wall might be indicated to narrow the base of the reduced breast and enhance projection.

- Hypermastatic women with a large amount of axillary fullness extending around to the back present a difficult problem. Liposuction can be tried, but full correction usually is impossible; the patient should be advised of this preoperatively.

Breast Contour and Avoiding the Boxy Breast

- Most of the volume reduction should be in the lateral quadrants.
- Primary excision laterally, combined with a new IMF extending laterally to the anterior axillary line, narrows the base of the breast and improves projection. 197
- A longer scar is much preferable to a dog-ear fullness at the ends or to a flat-bottomed, boxy breast.
- The lateral limb of the T should be extended at a 45-degree angle onto the anterior axillary line. This shortens the lateral radius and forces the reduced breast medially.
- Parenchymal tacking sutures secure the inferior pole and pedicle to the fascia of the pectoralis major muscle superiorly and medially, contributing to a rounded effect178 (Fig. 15).

Parenchymal Support

- Lockwood198 advocates superficial fascial system suspension with 2-0 and 3-0 nonabsorbable braided nylon suture during closure for longer-lasting contour. Braided permanent nylon sutures increase local wound complications, but alternative suture choices are available that might work equally well (e.g., Ethibond [Ethicon US, LLC, Somerville, NJ] or PDS [Ethicon]).
Breast Infiltration Techniques

- Hardwicke et al. conducted a systematic review of epinephrine infiltration in breast reduction and found a decrease in blood loss, decrease in need for transfusion, and no change in operative time or complication rate.
- Samdal et al. documented the value of infiltrating dilute epinephrine for the control of intraoperative bleeding in 12 consecutive patients. Blood loss was reduced by more than 50% when compared with the non-infiltrated side. Epinephrine injection was associated with no instance of flap compromise or postoperative bleeding.
- The resection is accomplished primarily with the knife blade and involves minimal electrocautery. Other authors support similar techniques to improve hemostasis and surgical precision.

This technique has been noted to yield excellent hemostasis, a more controlled excision, less fibrosis and internal scarring, and a softer breast in the long term compared with conventional methods.

OTHER CONSIDERATIONS

Reduction Mammaplasty in Adolescents

Cerrato et al. conducted a survey of 96 adolescents with macromastia and 103 control participants. The authors found that macromastia had a significant negative impact on the health-related quality of life, self-esteem, physical symptoms, and eating behaviors of adolescents. Concerns regarding hormone-induced recurrence of hypermastia and possible sensory alterations, difficulties with breastfeeding, interference with mammography, and other changes brought about by reduction surgery compel many plastic surgeons to delay reduction mammaplasty until patients are 20 years of age or older. Young women considering reduction mammaplasty should be counseled thoroughly about potential complications of surgery and the possibility of prosis and changes in breast shape after pregnancy. Specifically, a discussion about the resulting scars and time to scar maturation is mandatory.

McMahan et al. and Evans and Ryan considered the pros and cons of reduction mammaplasty during adolescence. McMahan et al. surveyed 48 women who had undergone reduction mammaplasty as teenagers (mean age at surgery, 17.8 years). Questions regarding preoperative, postoperative, and present symptoms and physical and psychological consequences of surgery were posed. Average length of follow-up was 5.9 years (range, 1.4–20.4 years). Overall, 94% of patients were satisfied with the results of their surgery such that they would recommend it to a friend. The most common complaints were prominent scars (60%) and sensory loss (35%). Good long-term relief of pain was reported by a majority (76%–89%). Despite at least some regrowth of breast tissue in 72%, 73% of women said they were happy with their current breast size. Only one patient required reoperation for recurrent hypermastia.

Evans and Ryan evaluated 15 women who had undergone modified McKissock reduction mammaplasty as teenagers. The patients were evaluated by physical examination and telephone questionnaire. The mean age at surgery was 17.7 years, and the average total breast tissue resected was 768 g (range, 450–1601 g). Follow-up averaged 42 months. Nipple sensation was unchanged or increased in 60% of patients, and all said they were pleased with the results of surgery. Recurrent hypermastia developed in one patient and necessitated reoperation. The authors concluded that reduction mammaplasty is safe and successfully relieves psychological, physical, and emotional symptoms in adolescents. Their indication for surgery is macromastia with stable breast size for the previous 2 years in a patient who is willing to accept the scars. Occasionally, the disfigurement is so severe that they waive the requirement of no increase in breast size for 2 years, as happened in the only recurrence in their series.

One policy regarding breast reduction in adolescents is to consider surgery when breast size has been stable for at least 12 months. Urgent surgical intervention might be indicated in certain cases because of emotional or physical symptoms. The most common complaint after reduction surgery in adolescents is prominent scars, hence short-scar techniques are ideal for this population.
Repeat Breast Reduction

A second breast reduction operation is sometimes needed for a number of reasons, including recurrent symptoms, poor cosmesis, breasts that are still too large, and asymmetry. Use of the same pedicle as in the first procedure is considered safest.

Hudson and Skoll presented a review of their 11-year experience with repeat reduction mammaplasty that consisted of 16 patients (28 breasts). The mean nipple–IMF distance was 11.4 cm from an average 7 cm at the first operation. At the second surgery, two patients underwent transection of the initial pedicles; vascular compromise of the NAC developed in both. Of five patients in whom the same pedicle was used, one experienced unilateral nipple necrosis. The authors recommended reusing the initial pedicle when possible. If the original pedicle is unknown, a free nipple graft is the next best option.

Losee et al. retrospectively analyzed their results in 10 cases of secondary reduction over a 37-year period. Three patients underwent a different breast reduction technique that transected the original pedicle; two had delayed wound healing that resolved with conservative care. In contrast to other investigators, Losee et al. concluded that secondary breast reduction is safe whether it is based on the same or a different pedicle than in the first operation.

Rohrich et al. present an algorithm to guide management and surgical treatment (Fig. 16). The authors discussed the importance of recognizing malignant neoplasms as a possible cause of recurrent hypermastia. Biopsy should be performed when appropriate. Additionally, inferior wedge resection works well for patients with pseudoptosis and those who require only a small (<500 g) reduction. The primary pedicle should be used if at all possible, and free nipple grafting should be strongly considered when the primary pedicle is not known.

By contrast, Ahmad et al. performed repeat reduction mammoplasty using the vertical scar reduction technique in 25 patients and were unaware of the previous pedicle in 12 patients. No NAC necrosis occurred, and complication rates were not different when the original pedicle was known (23%) versus unknown (0%).

Breast Reduction and Breast Cancer

Breast cancer is the most commonly diagnosed cancer in women and must always be considered when evaluating and treating patients with macromastia. Surgeons should consider ordering mammography, ultrasonography, and other appropriate imaging to screen all patients (especially those older than 40 years) before performing breast reduction or other elective breast procedures.

