

eMedicine Specialties > Plastic Surgery > Breast

Breast Reconstruction, Nipple–Areola Reconstruction

Yoon Sun Chun, MD, Clinical Instructor, Department of Surgery, Harvard Medical School; Associate Surgeon, Department of Surgery, Division of Plastic and Reconstructive Surgery, Brigham and Women's Hospital; Staff Surgeon, Department of Surgery, Division of Plastic and Reconstructive Surgery, Faulkner Hospital

Dennis P Orgill, MD, PhD, Professor of Surgery, Harvard Medical School; Associate Chief of Plastic Surgery, Brigham and Women's Hospital

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Introduction

Breast cancer is second only to skin cancer as the most common cancer in women. According to the American Cancer society, an estimated 193,000 women in the United States will be diagnosed with breast cancer in 2009. ^[1] Many of these patients will undergo breast conservation therapy. In 2008, according to the American Society of Plastic Surgery, approximately 80,000 women underwent breast reconstruction, most with expanders and implants and about 24,000 with some type of flap reconstruction. ^[2]

Following mastectomy, breast reconstruction can provide significant psychosocial benefits for women. Because the reconstructed nipple is not easily moved, nipple reconstruction is usually reserved as the final step in breast reconstruction and is critical for providing an aesthetically pleasing breast. ^[3] Patients with loss of the nipple and areola from cancer excision, trauma, or congenital absence continue to experience psychological distress even long after breast mound reconstruction has taken place. Studies have shown that recreation of the nipple-areola complex has a high correlation with overall patient satisfaction and acceptance of body image. ^[4] Thus, completion of the breast reconstruction by creating a nipple-areola complex that matches the contralateral nipple in terms of size, shape, projection, and position adds significantly to the reconstructive result.

Numerous techniques have been developed to reconstruct the nipple following mastectomy. These include intradermal tattooing, variations of local tissue flaps, skin grafts, cartilage grafts, tissue-engineered structures, and nipple-sharing techniques. The most common problem following nipple reconstruction is a decrease in projection, or nipple flattening. Thus, methods of secondary nipple reconstruction as well as restoration of nipple projection have been reported.

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History of the Procedure

The history of nipple reconstruction parallels that of breast reconstruction with autologous tissue, from the development of the latissimus dorsi flap by Tanzini in 1906 to modern transverse rectus abdominus myocutaneous (TRAM) and microvascular-free TRAM breast reconstruction.

Historically, nipple-areola complex reconstruction has been considered a secondary procedure to the more important breast mound reconstruction. To optimize positioning of the nipple, surgeons generally recommend waiting until complete settling of the reconstructed breast before performing nipple reconstruction. However, when nipple reconstruction is delayed for months to years, final reconstruction is often never completed, as patients often opt to minimize their exposure to further surgical procedures. Most recently, some have advocated immediate nipple reconstruction in free TRAM flap reconstructions to minimize operative procedures and to achieve earlier completion of the breast reconstruction. ^[5]

Nipple reconstruction techniques have evolved significantly over the years. From simple tattooing to the more technologically advanced, although rarely available, tissue engineering, ^[6] today's techniques are able to provide long-lasting, satisfactory reconstruction with minimal morbidity.

Indications

Nipple-areola reconstruction represents the completion of the breast restorative process and has significant psychological implications for women who undergo mastectomy. Nipple size, position, projection, and color are determining factors in the aesthetic symmetry of the reconstruction, qualifying an otherwise nondescript flesh mound as the new breast. Complete nipple-areola reconstruction with tattoo can visually draw attention away from the scars on the reconstructed breast mound. In addition, autologous flap breast reconstruction following skin-sparing mastectomy can usually be designed so that the entire flap skin paddle, along with the scar, is tattooed as an areola.

The benefit of nipple-areola reconstruction is supported by the findings of a retrospective psychological survey comparing the level of satisfaction of women who underwent breast reconstruction with or without nipple-areola reconstruction; a highly significant correlation was seen between level of satisfaction and presence of the nipple-areola complex. Artists and anatomists consider the nipple-areola complex an essential and defining component of the breast aesthetic unit, and the physical characteristics of the nipple gain importance as the breast mound decreases in size. Reconstruction of position, size, shape, and color of the native nipple-areola complex currently are attainable goals; functional restoration of erectile ability and erogenous sensation are goals for future reconstructive surgeons.

Relevant Anatomy

Nipple-areola anatomy is remarkably variable in dimension, texture, and color across ethnic groups and among individuals. Moreover, an appreciable difference often exists in the two nipple-areola complexes in the same patient. The presence of an elevated structure in the center of a pigmented area on the breast mound usually represents a nipple, yet wide variability exists as to what constitutes the normal dimensions of the complex. In general, an aesthetically balanced B-C cup breast has an areola diameter of 4.2-5 cm, with the nipple diameter and projection or height equal to one third to one fourth of the areola diameter.

The central position of the nipple cylinder in the areola also has significant variability, ranging from one fourth to one half of the radius off-center.

Nipple projection results from the primary location of the mammary ducts in the central portion of the nipple complex. This arrangement produces a semi-rigid structure with a significantly more fibrotic element than the soft and pliable surrounding areola. The contractile properties of the areola also contribute to the gradual change in nipple projection obtained with direct or neural stimuli.

Most methods of nipple reconstruction can be used whether the breast has been reconstructed with a flap or alloplastic materials. Flaps generally provide more mobile tissue and make it easier to achieve nipple bulk and projection. Previous scars from the mastectomy or previous biopsies need to be accounted for in terms of flap design so as not to compromise blood supply to the reconstructed nipple.

Contraindications

No general contraindications exist to reconstruction of the nipple-areola complex. However, evaluation of each patient's specific medical condition and surgical requirements may delay or contraindicate the procedure on a case-by-case basis.

Treatment

Medical Therapy

No medical therapy is available for nipple and areola reconstruction. Nonsurgical options include areola tattooing and prosthetic devices.

Areola tattooing is a widespread method of areola reconstruction because of its simplicity. It is well tolerated by most patients. Tattooing is often used before or after nipple-areola reconstruction to obtain a good color match

with the contralateral side. Some patients may opt for simple tattooing without surgical reconstruction, but this method produces a relatively unnatural appearance. The pigments used to obtain flesh colors are fairly stable over time, but, in some cases, early deterioration of the pigment components can lead to significant darkening of the pigment and unexpected color variations. Long-term fading is also common and may require re-tattooing of the nipple-areola reconstruction.^[7] When tattooing is used prior to surgical reconstruction, careful planning of the tattooed area is necessary to ensure complete coverage of the future nipple-areola complex.

Currently, prosthetic devices are rarely used; most patients opt for more permanent options.

