

Breast Reduction

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Learning Objectives: After studying this article, the participant should be able to: 1. Identify the anatomy of both the vascular supply and the innervation to the breast to design the appropriate pedicle in breast reduction. 2. Understand various approaches to breast reduction to be able to maximize both functional and aesthetic results. 3. Understand each step in the operative procedure to be able to provide consistent predictable results in breast reduction.

Summary: The objective with breast reduction surgery is to reposition the nipple, remove excess parenchyma, and tailor the skin to fit the new shape. This is a CME article meant to provide an overview of principles while trying not to provide a single practitioner viewpoint. The article includes a brief history, a review of the anatomy, and patient selection. The preoperative markings and operative technique for both inverted-T and vertical approaches are detailed. Postoperative care and potential complications are included. (*Plast. Reconstr. Surg.* 136: 531e, 2015.)

Overly large breasts are a burden. Numerous methods over the years have been designed to reduce their size and weight, but volume reduction alone is not enough. The goal today is to not only reduce size but also create a pleasing shape and, if possible, preserve sensation and function using a skin incision pattern best suited to the individual patient.

HISTORY

As with any procedure that does not have one ideal method, the history of breast reduction is replete with different procedures—all of which have their limitations.¹⁻²⁰ An important advance was made in recent history when Robert Wise²¹ in 1956 designed a skin resection pattern adapted from a brassiere design, which became known as the inverted T (Fig. 1). Significant advances in pedicle techniques were made by Pitanguy²² in the 1960s, who introduced the superior pedicle; McKissock²³ in 1972, with his description of a vertical bipedicle; and Robbins²⁴ in 1977 and Courtiss and Goldwyn²⁵ in 1977 (Fig. 2), who introduced the inferior pedicle. These pedicles were adapted to the Wise skin resection pattern and were taught to plastic surgery residents around the world.

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A focus on eliminating the horizontal scar length using the superior pedicle was popularized by Lasus,^{26,27} Marchac and de Olarte,²⁸ and Lejour et al.²⁹ This approach also enhanced breast shape by reducing the boxy appearance that sometimes occurred with the inverted T. The vertical skin incision pattern has been adapted to inferior,³⁰ medial,^{31,32} superomedial,^{33,34} and lateral pedicles.^{35,36}

When suction lipectomy became popular in the 1980s, this method of volume reduction was adapted to the breast to avoid the direct parenchymal resection approaches.³⁷⁻³⁹ This significantly reduced interference with blood supply and sensory innervation, allowed some elevation of the nipple and tightening of the skin, but is limited to patients with significant fat content of their breasts.

IMPORTANT NEUROVASCULAR ANATOMY

Embryologically, the breast develops as a fourth intercostal space structure, and it has an artery and venae comitantes that come up generally between the fourth and fifth ribs, originating

Disclosure: *Neither author has any financial conflicts to disclose.*

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Fig. 1. (Above) The pattern as described by Robert Wise in 1956 was designed from a brassiere. (Below) When the inferior wedge is removed and the pattern closed, the result is a cone shape. The pattern was designed for the skin resection pattern but is also a good design for the vertical approach. It is a good design for the parenchyma that is left behind. It is important to close both the skin and the parenchyma without tension. Skin will stretch more easily than parenchyma, but tension will change the shape with time. (From Hall-Findlay EJ. *Aesthetic Breast Surgery: Concepts & Technique*. St. Louis: Quality Medical, 2011. Image used with permission.)

in the internal mammary vascular system.^{40–43} The superficial blood supply comes mainly from the internal mammary artery as well, with contributions from the superficial branch of the lateral thoracic system and some contribution from the thoracoacromial system (Fig. 3, *above*). As the breast develops during puberty, the superficial skin and subcutaneous tissue through which the vessels travel gets pushed outward. These vessels course deeply around the periphery of the breast but travel up and around the breast parenchyma toward the nipple.

The blood supply to the various pedicles can be preserved with this understanding of anatomy.^{44–46} (See Video, Supplemental Digital Content 1, which displays intraoperative markings. The comparison of vertical with inverted T is also discussed and shown in the video. This video is

available in the “Related Videos” section of the full-text article on PRSJournals.com or at <http://links.lww.com/PRS/B388>.) The superior pedicle is supplied by the descending artery from the internal mammary system coming usually from the second interspace. It lies in the subcutaneous tissue over the breast parenchyma and can be easily found with a pencil Doppler probe. The medial pedicle is supplied by a branch that curves around the medial aspect of the breast, usually from the third interspace. The lateral pedicle is supplied by the superficial branch of the lateral thoracic artery, which curves up laterally in the subcutaneous tissue around the breast itself. The inferior (and central) pedicles are supplied by the deep system that comes up from the fourth interspace. Arteries from the fifth interspace do come up around the level of the inframammary fold and



Fig. 2. (Above) Design for an inverted-T, inferior pedicle. The Wise skin resection pattern is used and the angle of divergence of the flaps is measured so that the medial and lateral limbs match the length of the incision along the inframammary fold. (Below) Postoperative views of a standard inferior pedicle using the Wise skin resection pattern.

provide extra blood supply to an inferior pedicle, but these vessels are not available for a central pedicle.

Except for the deep artery with its venae comitantes (which appear to be enclosed between the thin layers of a septum), the arteries course separately from the veins. The venous system can often be seen through the skin, and it drains mainly superomedially.⁴⁷ The main nerve supply to the nipple and breast skin is the anterolateral branch of the fourth intercostal nerve, which sends a deep branch over the pectoralis fascia and a superficial branch up into the subcutaneous tissue.^{43,48} (See Video, Supplemental Digital Content 2, which displays the creation of a superomedial pedicle. This video is available in the “Related Videos” section of the full-text article on PRSJournal.com or at <http://links.lww.com/PRS/B389>.) The deep branch curves up toward the nipple at the breast meridian, and this can be preserved with full-thickness medial and inferior pedicles (Fig. 3, below). However, this is not the only innervation. There are also anteromedial branches from the third to fifth intercostal nerves. Supraclavicular