Ozmen et al. reviewed their experience with detection of breast cancer coincidentally with reduction mammoplasty. Between 1990 and 1998, the group performed 137 reduction mammoplasties and histologically examined 274 breast specimens, revealing three breast carcinomas (1.1%). The authors commented that those rates were higher than previously reported rates for incidental carcinomas in breast reduction specimens. Their recommendations are as follows:

- Order intraoperative frozen sections of any suspicious areas.
- Perform a thorough preoperative physical examination of all patients, and order mammography for those older than 35 years.
- Send all reduction specimens for pathological examination.
- Accurately mark the specimen location and laterality.
- Have the pathologist perform histological examination as if it were a breast cancer specimen.

Subsequently, Clark et al. reviewed 562 patients who underwent bilateral reduction mammoplasty and found that 4.4% had atypical ductal or lobular hyperplasia, 1.1% had ductal carcinoma in situ, and 0.7% had lobular carcinoma in situ. Similarly, Slezak and Bluebond-Langner presented a review of 629 patients who underwent bilateral reduction mammoplasty for symptomatic hypermastia and found a 1% rate of occult carcinoma. Because reduction specimens were carefully marked, the location, size, and margin status were easily identified and patients were offered a choice of partial or complete mastectomy.

In a prospective study, Ambaye et al. found
**Figure 16.** Algorithm for recurrent mammary hypermastia. *(Reprinted with permission from Rohrich et al.)*
that increasing the sampling rate of breast reduction specimens led to an increase in pathological findings—with a 4% rate of carcinoma and an 8.4% rate of atypical hyperplasia. Pitanguy et al.\textsuperscript{215} submitted breast reduction specimens from 2488 reduction mammoplasty patients for histopathological review. The goal was to determine the frequency of breast carcinoma accidentally encountered postoperatively. Malignant tumors were present in 0.5% of all patients. Similar studies—with much smaller sample sizes—noted an incidence of invasive breast cancer at the time of breast reduction of 0.68% to 2\%.\textsuperscript{216,217}

It is wise to routinely obtain mammograms of all surgical candidates unless the patient is younger than 25 years and has fibrous breasts. In addition, yearly clinical examinations by the operating surgeon are highly recommended.

With the advent of breast-conserving treatment of malignant disease, several authors have reported using modified reduction-pattern techniques for therapeutic partial mastectomy.\textsuperscript{218–220} Clough et al.\textsuperscript{218} described a series of 101 patients treated over 15 years in which modified Wise pattern skin excisions were combined with parenchymal resections to effectuate resect small malignancies. McCulley et al.\textsuperscript{219} and McCulley and Macmillan\textsuperscript{220} presented their approach, rationale, and results in a pair of articles in 2005. Modifications in skin excision and pedicle design were made to permit resection of malignant tumors in various locations in every quadrant of the breast. In a series of 50 consecutive patients, no resections of invasive tumors were incomplete, although incomplete resection of ductal carcinoma in situ necessitated completion mastectomy in four patients (8\%). None of the patients experienced delay in adjuvant treatment, and cosmetic outcome was deemed good or excellent in 63\% and satisfactory in 33\%.\textsuperscript{219}

**Breast Reduction after Radiation Therapy**

The increasing popularity of breast conservation in the management of breast cancer has resulted in a new patient population for the plastic surgeon. Requests for breast reduction in patients who previously underwent radiation treatment for breast cancer can be expected to increase steadily in the coming years. Interaction with the surgical oncologist is desirable from the beginning. For example, patients with hypermastia and breast cancer can be treated with a combination breast reduction-lumpectomy at the initial surgery. If radiation is indicated, a minimum 6-month interval should elapse between radiotherapy and the mammoplasty for the acute vascular changes induced by the radiation to subside.

Spear et al.\textsuperscript{221} reviewed three cases of breast reduction in irradiated breasts. The authors concluded that the procedure was safe and did not interfere with mammography or cancer surveillance. They recommended designing the pedicles broader and shorter than usual and undermining or mobilizing the breast flaps either minimally or not at all.

Snyder et al.\textsuperscript{222} reported their experience with five patients, each with a history of unilateral lumpectomy and radiation, who had undergone bilateral breast reduction 2 to 6 years after radiation. The patients underwent 20 pre- and 10 postoperative hyperbaric oxygen therapy sessions. Two patients had delayed wound healing on the non-irradiated side, and two patients had delayed healing on the radiated side. All patients were fully healed by 11 weeks postoperatively.

**OUTCOME STUDIES**

It is difficult to accurately compare the results of different procedures for reduction mammoplasty. Subtle differences in operative technique can produce considerable differences in postoperative results, even when the same operation is performed by the same surgeon. Add to that the myriad variables of patient age, weight, body build, breast size, degree of reduction desired and achieved, skin elasticity, distance of superior transposition of the NAC, and other individual idiosyncrasies, and it becomes evident why a meaningful comparison of operative procedures for breast reduction that might identify one operation as superior to others is practically impossible.

A number of recent outcome studies document relief of symptoms of hypermastia with reduction mammoplasty.\textsuperscript{54–61,66–72,223} Several of the reports are reviewed in the section, Symptomatology and Indications for Surgery.

Gonzalez et al.\textsuperscript{62} reviewed 600 consecutive patients who underwent reduction mammoplasty and surveyed them with a validated questionnaire to assess their
perceptions. The study had a survey response rate of 30%, and more than 95% of patients who responded were satisfied with their outcomes and would do it again.

Blomqvist et al.\textsuperscript{223} studied the long-term changes in health status and quality of life after reduction mammoplasty. Forty-nine women participated in the study. The participants were evaluated preoperatively using the Short Form 36 questionnaire, and analysis of the data indicated significantly poorer quality of life compared with age-matched controls. Postoperatively, quality of life was much improved for all parameters measured except sleep. The improvement seemed to be long lasting. Overweight patients benefited to the same extent as did women of normal weight, a persuasive argument for reimbursement by third-party payers irrespective of breast volume resected.

Miller et al.\textsuperscript{54} presented a report of 133 patients who had average total breast reductions of 1600 g. Ninety-three percent experienced decrease in symptoms, and 62% claimed increased activity level postoperatively. The authors noted an inverse correlation between postoperative chest size and activity level. The amount of tissue removed did not correlate with outcome.