Surgical Therapy

Areola reconstruction

- **Skin grafts:** Because it is a 2-dimensional structure, the areola usually does not pose the same degree of difficulty in reconstruction as the nipple. Time-honored methods of reconstruction have included skin grafts obtained from the contralateral nipple-areola complex or the medial thigh-vulva area. These grafts are intended to provide pigmented tissue that closely resembles the native areola. Currently, with great improvements in tattoo technique and a seemingly endless variety of pigments available, it seems unjustifiable to expose a patient to the risks of possible donor site complications to obtain the same or less satisfactory results than those obtainable with tattooing.
- **Banking:** The practice of banking portions of the excised areola to use as grafts in the reconstruction process is mentioned only to condemn it as oncologically unsound. These areola grafts used for areola reconstruction are unpredictable in terms of degree and direction of contraction and possible depigmentation. Typically, skin grafts are justified if they are needed to close the nipple donor site on the reconstructed nipple-areola complex, but, otherwise, little indication exists for their use.
- **Tattoo:** Tattooing of the reconstructed breast in the area of the expected nipple-areola complex is simple, easy to perform, readily correctable, and requires no significant patient participation or convalescence. Reconstruction of the areola by tattooing can be staged and often requires some touch-up, but it allows a great degree of control over size, definition of contour, and color match with the contralateral side. However, results are usually less than satisfactory when used in the absence of nipple reconstruction.
 - Tattooing is strictly an optical effect, with no structural support and no way to reproduce the projection and texture typical of the natural nipple-areola complex. Thus, tattooing is best employed as one stage of a combined approach toward nipple reconstruction, whether performed prior to or after elevation of the nipple structure.
 - Many tattoo pigments are available, allowing precise color matching with the contralateral areola. A color shade a little darker than the desired color is selected to allow for some fading, which invariably occurs in the weeks postinjection. One or more applications may be necessary to obtain the desired result. Commercial surgical tattoo equipment is usually adequate to treat thick skin, such as the lower abdominal and back skin transferred with myocutaneous flaps, and proper injection technique is easily acquired with minimal practice. In some cases, to facilitate later touch-up and obtain a more natural color distribution, tattooing the skin prior to elevation of the nipple structure may be advisable.

Nipple reconstruction

- The most challenging aspect of nipple reconstruction is the creation of a 3-dimensional projecting structure with texture, dimensions, and contour similar to the contralateral nipple. Moreover, the reconstruction must be lasting. Nipple reconstruction enhances the realism of breast reconstruction; the more projecting and 3-dimensional the structure, the more lifelike the reconstruction. Various options have included banking, nipple sharing, grafting, and local flaps.

- Nipple sharing can potentially harm the only erogenous structure left in the woman's breast, as the surgeon must decrease the projection and alter the structure of the contralateral nipple to match the reconstructed one. Considering all the possible alternative options, this seems the least likely to be recommended.
- Nipple reconstruction with local flaps is achieved with various techniques, each with its own proponents and benefits. These include the skate flap,^[8] bell flap,^[9] double opposing tab flap,^[10] star flap,^[3] top-hat flap, twin flap,^[11] propeller flap, S flap,^[12] rolled dermal-fat flap,^[13] and autologous cartilage. Recently, use of AlloDerm and filler injection to restore nipple projection has also been reported.^[14,15,4] Some have also advocated creating a more stable deepithelialized skin base for the reconstructed nipple to minimize loss of projection. Some of the most commonly used techniques are described below.
- Immediate nipple reconstruction has also been described. At the time of free-TRAM reconstruction, excess tissue that would otherwise be discarded can be folded to create the 3-dimensional component of the nipple. When used with skin-sparing mastectomy, this can offer areolar fullness, as well. While this technique requires experience to determine the ultimate location of the nipple-areola complex, it does expedite the entire reconstructive process. Bilateral reconstruction significantly facilitates the symmetry of nipple location.

Preoperative Details

- Stable breast mound reconstruction usually is obtained prior to nipple-areola reconstruction; therefore, nipple reconstruction is usually delayed approximately 3 months to allow for final settling of the new breast mound and to more precisely plan the new nipple position.
- Anatomic symmetry is important. When a contralateral nipple is present, the surgeon is provided a natural template to use in guiding reconstruction. For a large contralateral areola, an areola reduction procedure can be considered. Size, color, and, most importantly, position of the new nipple must closely match the opposite side.
- When a bilateral reconstruction is performed, the nipple-areola complex should be positioned along the breast meridian starting from the midclavicular point and extending to the breast fold to a point 11 cm from the midline. The complex should be placed at the most projecting point of the breast mound, approximately 21-23 cm from the sternal notch and 5-7 cm from the inframammary fold. These measurements are guidelines for the average case and must be reinterpreted in light of the specific anatomic configuration and aesthetic preferences of each patient and surgeon. For example, a significant range (5-9 cm) in distance between the areola and the inframammary fold is determined by the following factors:
 1. The size of the reconstructed breast
 2. The presence or absence of a well-defined fold
 3. The desired final breast appearance
- A moulage of the planned nipple and areola location is advisable to allow the patient to approve the final position.

Intraoperative Details

Skate flap

- Draw a small circle the exact size of the contralateral nipple in the appropriate position on the reconstructed breast. Confirm positioning by sternal notch-nipple measurements but also confirm aesthetically. If the mastectomy scar crosses the area, draw the following lines so that the wings and

body of the skate are designed away from the scar.

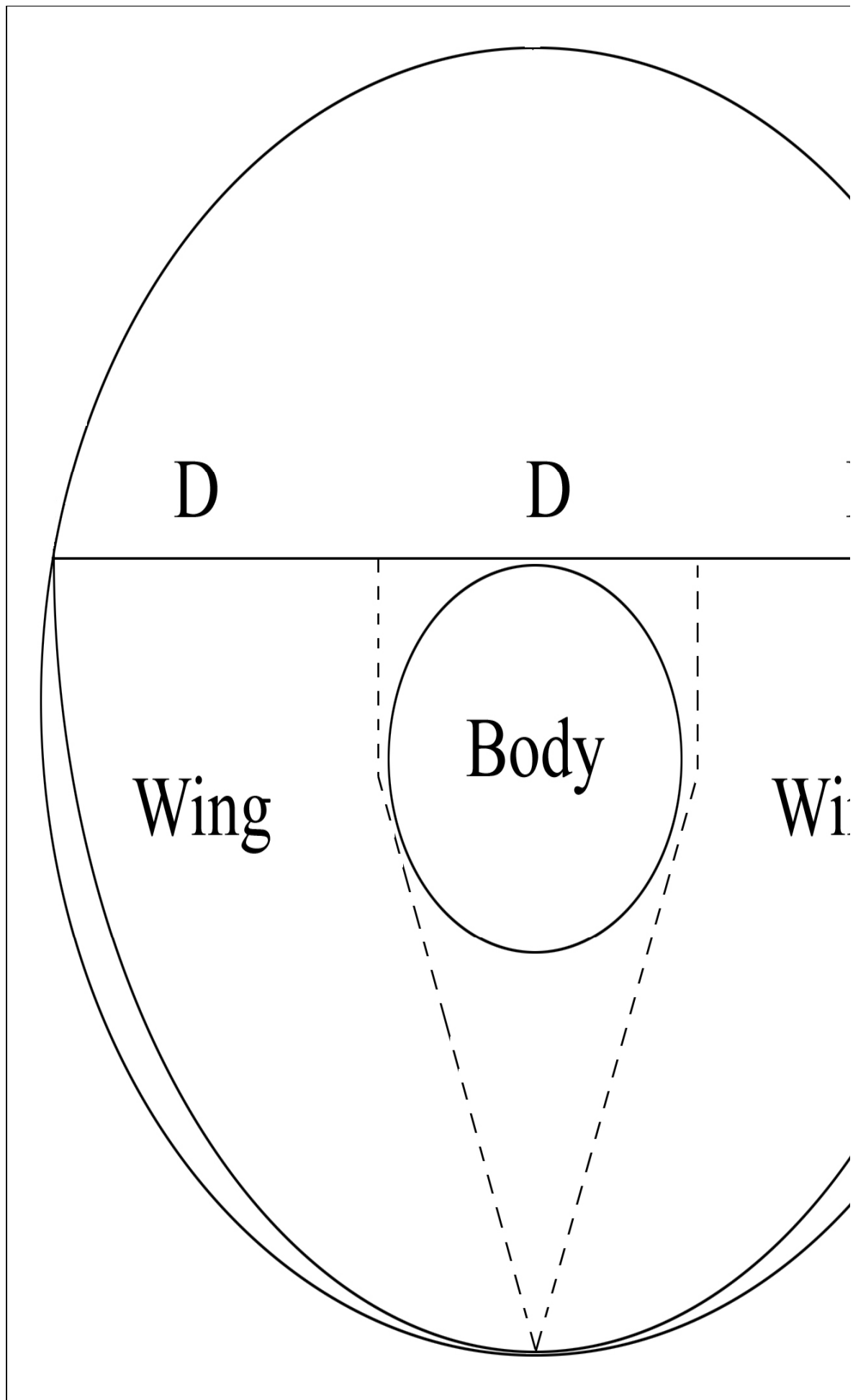


Diagram illustrating the layout of the skate flap. D is the diameter of the contralateral nipple, and the total length of the flap is twice the height (projection) of the contralateral nipple.