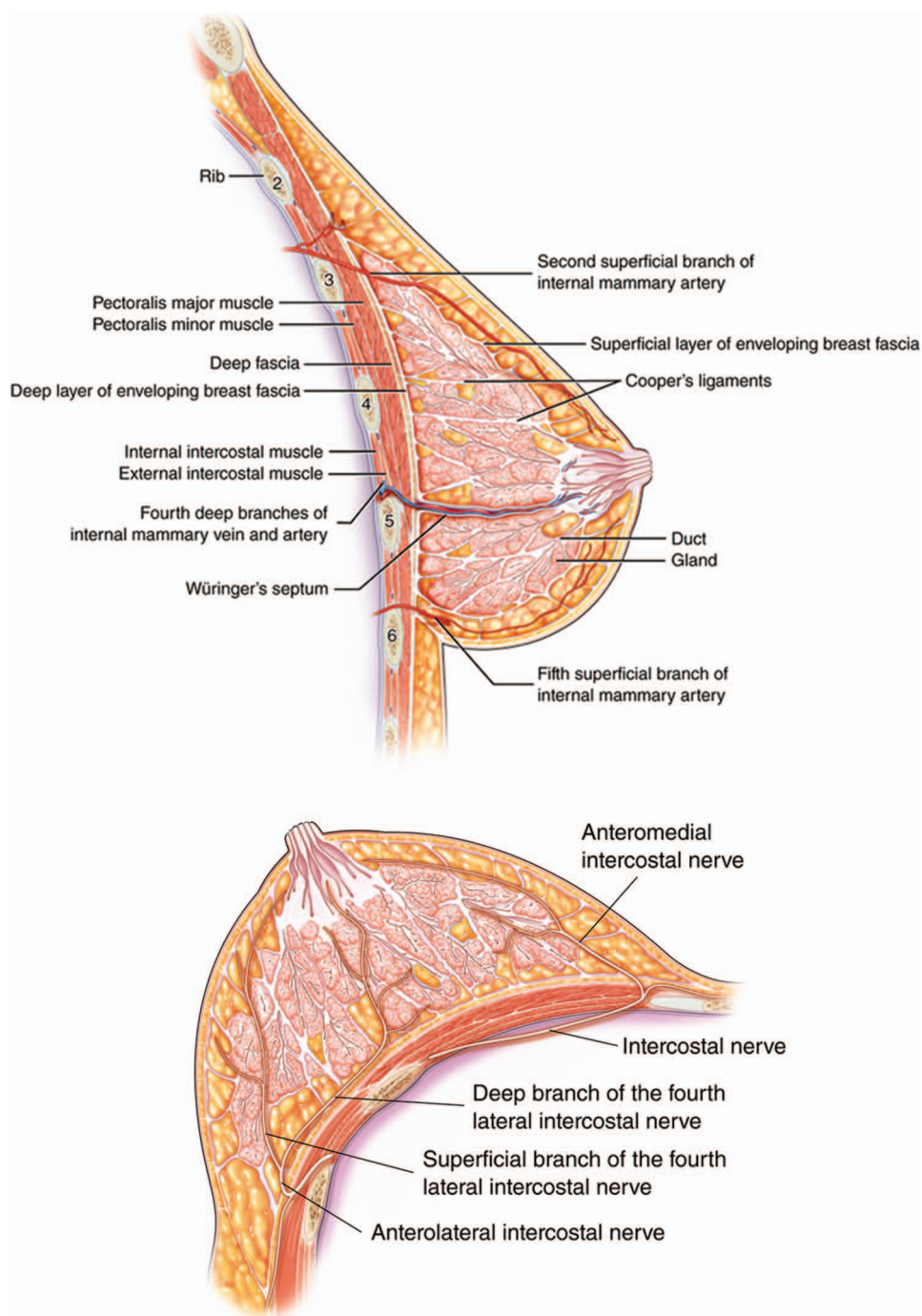
branches from the cervical plexus innervate the upper breast tissue.

PATIENT SELECTION

The surgeon must understand what the patient expects and desires. Managing patient expectations preoperatively is important, and this means that the surgeon must carefully assess each patient’s breast anatomy and communicate what can and cannot be achieved.

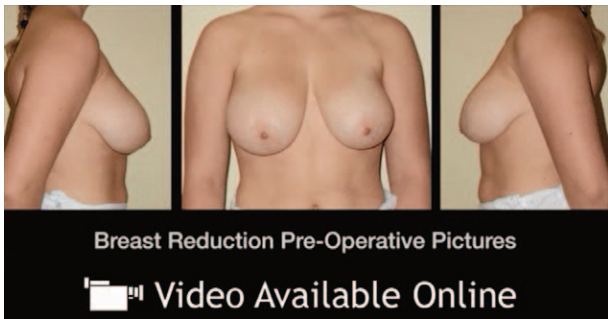
Important preoperative anatomical considerations include the degree and location of breast hypertrophy, the amount of skin excess and its elasticity, and the position of the breast “footprint” on the chest wall. Good results are possible with a variety of techniques and approaches, with surgeon experience being an important factor.

The inverted T, inferior pedicle breast reduction is very flexible and adaptable to most breast sizes.⁴⁹ The inferior pedicle relies on superior parenchymal resection and a strong skin brassiere to hold the remaining breast in position. The inverted-T incision pattern is also well



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Fig. 3. (Above) Blood supply to the breast consists of a deep artery and vein that course up into the parenchyma from the fourth interspace. The rest of the blood supply (mainly from the internal mammary system) comes up around the breast periphery and then courses toward the nipple in the subcutaneous tissue covering the breast. The veins travel just deep to the dermis, and the majority of them course superomedially. (Below) The innervation to the nipple is mainly from the anterior branch of the lateral fourth intercostal nerve. There is a superficial branch that will be damaged with all but the lateral pedicle. The deep branch that courses over the pectoralis muscle can in fact be preserved with many of the full-thickness pedicles (medial, inferior). There are many other nerves, especially medial, from the second, third, and fourth interspaces that also provide innervation to the nipple. (From Hall-Findlay EJ. *Aesthetic Breast Surgery: Concepts & Technique*. St. Louis: Quality Medical; 2011. Image used with permission.)



Video 1. Supplemental Digital Content 1 displays intraoperative markings. The comparison of vertical with inverted T is also discussed and shown in the video. This video is available in the “Related Videos” section of the full-text article on PRSJournals.com or at <http://links.lww.com/PRS/B388>.



Video 2. Supplemental Digital Content 2 displays the creation of a superomedial pedicle. This video is available in the “Related Videos” section of the full-text article on PRSJournals.com or at <http://links.lww.com/PRS/B389>.

suited to the medial and superomedial pedicles, which are less reliant on the skin as a brassiere.³⁴

The vertical skin resection patterns are mainly applicable to the small and moderate sized breasts with any chosen pedicle.^{50,51} Much larger breasts or those with very poor quality skin will need a wider skin resection pattern, and skin will need to be removed horizontally and vertically. The surgeon may choose a superior pedicle and plan to use only a vertical skin resection pattern but, if needed, the skin resection pattern can be extended and a horizontal component added. Patients with excellent skin quality will generally achieve a more pleasing cosmetic result with any procedure, and cases with poor quality skin will not be as good.

Some patients are “high-breasted” and some are “low-breasted.”⁵¹ The upper breast border can rarely be changed with any of the breast reduction

methods, and only minor changes can be made in the breast footprint. All pedicles have some risk of nipple necrosis, even when carefully created. Of the four main arteries available for the nipple, there may be only three dominant vessels, and sometimes the pedicle chosen does not have adequate circulation. Nipple necrosis may be more often a problem with a nondominant blood supply rather than intraoperative error.