Dabbah et al.\textsuperscript{57} surveyed 185 women after reduction mammoplasty. Preoperatively, the most common complaints were shoulder grooving, back pain, shoulder pain, and neck pain. The average amount of breast tissue removed was 855 g per breast. The average patient age at the time of surgery was 40 years. Postoperatively, 97% had improvement of symptoms and 59% were asymptomatic. Infection and fat necrosis occurred in 22%, necrosis of the NAC in 4%, and unsatisfactory scars in 4%. Overall, 95% of patients were happy or very happy with the results of surgery and 98% would recommend reduction mammoplasty to a friend.

Boschert et al.\textsuperscript{58} analyzed the results of reduction mammoplasty by the inferior pedicle technique in 72 patients. The authors concluded that bilateral reduction mammoplasty can produce substantial and stable long-term reductions in breast mass, long-term control of typical symptoms of hypermastia, and notable increase in exercise and other social activities.

Davis et al.\textsuperscript{59} surveyed 406 women who had undergone bilateral reduction mammoplasty between 1981 and 1992. The mean patient age at the time of surgery was 38 years, and the average reduction was 676 g per breast. The inferior pedicle technique was used in 85% and a Strombeck mammoplasty in the others. Postoperative complications occurred in 53% (215 women). Altered nipple sensation was reported in 25%, healing problems under the breasts in 19%, bleeding from incisions in 18%, infection requiring antibiotics in 12%, and loss of nipple-areola skin in 6%. Additional surgery was required in 5% of patients. Cup size decreased an average of two sizes in 72% of the patients. Overall, 87% of patients were satisfied with their results. Of the 13% who were dissatisfied, 18% had unacceptable scars, 9% felt their breasts were too large, 9% felt their breasts were too small, 8% had breast asymmetry, and 9% had unaesthetic breast contour. The study by Davis et al. is an excellent and honest outcome study. The reader should note that breast reduction in that study was not without complications (53%). Even though 87% of the patients were satisfied with their results, dissatisfied patients were specifically unhappy about breast size, shape, and scars. As we debate current breast reduction techniques, the reader should keep in mind that patients generally are happy. Nevertheless, we should not be lulled into complacency; there is always room for improvement.

Raispis et al.\textsuperscript{60} evaluated the long-term functional results of reduction mammoplasty by the inferior pedicle technique in 177 women. Significant relief of preoperative symptoms, increased ability to exercise, and high patient satisfaction were noted. In support of these subjective findings, Findikcioglu et al.\textsuperscript{53} conducted objective measurements of thoracic kyphosis, lumbar lordosis, and sacral inclination angles both pre- and postoperatively and found marked improvements in all three angles after reduction mammoplasty.

Brown and Young\textsuperscript{224} summarized a 75-patient, 3-year experience with reduction mammoplasty. The inferior pedicle technique was performed in 59 patients and free nipple grafting in 16. The average amount of breast tissue removed was 969 g (range, 130–3300 g). Average hospital stay was 4 days. The overall complication rate was 22%, and complications were more frequent in inpatients who had larger resections. The most common complication was fat necrosis, which developed in 9% of patients; necrosis of the NAC occurred in 4%. Approximately 40% of patients received one to two units
of autologous blood. When patients were questioned approximately 8 months postoperatively regarding their feelings toward surgery, 75% said they were extremely satisfied with the result, 24% said they were satisfied, and only 1% said there were not satisfied. Patients older than 40 years experienced the greatest relief from physical symptoms of back, neck, or shoulder pain. The vast majority of patients reported psychological improvement and a better self-image, with increased participation in daily activities and ability to dress normally.

Wallace et al.225 surveyed 282 women for the occurrence of pain after various kinds of breast surgery, including 49 breast reductions. One year after surgery, the women who underwent breast reduction had the lowest incidence of pain at 22%. The subset of breast reduction patients who reported chronic pain were significantly (P < 0.05) younger (mean age, 34 years) than the remaining patients. The patients undergoing breast reduction were also more likely to report pain in a specific location than were patients in other groups, and their pain was intermittent and of short duration. The authors found the 22% incidence of chronic pain after breast reduction to be surprising but speculated that it might have been caused by transection of some intercostal and supraclavicular nerves during surgery,45 with subsequent regeneration and hyperactivity, which would be consistent with the symptomatology.

Shermak et al.226 found a correlation between increasing patient age and the risk of infection and wound healing complications. In their review of 1192 consecutive patients who underwent reduction mammoplasty, they found that patients older than 50 years had a greater risk of infection (OR, 2.7; P = 0.003) and a trend toward wound healing problems (OR, 1.6; P = 0.09).

PATIENT SATISFACTION

In 1964, Strombeck227 presented a survey of his patients that indicated better than 80% satisfaction with the results of reduction mammoplasty. In 1986, Pers et al.228 verified similar satisfaction with a survey of their own patients. Later, Serletti et al.229 analyzed the responses to questionnaires sent to 116 who had undergone reduction mammoplasty between 1974 and 1985. Only patients who had >800 g of tissue removed were surveyed. Among the procedures represented were amputations (34%), inferior pedicle techniques (28%), Skoog mammoplasty (36%), and McKissock mammoplasty (2%). Patients were asked whether they were pleased with the size, shape, and symmetry of their breasts, about relief of any preoperative symptoms, and what their attitude was toward postoperative nipple sensation. Overall, more than 90% of patients stated that they were satisfied with the results of surgery, 95% would recommend the surgery to their friends, 94% would have the procedure done again, and only 5% said that they would not. These figures are consistent with a commonly held belief that reduction mammoplasty patients are among the happiest in a plastic surgeon’s practice.

Coriddi et al.230 pre- and postoperatively surveyed 38 patients who underwent breast reduction surgery with a validated survey instrument (BREAST-Q) to assess satisfaction and quality of life. Unsurprisingly, statistically significant improvements were observed in breast appearance and psychosocial, sexual, and physical well-being.

COMPLICATIONS

General complications associated with breast reduction surgery are similar to those associated with other elective breast procedures and include pain, bleeding, infection, hematoma, seroma, and unacceptable scars. Several specific complications merit special discussion, namely vascular compromise of the NAC, loss of nipple sensation, breast-feeding changes, and interference with breast cancer screening.

One serious complication of reduction mammoplasty is damage to the vascular supply of the NAC. Confirmation of adequate nipple perfusion usually is based on clinical examination. Alternatively, the blood supply to the nipple can be ascertained by laser Doppler flowmetry (LDF). Hallock231 evaluated 31 nipples in 16 patients undergoing breast reduction and compared the quantitative flowmetric data with clinical impressions derived from skin color, capillary refill time, etc. Hallock232 measured perfusion of identical spots on the areola preoperatively and immediately after inset into its final position. If the post-inset blood flow was thought to be <50% of the preoperative value, the pedicle was
explored. Clinical methods predicted 13 failures, and LDF predicted 11. In four cases, the LDF predicted success and the clinical methods predicted failure. These were not converted to free grafts but were salvaged as viable nipples, for a better functional result than if the pedicle had been divided. The author emphasized that although LDF is not exact, it can be a helpful adjunct to clinical tests of perfusion, particularly in darkly pigmented areolas.

