The twentieth century witnessed dramatic changes in the surgical management of breast cancer in both the breast and the axilla. Publication of several landmark studies led to the evolution of breast cancer surgery from radical and deforming to breast conserving but also elucidated the systemic nature of the disease. Management of the axilla has mirrored that seen in the breast with movement away from standard axillary node dissection (ALND) toward less radical axillary surgery with the adoption of the sentinel lymph node biopsy. Herein only the surgical management of the breast will be discussed because the management of the axilla is covered elsewhere in this edition.

FROM RADICAL MASTECTOMY TO BREAST-CONSERVING SURGERY

Several landmark trials with decades of follow-up form the foundation of contemporary breast surgery. The National Surgical Adjuvant Breast and Bowel Project (NSABP) B-04 trial compared radical mastectomy (RM) to total mastectomy (TM) with or without radiation therapy in a prospective randomized fashion. In the TM arm, axillary dissection was performed only if lymph nodes were positive. Enrollment of more than 1600 women began in 1971, and the most recent publication with 25 years of follow-up was published in 2002. The investigators reported no difference in either group with regard...
to disease-free survival, relapse-free survival, distant-disease-free survival, or overall survival,\(^1\) confirming no advantage to RM.

Subsequently, a total of 6 prospective randomized trials enrolling patients from 1973 to 1989 validated the survival equivalence of mastectomy and breast-conserving surgery. The largest and perhaps most well known is the NSABP B-06 trial. This trial prospectively randomized women with tumors less than 4 cm to mastectomy, lumpectomy, or lumpectomy with radiation. All women had an ALND regardless of treatment assignment or nodal status; negative margins, defined as no tumor at ink, were required. The 20-year follow-up data were published in 2002; the investigators found no difference in disease-free, distant-disease-free, or overall survival\(^2\) between any of the treatment arms. The data did demonstrate, however, a significant reduction in local recurrence (LR) after lumpectomy with the addition of radiation therapy (39.2% vs 14.3%, \(P<.001\)) as did the 6 other conservation trials outlined in Table 1. Collectively, these trials established breast-conserving therapy (BCT), consisting of margin negative lumpectomy and radiation therapy, as appropriate therapy for women with invasive breast cancer. Based on these trials, the National Institutes of Health (NIH) issued a Consensus Conference statement in 1990 recommending BCT as the preferred surgical treatment of women with early stage breast cancer.\(^3\) Furthermore, they estimated approximately 80% of women with newly diagnosed breast cancer to be eligible for BCT. Not surprisingly, in response to this NIH recommendation, the percentage of women selecting BCT as their therapeutic choice steadily increased.

**PATIENT SELECTION**

Long-standing contraindications to BCT exist and are classified as absolute or relative. Absolute contraindications include multicentric disease (tumors in more than one quadrant of the breast), diffuse malignant-appearing calcifications, inflammatory breast cancer, prior radiation to the chest or breast or inability to receive radiation, persistent positive margins despite appropriate attempts for breast-conserving surgery, and the need for radiation during pregnancy.

Relative BCT contraindications may be debated. Surgeons tend to reserve BCT for those women with tumors less than 5 cm in whom negative margins can be achieved while maintaining an acceptable cosmetic outcome. More important, however, than the true size of the tumor is the ratio of the tumor size to the breast size. A 5-cm tumor may be easily excised if located in the upper outer quadrant of a woman with large