- The axis of the skate is designed to fall on the underside of the reconstructed nipple and is drawn twice as long as the contralateral nipple height to compensate for inevitable contraction (see the image above). The base of the skate is drawn 3 times the diameter of the contralateral nipple (D). The 2 lateral portions of the skate (wings) are then elevated in the deep subdermal layer up to the center of the flap (body), where the subcutaneous fat is preserved to add bulk to the structure.
- The elevated nipple thus has a double blood supply from the superior skin pedicle and from the deeper subcutaneous fat-muscle at the base of the stalk. The flaps then are wrapped around the central stalk and sutured with fine absorbable sutures. The flaps' donor sites usually can be closed primarily; in some cases, a small skin graft may be required at the base of the nipple to prevent flattening of the structure with undue tension on the closure. Skin grafts are easily obtained from along the scar lines on the breast.

Bell flap

- Design of this flap consists of a bell-shaped random pattern skin flap with a circular subcutaneous island flap.^[9]

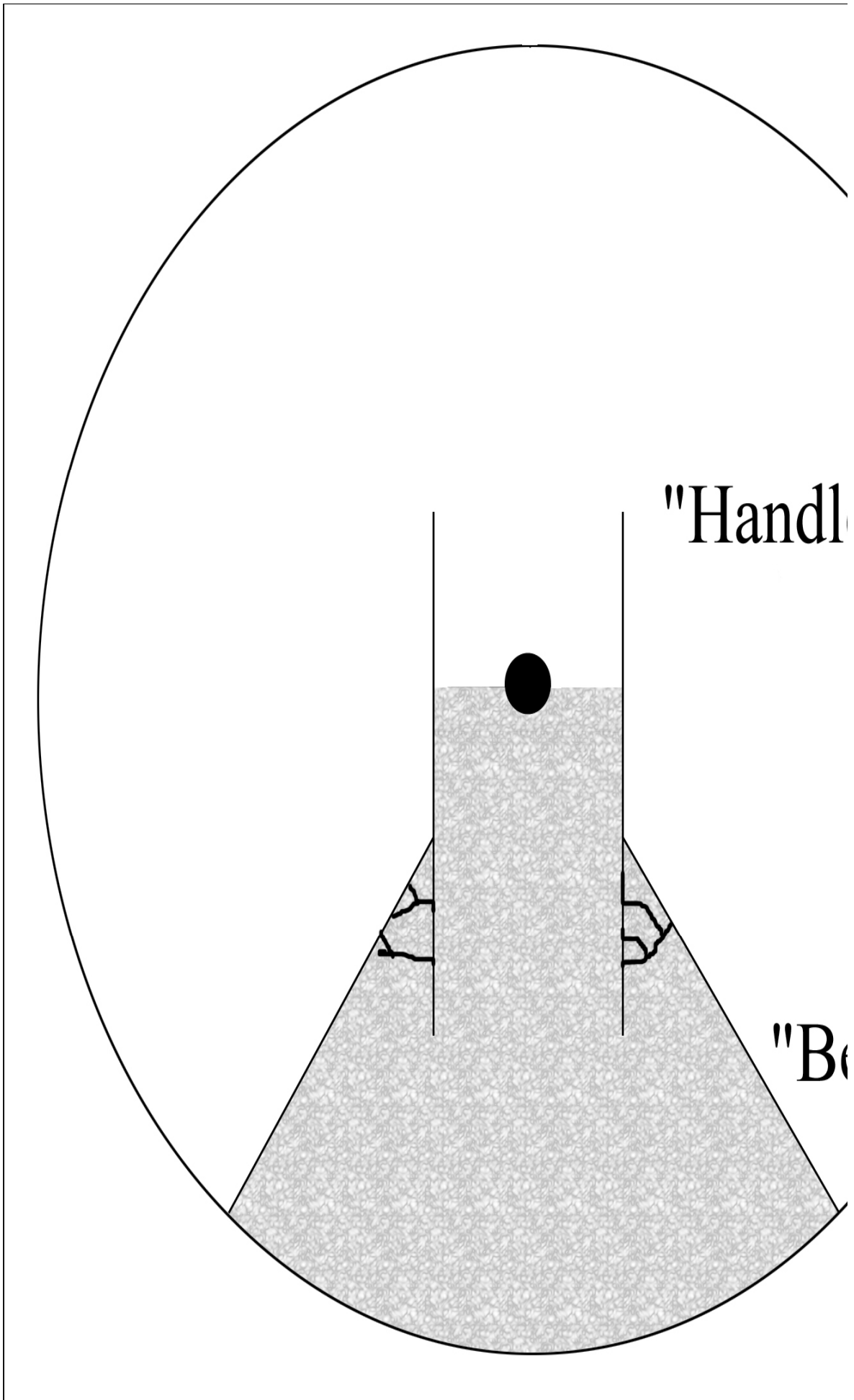
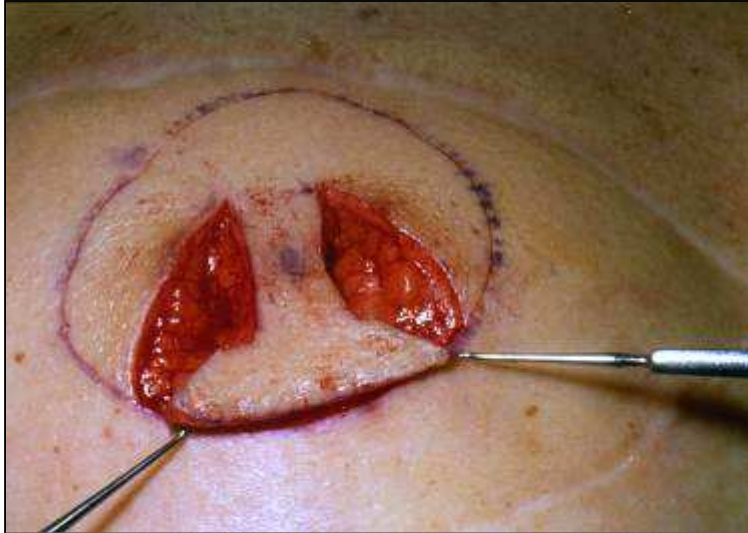


Diagram illustrating the layout of the bell flap. Note the triangles excised between the "handle" and the "bell" of the flap to allow for easier folding.

- The diameter of the circle is 15-20% larger than the contralateral areola. The base of the flap (blood supply) should have a minimal width of one fourth of the diameter of the circle. The free end of the flap (bottom of the bell) consists of an arc equalling one sixth of the circumference of the circle.



Intraoperative sequence of nipple reconstruction with the bell flap: initial layout and dissection of the flap.