Roth et al. evaluated nipple perfusion before and after reduction mammaplasty in 54 patients. Laser Doppler showed that immediate postoperative nipple perfusion averaged 4.8 mL/min/100 g in patients who experienced no complications associated with surgery. In patients who experienced minor complications (n = 9) or gross necrosis (n = 3), the nipple perfusion values were 1.4 and 0.8, respectively. Values in the range of 1 to 2 mL/100 g indicate marginal perfusion, and patients should be followed closely. Values <1 signify inadequate perfusion and warrant suture removal or consideration for exploration or free nipple grafting. In contrast to the previous laser study by Hallock, which used relative values, the study by Roth et al. reported absolute Doppler values, which the authors think are more accurate. The authors recommended laser Doppler for monitoring perfusion of the NAC in cases of large reductions and in dark-skinned patients.

Perbeck et al. used LDF and fluorescein flowmetry to evaluate viability of the NAC in 16 patients undergoing reduction mammaplasty. Quantitative values for blood flow were obtained at numerous points on the areola before, during, and after surgery. LDF showed a 2.5x increase in circulation to the skin over preoperative levels after deepithelialization. When epinephrine was injected, the circulatory increase was only 1.5x the preoperative level. All postoperative measurements of blood flow were higher than those obtained 5 minutes preoperatively, suggesting a great reserve capacity for blood flow to the nipple even after the pedicle is cut.

Tracy et al. used LDF to assess the blood supply of various types of pedicles in 21 patients undergoing reduction mammaplasty. Blood flow was measured in milliliters per minute per 100 g of tissue. Areolar perfusion during the immediate postoperative period declined by 23% with the Skoog technique, by 18% with a central pedicle technique, and by 21% with an inferior pyramidal technique. The laser Doppler predicted nipple failure in a Skoog mammaplasty, and conversion to a free nipple graft was performed. Two weeks after breast reduction, LDF values were 12% below baseline (Skoog), 2% above baseline (central pedicle), and 44% below baseline (inferior pyramidal). In contrast, free nipple grafts evaluated 2 weeks postoperatively showed an increase of 89% above baseline, presumably from graft revascularization. Although the study by Tracy et al. is interesting, one must remember that these operations are especially technique-dependent and have widely varying success rates in the hands of different surgeons.

Loss of the NAC during reduction mammaplasty is a devastating yet recognized complication associated with the procedure. Hallock reported salvage of the nipple by intradermal tattooing in five patients. Because the pigment tends to fade with time, many surgeons tend to overcorrect initially by using too dark a color, and this impulse must be checked. It is far easier to bring the patient back to the office for minor touchups than to deal with a hyperpigmented areola. In general, pigment retention is much better in a reconstructed NAC than in a free nipple graft.

Several authors have found an association between BMI and postoperative complication rate. Chun et al. reviewed 675 consecutive breast reduction patients and found a significant correlation between BMI > 35 and overall complication rate (OR, 2; P = 0.004). Similarly, Chen et al. found a significant correlation between BMI > 30 and overall complication rate (OR, 11.8; P < 0.001). Henry et al. found that BMI > 32 and resection weight > 800 g correlated with wound healing complications, resection weight > 800 g inversely correlated with hypertrophic scarring, and intraoperative hypotension (systolic blood pressure < 90 mm Hg at any time during the procedure) correlated with hematoma.

Changes in Nipple Sensation

Loss of sensation to the nipple is a well-known complication of reduction mammaplasty, but some patient characteristics and reduction techniques are associated with a higher incidence of nipple insensitivity than others. Gonzalez et al. used pre- and postoperative Semmes-Weinstein pressure threshold testing to quantify
NAC sensation before and after breast reduction surgery by either the central parenchymal pedicle technique or a laterally based inferior pedicle technique. The study group consisted of 43 patients (84 breasts) whose test results were compared with control breasts (A or B cups). Overall, nipple sensitivity was lost in 9.5% of breasts and correlated with increasing breast size and corresponding amount of resection. When $<440\text{ g}$ per breast was resected, nipple sensation was retained 100% of the time. Similarly, Longo et al. found a significant decrease in static and dynamic 1-point discrimination at 4-year follow-up after superomedial pedicle reduction ($P < 0.001$).

Other authors evaluated sensation in postoperative patients after reduction for severe mammary hypertrophy correlated increased volume of resection with decreased NAC sensibility. Makki and Ghanem, in a retrospective review of 164 patients with a mean resected volume of 1037 g, reported diminished sensation in 31%. Atterham et al. presented a series of 242 women and likewise correlated decreased sensation with increasing volume of resection. In their series, 52% showed decreased sensibility postoperatively and sensation was absent in 10%.

Other evidence suggests that breast sensibility can actually improve after reduction mammoplasty. Slezak and Dellon documented worse baseline sensation in the nipple, areola, and periareolar skin of women who had gigantomastia ($\geq$D cup) compared with the same parameters in small-breasted women. The authors postulated that this altered physiology could be related either to increased surface area of large breasts and a constant number of nerve fibers or to a stretching or traction injury to the intercostal nerves caused by the breast enlargement. Thirteen women with gigantomastia were evaluated perioperatively using vibrometers and Semmes-Weinstein testing. Six patients subsequently underwent breast reduction by amputation and free nipple graft, and four underwent McKissock mammoplasty. Of nine patients available for follow-up, six had better sensation, two were less sensitive, and one had unchanged nipple sensation. The postoperative increase in nipple sensitivity occurred irrespective of type of surgery, and the sensibility achieved after McKissock reduction did not differ notably from that after amputation and free nipple graft procedure.

Retained nipple sensation after reduction mammoplasty with free nipple graft is not a new phenomenon. Townsend found that only eight of 46 breasts had no return of sensation after nipple grafting. The time at which sensation returned was variously stated as 2 to 12 months. In another study, Temple and Hurst evaluated 45 women undergoing inferior pedicle breast reduction. Pressure threshold measurements were obtained preoperatively and at 2 and 6 weeks postoperatively using Semmes-Weinstein monofilaments. All areas tested were shown to have significant improvement at 2 weeks ($P < 0.01$). Further improvement was recorded at 6 weeks. Only 2% of breasts had nipple numbness at 6 weeks. The authors cited relief of chronic traction nerve injury as the reason for the improved sensibility.