### Table 1

**Prospective randomized trials evaluating mastectomy and breast-conserving surgery**

<table>
<thead>
<tr>
<th>Trial</th>
<th>N</th>
<th>Follow-up (y)</th>
<th>Overall Survival</th>
<th>Mastectomy (%)</th>
<th>BCT + XRT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSABP B-06(^2)</td>
<td>1851</td>
<td>20</td>
<td></td>
<td>47.2</td>
<td>46.2</td>
</tr>
<tr>
<td>National Cancer Institute, United States(^68)</td>
<td>247</td>
<td>10</td>
<td></td>
<td>75.0</td>
<td>77.0</td>
</tr>
<tr>
<td>EORTC(^59)</td>
<td>903</td>
<td>8</td>
<td></td>
<td>64.0</td>
<td>66.0</td>
</tr>
<tr>
<td>Danish Breast Cancer Group(^70)</td>
<td>793</td>
<td>20</td>
<td></td>
<td>49.1</td>
<td>53.7</td>
</tr>
<tr>
<td>Milan(^71)</td>
<td>701</td>
<td>20</td>
<td></td>
<td>58.8</td>
<td>58.3</td>
</tr>
<tr>
<td>Institute Gustave-Roussy(^72)</td>
<td>179</td>
<td>10</td>
<td></td>
<td>80.0</td>
<td>79.0</td>
</tr>
</tbody>
</table>

**Abbreviations:** BCT, breast-conserving therapy; EORTC, European Organization for Research and Treatment of Cancer; XRT, radiation therapy.
pendulous breasts, whereas excising a 2-cm tumor located in the remote upper inner quadrant or at the 6-o’clock position in a woman with an A-cup breast size may result in an unacceptable cosmetic result. Furthermore the ability to remove multifocal lesions (2 cancers in the same quadrant) must be individualized and made in real time. Active connective tissue disease (especially scleroderma or active systemic lupus erythematosus) involving the skin of the breast precluding radiation is typically considered a contraindication. However, in patients with a connective tissue disorder and no history of involvement of the skin of the breast, radiation may be possible and consultation with a radiation oncologist before surgery may be meaningful in the decision-making process. Having a focally positive margin has long been considered a contraindication for BCT; however, the 2012 National Comprehensive Cancer Network’s guidelines permit consideration of BCT in these cases, with the caveat that a higher dose of boost radiation be considered for the tumor bed. Involving a radiation oncologist in this decision would also be helpful. Skin dimpling, nipple and areolar retraction, and tumor location are not contraindications to BCT, yet these should be considered in the preoperative assessment, specifically with respect to the ability to achieve negative margins. Young age is not a contraindication to BCT.

CURRENT TRENDS IN BREAST SURGERY

Despite the NIH recommendation for BCT, mastectomy rates in the United States have consistently been higher than the anticipated 20% rate estimated by the NIH. In fact, 6 single-institution studies have reported unilateral mastectomy rates ranging between 35% and 52%. Reasons for persistent or increasing use of mastectomy are unclear; but many hypothesize this is caused by a variety of clinical factors, such as magnetic resonance imaging (MRI) of the breast, young patient age, increased use of genetic testing, patient education and awareness, patient preference, and/or availability and improvements in reconstruction options. Controversy exists as to whether these trends are isolated among individual institutions or reflective of a broader national trend because others find no increase in their mastectomy rates. Further, Habermann and colleagues reviewed the breast cancer treatment of 233,754 patients as reported to the Surveillance, Epidemiology, and End Results (SEER) database between 2000 and 2006. They found that mastectomy rates decreased from 40.8% in 2000 to 37.0% in 2006 (P<.001). Although this population-based analysis finds contradictory results to the single-institutional series, the SEER data may be slower to identify early trends. Despite this, it still documents mastectomy rates in the United States to be well more than the 20% to 25% rates seen in Europe and elsewhere. Little is known as to why women choose mastectomy when they are eligible for BCT; but one study suggests it may be related to a personal history of contralateral breast cancer, absence of medical comorbidities, or young patient age but does not seem to be influenced by primary tumor characteristics.