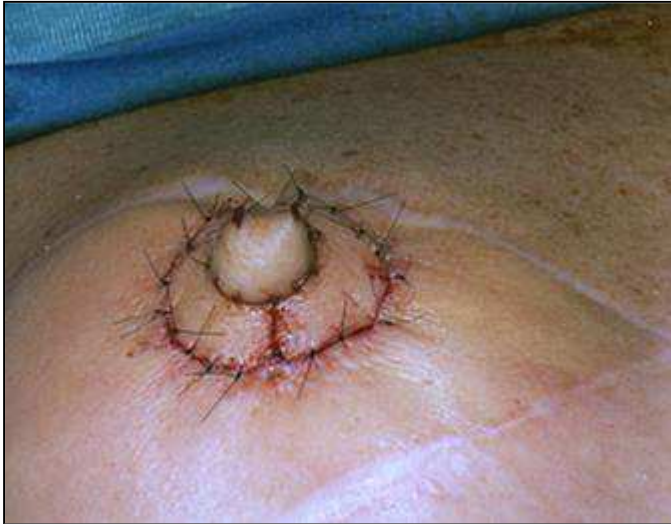
- Elevate the flap by incising the bell shape in the subcutaneous layer and extending the dissection in the deeper fat plane toward the center of the handle to preserve blood supply.



Intraoperative sequence of nipple reconstruction with the bell flap: elevation and initial apposition of the flap.

- After completing the elevation, fold the 2 sides of the bell on the handle to make up the lateral portion of the elevated nipple. Fold the flap upon itself with fine absorbable sutures. Incise the entire circumference in the subcutaneous plane, and approximate with fine sutures the two sides of the defect obtained by the elevation of the bell. As the obtained nipple-areola complex is smaller in diameter than the donor site, apply a permanent purse string suture in the subdermal plane to shrink the donor site down and allow

tensionless approximation of the wound edges to the neo-areola.



Intraoperative sequence of nipple reconstruction with the bell flap: final reconstruction.

Double opposing tab flap

- Determine areola size by the contralateral areolar dimensions. Plan a transverse incision along the diameter of the circle equal to 3 times the height of the final nipple. Plan two semicircular incisions extending in a radial configuration from the middle incision in an S shape. The width of each flap base should be 18 mm.

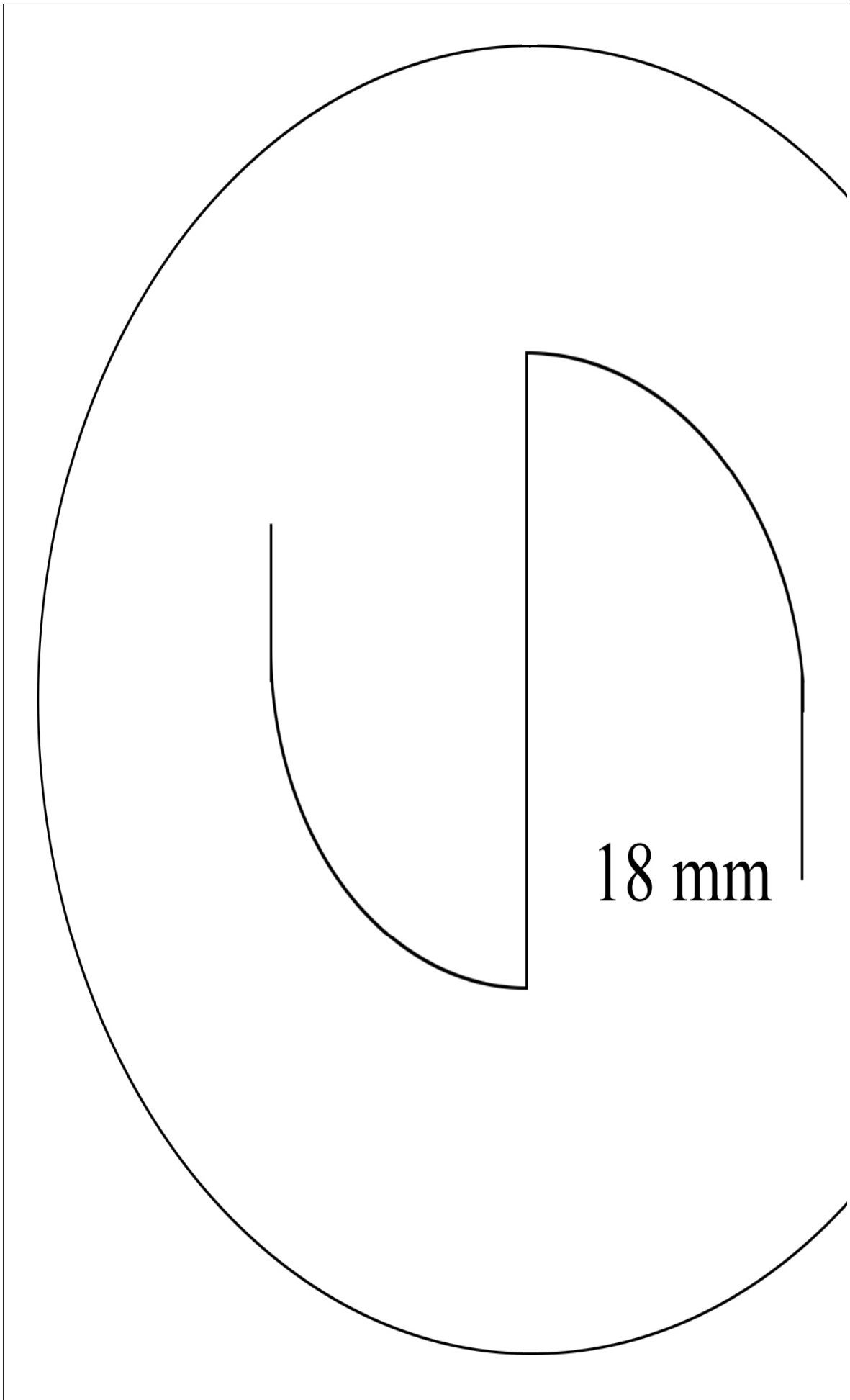


Diagram illustrating the layout of the double opposing tab flap. Note that the minimum recommended base width for the tabs is 18 mm. The 2 tabs are elevated and rotated to face each other as if 2 hands were joined in prayer.

- Raise the two flaps in the subdermal fat plane and then oppose and suture with fine absorbable sutures. The donor sites are closed primarily and the areola is tattooed.

Star flap

- The modified star flap procedure involves marking the areola diameter equal to the contralateral areola. Within this circle, a 3-arm star is drawn. The base of the star is located at the margin of an ideal circle in the center of the areola, with the diameter equal to one fifth of the main areola diameter.