In the very large breast, the surgeon may believe that the circulation to any pedicle is not going to be reliable, and may choose to use a free nipple graft.⁵² This decision will result in a flatter nipple that lacks both sensation and the ability to breastfeed.

Informed Consent

Following individualized patient assessment, the specific technique is selected and the procedure with location of incisions is outlined for the patient on a diagram or even on her own skin. We explain it as a “tradeoff” of scars on the breast for functional and/or cosmetic improvement. Patients are informed that the resulting scars will be permanent and that scar healing is unpredictable.

The patients are first educated regarding the surgical risks (those things related to wound healing) and then about cosmetic risks (those things related to appearance) (**Reference 57, Level of Evidence: Risk, III**).^{53–59} It is important to inform patients about the possible loss of sensation to the nipple-areola complex or even the skin of the breast,^{60–70} inability to lactate,⁷¹ and the rare possibility of nipple-areola loss and the likelihood of breast asymmetry⁷² following surgery (**Reference 70, Level of Evidence: Therapeutic, III**).

Preoperative mammography is the most sensitive screening tool for analyzing the breast gland for abnormal pathologic conditions.⁷³ Mammography is ordered based on the recommendations of the governing organizations in a given country. In the United States, women have their first mammogram at age 40, whereas in Canada and Europe, the screening begins at age 50. In patients with a strong family history or other risk factors for breast cancer, a mammogram may be obtained at age 35.

DESIGN AND PREOPERATIVE MARKING

The key to a good breast reduction design is having an understanding of what the chosen method can offer in relation to the breast footprint and the breast shape in both the short term and the long term. (See Video, Supplemental Digital Content 3, which



Video 3. Supplemental Digital Content 3 displays blood supply to the nipple and other various pedicles. This video is available in the “Related Videos” section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B390>.

displays blood supply to the nipple and other various pedicles. This video is available in the “Related Videos” section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B390>.) Once the surgeon can visualize the result that the mound shaping will achieve, a decision can be made about nipple positioning. The optimal method of identifying the exact location of the inframammary fold is by placing a tape measure horizontally in the fold under both breasts. Although many surgeons advise placing the new nipple at the level of the inframammary fold, this is sometimes misleading. The ideal nipple position is slightly below the middle position on the breast mound. The nipple appears better in the lower half of the breast than in the upper half. It is always easier to raise a nipple that has been placed too low, but it is difficult to lower a nipple that has been placed too high.

It is better to be able to visualize the final result and then determine the new nipple position. In general, an ideal nipple on an average C cup brassiere is approximately 10 cm down from the upper breast border and approximately 10 cm from the chest midline (drawn straight, not around the breast). Some surgeons prefer to place the nipple at the level of the inframammary fold, but all surgeons need to be able to stand back, evaluate their design, and make adjustments as needed.⁷⁴

The breast meridian should not necessarily be drawn through the preoperative nipple position, but it should be drawn through the ideal nipple position. A nipple appears best when it points slightly outward and slightly downward—it is better to place it slightly too low and slightly lateral if in doubt. The surgeon who performs both a standard inverted-T inferior pedicle breast reduction and a vertical breast reduction will realize that the

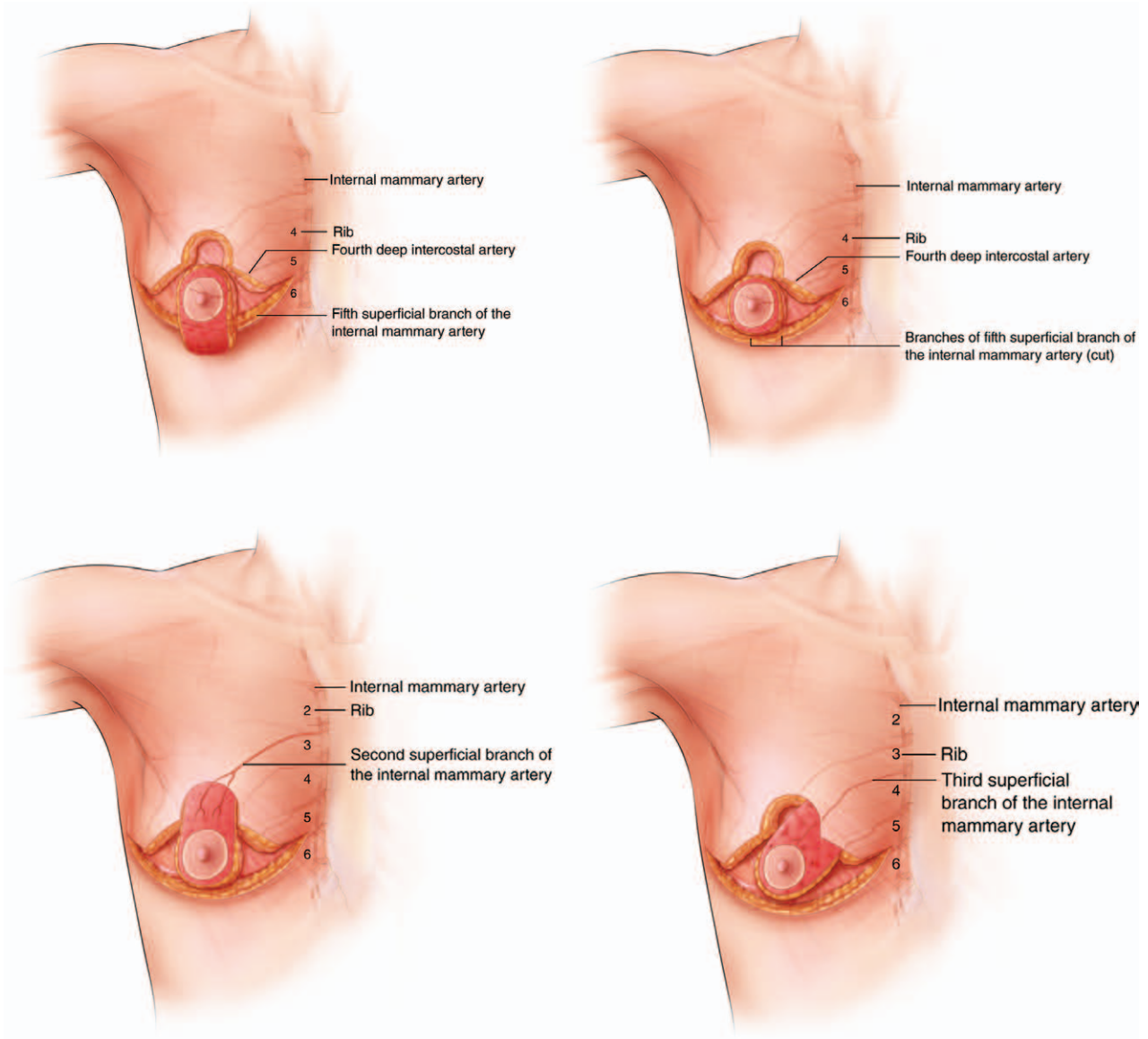
inverted-T breast will have a wider horizontal base, and the new nipple position should be farther lateral than a vertical breast reduction (which results in a narrower breast base).

