Chapter 1

Oncoplastic Surgery

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Additional information is available at the end of the chapter

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1. Introduction

The evolution of breast cancer management, following an arc of scientific discovery, is steeped in rich tradition and sacrament. A basic historical understanding of key discoveries in oncology sets the framework for our modern standards in cancer management, including our various applications in the field of breast oncology, breast reconstruction, and the “marriage” of the two, aptly named “oncoplastic surgery”.

Cancer was first described by Hippocrates, the ancient Greek physician considered the father of medicine, who observed that malignant tumors resembled crabs (Gr. karkinos), with its mass-like center and appendages arching outward. [1] Cancer is an age-old disease that has continued to elude mankind for centuries. The process of uncontrolled cell division, cancer refers to a process by which the hosts own cells divide rapidly in a seemingly chaotic, haphazard way, but, in actuality, is the result of complex genetic and environmental factors that "program" a person's own normal cells to acquire a malignant quality, ultimately leading to the infiltration of normal organs by these masses of abnormal cells. [1]

Breast cancer is the world's leading cancer in women second to all skin malignancies. [2] Behind lung cancer, breast cancer is the second leading cause of cancer mortality in women. [2] It affects approximately one in eight women over a lifetime, translating into roughly over 230, 000 new cases of invasive breast cancer and over 50, 000 cases of non-invasive breast cancer per year in the country alone. About 40, 000 people die of breast cancer annually in the U. S. It continues to be a major cause of mortality world-wide, particularly in developing countries, where access to prevention, screening, and even appropriate management might be scarce. [2]

Breast cancer incidence increased in the 1980s and 1990s, a trend that was multifactorial, largely attributable to the increase in screening mammography, but also associated with reproductive risk factors and environmental risks such as the widespread use of hormone replacement therapy. The incidence has remained relatively stable in recent years, reflecting a decline in

the use of exogenous hormones in post-menopausal women and a stabilization in numbers of women undergoing screening. [2]

Breast cancer incidence is strongly related to age, peaking in the later decades. Other risk factors implicated in the development of breast cancer include genetics (strong family history of breast or other related malignancies), hormonal and reproductive risk factors such as early menarche, late menopause, late onset of first pregnancy, hormone replacement therapy, and environmental risk factors including obesity, excess alcohol, high-dose radiation, and possibly nutritional factors. People at high risk for breast cancer include those previously diagnosed with breast cancer, those with atypical cells on a breast biopsy, and patients with mammographically dense breasts. [2]

Paralleling our improved understanding of breast carcinogenesis, risk factors, and improved surveillance are a multitude of advances in treatments.

The first loosely documented case of treated breast cancer was in 550 B. C. in the Persian Queen Atossa, who commissioned her slave Democedes to perform a primitive lumpectomy, essentially coring out her tumor, and allowing closure via secondary intention. [1] Treatments in centuries to follow ranged from drainage of "black bile, " salves, prayer, various home remedies, breast amputation, and treatment of depression. In the early 19th Century, William Halsted first described his radical mastectomy. The Halsted radical mastectomy involved removal of the entire breast gland, axillary lymph nodes, and chest wall muscles. Along with myriad other advances, with the advent of Joseph Lister's antiseptic techniques and general anesthetic developments discovered at the turn of the century, a surgical endeavor that would have been considered almost universally fatal was now conceivable. [1]

1.1. Images

At the time, the Halsted mastectomy was believed to offer a true cure for the breast cancer patient, given that she survived surgery. The theory of breast cancer representing a systemic disease had been washed away with Galen's black bile. A local disease required radical local treatment, regardless of physical deformity and lack of functionality. As such, the results were uniformly disfiguring but accepted as the singular option for survival. During this period, cancer was believed to be a local disease that spread in a predictable, time dependent fashion, therefore enlisting a massive operation to remove all cancer cells in order to render a patient cured. This procedure represented the standard of care for the next century, despite many patients presenting with small cancers not requiring such a radical approach.

Despite the improved short-term survival in patients undergoing maximal debulkment, long term results of this approach did not fare as well. By the mid 20th Century, the National Surgical Adjuvant Breast and Bowel Project (NSABP) had been conceived. [5] In 1971, Drs. Bernard and Edwin Fisher conducted animal studies that demonstrated metastases of tumor cells to both the lymphatics and the circulation, thereby laying question to Halsted's model of breast cancer as a "local" disease. In a trial of 1600 women undergoing Halsted radical mastectomy versus the less invasive total mastectomy, which spared lymph nodes and chest wall muscles, outcomes were comparable for the two groups, leading to the abandonment of the Halstead

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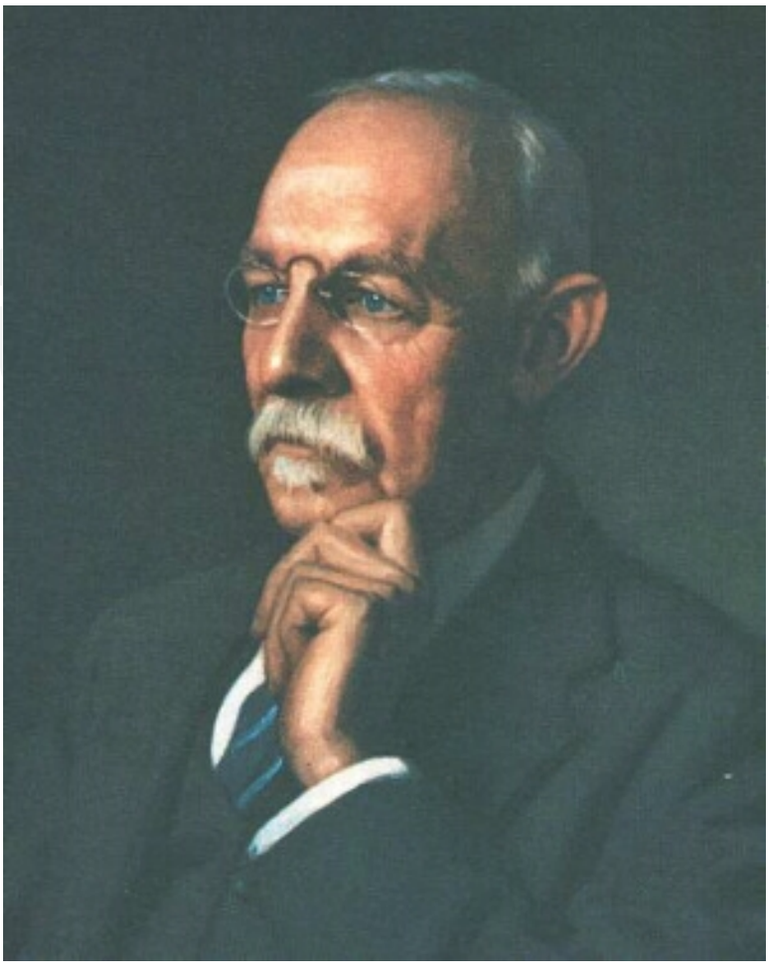

Figure 1. Dr. William Halsted [3]

radical mastectomy. This development heralded a new era of "minimally invasive" breast surgery. [5] Shortly, the same group was comparing lumpectomy to a modified radical mastectomy, learning that lumpectomy with the addition of breast irradiation demonstrated equivalent survival rates despite a slight increase in local recurrence rates. [6] Next, a series of trials adding systemic therapy to surgical treatment, ranging from chemotherapy to specialized hormonal treatments, were conducted, showing a further improvement in survival and local recurrence rates in select patients. [7] Advances in modern chemotherapy have significantly influenced the landscape of breast cancer treatment. The survival rate for early-stage breast cancer is greater than 90 percent, and even many patients with Stage IV breast cancer, the most advanced stage indicating wide-spread disease, can expect a longer survival on systemic therapies. [2] These treatments range from traditional chemotherapy to targeted agents such as anti-hormonal drugs (tamoxifen, aromatase inhibitors) and Herceptin (trastuzumab). Newer techniques in radiation therapy have also made lumpectomy exceptionally safe while lowering recurrence rates significantly.