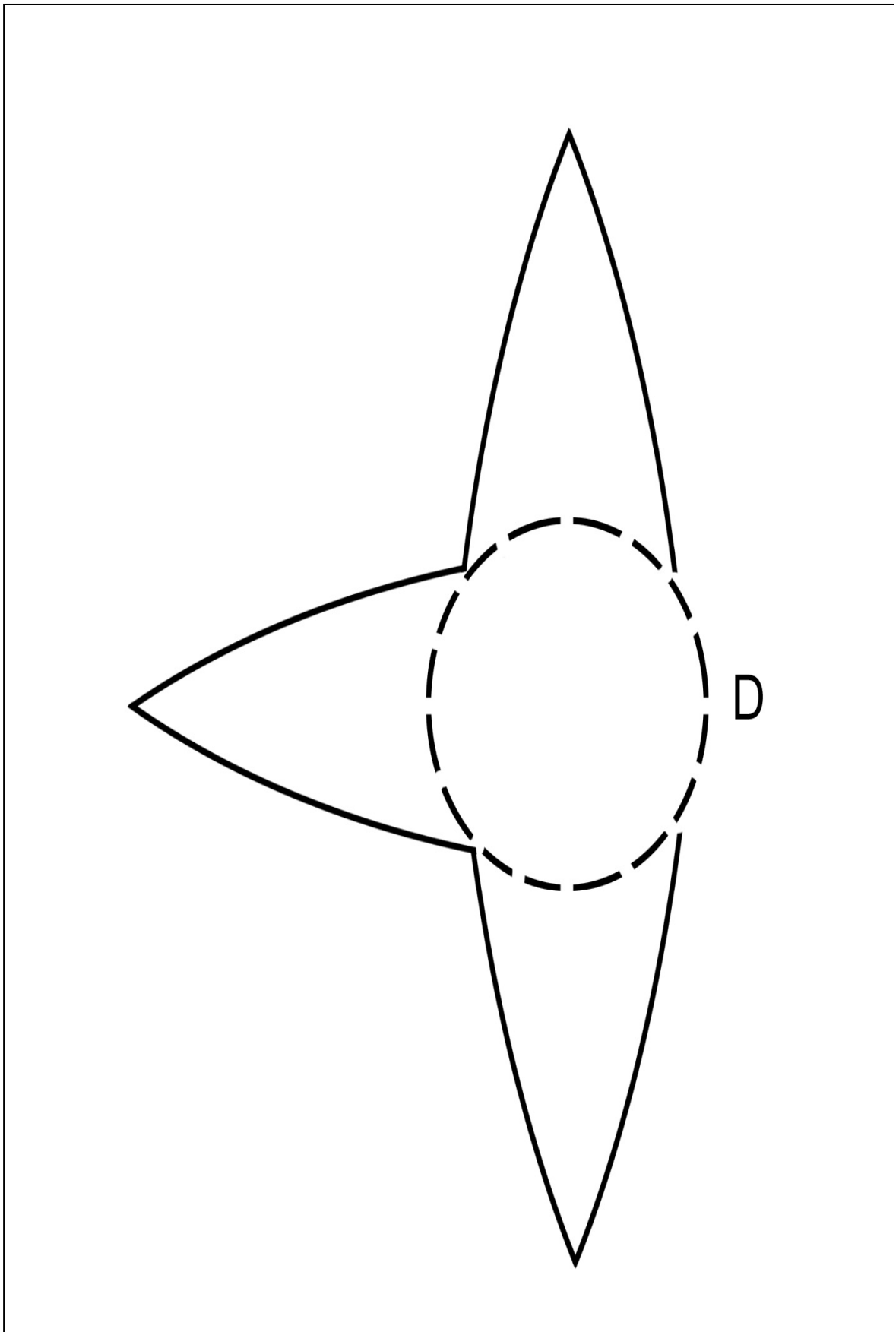


Diagram illustrating the layout of modified star flap for nipple reconstruction. D is the diameter of the contralateral nipple. The 2 lateral arms wrap around to form a cylindrical structure and the central arm provides the top.

- The "arms" of the flap are elevated in the subcutaneous tissue, increasing in thickness to include the fat as the dissection progresses toward the middle of the flap. Once elevated, the 2 lateral arms are folded over from the base to form a cylindrical mound, and the central arm provides the top. This creates a projecting structure that is self-supporting and stable.



Intraoperative photograph of a nipple reconstruction using modified star flap. The 3-arm donor sites are closed primarily.

- The donor site is closed primarily and does not require a skin graft. Pigment tattooing is performed once the reconstruction is deemed stable.



Postoperative photograph of the same patient.

Spiral flap

- The recently reported spiral flap uses the residual mastectomy scar to reconstruct a nipple.^[16] This method can be used in tissue expander or prosthesis breast reconstruction in which the new nipple position lies near the center of the mastectomy scar.
- A laterally based flap is elevated using the scar tissue medial to the new nipple position. The flap is approximately 5-6 cm long and 1 cm wide, and the base is 2 cm wide. The elevated flap is twisted in a spiral fashion on its main axis and sutured. The donor site is closed primarily.

Trapeze flap (modified Thomas technique)^[17]

- A trapeze flap is designed with the greater base equal to 3 times the diameter of the contralateral nipple and the height equal to 2 times the height of the contralateral nipple. The greater base is divided into 3 parts, and the central third serves as the pedicle of the flap.
- The flap is elevated and the vertical banks are sutured to form a cylindrical structure. The top is closed by a purse-string suture technique. The flap donor site is closed primarily. A hemicircular patch corresponding to the base of the new nipple is de-epithelialized to provide a platform on which the nipple will rest, minimizing risk of invagination.

Postoperative Details

- Support and protect the reconstructed nipple in the postoperative period. Dress the wound with antibiotic ointment and petroleum jelly dressing with a circular hole cut in the center. Then surround the nipple with petroleum jelly dressing and protect it with a standard maternity plastic nipple shield, a plastic medicine cup, or a syringe splint secured with adhesive tape.^[18] Change this dressing often and maintain for 2 weeks postreconstruction. Recommend wearing an appropriately fitting noncompressing bra.
- In cases of secondary treatment of failed nipple reconstructions, various treatment options are available, including repeating the original operation (particularly in the case of a skate flap) or inserting banked or autologous cartilage under a new skin flap to improve structural support and projection. The use of commercially available processed dermis (AlloDerm) as an insert or as an adjunct to re-elevation of a local flap can also improve the final outcome.^[15]

Complications

- Possible complications include partial and total loss of the nipple, epidermolysis, loss of nipple projection, and discoloration. Avoidance of smoking, accurate dissection, and the creation of a nipple that is initially 20-30% larger than the contralateral side minimize the chances of complications related to poor blood supply.
- Loss of nipple projection commonly occurs a few years after reconstruction. This problem may be reduced with the use of bell and double opposing tab flaps; nevertheless, it remains a frequent finding.^[10] Secondary nipple reconstruction can be performed by re-elevating the flap; inserting autologous dermal tissue, fat, or autologous or banked cartilage; and using filler injection or AlloDerm. Discoloration and uneven pigment distribution may occur over time and can usually be corrected with tattooing.

Outcome and Prognosis

Successful nipple-areola reconstruction is expected to maintain nipple projection and areola size; however, longevity of this reconstruction is highly variable and is influenced by factors such as scar contracture, tissue thickness, radiation, and trauma. Tattooing is commonly repeated.