The inverted-T, inferior pedicle design uses the Wise pattern for the skin that remains as a brassiere to hold the breast shape (Fig. 2). Many of the vertical procedures use the Wise pattern as a pattern for the parenchyma that remains, and the skin then redrapes over that pattern (Fig. 1). The inverted-T design tries to match the horizontal length of the skin flaps to match the total horizontal length of the inferior incision (in or just above the inframammary fold). Some surgeons design the areolar opening preoperatively, and some design it intraoperatively. The circumference of the areolar skin opening should match the circumference of the ideal areola. Areolar skin is more elastic and tends to stretch out to fit the areolar opening. When a surgeon uses a “circumvertical” pattern, a permanent suture is often needed to prevent stretching.^{30,75} The circumference of a 5-cm-diameter areola is 16 cm, and the circumference of a 4.5-cm-diameter areola is 14 cm (the original Wise pattern).

The angle of divergence for the vertical limbs of the skin resection pattern will depend on the size of the breast. The important determinant is what is left behind (which should be symmetrical from side to side) and not what is being removed. We believe that it is very helpful for the surgeon to pinch the vertical limbs together and make sure that closure without tension can be achieved. When the skin is being used as a brassiere, the skin flaps need to be fairly tight, but in a vertical approach, the skin resection pattern is not being used to hold the breast but can be loose because it only needs to adapt to the new breast shape. There is an ongoing controversy about the ability of the skin to act as a brassiere in determining long-term breast shape.

OPERATIVE TECHNIQUE

The chosen pedicle is usually deepithelialized first (Figs. 4 and 5). (See **Video, Supplemental Digital Content 4**, which displays innervation to the nipple and other various pedicles. This video is available in the “Related Videos” section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B391>.) It is important with an inferior pedicle that it be created full thickness because the blood supply is deep from the fourth interspace. Some surgeons will suture the pedicle up to the chest wall, but there is no evidence that these sutures hold in the long term. They may,

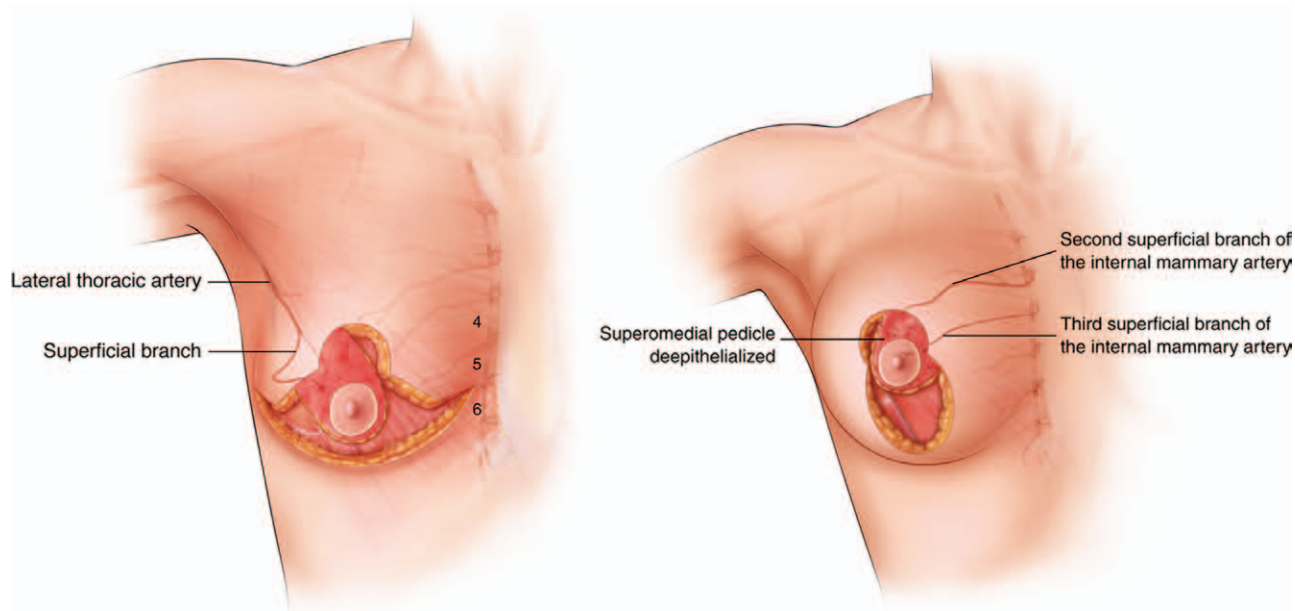


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Fig. 4. Drawings of the different pedicles. (*Above, left*) Inferior pedicle. The blood supply for an inferior pedicle comes from both the deep artery and vein coming up just above the fifth rib and the more superficial arteries from the fifth interspace coursing down around the periphery of the breast and then traveling up in the subcutaneous tissue. (*Above, right*) Central pedicle. The blood supply for the central pedicle is dependent entirely on the artery and venae comitantes that penetrate up from the fourth interspace. (*Below, left*) The superior pedicle. The blood supply for the superior pedicle is from the descending branch of the artery coming from the second interspace of the internal mammary system. This artery can be easily found with a pencil Doppler probe. (*Below, right*) The medial pedicle. The blood supply to the medial pedicle curves up around the periphery of the breast from the third interspace and runs in the subcutaneous tissue toward the nipple. (From Hall-Findlay EJ. *Aesthetic Breast Surgery: Concepts & Technique*. St. Louis: Quality Medical; 2011. Images used with permission.)

however, help to hold tissue in place so that breast tissue has a chance to heal to other breast tissue, providing a permanent shape. The skin and parenchyma are resected next. Some surgeons prefer cutting cautery to remove parenchyma, and some use a cold scalpel. There is no evidence that one is better than the other.