Other investigators compared different surgical techniques, attempting to determine whether particular patterns of resection impart better postoperative sensation. Hamdi et al. investigated breast sensation in superior pedicle versus inferior pedicle mammoplasty. First, in an anatomic study, cadaver dissections were designed to quantify the nerve branches preserved in the pedicles during reduction surgery. The authors found slightly more branches in inferior pedicles compared with superior pedicles, but nerve branch preservation was generally unreliable. Anterior and lateral branches of the second through fourth intercostal nerves were found in both groups and became more superficial near the areola. Based on that finding, the authors suggested that careful deepithelialization of the pedicle is important to keep the superficial nerves intact near the areolar border.

Next, Hamdi et al. clinically analyzed breast sensation after superior versus inferior pedicle mammoplasty (18 and 20 patients, respectively). Through the use of Semmes-Weinstein monofilaments, decreased nipple sensibility in both groups was documented at 3 months. The breast skin had better sensation after superior pedicle techniques, whereas the areola had slightly better sensation after inferior pedicle techniques. At 6 months, the mean values for NAC sensation were comparable between the groups. No patient had a completely insensate NAC at 6 months, although approximately half the breasts had not regained their preoperative level of sensation.

Greuse et al. prospectively assessed breast sensitivity after Lejour vertical mammoplasty (with
superior pedicle) in 80 breasts. Assessments were conducted preoperatively and at 3, 6, and 12 months postoperatively using Semmes-Weinstein monofilaments (constant-pressure threshold), heated and cooled metal probes (for hot and cold perception), calipers (for static and moving 2-point discrimination tests), and a Biotensiometer (to measure the vibration threshold).

The authors divided their experimental group into two subgroups. Group I had sternal notch to nipple <29 cm and <500 g of tissue removed. Group II had sternal notch to nipple >29 cm and >500 g of tissue resected. In the less ptotic patients with moderate hypertrophy (Group I), an initial postoperative decline was noted in sensitivity, although all patients eventually returned to their preoperative levels. In the larger-breasted, more ptotic patients (Group II), pressure sensitivities recovered after 1 year, although sensitivity to temperature and vibration remained diminished on the NAC. Interestingly, patients did not complain of decrease in breast sensation.

Nahabedian and Mofid\textsuperscript{247} reported a series of 72 women who underwent reduction by either a medial pedicle technique (patients with severe hypertrophy) or an inferior pedicle technique (mild to moderate hypertrophy). Sensibility testing was performed using the pressure-specified sensory device (a computer-assisted tool similar to Semmes-Weinstein testing). Total sensation was obtained in 86% of the patients who underwent a medial pedicle technique and in 92% of those who underwent an inferior pedicle technique. Interestingly, quantitative testing showed lower thresholds in the medial pedicle group and increased thresholds in the inferior pedicle group compared with controls, but the findings were not statistically significant.

Changes in Breast-Feeding

Aboudib et al.\textsuperscript{248} compared the late results of reduction mammoplasty by the Pitanguy technique in 39 patients who did not become pregnant after surgery (Group A) and 11 patients who did (Group B). No significant differences were shown between the groups in terms of weight gain, breast volume, or breast ptosis. Nine women in Group B reported normal lactation and breast-feeding. The other two women reported decreased milk secretion and did not nurse. Overall, 92% of patients were gratified by the results of surgery, although women who became pregnant after breast reduction were less satisfied (81%) than those in Group A (95%). The reason for the disparity was a higher rate of ptosis after pregnancy.

Sandmark et al.,\textsuperscript{249} in their retrospective analysis of 292 patients who underwent breast reduction by six different procedures, reported that 32 of 49 women who gave birth during the follow-up period could nurse their babies. The volume of milk production varied widely and was insufficient for complete infant feeding in all cases.

Marshall et al.\textsuperscript{250} studied breast-feeding in women after reduction mammoplasty. The patients’ abilities to nurse were directly supervised, assessed, and recorded for up to 3 months after delivery. Of 30 women in the study, 28 (93%) wished to breast-feed and 22 (73%) were doing so as of discharge from the hospital. After 3 months, the number of nursing mothers dropped to 27%. All babies (except one born of a mastopexy patient) required complementary feeds. In the control population of non-reduced patients, 82% were breast-feeding at the time of discharge from the hospital and 54% were still breast-feeding after 3 months. Seven percent of babies were able to feed entirely from the breast without complementary feedings. Although no one reduction mammoplasty operation was clearly superior in avoiding transection of the lactiferous ducts, the author recommended leaving all functional breast tissue attached to the nipple in a physiological manner whenever possible.

Harris et al.\textsuperscript{251} examined breast-feeding ability and behavior in patients who had undergone reduction mammoplasty. The authors surveyed 68 women who had undergone breast reduction by the inferior pedicle technique, 20 of whom became pregnant after surgery. All 20 reported postpartum lactation; seven (35%) nursed their infants for at least 2 months, nine (45%) nursed for up to 2 weeks, and the other four did not attempt breast-feeding. Those who stopped early or did not attempt nursing did not do so because of insufficient milk production.

Brzozowski et al.\textsuperscript{252} looked at breast-feeding after inferior pedicle breast reduction. A survey of 78 women who gave birth after surgery found that 41 (53%) did not attempt to breast-feed, 14 (18%) were unsuccessful, 15 (19%) breast-fed exclusively, and eight (10%) breast-fed with formula supplementation. Postpartum breast engorgement and milk production were experienced by
31 of 41 patients who did not attempt to breast-feed. The authors concluded that breast-feeding is possible after reduction mammoplasty and that the percentage of patients who successfully do so is comparable to the proportion in the general population. These data should be reviewed with patients of child-bearing age as part of the informed consent process before reduction surgery.

**Interference with Breast Cancer Screening**

Because of the extensive dissection inherent in reduction mammoplasty, some authors have expressed concern regarding the possibility that postoperative fibrosis and scar tissue might interfere with breast cancer detection. Beer et al.\(^\text{253}\) retrospectively assessed their ability to diagnose breast tumors after reduction. Ultrasound was unreliable in differentiating breast masses. The authors recommended mammograms 3 months after breast reduction to establish a baseline from which to track postsurgical changes and emphasized that excisional biopsy should be performed if any doubt exists regarding the diagnosis suggested by the imaging modalities.

The issue of fat necrosis after breast reduction surgery continues to be debated.\(^\text{254,255}\) The use of electrocautery during mammoplasty can trigger necrotic changes in breast fat. The changes are difficult to differentiate from breast carcinoma. Surgical techniques involving parenchymal resection using the knife can lessen this problem. The clinical and radiological features of fat necrosis were described by Mandrekas et al.\(^\text{254}\).