Currently, breast conservation (lumpectomy), skin- and nipple-sparing mastectomies, and less radical lymph node resections all constitute oncologically sound procedures with minimal

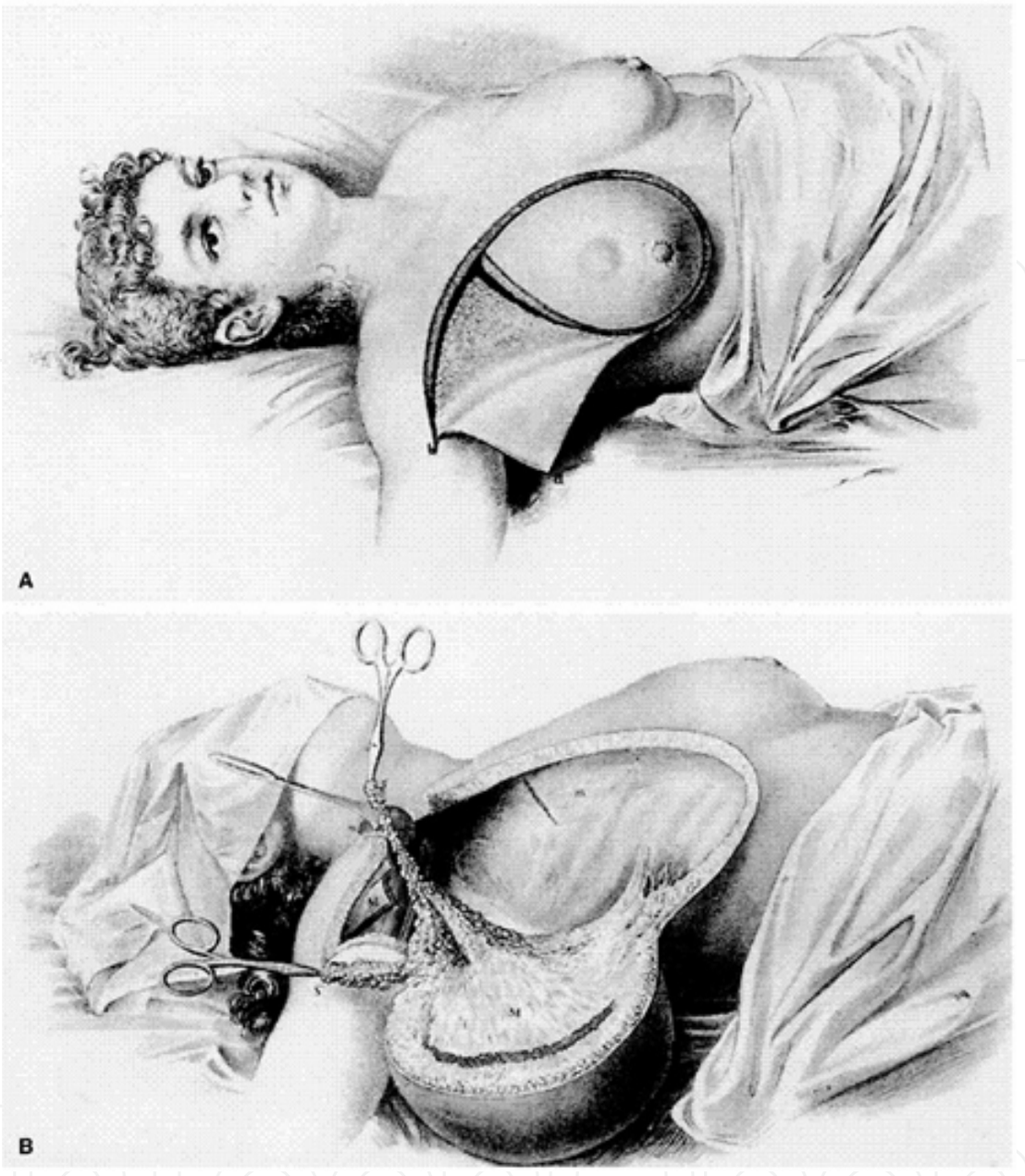

Figure 2. The Halsted Radical Mastectomy [4]

alteration of a patient's natural breast. Furthermore, advances in breast reconstruction, including "oncoplastic" surgery (the restoration of tissue contours while removing all cancer), afford women the opportunity to restore their bodies.

2. Defining oncoplastic surgery

In its simplest terms, oncoplastic surgery refers to combining a surgery used to treat or prevent breast cancer with a reconstructive procedure that will ultimately enhance cosmetic results. [8]

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This undertaking must be accomplished while adhering to strict oncologic principles. The components of oncoplastic surgery include:

1. Excision of cancer with adequately wide free margins to achieve locoregional control, immediate remodeling of defect
2. Contralateral symmetrization/reconstruction
3. Immediate and late reconstruction after mastectomy
4. Breast Conserving Surgery (BCS) with volume replacement or volume displacement

In this chapter each of these components will be described in detail. Some surgical techniques will be presented, but this chapter is intended as a framework to present the principles of oncoplastic surgery. The creativity and controversy that surrounds this burgeoning field will make for exciting future trends in breast surgery.

3. Oncoplastic Breast Conservation Surgery (BCS)

Techniques for oncoplastic BCS are both innovative and varied. As discussed previously, whole breast radiation added to BCS offers equivalent overall survival to mastectomy. [7] In general, BCS is sssociated with superior cosmetic outcomes, and patients report greater satisfaction with body image and less psychological distress. The two major types of breast conservation include lumpectomy and quadrantectomy. Quadrantectomy was popularized in Europe and is still used there frequently. Quadrantectomy adheres to segmental anatomy of the breast. Components of quadrantectomy include resection of anterior skin and inclusion of pectoralis fascia. The goal in a quadrantectomy is to obtain a 1-2 cm margin. The wide margin is cited as one of the main benefits of quadrantectomy, with a local recurrence rate around 3-4% at 20 years. [9] However, inferior cosmetic results stemming from resecting an entire quartile of the breast lead to lower overall satisfaction. [10]

Lumpectomy was popularized in the United States, largely in response to the cosmetic limitations of the quadrantectomy, but this more limited resection carried with it problems of having a lower negative margin rate and a slightly higher local recurrence rate. The lumpectomy is a conservative resection. Skin is generally not included. Pectoralis fascia is not always included. The goal in a lumpectomy is a small margin (>1mm), although there is no consensus of what number represents a negative margin. The lumpectomy operation is supported by NSABP-B06, which a 14% local recurrence at 20 years for invasive disease [6]. Enhanced cosmetic results were reported with this technique.