Medial, superomedial, superior, and lateral pedicles can be thinned. The arteries enter the breast deep at the breast periphery but they then travel in the subcutaneous tissue and enter the areola superficially. The medial and lateral pedicles are usually kept full thickness to try to preserve ducts and sensation, but often the superior pedicle needs to be



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Fig. 5. Drawings of the different pedicles, continued. (Left) The lateral pedicle. The blood supply to the lateral pedicle comes from the superficial branch of the lateral thoracic artery. It also curves around the periphery of the breast and courses in the subcutaneous tissue toward the areola. This artery is also easily found with a pencil Doppler probe. It is important to be aware that the artery sometimes comes into the breast tissue somewhat lower than the usual lateral pedicle design. (Right) The superomedial pedicle. The true superomedial pedicle carries blood supply from both the second and third interspaces from the internal mammary system. The superomedial pedicle here is shown with a vertical skin resection pattern. It is important for surgeons to understand that the different pedicles can be combined with different skin resection patterns. The superior pedicle can be more difficult to inset than the other pedicles, and it often needs to be thinned. This is safe because the artery is only approximately 1 cm deep to the skin surface and the veins lie just under the dermis. The true superomedial pedicle has a more robust blood supply but is somewhat more difficult to inset than a medial pedicle, but it can be thinned deep to the descending artery from the second interspace to allow for an easier inset. (From Hall-Findlay EJ. *Aesthetic Breast Surgery: Concepts & Technique*. St. Louis: Quality Medical; 2011. Images used with permission.)



Video Available Online

Video 4. Supplemental Digital Content 4 displays innervation to the nipple and other various pedicles. This video is available in the "Related Videos" section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B391>.

thinned so that it can be more easily inset. The lateral and medial pedicles are rotated into position and the whole base rotates as well. The superior pedicle⁷⁶

needs to be folded up; if it is not thinned, the arteries can end up being inadvertently compressed.

With the inverted-T inferior pedicle procedure, both skin and breast tissue are removed from above the pedicle centrally but below the Wise pattern medially and laterally. This creates a horizontal type wedge resection of skin and parenchyma, and this tends to create a medial and lateral dog-ear. It is important to try to match the length of the skin flaps to the incision in the inframammary fold to help try to prevent these puckers. It is important to remove tissue deep to the skin to smooth out the dog-ear effect.

With the vertical type approaches that use a medial, superior, or lateral pedicle, both the skin and parenchyma are removed as a vertical wedge.^{77–80} (See Video, Supplemental Digital Content 5, which displays parenchymal resection. This video is available in the "Related Videos" section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B392>.) This means there are also



Video 5. Supplemental Digital Content 5 displays parenchymal resection. This video is available in the “Related Videos” section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B392>.



Video 6. Supplemental Digital Content 6 displays final resection and closure. This video is available in the “Related Videos” section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B393>.

two dog-ears created but superiorly and inferiorly rather than laterally and medially. The superior dog-ear is absorbed into the new areolar opening, but the inferior pucker can create problems. Small puckers will settle, but larger puckers can be removed by adding further skin resection horizontally. The puckers with the vertical approaches may need later revision. (See Video, Supplemental Digital Content 6, which displays final resection and closure. This video is available in the “Related Videos” section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B393>.) It is harder to correct the medial and lateral dog-ears from the inverted-T approaches. The vertical incision should not be gathered because the extra length is needed to accommodate projection. Cinching the skin also leads to wound healing problems and is unnecessary because the incision stretches out with time. In contrast, if it does not

stretch, the surgeon may need to revise the pleating that is left behind⁸¹ (Figs. 6 and 7). Liposuction can be performed beyond the Wise pattern in any type of breast reduction to help shape the peripheral fatty tissue. This is the primary role of suction lipectomy in breast reduction. (See Video, Supplemental Digital Content 7, which displays how suction lipectomy is incorporated into the procedure and discusses the pucker that results at the bottom end of the vertical incision. This video is available in the “Related Videos” section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B394>.)

Skin closure is best achieved without tension to prevent delayed wound healing problems. Because the inverted-T inferior pedicle design relies on the skin as a brassiere, skin repair under some tension is essential. It is essential to elevate and handle these skin flaps in such a way as to include all adipose tissue above the superficial fascial system to minimize problems with the flaps. Tension is not needed in the vertical approaches and should be avoided if at all possible, because tension can actually be detrimental to initial shape resolution. (See Video, Supplemental Digital Content 8, which displays the summary of superomedial vertical breast reduction with inclusion of preoperative and postoperative photographs of the patient. This video is available in the “Related Videos” section of the full-text article on PRSJJournal.com or at <http://links.lww.com/PRS/B395>.) In the unusual event that a suspicious mass is encountered during a breast reduction, the next steps will depend on the nature of the mass and the stage at which the mass is found.^{82,83} If frozen section is available, this will help to define the problem. If such is not available, the mass can be resected and the surgical site marked with surgical clips. The breast procedure can be terminated with closure or completed, depending on the stage of the procedure.

INTRAOPERATIVE CARE

There is no consensus on drain use, but the principle is to remove fluid and blood that build up in the potential dead space from tissue removal. Generally, drains are removed when the output is less than 25 to 30 cc in a 24- to 48-hour period.

Bacteria are present in breast ducts, and most surgeons accept that breast surgery is not completely “clean.” At least one preoperative antibiotic dose is usually used, and some surgeons will continue antibiotics, especially for large breast reductions or in patients with higher body mass indexes.⁸⁴



Fig. 6. (Above, left and center) This 58-year-old woman requested a breast reduction. She was 5 feet 6 inches tall, weighed 210 pounds, and wore a 43H brassiere. The upper breast border will not change postoperatively, and the patient will maintain the same amount of upper pole fullness. (Above, right) The preoperative markings with a true superomedial pedicle that incorporates a dual axial blood supply from the internal mammary system at both the second and third (usually) interspaces. The new nipple is marked 11.5 cm down from the upper breast border (*dotted line*), which is well above the inframammary fold. This patient has a long vertical footprint. The new breast meridian is drawn in its ideal (not existing) position. The pedicle is based approximately 4 cm down into the skin resection pattern so that the inferior border of the medial pedicle will become the medial pillar. The upper base of the pedicle is extended across and just lateral to the breast meridian so that it incorporates the strong descending artery from the second interspace. The new areolar opening measures 17 cm, which is close to matching a 5-cm-diameter areola. (Below, left) Intraoperative view after 560 g was removed from the right breast and 550 g from the left breast. Another 850 cc of fat was removed with suction lipectomy. Note that the vertical incision is not gathered or cinched up. (Below, center and right) Frontal and lateral views at 1 year after breast reduction. The inframammary fold has risen.

POSTOPERATIVE CARE

Many surgeons will use glue or tape to cover the incisions. Patients are allowed to shower once the incisions are sealed (usually 24 hours) or once the drains are removed.

Most surgeons will use a surgical brassiere or wrap for a couple of weeks postoperatively to provide some form of support. Excess compression is not advisable, to avoid compressing the circulation to the nipple-areola complex.



Fig. 7. Supine view at 1 year after breast reduction showing the vertical scar.