In our experience, breast imaging techniques, including computed tomography and magnetic resonance imaging, often are used in conjunction with mammography and ultrasonography in cases in which the findings of routine screening are unclear. Additionally, less invasive techniques, including the Mammotome Biopsy System (Devicor Medical Products, Leica Biosystems, Cincinnati, OH), can be performed instead of formal excisional breast biopsy.

**MASTOPEXY**

Mastopexy or “breast lift” procedures are designed to treat breast ptosis. Mastopexy procedures mirror many of the breast reduction techniques; the main difference is less parenchymal resection with mastopexy. Like reduction mammoplasty, modern mastopexy operations produce shorter scars, more parenchymal support, and greater longevity than in the past.

**BREAST PTOSIS**

The amount of breast parenchyma changes with body weight, pregnancy, and hormonal changes. The skin envelope, supporting ligaments, and ductal structures are stretched as the parenchyma enlarges. Ptosis results when the parenchymal volume decreases and the skin envelope and supporting structures do not retract. The breast then assumes a lower position on the chest wall and youthful breast contour is lost.

Regnault\(^\text{256}\) defined mammary ptosis and classified the deformity according to the relative positions of the nipple and the IMF, as follows:

- **Grade I:** mild ptosis in which the nipple lies at the level of the IMF
- **Grade II:** moderate ptosis in which the nipple lies below the level of the IMF but remains above the most dependent part of the breast parenchyma
- **Grade III:** severe ptosis in which the nipple lies well below the IMF and is at the most dependent part of the breast parenchyma along the inferior contour of the breast
- **Pseudoptosis:** the nipple lies above or at the level of the IMF, but the majority of the breast parenchyma has descended below the level of the fold; the areola–IMF distance is increased; pseudoptosis can be seen with “bottoming out” of a reduced breast

Brink\(^\text{257}\) addressed the morphological differences among types of breast ptosis, namely glandular ptosis, true ptosis, parenchymal maldistribution, and pseudoptosis (Fig. 17). The author asserted that procedures used to address ptosis of the breast should be “type specific.”

In a follow-up to his original article, Brink\(^\text{258}\) noted that a high IMF is a minor variant of tubular breast deformity. Lower-pole breast hypoplasia mimics a ptotic breast but can be differentiated from true ptosis by the
position of the nipple (Fig. 17). Correction consists of breast augmentation, filling out the lower pole, and lowering the IMF.

HISTORY

Operations to correct sagging breasts and to reposition the nipple in a more aesthetic location in relation to the breast mound have evolved along with procedures for breast reduction, and much of the history of mastopexy parallels that of reduction mammaplasty. From a practical standpoint, mastopexy and attempts to relocate the areola are at one end of the spectrum of breast reduction surgery: the part that involves removal of <300 g of tissue and results in smaller scars. Numerous authors have contributed to the art of mastopexy. Many of the techniques developed over the years have become of historical interest only, replaced by innovative methods that provide more parenchymal support, better projection, and longer-lasting results.

Goulian originated the concept of a “dermal mastopexy” in which the excessive breast skin in the lower quadrants is deepithelialized, the NAC is relocated superiorly, and the dermis is folded upon itself during approximation of the skin edges to tighten the envelope.

Periareolar donut mastopexy techniques have been suggested for the correction of minimally ptotic breasts. The approach was initially attractive because it places the scar in the perimeter of the areola, where it can be concealed by natural anatomic boundaries. Unfortunately, the published results of donut mastopexies have been less than satisfactory, often producing flattened, under-projected breasts with early recurrence of deformity. The primary support structure in the Goulian and donut mastopexies is the skin, which does not stand up to the test of time.

CURRENT TECHNIQUES

Most of the breast reduction techniques described in the previous section of this review are also applicable to mastopexy. The principles of reliable NAC transposition, maximal parenchymal support, and minimal scars are even more important in mastopexy, which is more of a cosmetic procedure compared with reduction mammaplasty.

In patients with mild ptosis or pseudoptosis who desire larger breasts, marked improvement is possible by simply augmenting the breast volume. Patients with second- and third-degree breast ptosis who do not wish to have larger breasts will probably need repositioning of the NAC, with or without simultaneous augmentation.

Many women additionally seek restoration of upper-pole fullness, which is not obtained with many mastopexy techniques. In some instances, simultaneous placement of an implant is required to meet the expectations, but simultaneous breast augmentation-mastopexy is a difficult procedure and should be approached with caution.

Surgical Goals

The goals of mastopexy surgery are as follows:

1. Reliable NAC transposition to an aesthetic position on the breast mound
2. Recreation of a pleasing breast shape

Figure 17. Different types of breast ptosis. (Reprinted with permission from Brink.)
3. Production of optimal scar quality; short-scar techniques are preferred when possible; mastopexy procedures trade scars for improved breast contour; patients should be informed in detail, preoperatively, about scar placement and quality.

**Periareolar Techniques**

Modern periareolar techniques combine the donut mastopexy approach as noted above with parenchymal remodeling to improve projection and to promote longevity. In 1990, Benelli described his “round block” technique for the correction of sagging breasts. With the technique, a concentric, oval area surrounding the areola is deepithelialized (Fig. 18).

The breast skin is undermined only at the lower pole, leaving the NAC on a wide, superiorly based dermoparenchymal pedicle. The large glandular flap beneath the areola is split vertically, and each wing is tacked to the periosteum of the fourth or fifth rib on the opposite side of the breast, creating a crisscross sling of parenchyma. A nonabsorbable purse-string suture is placed at the level of the dermis around the outer perimeter of the incision; tightening the suture narrows the diameter of the periareolar skin. Any excess can be resected at the time of closure.

In 24 of 32 patients undergoing mastopexy, de Benito and Sanza added implant augmentation to the round block technique presented by Benelli. The authors stated that a silicone prosthesis was indicated to ensure adequate breast volume and improve postoperative contour. The implant produced a lasting “filling” of the upper breast pole, and less subsequent drooping occurred because the crossing flaps acted as an internal dermal brassiere. Most visible scars were eliminated. An under-projecting NAC could be avoided by leaving extra length (6.5 cm) between the nipple and the IMF instead of the 5 cm that Benelli recommended. Patients in whom the nipple had to be relocated upwards for no more than 7 cm and those who required reduction of <500 g had the best outcomes from the procedure. Resection of a skin donut no larger than 10 cm in diameter was conducive to a good result, as was the use of a subglandular implant even at the expense of a greater reduction.