Milan II, a large randomized trial comparing lumpectomy with quadrantectomy, compared lumpectomy to quadrantectomy. Tumors up to 2. 5cm in size were included, and both patient groups received adjuvant radiation therapy. The overall survival for the two groups was equivalent, but the local recurrence risk at 5 years was slightly superior in the quadrantectomy group. [10]

Oncoplastic BCS emerged as a way to reconcile the higher local recurrence rate seen with lumpectomy versus quadrantectomy and the inferior cosmetic results seen with quadrantectectomy versus lumpectomy. Oncoplastic BCS was first described by Audretsch in 1998 and emerged as a specialty in Europe. [8] It evolved specifically to address the dissatisfying cosmetic results of partial breast resections. Up to 30% of patients that undergo either type of BCS have a residual deformity, nipple distortion, or asymmetry, a problem that oncoplastic surgery aimed to mitigate. By definition, oncoplastic BCS combines a breast conserving resection of cancer with well-established plastic surgery techniques that remove breast tissue encompassing the known cancer.

The indications for oncoplastic BCS include patients considering a reduction mammaplasy/pexy at time of diagnosis, patients with an expected poor cosmetic outcome after standard BCS, patients with free or involved margins seeking correction of defect, or requiring an oncologic re-excision, patients with unfavorable tumor to breast size (>10-20% volume), and patients with unfavorable tumor location (inferior, medial, central quadrants). Contraindications include inflammatory breast cancer, no tumor-free margins obtained, multicentric carcinoma (relative), no adjuvant XRT (relative), no response to or progression of disease on neoadjuvant chemotherapy. [11]

There are two major classifications of oncoplastic BCS, volume replacement and volume displacement. [12] Volume replacement involves transposition of autologous tissue into the segmental mastectomy defect. This technique maintains the original size and shape of the breast, therefore not obviating the need for contralateral surgery for symmetry. The second type, volume displacement, involves permanently removal of breast tissue. The breast is "reshaped" with residual breast tissue. With this technique, the original size & shape is altered, and a contralateral procedure to restore symmetry is generally required. [12]

The various different types of volume displacement oncoplastic BCS are depicted pictorially (Figs 3-14). [13]

Several series over past decade demonstrate over a 90% survival rate for early breast cancers undergoing oncoplastic BCS and an acceptable low local recurrence rate (highest 9. 4%, Clough et. al.). [Table 1] [11, 14, 15]

Author	Year	Number of subjects	Weight (g)/Volume of specimen	Close/Involv. margins (re-excision/mastectomy)	Local recurrence rate	Survival rate	FU period (mths)
Clough et al.	2003	101	222		9.4%	95.7%	44
Kaur et al.	2005	30	200	16%			
Rietjans et al.	2007	148	198	2.02%	3%	92.47%	74
Giacalone et al.	2007	31	190	21%			
Ballester et al.	2008	86	150	12.7%	2%		20
Meretoja et al.	2010	90		12.2%	0%		26
Fitoussi et al.	2010	540	187.7	18.9%	6.8%	92.9%	49

Table 1. Outcomes of oncoplastic BCS

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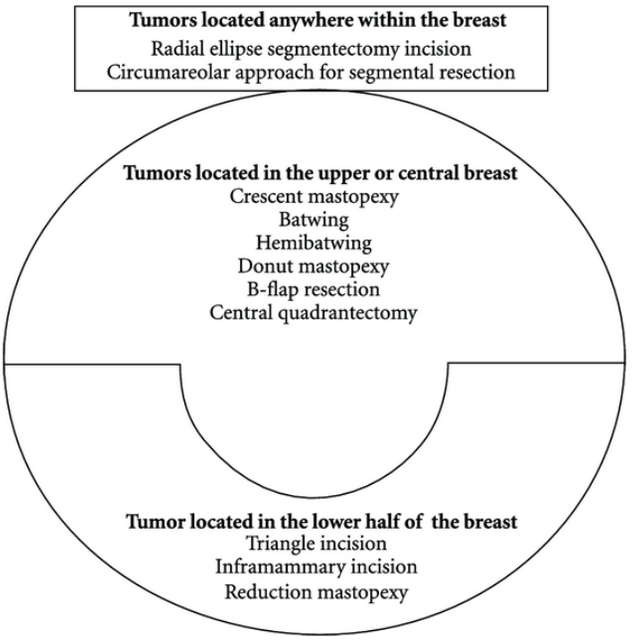