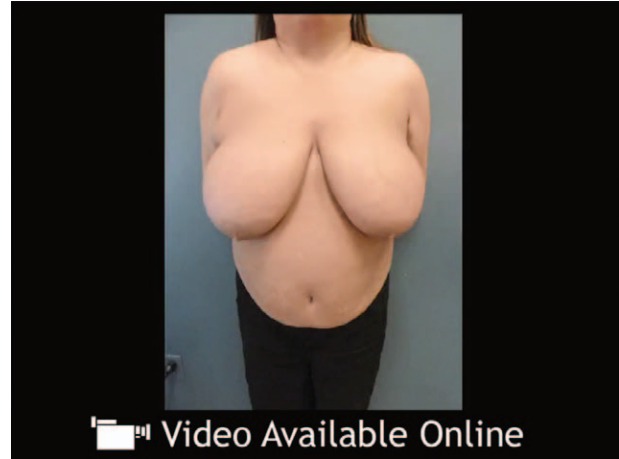
Video 7. Supplemental Digital Content 7 displays how suction lipectomy is incorporated into the procedure and discusses the pucker that results at the bottom end of the vertical incision. This video is available in the “Related Videos” section of the full-text article on PRSJournals.com or at <http://links.lww.com/PRS/B394>.



Video 8. Supplemental Digital Content 8 displays summary of superomedial vertical breast reduction with inclusion of preoperative and postoperative photographs of patient. This video is available in the “Related Videos” section of the full-text article on PRSJournals.com or at <http://links.lww.com/PRS/B395>.

Early Wound Complications and Delayed Wound Healing

Wound healing problems, open wounds, and skin loss are the most commonly encountered complications in the breast reduction surgery patient. The incidence of these complications increases with the resection weight of the specimen. They are normally at the point of greatest stress or “tension” on the closure and in the areas that are most remote from the blood supply. These may progress to partial wound dehiscence. The deleterious effects of cigarette smoking following breast reduction has been studied and confirmed in the literature in both prospective⁸⁵ and retrospective studies.⁸⁶



Video 9. Supplemental Digital Content 9 displays inverted-T inferior pedicle markings and surgery. This video is available in the “Related Videos” section of the full-text article on PRSJournals.com or at <http://links.lww.com/PRS/B396>.

Hematoma and Seroma

The rate of major hematoma formation in breast reduction is approximately 1 to 2 percent. Seromas usually appear later and may be aspirated. Seromas are less likely to resolve spontaneously with the inverted-T skin resection pattern than with the vertical pattern because the inframammary scar can block drainage. (See Video, Supplemental Digital Content 9, which displays inverted-T inferior pedicle markings and surgery. This video is available in the “Related Videos” section of the full-text article on PRSJournals.com or at <http://links.lww.com/PRS/B396>.)

Nipple-Areola Ischemia

Partial or total nipple necrosis, although a well-described complication of breast reduction, can be devastating for the patient and the surgeon. It is not always possible for a surgeon to make the diagnosis of nipple ischemia, especially in black or dark skin patients. In light skin patients, circulatory problems are suggested by a nipple that is pale or dusky. The former is suggestive of arterial insufficiency, but purple congestion is associated with poor venous outflow.

In large reductions, the pedicle may be folded and compressed, resulting in a decrease in circulation. If tension is suspected, surgical maneuvers to alter this tension can be initiated. Sometimes, simply removing sutures will restore circulation. It may be best, if initial maneuvers are unhelpful, to allow the nipple to declare itself over time and allow any devitalized areas to demarcate before

any definitive treatment is attempted. It is surprising that nipples that appeared quite threatened at the time of surgery can in fact show viability, especially if the surrounding areola tissue is viable.

Long-Term Complications

The most common long-term complications of breast reduction include suboptimal scar formation, such as hypertrophic, painful, or even keloid scars, and problems with loss of shape with loss of upper pole breast fullness (bottoming-out), nipple malposition, and asymmetry. A common problem shared by virtually all techniques of breast reduction is inferior descent of the lower pole of the parenchymal tissue. When breast tissue is left in the most dependent region of the breast, predisposing it to be acted on by gravity, bottoming-out can occur, and this type of breast reduction can actually push the inframammary fold to a lower level. Bottoming-out can be caused by recurrent glandular ptosis in all reduction techniques if the surgeon attempts to push tissue up higher into the upper pole. It will inevitably drop back down, especially if not enough of the inferior gland is removed.

Asymmetries

All humans are asymmetric. Liposuction is a valuable treatment adjunct in reducing the volume of a previously operated breast, and in such a situation, tightening of the skin envelope to enhance the symmetry and breast shape can be achieved by “tailor-tacking” to optimize skin envelope symmetry, deepithelialization, and skin edge reapproximation.

Fat Necrosis

Large suture bites used in the breast parenchyma are not only unnecessary but can also cause fat necrosis. Breast tissue should only be approximated—not sutured under tension. Fat necrosis can also result at the distal end of a pedicle from lack of blood supply.

SUMMARY

Breast reduction can be accomplished by several different methods. All involve a pedicle design (or free nipple graft) to move the nipple-areola complex, a parenchymal resection pattern, and a skin resection pattern. Most surgeons should have several different options in their repertoire to adapt to different patient presentations.