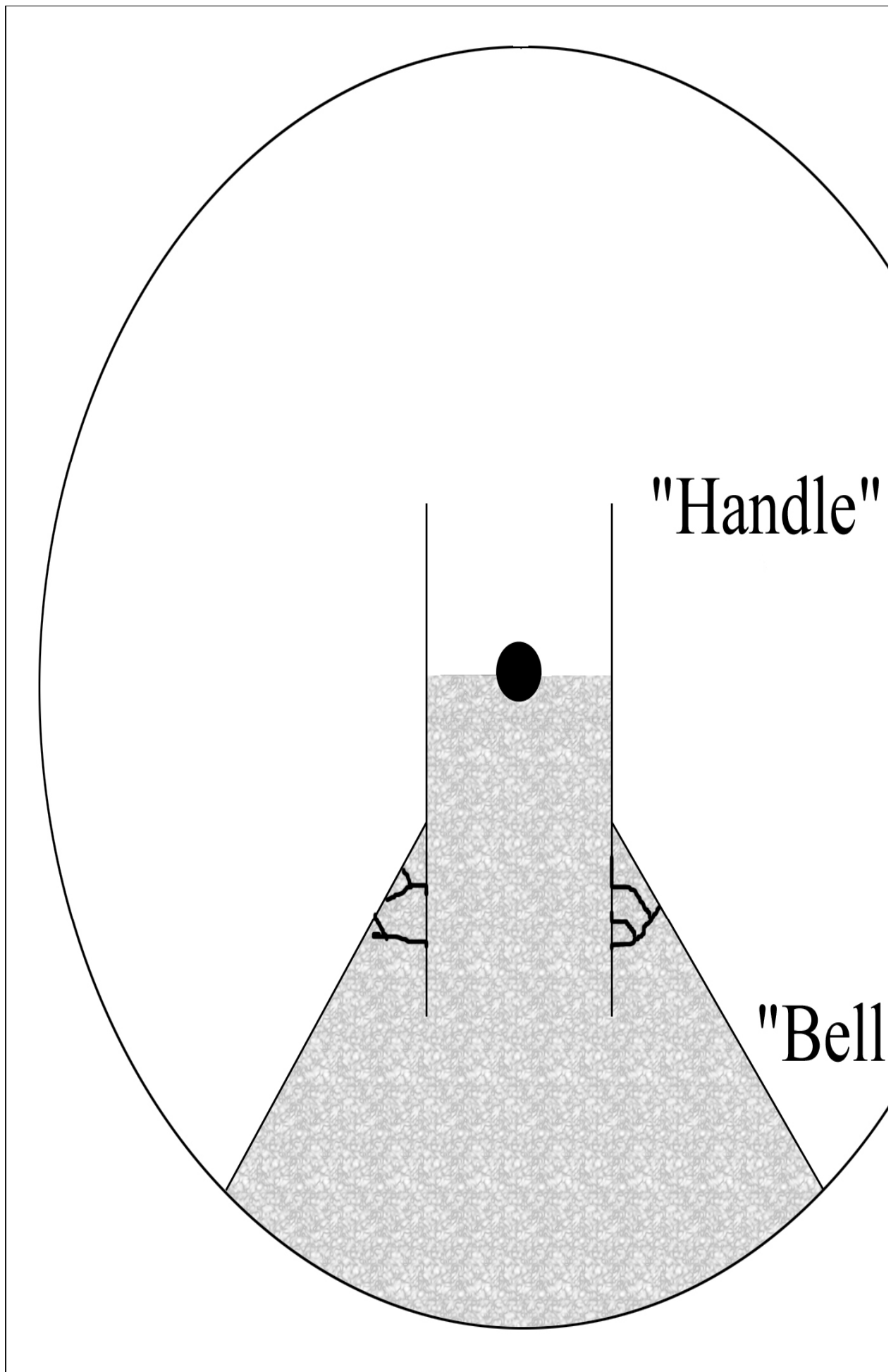
Future and Controversies

Nipple areola reconstruction is an essential component of complete and satisfactory breast reconstruction. This procedure can be performed with a minimum of patient discomfort, requires minimal postoperative care, and has a high degree of patient satisfaction. Various techniques are available that can be customized to meet specific patient requirements. Alloplastic materials such as porous polyethylene have been proposed for nipple reconstruction but have not been extensively tested in patients; concern exists about implant exposure.

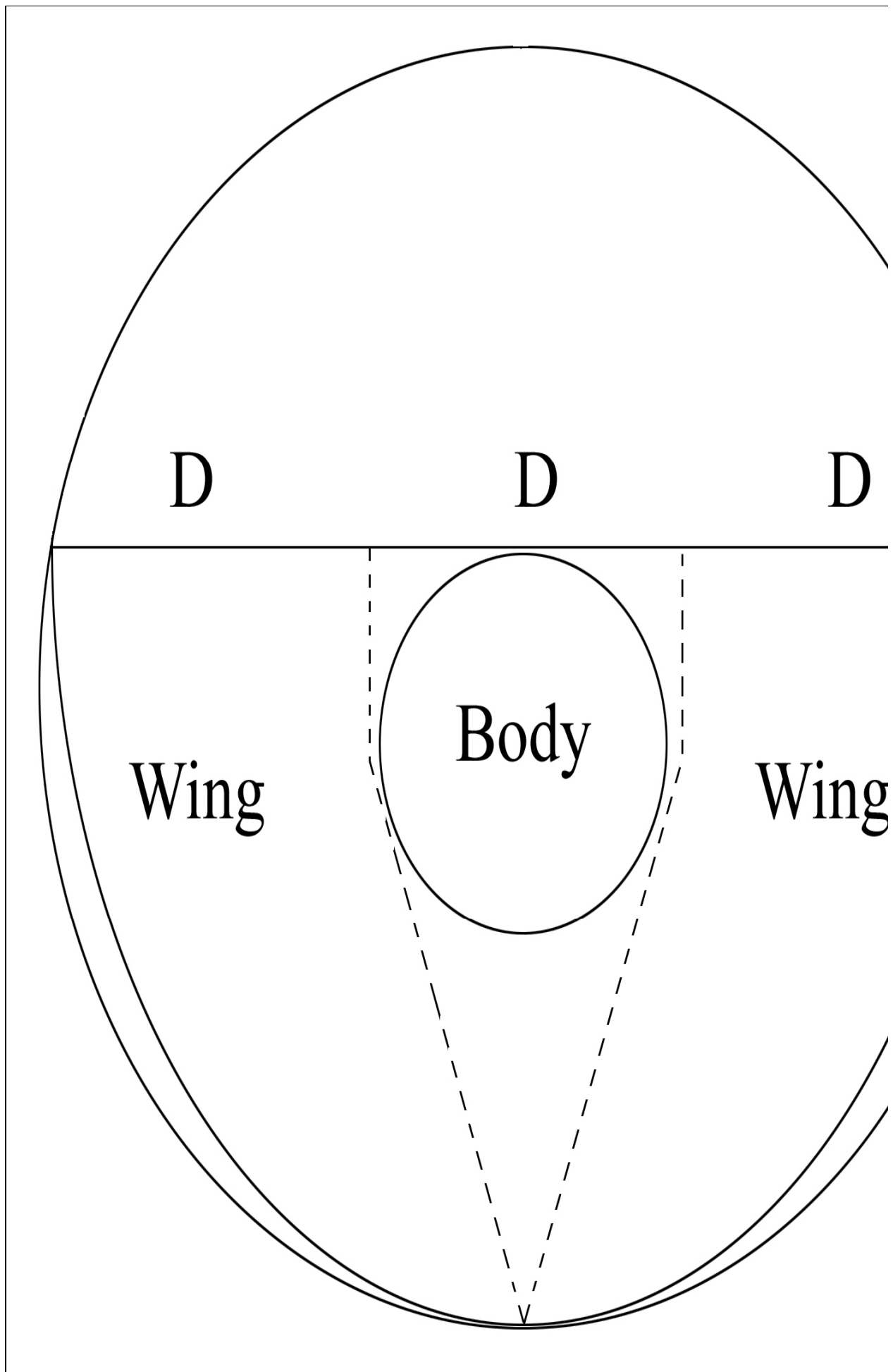
Recently, the role of nipple-sparing mastectomy continues to evolve and presents a controversial debate, especially in the setting of therapeutic mastectomy.^[19,20] No reconstructed nipple-areola complex will match the physical properties of the natural nipple-areola complex. Thus, nipple-sparing mastectomy can potentially achieve more a natural, aesthetic breast reconstruction by preserving the natural nipple-areola complex and

obviating the need for future nipple-areola reconstruction. However, long-term studies need to be performed and careful selection criteria should be met to ensure oncologic and surgical safety.