Perhaps more significant in recent years than an elevated mastectomy rate has been the profound increase in contralateral prophylactic mastectomies (CPM). Tuttle and colleagues first identified this trend in 2007 noting in a SEER dataset that CPM increased among women undergoing mastectomy from 4.2% in 1998 to 11.0% in 2003. These rates were seen in all stages of cancer and highest in those with young age, lobular histology, and a prior diagnosis of cancer. Memorial Sloan Kettering reviewed their CPM rates and found them to mirror that seen in the SEER database, with rates increasing form 6.7% in 1997 to 24.2% in 2005. Only 13% of patients with CPM had a BRCA mutation or a prior history of mantle radiation, patient groups for whom CPM may be considered routinely; 22% of patients with CPM had ductal...
carcinoma in situ (DCIS), a noninvasive form of breast cancer without the potential to spread. These trends are difficult to reconcile when one considers that the risk of contralateral breast cancer is estimated to be 0.5% to 0.7% per year and declining in women without a BRCA mutation. However, Abbott and colleagues surveyed 74 women to assess patient perception of contralateral breast cancer risk and found patients estimated their contralateral breast cancer risk to be 31%, well more than the documented rates. Similar to the elevated unilateral mastectomy rates, there is a lack of clarity on the reasons for the increasing rates of CPM, which again seems to be a trend isolated to the United States because a recent European study found only 2.6% of mastectomy patients in Europe choose CPM.

BCT

The adoption of mammographic screening and improvements in screening techniques has resulted in an increase in the diagnosis of early stage nonpalpable breast cancers amenable to BCT. The term *breast conservation therapy* collectively refers to all surgical definitions for breast preservation procedures with tumor removal, including quadrantectomy, lumpectomy, tumorectomy, partial mastectomy, and others. Quadrantectomy was popularized by Veronesi and colleagues and refers to an en bloc excision of the skin, breast parenchyma with a 2- to 3-cm margin around the tumor, and pectoralis fascia. Once excised, the remaining breast tissue frequently must be mobilized off the pectoralis muscle and from the skin to allow reapproximation of the tissues with minimal distortion of breast contour and/or the skin. Lumpectomy generally refers to a less generous tissue excision and aims to remove the localized or palpable lesion with about a 1-cm margin. Nonpalpable breast tumors must be localized to aid in removal. Wire localization represents the most widely used technique because the wires may be placed with mammographic, ultrasound, or MRI guidance. Although this has been the standard for years, the process can be inconvenient for patients who must remain with the wire extending through the breast skin risking wire migration during transport. Finally, wire localization requires coordination of both surgery and radiology schedules. Recently, there has been significant interest in other localization options to minimize these concerns, including hematoma-directed ultrasound-guided lumpectomy, radio-guided occult lesion localization, and radioactive seed localization. All of these options use image-guided localization and can be done intraoperatively or, in the case of seed localization, several days before surgery. Although none of these alternatives have been widely adopted, RSL is gaining favor because the localizing seed is deemed to be safe, does not migrate, and may be associated with lower rates of positive margins.

Technically, lumpectomy incisions should be placed directly over the tumor whenever possible to avoid tunneling through the breast, but incision placement should keep in mind the possibility of future mastectomy. The incision is made through the dermis into the subcutaneous tissue, and then flaps are raised in all directions around the tumor to allow for appropriate exposure and mobilization of the breast tissue. Regardless of how the specimen is removed, it should be oriented in some way to ensure margins can be properly inked and identified by the pathologist. Although orientation of the specimen is critical, the precise process of how this is done varies among surgeons, pathologists, and institutions and carries important implications for re-excision surgery. Multiple studies evaluating specimen orientation by surgeon inking, specialized radiopaque margin markers, or shaved oriented cavity margins have been performed without consensus on the best technique. Once the specimen
is removed, many surgeons will leave radiopaque clips in the lumpectomy cavity marking the tumor bed to assist with radiation treatment planning and mammographic follow-up. Debate exists as to whether the cavity should be closed after tumor excision given the potential risk of positive margins requiring re-excision; opponents argue that rearranging the breast tissue limits the reidentification of the original positive margin site at re-excision. Finally, the incision is closed in layers, typically with a running monofilament suture for the skin.