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REFERENCES

1. Passot R. La correction esthetique du prolapsus mammaire par la procede de la transposition du mamelon. *Presse Med.* 1925;33:317–318.
2. Biesenberger H. Eine neue Methode der Mammoplastik. *Zentralbl Chir.* 1928;55:2382–2387.
3. Arie G. Una nueva tecnica de mastoplastia. *Rev Iber Latino Am Cir Plast.* 1957;3:28–35.
4. Strombeck JO. Mammoplasty: Report of a new technique based on the two-pedicle procedure. *Br J Plast Surg.* 1960;13:79–90.
5. Dufourmentel C, Mouly R. Plastie mammaire par la methode oblique. *Ann Chir Plast.* 1961;6:45–58.
6. Skoog T. A technique of breast reduction: Transposition of the nipple on a cutaneous vascular pedicle. *Acta Chir Scand.* 1963;126:453–465.
7. Robertson DC. The technique of inferior flap mammoplasty. *Plast Reconstr Surg.* 1967;40:372–377.
8. Weiner DL, Aiache AE, Silver L, Tittiranonda T. A single dermal pedicle for nipple transposition in subcutaneous mastectomy, reduction mammoplasty, or mastopexy. *Plast Reconstr Surg.* 1973;51:115–120.
9. Regnault P. Reduction mammoplasty by the “B” technique. *Plast Reconstr Surg.* 1974;53:19–24.
10. Ribeiro L. A new technique for reduction mammoplasty. *Plast Reconstr Surg.* 1975;55:330–334.
11. Peixoto G. Reduction mammoplasty: A personal technique. *Plast Reconstr Surg.* 1980;65:217–226.
12. Balch CR. The central mound technique for reduction mammoplasty. *Plast Reconstr Surg.* 1981;67:305–311.
13. Nicolle F. Improved standards in reduction mammoplasty and mastopexy. *Plast Reconstr Surg.* 1982;69:453–459.
14. Labandter HP, Dowden RV, Dinner MI. The inferior segment technique for breast reduction. *Ann Plast Surg.* 1982;8:493–503.
15. Hester TR Jr, Bostwick J III, Miller L, Cunningham SJ. Breast reduction utilizing the maximally vascularized central breast pedicle. *Plast Reconstr Surg.* 1985;76:890–900.
16. Benelli L. A new periareolar mammoplasty: The “round block” technique. *Aesthet Plast Surg.* 1990;14:93–100.
17. Sampaio Goes JC. Periareolar mammoplasty: Double skin technique with application of mesh support. *Clin Plast Surg.* 2002;29:349–364.
18. Chiari AJ. The L short scar mammoplasty: A new approach. *Plast Reconstr Surg.* 1992;90:233–246.
19. Aiache AE. Arch reduction mammoplasty. *Plast Reconstr Surg.* 1999;103:862–868.
20. Corduff N, Taylor GI. Subglandular breast reduction: The evolution of a minimal scar approach to breast reduction. *Plast Reconstr Surg.* 2004;113:175–184.
21. Wise RJ. A preliminary report of a method of planning the mammoplasty. *Plast Reconstr Surg.* 1956;17:367–375.
22. Pitanguy I. Surgical treatment of breast hypertrophy. *Br J Plast Surg.* 1967;20:78–85.
23. McKissock PK. Reduction mammoplasty with a vertical dermal flap. *Plast Reconstr Surg.* 1972;49:245–252.

24. Robbins TH. A reduction mammoplasty with the areola-nipple based on an inferior dermal pedicle. *Plast Reconstr Surg.* 1977;59:64–67.
25. Courtiss E, Goldwyn R. Reduction mammoplasty by the inferior pedicle technique. *Plast Reconstr Surg.* 1977;59:500–507.
26. Lassus C. A technique for breast reduction. *Int Surg.* 1970;53:69–72.
27. Lassus C. A 30-year experience with vertical mammoplasty. *Plast Reconstr Surg.* 1996;97:373–380.
28. Marchac D, de Olarte G. Reduction mammoplasty and correction of ptosis with a short inframammary scar. *Plast Reconstr Surg.* 1982;69:45–55.
29. Lejour M, Abboud M, Declety A, Kertesz P. Reduction of mammoplasty scars: From a short inframammary scar to a vertical scar (in French). *Ann Chir Plast Esthet.* 1990;35:369–379.
30. Hammond DC. Short scar periareolar inferior pedicle reduction (SPAIR) mammoplasty. *Plast Reconstr Surg.* 1999;103:890–891.
31. Asplund OA, Davies DM. Vertical scar breast reduction with medial flap or glandular transposition of the nipple-areola. *Br J Plast Surg.* 1996;49:507–514.
32. Hall-Findlay EJ. A simplified vertical reduction mammoplasty: Shortening the learning curve. *Plast Reconstr Surg.* 1999;104:748–759.
33. Finger RE, Vasquez B, Drew GS, Given KS. Superomedial pedicle technique of reduction mammoplasty. *Plast Reconstr Surg.* 1989;83:471–480.
34. Davison SP, Mesbahi AN, Ducic I, Sarcia M, Dayan J, Spear S. The versatility of the superomedial pedicle and various skin reduction patterns. *Plast Reconstr Surg.* 2007;120:1466–1476.
35. Cárdenas-Camarena L, Vergara R. Reduction mammoplasty with superior-lateral dermoglandular pedicle: Another alternative. *Plast Reconstr Surg.* 2001;107:693–699.
36. Blondeel PN, Hamdi M, Van de Sijpe KA, Van Landuyt KH, Thiessen FE, Monstrey SJ. The latero-central glandular pedicle technique for breast reduction. *Br J Plast Surg.* 2003;56:348–359.
37. Matarasso A, Courtiss EH. Suction mammoplasty: The use of suction lipectomy to reduce large breasts. *Plast Reconstr Surg.* 1991;87:709–717.
38. Gray LN. Update on experience with liposuction breast reduction. *Plast Reconstr Surg.* 2001;108:1006–1010.
39. Moskovitz MJ, Muskin E, Baxt SA. Outcome study in liposuction breast reduction. *Plast Reconstr Surg.* 2004;114:55–60.
40. van Deventer PV. The blood supply to the nipple-areola complex of the human mammary gland. *Aesthetic Plast Surg.* 2004;28:393–398.
41. O'Dey Dm, Prescher A, Pallua N. Vascular reliability of nipple-areola complex-bearing pedicles: An anatomical microdissection study. *Plast Reconstr Surg.* 2007;119:1167–1177.
42. Taylor GI, Corlett RJ, Dhar SC, Ashton MW. The anatomical (angiosome) and clinical territories of cutaneous perforating arteries: Development of the concept and designing safe flaps. *Plast Reconstr Surg.* 2011;127:1447–1459.
43. Würinger E, Mader N, Posch E, Holle J. Nerve and vessel supplying ligamentous suspension of the mammary gland. *Plast Reconstr Surg.* 1998;101:1486–1493.
44. Hall-Findlay EJ. Pedicles in vertical breast reduction and mastopexy. *Clin Plast Surg.* 2002;29:379–391.
45. Hamdi M, Hall-Findlay EJ. Pedicle choices in breast reduction. In: Hamdi M, Hammond D, Nahai F, eds. *Vertical Scar Mammoplasty.* Berlin: Springer-Verlag; Heidelberg; 2005:11–15.
46. van Deventer PV, Page BJ, Graewe FR. The safety of pedicles in breast reduction and mastopexy procedures. *Aesthetic Plast Surg.* 2008;32:307–312.
47. Corduff N, Rozen WM, Taylor GI. The superficial venous drainage of the breast: A clinical study and implications for breast reduction surgery. *J Plast Reconstr Aesthet Surg.* 2010;63:809–813.
48. Schlenz I, Kuzbari R, Gruber H, Holle J. The sensitivity of the nipple-areola complex: An anatomic study. *Plast Reconstr Surg.* 2000;105:905–909.
49. Hidalgo DA. Improving safety and aesthetic results in inverted T scar breast reduction. *Plast Reconstr Surg.* 1999;103:874–886.
50. Spear SL, Howard MA. Evolution of the vertical reduction mammoplasty. *Plast Reconstr Surg.* 2003;112:855–868.
51. Hall-Findlay EJ. The three breast dimensions: Analysis and effecting change. *Plast Reconstr Surg.* 2010;125:1632–1642.
52. Gradinger GP. Reduction mammoplasty utilizing nipple-areola transplantation. *Clin Plast Surg.* 1988;15:641–654.
53. Davis GM, Ringler SL, Short K, Sherrick D, Bengtson BP. Reduction mammoplasty: Long-term efficacy, morbidity, and patient satisfaction. *Plast Reconstr Surg.* 1995;96:1106–1110.
54. Schnur PL, Schnur DP, Petty PM, Hanson TJ, Weaver MS. Reduction mammoplasty: An outcome study. *Plast Reconstr Surg.* 1997;100:875–883.
55. Cruz-Korchin N, Korchin L. Vertical versus Wise pattern breast reduction: Patient satisfaction, revision rates, and complications. *Plast Reconstr Surg.* 2003;112:1573–1578; discussion 1579–1581.
56. Karp NS. Medial pedicle/vertical breast reduction made easy: The importance of complete inferior glandular resection. *Ann Plast Surg.* 2004;52:458–464.
57. Cunningham BL, Gear AJ, Kerrigan CL, Collins ED. Analysis of breast reduction complications derived from the BRAVO study. *Plast Reconstr Surg.* 2005;115:1597–1604.
58. Spector JA, Kleinerman R, Culliford AT IV, Karp N. The vertical reduction mammoplasty: A prospective analysis of patient outcomes. *Plast Reconstr Surg.* 2006;117:374–381; discussion 382–383.
59. Thoma A, Ignacy TA, Duku EK, et al. Randomized controlled trial comparing health-related quality of life in patients undergoing vertical scar versus inverted T-shaped reduction mammoplasty. *Plast Reconstr Surg.* 2013;132:48e–60e.
60. Craig RD, Sykes PA. Nipple sensitivity following reduction mammoplasty. *Br J Plast Surg.* 1970;23:165–172.
61. Farina MA, Newby BG, Alani HN. Innervation of the nipple-areola complex. *Plast Reconstr Surg.* 1980;66:497–501.
62. Courtiss EH, Goldwyn RM. Breast sensation before and after plastic surgery. *Plast Reconstr Surg.* 1976;58:1–13.
63. Fish JS, Bain JR, Levine R. Breast sensation following reduction mammoplasty. *Can J Plast Surg.* 1994;2:28–31.
64. Tairysh GV, Kuzbari R, Rigel S, Todoroff BP, Schneider B, Deutinger M. Normal cutaneous sensibility of the breast. *Plast Reconstr Surg.* 1998;102:701–704.
65. Temple CL, Hurst LN. Reduction mammoplasty improves breast sensibility. *Plast Reconstr Surg.* 1999;104:72–76.
66. Hamdi M, Greuse M, DeMey A, Webster MH. A prospective quantitative comparison of breast sensation after superior and inferior pedicle mammoplasty. *Br J Plast Surg.* 2001;54:39–42.
67. Mofid MM, Dellon AL, Elias JJ, Nahabedian MY. Quantitation of breast sensibility following reduction mammoplasty: A comparison of inferior and medial pedicle techniques. *Plast Reconstr Surg.* 2002;109:2283–2288.
68. Godwin Y, Valassiadou K, Lewis S, Denley H. Investigation into the possible cause of subjective decreased sensory perception in the nipple-areola complex of women with macromastia. *Plast Reconstr Surg.* 2004;113:1598–1606.