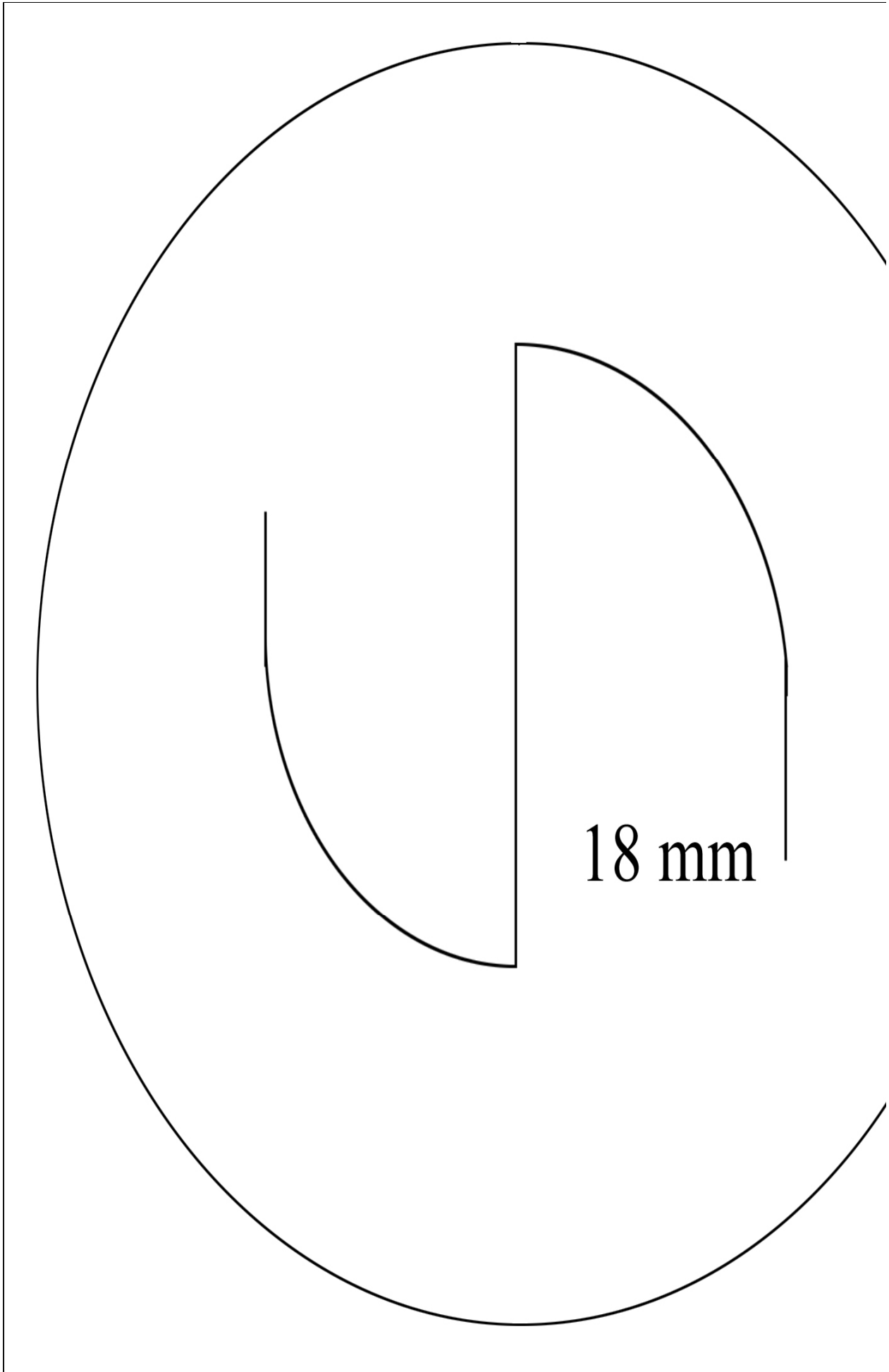
Multimedia



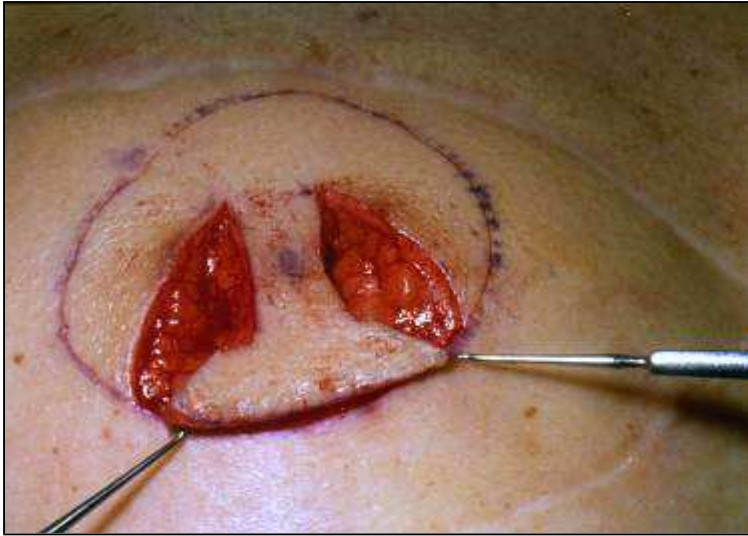
Media file 1: Diagram illustrating the layout of the bell flap. Note the triangles excised between the "handle" and the "bell" of the flap to allow for easier folding.



Media file 2: Diagram illustrating the layout of the skate flap. D is the diameter of the contralateral nipple, and the total length of the flap is twice the height (projection) of the contralateral nipple.



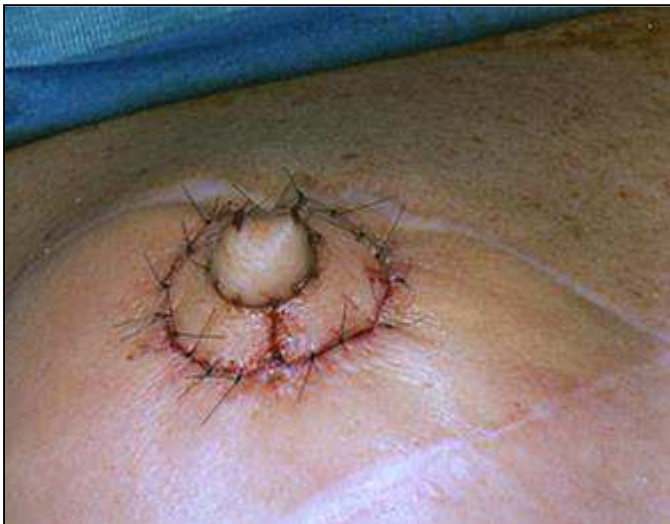
Media file 3: Diagram illustrating the layout of the double opposing tab flap. Note that the minimum recommended base width for the tabs is 18 mm. The 2 tabs are elevated and rotated to face each other as if 2 hands were joined in prayer.