Figure 3. Types of volume displacement based on tumor location

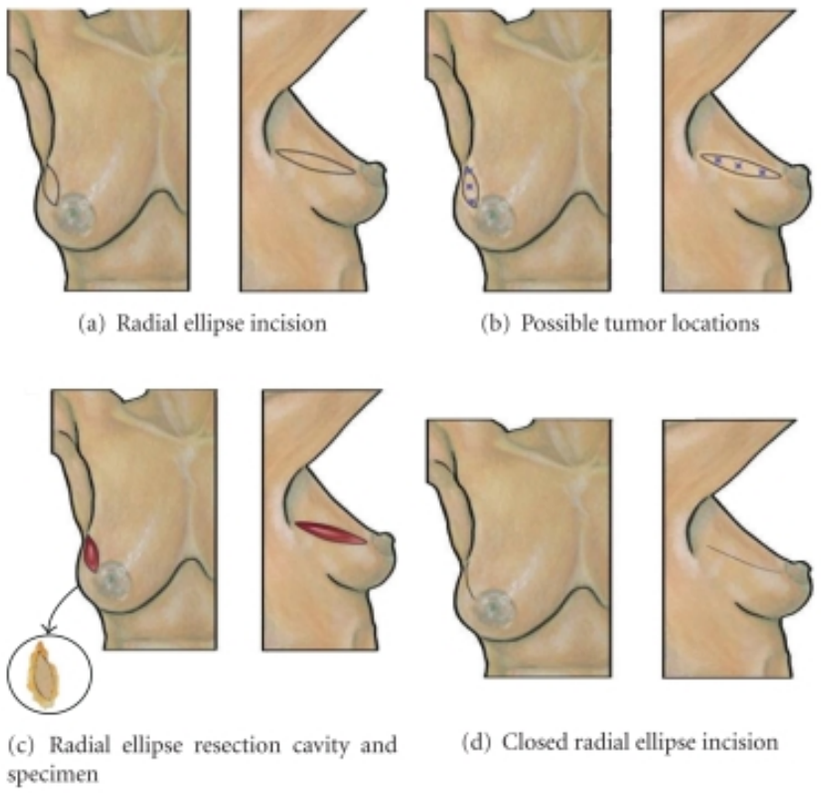

Figure 4. Radial ellipse incision for all tumor locations

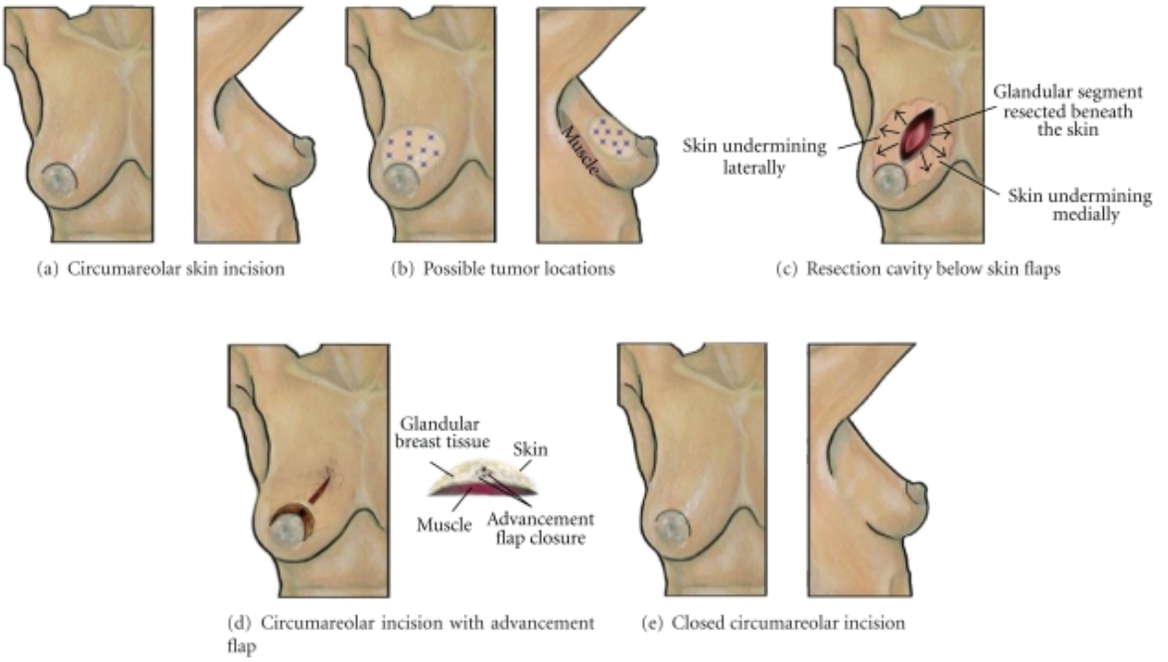

Figure 5. Circumareolar incision for all tumor locations

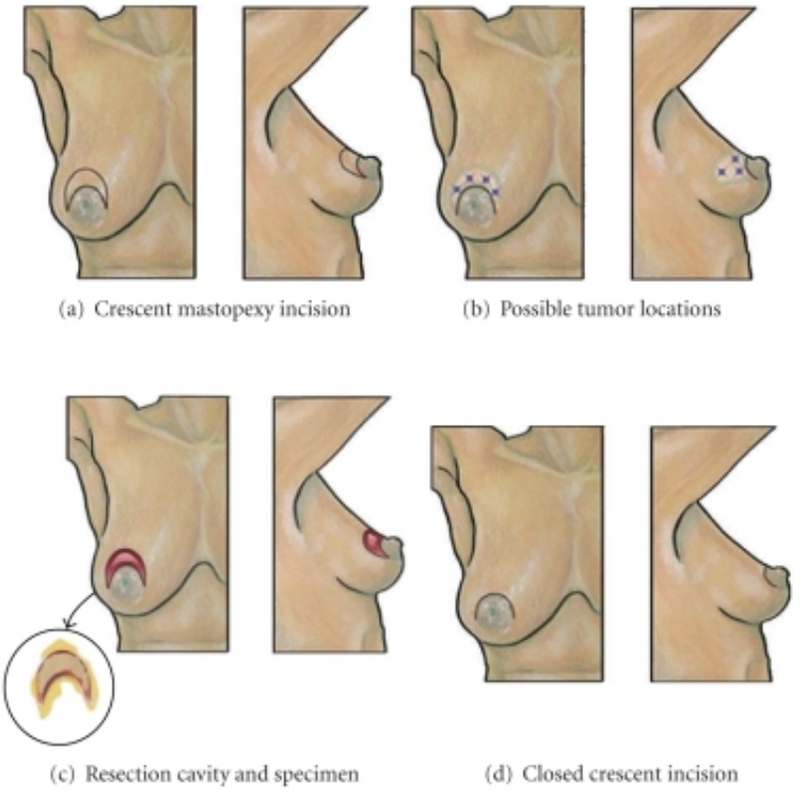

Figure 6. Crescent mastopexy for upper-pole or central tumors

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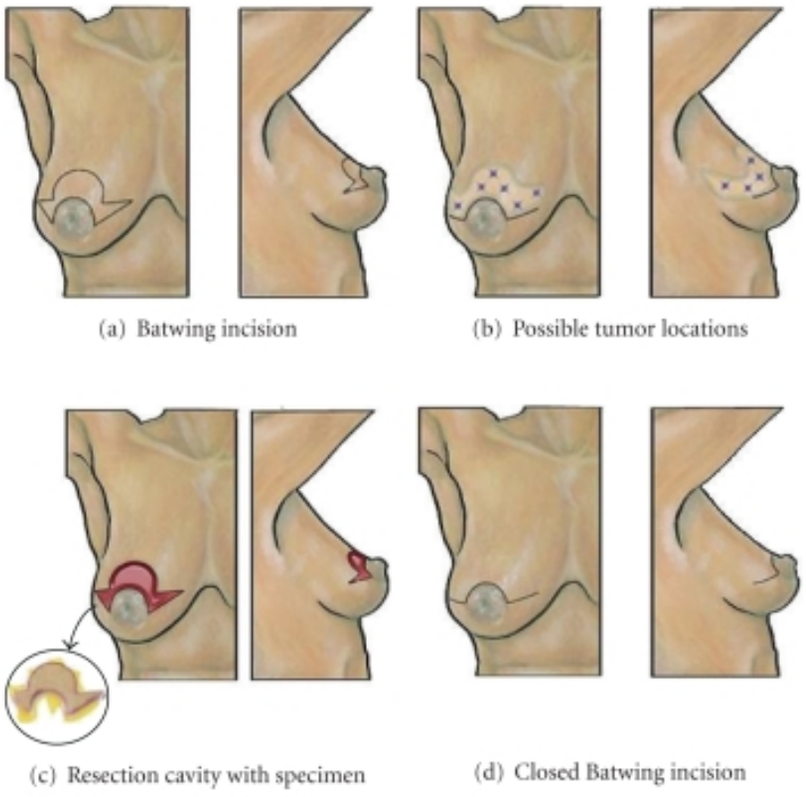