The experience reported by Brink parallels the above. In a series of 17 patients who were classified as having true ptosis, the best aesthetic results were obtained with a combination of Benelli’s round block mastopexy and subglandular augmentation mammoplasty. Brink reported a preference for creating a crescent-shaped skin incision (Fig. 19) to minimize tenting at 12 o’clock, which strictly avoids undermining the inferior half of the breast to preserve Cooper’s ligaments. The NAC is moved superiorly based on a purely parenchymal pedicle, and a simultaneous subglandular augmentation mammoplasty is performed through the periareolar incision. The implant fills out the inferior pole of the breast and lowers the superiorly displaced IMF. Complications associated with the procedure reported by Brink were minimal and were related primarily to stretching of the areolar complex and associated hypertrophic scarring. Subdermal sutures prevented stretching but caused unattractive protrusion of the areola.

![Figure 18](image-url)
Figure 19. Crescentic incision for areolar translation in mastopexy. (Reprinted with permission from Brink.257)
Dinner et al. reported addressing the “pouty” areolar deformity problem as follows. After extensive undermining of the central dermal parenchymal pedicle and final repositioning of the nipple, a series of four braided nylon sutures are placed as a purse string in the dermis 4 to 5 mm from the skin edge. The deepithelialized area is then stretch-anchored by a series of transcutaneous sutures placed at the 12, 3, 6, and 9 o’clock positions. The suture is passed through the skin, through the peripheral margin of deepithelialized zone, and back through the skin. It is then tied over a bolster under moderate tension. According to the authors, the refinement stretches the dermis around the areola and minimizes areolar pseudoherniation. They recommended it for the correction of tubular breasts and for total mastectomy with immediate reconstruction using a circular skin incision for the approach.

de la Fuente and Martin del Yerro described modification of the periareolar mastopexy with immediate implantation in nine patients from ages 23 to 55 years. The deformities represented included mild to moderate ptosis (n = 5); postmastectomy reconstruction in need of contralateral breast contouring (n = 2); sequela of reduction mammaplasty (n = 1); and hypoplastic tuberous breast (n = 1). The authors emphasized placement of a submuscular implant and avoided the areolar pseudoherniation associated with periareolar techniques by using a nonabsorbable purse-string suture in the peripheral dermis of the deepithelialized area. They noted that although temporary flattening and under-projection are common after surgery, patients who underwent simultaneous implant augmentation progressively improved with time.

Periareolar techniques have clearly improved with modifications that permit parenchymal remodeling for increased support. However, we still find it difficult to preserve or restore adequate projection with these techniques. The best results are obtained in patients with minimal ptosis.

Vertical Scar Techniques and Inverted T Scar Techniques

Vertical scar and inverted T scar techniques parallel the reduction mammaplasty techniques discussed previously. The vertical techniques presented by Lassus, Lejour, Hall-Findlay, and Hammond work equally well for mastopexy, if not better. Vertical techniques can be applied to patients with all degrees of ptosis, but inverted T and Wise pattern excisions are commonly used in patients with severe ptosis. Rohrich et al. reviewed current concepts and the evolution of the short-scar mastopexy techniques.

Improving Breast Projection in Mastopexy

Several modifications of mastopexy techniques have been proposed to improve breast projection. Projection in mastopexy is accomplished by several maneuvers:

- Use the native parenchymal thickness and then compression of the remaining glandular tissue to produce coning. This is true of almost every mastopexy procedure in some form. Coning is easily produced, but getting it to last is a challenge. Closure of inferior breast pillars is the most secure way to maintain this “compression” over time.
- Perform parenchymal stacking, such as the Graf-Biggs procedure (see below).
- Include mastopexy plus implant.

Graf et al. reported a technical variant that produces better long-term upper-pole fullness and shape to breasts after mastopexy or reduction surgery. Briefly described, a dermoglandular, inferiorly based chest wall flap is transposed superiorly beneath a pectoralis loop and is suspended by the sling of muscle (Fig. 20), producing parenchymal stacking, upper pole fullness, and breast projection. Some concern has been voiced regarding the placement of breast tissue beneath the pectoralis major muscle, but it has not been an issue in the experience of Graf et al. The standard procedure results in a periareolar scar and a vertical scar that extends laterally. In patients who have poor skin elasticity and excessive laxity, an inverted T scar might be indicated. The inferiorly based chest wall flap maneuver can also be incorporated into other mastopexy techniques.

Another variation drapes a 2-cm-wide periareolar dermal cloak for glandular support in mastopexy. The
shape of the flap corresponds to the initial skin pattern of the mammaplasty and is pedicled to the NAC. Once parenchymal reshaping is accomplished, the dermal cloak is firmly secured to the pectoralis major and the glandular tissue.

According to Gulyás, advantages of the dermal cloak include a round, central, projecting nipple; compression of the glandular breast tissue; redefinition of the NAC position; and long-term glandular support. Disadvantages include longer operative time, increased risk of dermal cysts, and the reality that the dermal cloak does not replace glandular remodeling.

Caldeira and Lucas reported a similar modification that uses flaps of pectoralis major muscle to enhance support of the breast. In addition to improved shape and projection, the authors noted a decrease in postoperative scar widening by allowing the muscle to support the weight of the breast. Flowers and Smith described a flip-flap mastopexy that creates a wide, superiorly based parenchymal flap deep to the vertical bipedicle for nipple transposition (McKissock type). The flap is anchored to the pectoralis fascia at the level of the second rib with 2-0 polyglactin sutures (Fig. 21). The flip-flap mastopexy allows reliable relocation of the nipple and breast tissue while reducing tension on the skin flaps. The technique can be coupled with a breast implant where indicated.

In an effort to support the lower pole of the ptotic breast, Svedman deepithelialized a crescentic area of skin just below the inframammary crease and dissected a lower thoracic fasciocutaneous flap. With this method, the flap is folded over the caudal half of the breast gland to form a fasciocutaneous sling for the inferior pole of the breast (Fig. 22).
Blood supply to the flap is principally via lateral intercostal arteries and terminal branches of the internal thoracic artery and from epigastric arteries at the level of the sixth rib. Svedman\textsuperscript{269} reported that the flap contributes 25 to 80 mL of volume to the breast and obviates the need for a prosthesis. Follow-up at 3 and 6 months documented early stability of the fasciocutaneous cup; i.e., the nipple–IMF distance did not change substantially, although the distance between the sternal notch and the IMF had increased by approximately 1 cm at the 3-month visit. This caudal shift of the IMF was not noticed by patients, however.

Rubin and Khachi\textsuperscript{277} reported using a standard Wise pattern skin incision with an inferior pedicle, but with their method, they de-epithelialize the pedicle and the medial and lateral triangles of the Wise pattern. They then fold in the medial and lateral tissue to the inferior/central pedicle to create a dermal sling and provide some “auto-augmentation.” Next, the authors suspend the dermis to the pectoralis fascia to further improve breast position and projection. Similarly, Colwell and Breuing\textsuperscript{278} reported the use of AlloDerm (Acelity, San Antonio, TX), a cadaveric acellular dermal matrix, as an internal dermal sling to control breast shape, position, and base width.