69. Schreiber JE, Giroto JA, Mofid MM, Singh N, Nahabedian MY. Comparison study of nipple-areolar sensation after reduction mammoplasty. *Aesthet Surg J*. 2004;24:320–323.
70. Schlenz I, Rigel S, Schemper M, Kuzbari R. Alteration of nipple and areola sensitivity by reduction mammoplasty: A prospective comparison of five techniques. *Plast Reconstr Surg*. 2005;115:743–754.
71. Cruz-Korchin N, Korchin L. Breast-feeding after vertical mammoplasty with medial pedicle. *Plast Reconstr Surg*. 2004;114:890–894.
72. Hoffman S. Recurrent deformities following reduction mammoplasty and correction of breast asymmetry. *Plast Reconstr Surg*. 1986;78:55–62.
73. Selber JC, Nelson JA, Ashana AO, et al. Breast cancer screening prior to cosmetic breast surgery: ASPS members' adherence to American Cancer Society guidelines. *Plast Reconstr Surg*. 2009;124:1375–1385.
74. Hall-Findlay E. Breast analysis. *Aesthetic Breast Surgery: Concepts & Techniques*. St. Louis: Quality Medical; 2010:67–98.
75. Mottura A. Circumvertical reduction mammoplasty. *Aesthetic Surg J*. 2000;20:199–204.
76. Lejour M. Vertical mammoplasty and liposuction of the breast. *Plast Reconstr Surg*. 1994;94:100–114.
77. Pallua N, Ermisch C. "I" becomes "L": Modification of vertical mammoplasty. *Plast Reconstr Surg*. 2003;111:1860–1870.
78. Hidalgo DA. Vertical mammoplasty. *Plast Reconstr Surg*. 2005;115:1179–1197.
79. Lista F, Ahmad J. Vertical reduction mammoplasty: A 15 year experience including a review of 250 consecutive cases. *Plast Reconstr Surg*. 2006;117:2152–2165.
80. Hamdi M, Van Landuyt K, Tonnard P, Verpaele A, Monstrey S. Septum-based mammoplasty: A surgical technique based on Würinger's septum for breast reduction. *Plast Reconstr Surg*. 2009;123:443–454.
81. Matthews JLK, Oddone-Paolucci E, Lawson DM, Hall-Findlay EJ. Vertical scar breast reduction: Does gathering the incision matter? *Ann Plast Surg*. E-published ahead of print July 4, 2014.
82. Jansen DA, Murphy M, Kind GM, Sands K. Breast cancer in reduction mammoplasty: Case reports and a survey of plastic surgeons. *Plast Reconstr Surg*. 1998;101:361–364.
83. Hage JJ, Karim RB. Risk of breast cancer among reduction mammoplasty patients and the strategies used by plastic surgeons to detect such cancer. *Plast Reconstr Surg*. 2006;117:727–735.
84. Shortt R, Cooper MJ, Farrokhhyar F, Bain J. Meta-analysis of antibiotic prophylaxis in breast reduction surgery. *Can J Plast Surg*. 2014;22:91–94.
85. Bartsch RH, Weiss G, Kästenbauer T, et al. Crucial aspects of smoking in wound healing after breast reduction surgery. *J Plast Reconstr Aesthet Surg*. 2007;60:1045–1049.
86. Bikhchandani J, Varma SK, Henderson HP. Is it justified to refuse breast reduction to smokers? *J Plast Reconstr Aesthet Surg*. 2007;60:1050–1054.