Figure 7. Batwing incision for upper-pole or central tumors

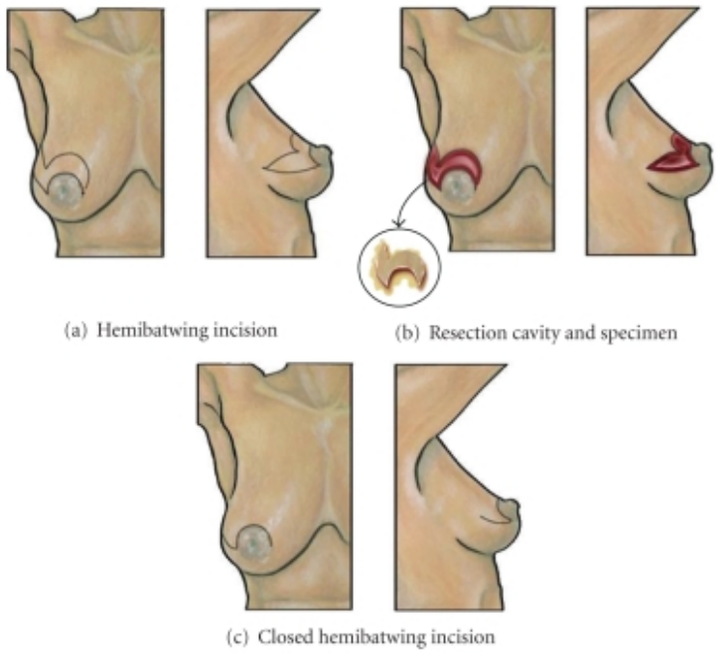

Figure 8. Hemibatwing incision for upper-pole or central tumors

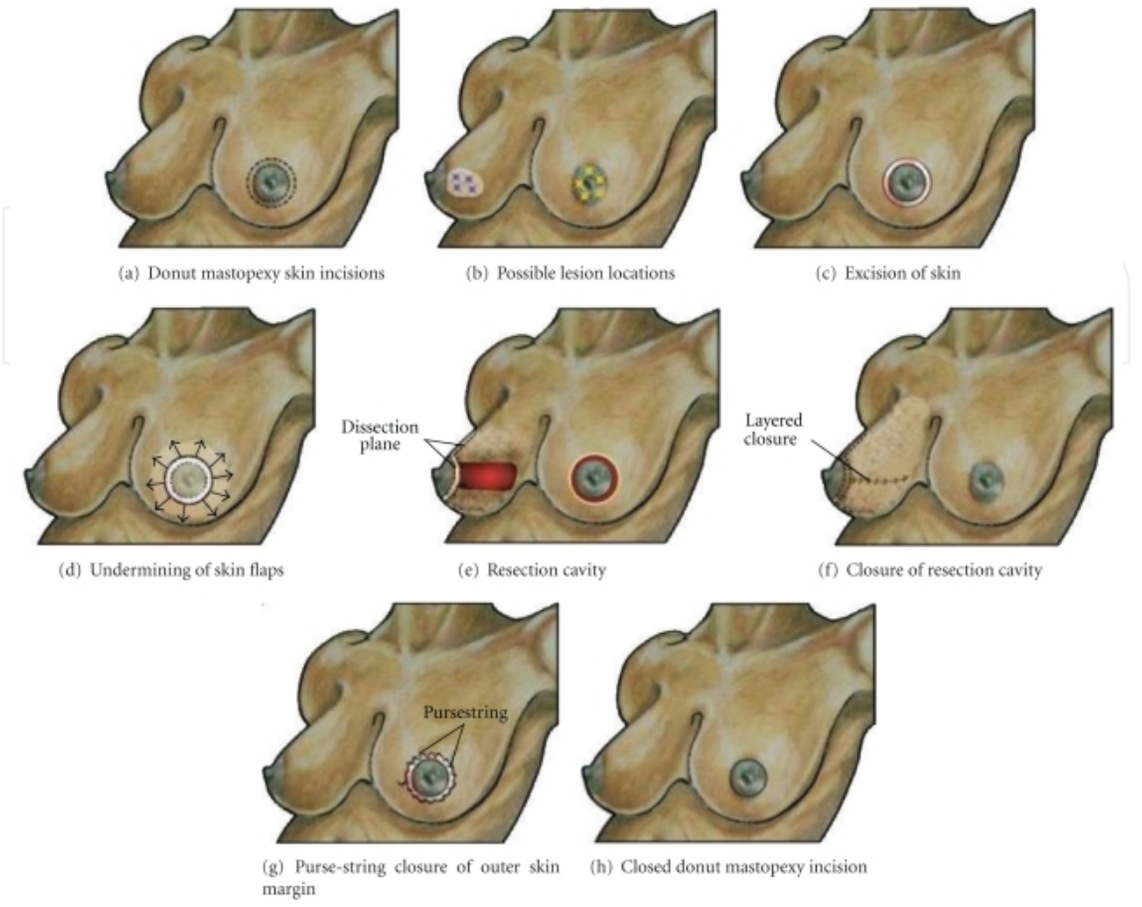

Figure 9. Donut mastopexy for upper-pole or central tumors

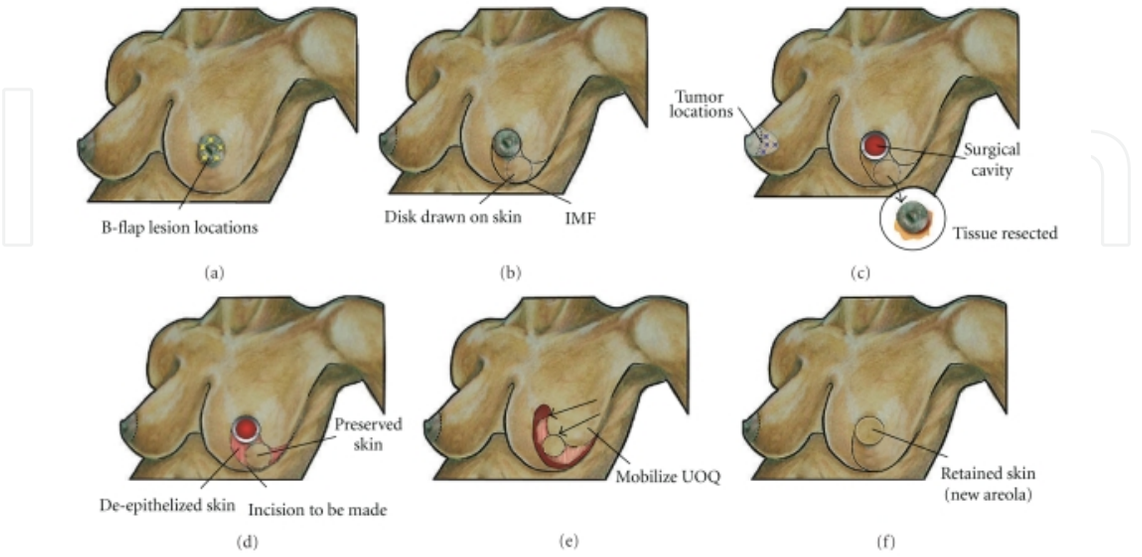

Figure 10. B-flap for central tumors

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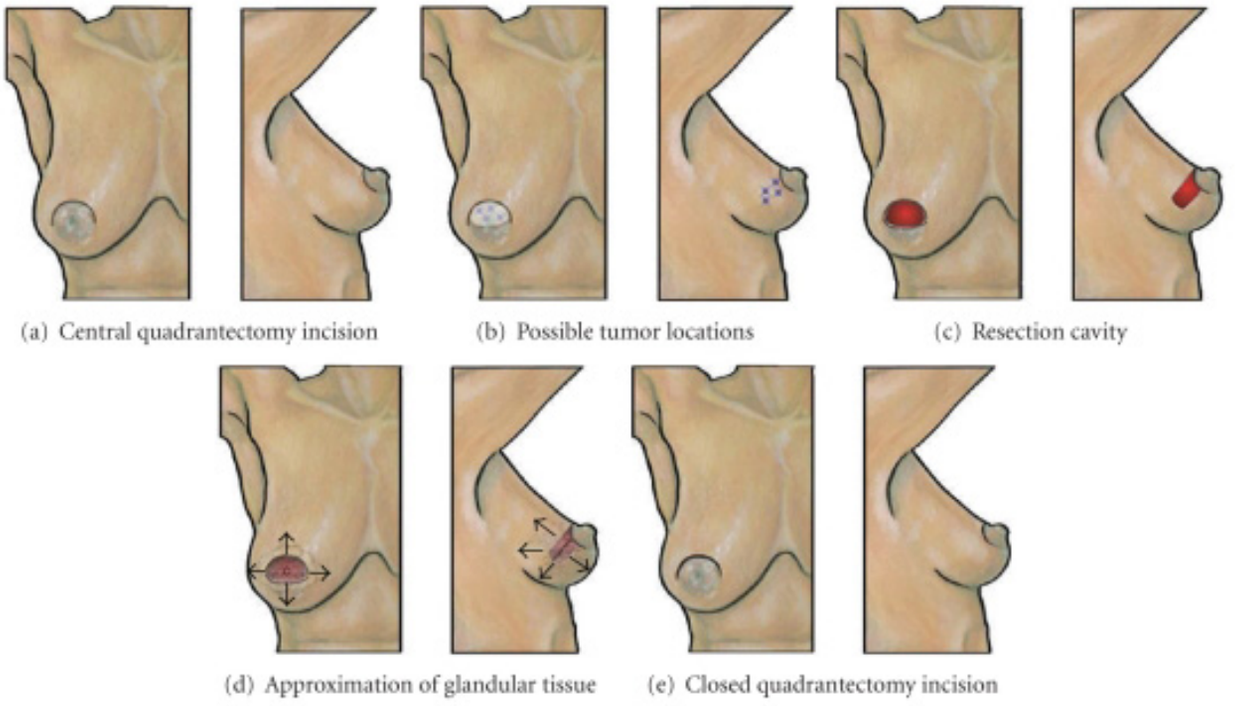