MARGINS

Achieving negative surgical margins is a hallmark of successful BCT because this is associated with a lower rate of LR. However, what constitutes a negative margin remains a matter of significant debate. One particular problem in determining the effect of subtle differences in increasing margin width on local control is the general lack of standardization in specimen processing and microscopic analysis of lumpectomy specimens. It is important to understand how the margin processing is done at one’s institution because this can influence interpretation of margin results, rates of positive margins, and the need for re-excision. Both tangential shaved margins and perpendicular inked margins are common techniques for lumpectomy specimen processing. Tangential margin reporting classifies margins as positive or negative, whereas perpendicular margin assessment reports positive or negative and gives a margin distance. This nuance is important because one study found a 49% positive margin rate with tangential shaved margins compared with only 16% if done by the perpendicular margin technique. Further, because the tangential method allows for only a positive or negative result, it limits the surgeon’s ability to discriminate among patients with close margins to determine the need for re-excision. As a result, re-excision rates were higher in the tangential arm (75% vs 52%, \( P < .001 \)) despite no difference in residual disease found in the re-excision specimens (27% vs 32%).

The NSABP has long defined a negative margin as no tumor at ink regardless of the proximity of the nearest tumor cell. Historically, other series have argued that margins of more than 1 mm, more than 2 mm, more than 5 mm, or even more than 10 mm provide better local control. A recent meta-analysis reviewed 21 studies and 14 571 patients undergoing BCT. Data demonstrate a significant increase in LR for positive margins with an odds ratio (OR) of 2.42 (\( P < .001 \)) compared with negative margins. Direct comparison between different margin widths found no statistically significant improvement in local control. Although a weak trend was identified suggesting declining LR with increasing margin distance, this trend disappeared after adjustments for radiation boost treatment and endocrine therapy. Also of interest is the lack of standardized practice with respect to re-excision. Wide variation in re-excision patterns exists within and across institutions. McCahill and colleagues reviewed 2206 women undergoing BCT and found only 85% of those with positive margins completed re-excision, whereas 47.9% with margins less than 1 mm, 20.2% of those with 1.0- to 1.9-mm margins, and 6.3% with more than 2.0-mm margins had re-excision. Additionally, re-excision varied from 0% to 70% among surgeons (\( P = .003 \)) and was not affected by surgeon volume. Re-excisions also varied from 1.7% to 20.9% among institutions. These differences underscore the controversies with respect to lumpectomy margins and challenges of using margin status as a quality metric for breast cancer surgery. Regardless, in practice, positive or unknown margins should prompt re-excision because positive margins are associated with significantly increased rates of LR, even with radiotherapy. Diligent margin re-excision can result in successful preservation of the breast in up to 95% of cases.
even with multiple re-excisions. Although multiple re-excisions do not affect rates of LR, caution must be used because it may negatively affect cosmetic outcome.

**MRI AND BCT**

The use of breast MRI in patients with breast cancer increased dramatically from 10% in 2003 to 27% to 40% by 2007\(^9\)\(^,\)\(^12\)\(^,\)\(^30\) in part because of its superior sensitivity over mammography in identifying occult malignancies or extensive disease otherwise missed on conventional imaging. Surgeons and patients assumed that better delineation of disease would assist with surgical planning, reduce re-excision rates, and improve local control. However, current data do not validate these perceived benefits. Breast MRI frequently leads to more extensive surgery with wider excision specimens in 3% to 14% of patients and conversion to mastectomy from BCT in 3% to 33%,\(^31\) yet several studies, including the prospective randomized Comparative Effectiveness of MRI in Breast Cancer (COMICE) trial,\(^30\)\(^,\)\(^32\)\(^,\)\(^33\) found no difference in positive margins or re-excision rates; the prospective randomized MR mammography of nonpalpable breast tumors (MONET) trial\(^34\) found a paradoxically increased rate of positive margins and re-excisions in the MRI group (Table 2). Data addressing the effect of MRI on local control are conflicting. One study found a decrease in LR at 40 months in patients having MRI compared with those not having MRI (1.2% vs 6.8%, \(P < .01\)),\(^35\) whereas another found LR rates of 3% at 8 years in MRI patients versus 4% in patients not having MRI (\(P = .51\)).\(^36\) Further, Solin and colleagues\(^36\) found MRI had no influence on overall survival (86% vs 87%, \(P = .51\)). Similarly, the COMICE trial has demonstrated no difference in disease-free survival according to MRI usage. Unfortunately, the MONET trial was not designed to address LR or survival.