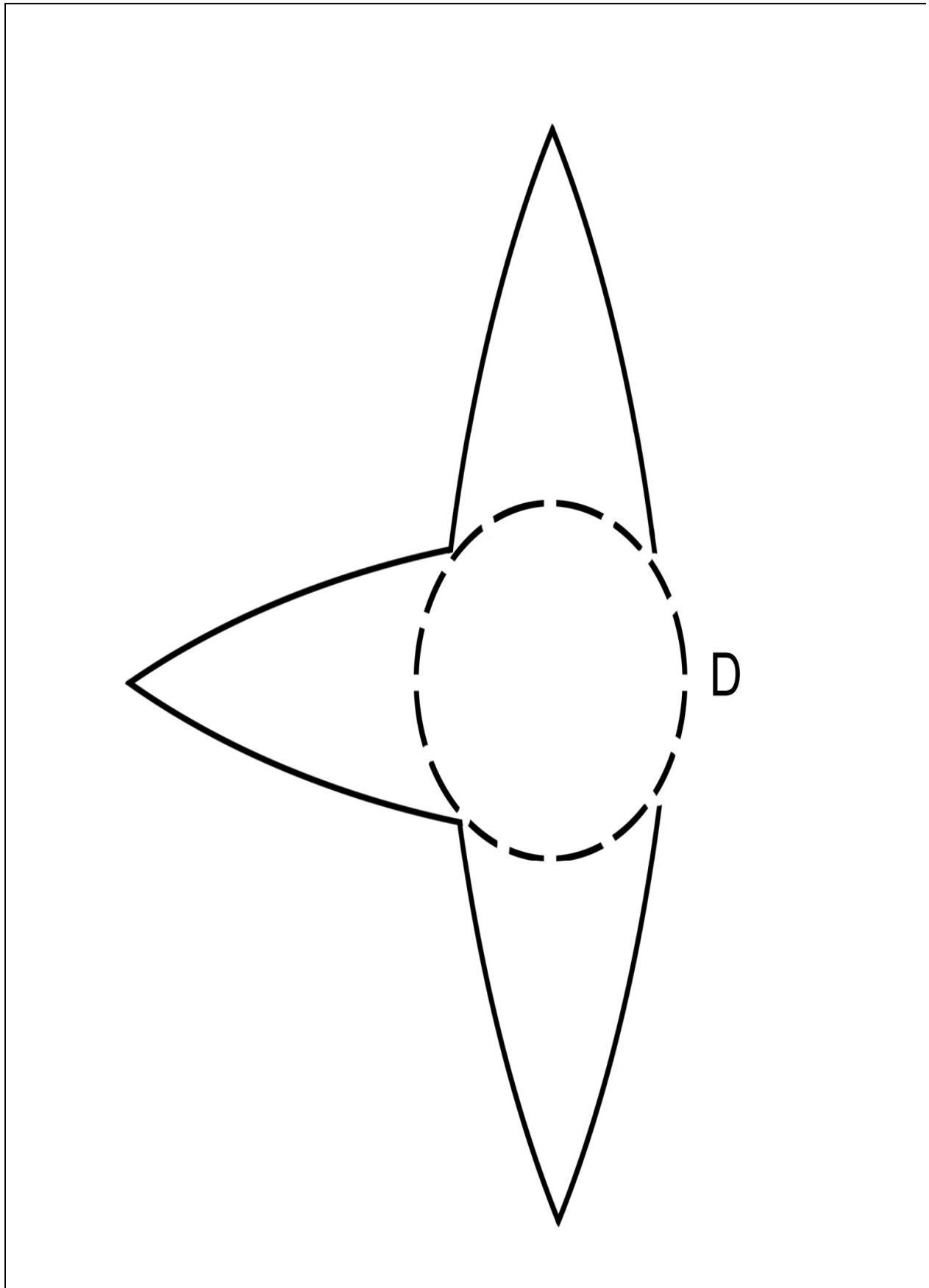
Media file 4: Intraoperative sequence of nipple reconstruction with the bell flap: initial layout and dissection of the flap.



Media file 5: Intraoperative sequence of nipple reconstruction with the bell flap: elevation and initial apposition of the flap.



Media file 6: Intraoperative sequence of nipple reconstruction with the bell flap: final reconstruction.



Media file 7: Diagram illustrating the layout of modified star flap for nipple reconstruction. D is the diameter of the contralateral nipple. The 2 lateral arms wrap around to form a cylindrical structure and the central arm provides the top.



Media file 8: Intraoperative photograph of a nipple reconstruction using modified star flap. The 3-arm donor sites are closed primarily.



Media file 9: Postoperative photograph of the same patient.

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Keywords

breast reconstruction, nipple-areola complex, breast cancer, athelia, transverse rectus abdominus myocutaneous reconstruction, TRAM reconstruction, microvascular-free TRAM breast reconstruction, mastectomy, breast surgery, breast implant, nipple surgery, nipple reconstruction, areola reconstruction

Contributor Information and Disclosures

Author

Yoon Sun Chun, MD, Clinical Instructor, Department of Surgery, Harvard Medical School; Associate Surgeon, Department of Surgery, Division of Plastic and Reconstructive Surgery, Brigham and Women's Hospital; Staff Surgeon, Department of Surgery, Division of Plastic and Reconstructive Surgery, Faulkner Hospital
Yoon Sun Chun, MD is a member of the following medical societies: American Medical Association, American Society of Plastic Surgeons, Association of Women Surgeons, Johns Hopkins Medical and Surgical Association, and Massachusetts Medical Society

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Coauthor(s)

Dennis P Orgill, MD, PhD, Professor of Surgery, Harvard Medical School; Associate Chief of Plastic Surgery, Brigham and Women's Hospital

Dennis P Orgill, MD, PhD is a member of the following medical societies: American Burn Association, American Medical Association, American Society for Reconstructive Microsurgery, Massachusetts Medical Society, and Plastic Surgery Research Council

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Medical Editor

Pankaj Tiwari, MD, Assistant Professor, Division of Plastic Surgery, Ohio State University

Disclosure: Nothing to disclose.

Pharmacy Editor

Francisco Talavera, PharmD, PhD, Senior Pharmacy Editor, eMedicine

Disclosure: eMedicine Salary Employment

Managing Editor

Saleh M Shenaq, MD†, Former Director and Founder, The International Brachial Plexus Institute; Former Chief, Section of Plastic Surgery, Methodist Hospital, Houston

Saleh M Shenaq, MD† is a member of the following medical societies: American Academy of Anti-Aging Medicine, American Academy of Pediatrics, American Association for Hand Surgery, American Association for the Advancement of Science, American Association of Plastic Surgeons, American Burn Association, American College of Physician Executives, American College of Surgeons, American Congress of Rehabilitation Medicine, American Medical Association, American Society for Aesthetic Plastic Surgery, American Society for Reconstructive Microsurgery, American Society for Surgery of the Hand, American Society of Gene Therapy, American Society of Law Medicine and Ethics, American Society of Maxillofacial Surgeons, American Society of Plastic Surgeons, American Trauma Society, Association for Academic Surgery, International College of Surgeons, Lipoplasty Society of North America, Plastic Surgery Research Council, Society for Neuroscience, Society of Surgical Oncology, Southern Medical Association, Texas Medical Association, and Texas Society of Plastic Surgeons

Disclosure: Nothing to disclose.

CME Editor

Nicolas (Nick) G Slenkovich, MD, Director, Colorado Plastic Surgery Center

Nicolas (Nick) G Slenkovich, MD is a member of the following medical societies: American Academy of Otolaryngology-Head and Neck Surgery, American College of Surgeons, American Medical Association, American Society of Aesthetic Plastic Surgery, American Society of Plastic Surgeons, and Colorado Medical Society

Disclosure: Nothing to disclose.

Chief Editor

James Neal Long, MD, Assistant Professor of Plastic and Reconstructive Surgery, Division of Plastic Surgery, University of Alabama at Birmingham and Kirklin Clinics

James Neal Long, MD is a member of the following medical societies: Alpha Omega Alpha, American College of Surgeons, American Medical Association, American Society of Plastic Surgeons, Plastic Surgery Research Council, Sigma Xi, Southeastern Society of Plastic and Reconstructive Surgeons, and Southeastern Surgical Congress

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