Figure 11. Central quadrantectomy for central tumors

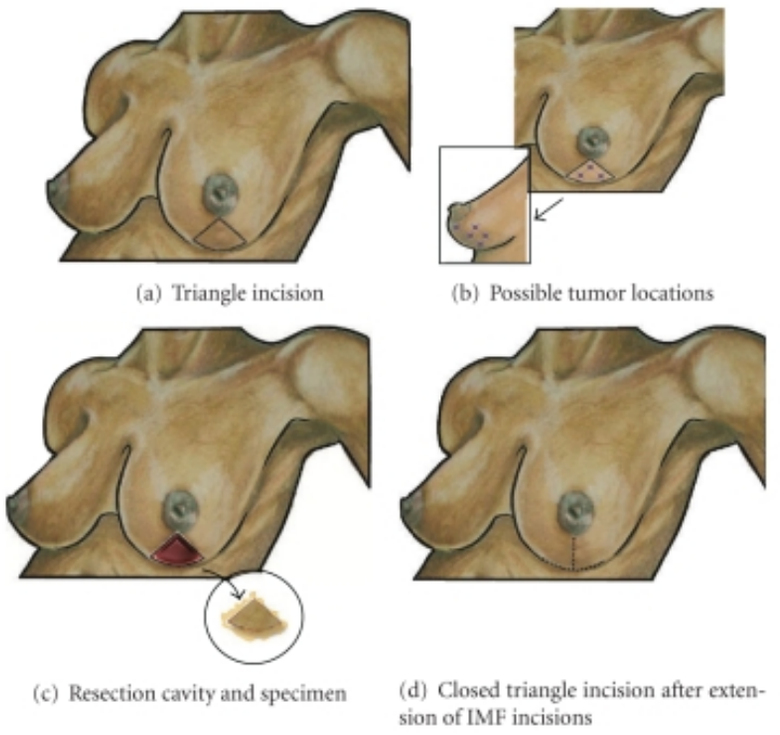

Figure 12. Triangle incision for lower pole tumors

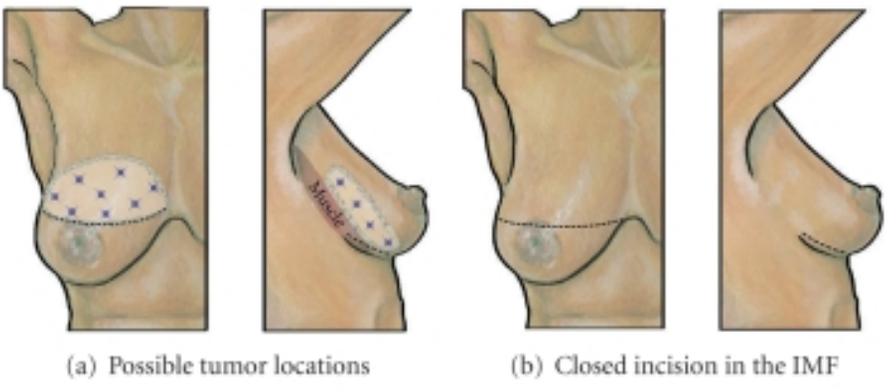

Figure 13. Inframammary incision for lower pole tumors

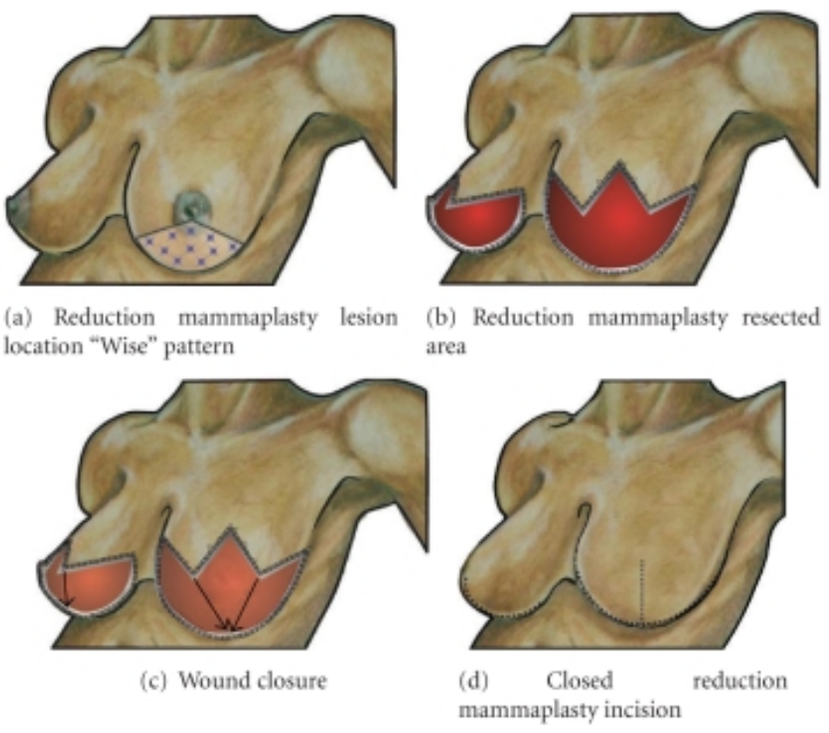

Figure 14. Reduction mastopexy for lower pole tumors

The proponents of oncoplastic BCS site the larger volume resections performed given the large degree of freedom for the deliberate creation of defects, theoretically improving the oncologic safety of the procedure. Inherently, wider margins are generally achieved and whole breast radiation can be applied more liberally and uniformly without significant risk to the breast contour. Furthermore, oncoplastic BCS can be applied to larger tumors, making breast conservation available to more women. Finally, many patients and practitioners report superior cosmetic results with oncoplastic BCS. [11, 14, 15, 16]