As is true with reduction surgery, many techniques work well and there is not one best operation for all patients. Other considerations are the breast shape that a certain mastopexy is likely to produce and the particular circumstances of the case. For example, inferior pedicle techniques tend to lower the IMF, whereas superior pedicle or medial pedicle techniques (Lassus,\textsuperscript{22,159,172} Lejour,\textsuperscript{21,27,160} Hall-Findlay,\textsuperscript{144,165} Hammond\textsuperscript{178}) cause the IMF to rise. As another example, in the event of a contralateral breast-matching procedure after breast reconstruction, a mastopexy without projection might be desirable. In that situation, an inferior pedicle technique minimizes parenchymal stacking and avoids excessive coning.

Furthermore, many of the breast reduction techniques presented in the previous section are applicable to mastopexy. In particular, the short-scar mammoplasty techniques, including those presented by Gôes,\textsuperscript{20} Lassus,\textsuperscript{158} Lejour,\textsuperscript{160} Hall-Findlay,\textsuperscript{144} and Hammond,\textsuperscript{178} can be applied to mastopexy. No one technique has clear advantages over the others. It is recommended that plastic surgeons critically assess results with various techniques
and develop and refine a preferred method to produce the best breast shape with longer lasting results for mastopexy procedures.

THE TUBEROUS BREAST

According to Rees and Aston, the tuberous breast is a truncated gland deficient in both vertical and horizontal dimensions. The base of the breast is constricted, and the areola is disproportionately large, producing an apparent herniation of the breast tissue into the areola (pseudoherniation).

Numerous techniques have been described to correct tubular breast deformity. Several authors have advocated periareolar or donut mastopexy for correction. The skin flaps are undermined for a short distance, and the breast tissue is allowed to telescope inward, which shortens the protruding, elongated gland but does nothing to widen the base.

In 1987, Dinner and Dowden indicated that the constricted base of a tubular breast is primarily caused by relative skin deficiency. The authors suggested vertical skin release with interpolation of an inframammary flap to expand the base diameter.

Versaci and Rozzelle listed the objectives of surgery for correction of tuberous breasts as follows:

- Expand the circumference of the breast base.
- Expand the skin of the lower hemisphere of the breast.
- Release the skin tightness at the breast-areola junction.
- Lower the IMF.
- Increase breast volume.
- Reduce the size of the areola and correct its herniation.
- Correct the breast ptosis if needed.

Versaci and Rozzelle noted that they favor tissue expansion for increasing skin volume and reported their experience with seven patients (10 breasts) using a combination of separate expanders and implants or the Becker 50/50 expander-implant. The authors recommended a two-stage approach. At the first stage, the tissue expander is inserted; at the second stage, the expander is exchanged for a permanent implant (or, if a Becker device, the fill port is removed) and the areola is reduced. Complications that occurred in the series were few, and the illustrated results are as good as can be expected when dealing with this difficult problem.

Substantial constricted tuberous breast deformities are best treated with a staged procedure including initial expander placement. The use of an inflatable implant expander is a viable option, particularly for a patient who has a mild to moderate deformity for whom adequate correction might be achieved with early postoperative overexpansion and second stage port removal in the office.

The plastic surgeon should be particularly aware of mild tuberous or constricted breast deformities presenting for breast augmentation. Patients with mild tuberous or constricted breast deformities who present for breast augmentation are frequently unaware of their anatomic deficiencies and abnormalities. Not only should these be indicated, but specific surgical techniques should be directed toward correcting the deformities. For mild constricted breast deformities, a periareolar approach is preferable, as is choice of implant that offers more inferior pole projection. Many of the mild tuberous breast deformities are adequately corrected in one stage but might require breast parenchymal scoring and IMF lowering for adequate correction.

BREAST ASYMMETRY

Developmental breast asymmetry is not uncommon. Mild disparities in breast size are of little consequence to most women, but severe asymmetries can be the cause of both physical discomfort and psychological distress. Asymmetrical breasts not only impair a woman’s self-image but also make proper fitting of clothes and undergarments extremely difficult.

Sandsmark et al. reviewed the postoperative course of 87 patients who sought surgical relief of breast asymmetry. Fifty-four (62%) of the women were treated by reduction mammaplasty or mastopexy alone, and the other 33 also received an implant. Overall, 90% were satisfied with the results of surgery, and patient satisfaction...
was not significantly different between those who received an implant and those who did not. The authors did note more frequent problems and more postoperative procedures needed for correction in patients with implants than in those without.

In a similar study, Kuzbari et al.²⁸⁵ analyzed the long-term results of 30 patients treated for developmental breast asymmetries with a variety of procedures, including bilateral or unilateral reduction mammoplasty, unilateral reduction with contralateral mastopexy or augmentation, unilateral reduction or unilateral augmentation, bilateral augmentation with unilateral mastopexy, and unilateral augmentation with chest wall reconstruction. Patients were interviewed and examined 3 to 16 years after surgical correction. The purpose of the study was to assess which operative techniques yield the best outcomes over time and whether patient age at time of surgery is a factor. The preconception was that postponing surgery until the breast matured at age 18 years or so would provide a more definitive, longer-lasting effect. Patients who underwent bilateral reduction mammoplasty or unilateral reduction mammoplasty with contralateral mastopexy had the most satisfactory long-term results. Patients who underwent surgery after age 18 years fared slightly better than those who did so when they were younger, but the difference was not significant. The authors concluded that it is not always justifiable to delay surgery in adolescents with severe asymmetry of the breast. In general, patients were very happy with their results.

NIPPLE HYPERTROPHY

Hypertrophy of the nipple is an uncommon condition with a strong familial tendency. The hypertrophy typically begins after puberty, intensifies with pregnancy, and endures past menopause. It is independent of breast size.

Regnault²⁸⁶ reviewed the treatment of nipple hypertrophy and proposed correction by cylindrical resection of skin and hypodermis, leaving the ducts intact (Fig. 23). Sperli²⁸⁷ described a complex technique for functional reduction of nipple height and diameter. With this technique, the ducts are again preserved.

Although duct-preserving procedures are enticing and are indicated in any patient with the possibility of future child bearing, many women with nipple hypertrophy are finished having children and duct preservation is not critical. For this subgroup of patients, simple and transverse nipple amputation with purse-string closure yields simple, reliable, and predictable results for correction of nipple hypertrophy.

![Figure 23. Technique of nipple circumcision. (Modified from Regnault.²⁸⁶)](image-url)
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