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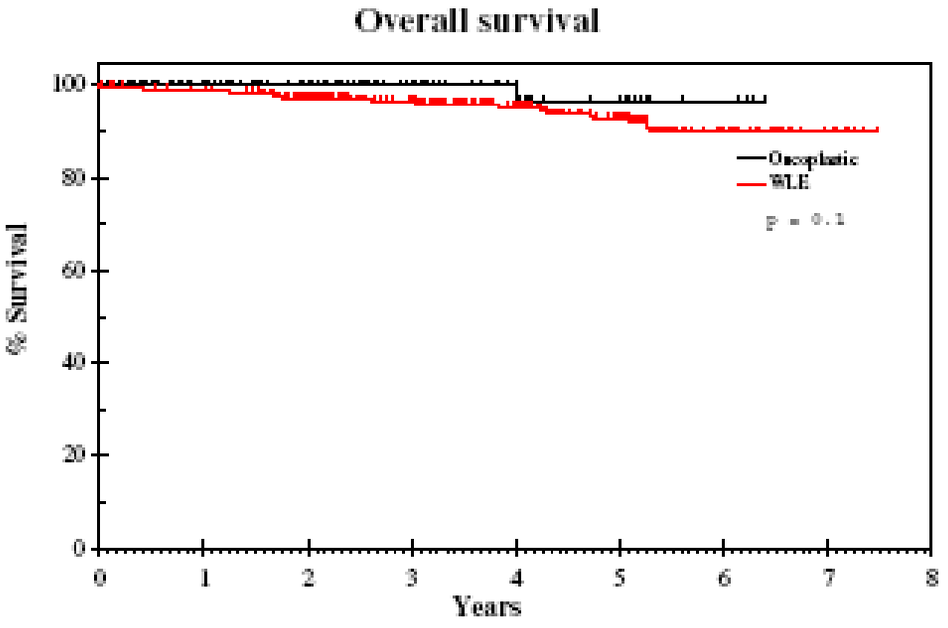

Figure 15. Overall survival oncoplastic BCS versus standard lumpectomy [11]

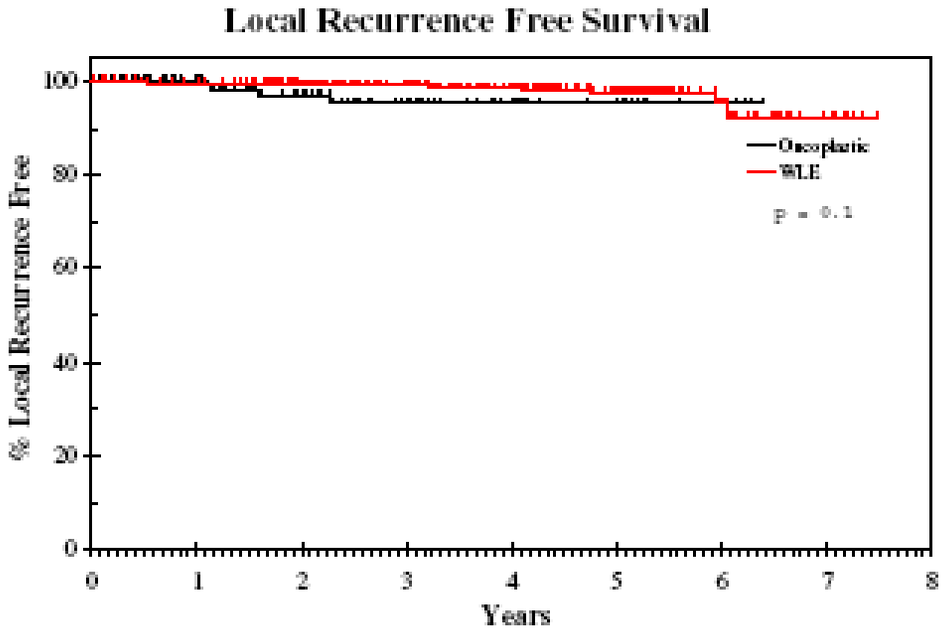

Figure 16. Local-recurrence free survival oncoplastic BCS versus standard lumpectomy [11]

Criticism for oncoplastic BCS includes the fact that most data are from single institution series with short follow up. Furthermore, there have been no formal studies showing that oncoplastic surgery changed management from mastectomy to less invasive breast conservation, despite the theoretical benefits listed above for patients with larger tumors. Studies have not yet demonstrated higher patient satisfaction with oncoplastic BCS versus standard BCS. Finally,

oncoplastic techniques are generally creative and challenging. While some embrace the innovative concept, others are resistant to changing tried and tested standard techniques.

4. Oncoplastic mastectomy

Oncoplastic mastectomy follows the same principle as oncoplastic breast conservation, that is, the restoration of natural breast contour following resection for cancer. An oncoplastic mastectomy is indicated for any patient who is a candidate for immediate reconstruction following total mastectomy. Contraindications include inability to obtain free margins, inflammatory breast cancer, post-operative XRT (relative and becoming largely outdated as a contraindication), and concomitant physical/psychological illness prohibiting reconstruction.

Traditional extended transverse mastectomy incisions yielded modest results in clothing at best. Earlier breast cancer detection has allowed for increased flexibility in skin preservation during mastectomy and reconstruction. Modern mastectomy incisions follow current principles of aesthetic breast surgery. As such, scars on the medial and upper poles are often avoided. Furthermore, in the 1980s, the non-elliptical incision was introduced, resulting in a considerable improvement in the nature of the original deformity created. It is accepted that the original deformity made during initial incision significantly influences the eventual cosmetic outcome, the preservation of native skin envelope being paramount to achieving favorable results.

The skin-sparing mastectomy (SSM) incorporates an anatomic incision with preservation of skin envelope. Other considerations in the SSM include removal of the nipple areolar complex (NAC) except in the specialized nipple-sparing version of the SSM, removal of initial biopsy site, and adequate exposure to allow for possible axillary dissection. Reconstructive considerations that come into clinical decision-making include breast size, degree of ptosis, general health of the patient, patient preference, and history of active tobacco use. Contraindications to SSM include extensive skin involvement and inflammatory breast cancer.

Results of SSM are favorable, demonstrating a risk of local failure of approximately 6. 2% with the exclusion of extensive inflammatory component. [17] Simmons et al (*ASO* 1999) conducted a retrospective review of 231 patients, showing local and distant recurrence rates following SSM to be 3. 90% and 3. 90% respectively (no significant difference vs. traditional mastectomy). [18] A lack of prospective data is limiting.

Nipple areolar complex sparing mastectomy (NSM) is the most recent incarnation of the SSM. In its early evolution, the NSM faced considerable opposition. Early studies of mastectomy specimens showed occult tumor in proximity to the NAC. Furthermore, in the 1960s, a series of high risk patients undergoing prophylactic subcutaneous mastectomy, during which a rim of tissue was deliberately left beneath the nipple areolar complex for perfusion, developed breast cancer, putting the oncologic safety of the modern NSM in question. Other considerations include avoidance of necrosis of the NAC, satisfactory NAC position, and implant preservation in the case of an implant-based reconstruction. Avoidance of necrosis hinges upon careful planning of incision and preservation of skin and intercostal perforators (see Figure 17 for examples of skin incisions). [19]

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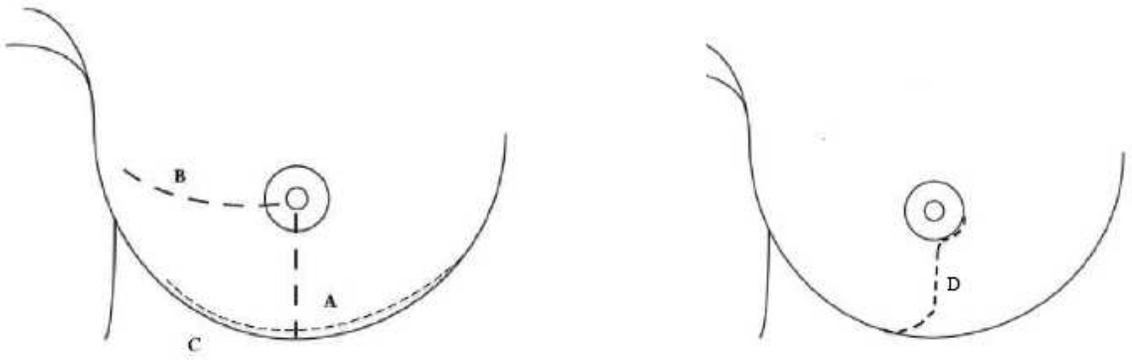

Figure 17. Examples of skin incisions for optimal NAC perfusion in NSM

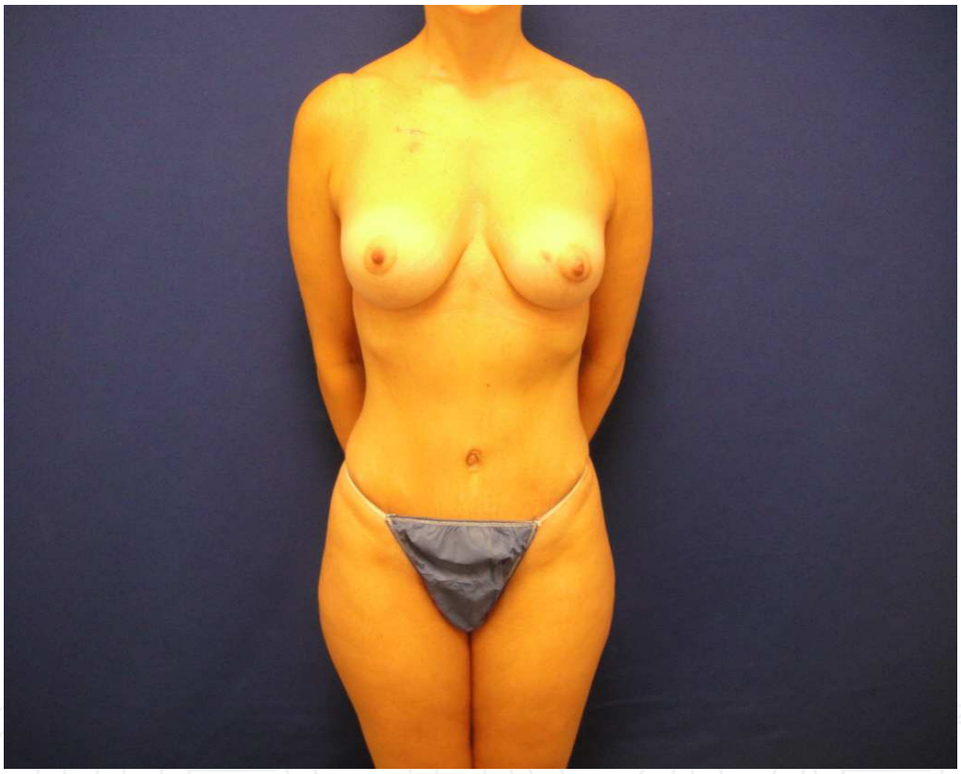

Figure 18. Preoperative BRCA positive patient

The principle upon which NSM is based is that NAC involvement occurs in relatively few patients with favorable tumor characteristics. Unfavorable tumor characteristics that suggest the potential presence of cancer cells in the NAC include subareolar or multicentric tumors, positive nodal status and extensive intraductal component. Inclusion for NSM (varies between authors) is generally: tumor ≤ 3- 4. 5 cm in size, tumor ≥ 1-2. 5 cm from areola, ≥ 4 cm from center of nipple, no gross involvement of the NAC (bloody discharge, Paget's), and retroareolar tissue sampling negative. Additional relative inclusion criteria include no to minimal lymph node involvement, uni-focality, and ptosis less than Grade 4. [20]

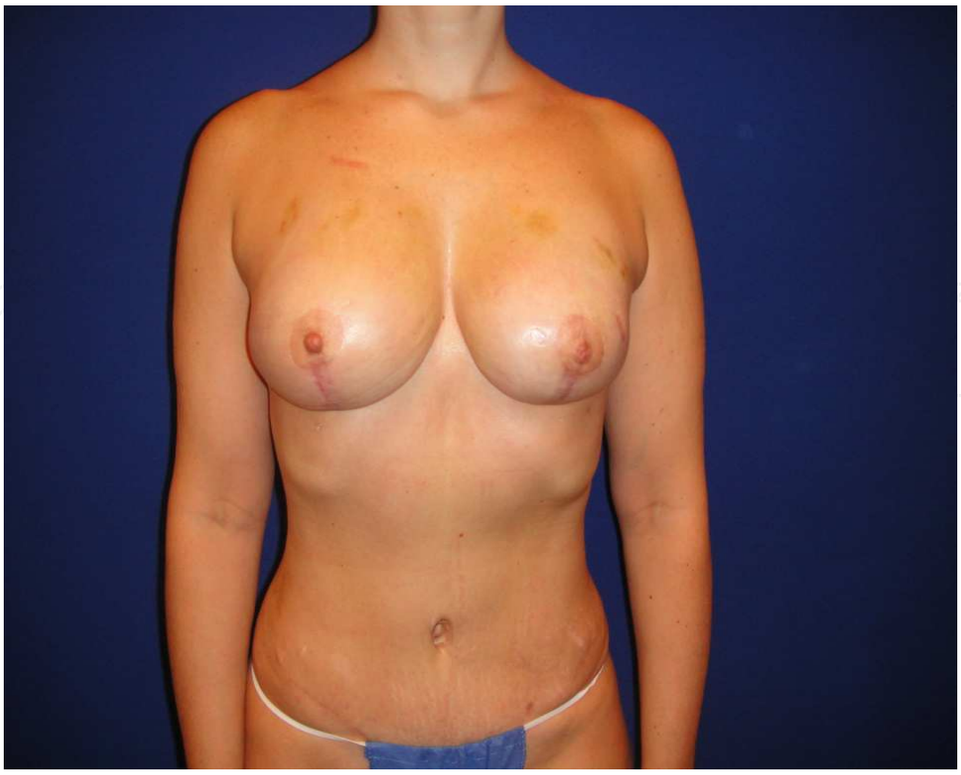

Figure 19. Post-operative BRCA patient status post NSM, PAP reconstruction

Large studies report occult nipple involvement with cancer between 5. 6 and 31% of the time with a local recurrence rate of < 5%. Cancer has been found in the retained nipple after risk-reducing mastectomy in the prophylactic setting <1% of the time. Nipple necrosis rates have been reported to be between 8 and 16%. Reconstructive factors including large breast size and excessive ptosis are associated with nipple necrosis and frank nipple loss. [21, 22]

5. Conclusions

Oncoplastic Breast Surgery represents an attractive and creative alternative to traditional methods. Despite barriers to its adoption, all evidence points to the oncologic safety and efficacy of oncoplastic surgery with improved patient satisfaction. Further prospective study is needed as we enter into the unique era of combining surgical disciplines.

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