Incorporation of MRI into the diagnostic algorithm of women with breast cancer varies across the country but may be most appropriate in patients with the following:

- An occult primary breast cancer
- When conventional imaging is suboptimal
- When discordance is present between the physical examination and conventional imaging
- To monitor tumor response after neoadjuvant chemotherapy

Patients undergoing MRI should be counseled regarding the potential need for second-look procedures or additional biopsies and encouraged to complete any additional diagnostic procedures before finalizing the surgical plan because MRI may overestimate the extent of the disease in 33% of patients with unifocal disease and underestimate the extent of disease in 40% of patients with multifocal disease.\(^37\)

Finally, it is important to note that the incidence of MRI-only detected additional

<table>
<thead>
<tr>
<th>Study Type</th>
<th>N</th>
<th>Endpoint</th>
<th>No MRI (%)</th>
<th>MRI (%)</th>
<th>(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pengel(^33)</td>
<td>Retrospective</td>
<td>349</td>
<td>Positive margins</td>
<td>19.4</td>
<td>13.8</td>
</tr>
<tr>
<td>Bleicher(^30)</td>
<td>Retrospective</td>
<td>577</td>
<td>Positive margins</td>
<td>13.8</td>
<td>21.6</td>
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<tr>
<td>COMICE(^32)</td>
<td>RCT</td>
<td>1623</td>
<td>Reoperation or re-excision</td>
<td>19.0</td>
<td>19.0</td>
</tr>
<tr>
<td>MONET(^34)</td>
<td>RCT</td>
<td>418</td>
<td>Reoperation or re-excision</td>
<td>28.0</td>
<td>45.0</td>
</tr>
</tbody>
</table>

Abbreviation: RCT, prospective randomized controlled trial.
lesions far exceeds contemporary local failure rates of less than 10% with modern adjuvant chemotherapy and radiation regimens.\textsuperscript{38}

**NEOADJUVANT CHEMOTHERAPY AND BCT**

Neoadjuvant chemotherapy increases eligibility for breast-conserving surgery, especially in patients presenting with locally advanced breast cancer or in borderline cases whereby the tumor-to-breast size ratio will not allow for excision and acceptable cosmetic results. NSABP B-18\textsuperscript{39} established the efficacy of neoadjuvant therapy randomizing women with early stage breast cancer to 4 cycles of neoadjuvant or adjuvant doxorubicin plus cyclophosphamide. An updated analysis with more than 16 years of follow-up demonstrates no difference in overall survival, disease-free survival, or event-free survival\textsuperscript{40} between the two arms. Further, women receiving neoadjuvant therapy had a higher rate of pathologic negative axillary lymph nodes at surgery and a higher rate of BCT. Overall, 9\% of women had a pathologic complete response (pCR). The first-generation trials comparing neoadjuvant with adjuvant chemotherapy are listed in Table 3. Second-generation randomized phase III trials incorporating paclitaxel and docetaxel into neoadjuvant regimens as well as those evaluating preoperative targeted therapies like trastuzumab continue to demonstrate improved BCT rates but importantly demonstrate higher pCR rates, 10\% to 28\% for trials incorporating paclitaxel and docetaxel and 36\% to 78\% for trials incorporating trastuzumab.\textsuperscript{41} Achievement of pCR has been associated with an improved overall survival and disease-free survival.

Surgeons considering neoadjuvant chemotherapy and the possibility of BCT must ensure the tumor is properly marked with a clip before the start of therapy to allow localization and removal of the tumor bed in the event of a pCR. Although imaging regimens for patients undergoing neoadjuvant chemotherapy vary, many clinicians prefer MRI imaging before chemotherapy and then again before surgery to aid in surgical planning. Any imaging abnormalities identified on prechemotherapy imaging should be completely evaluated before the start of treatment.

**ONCOPLASTIC SURGERY**

Oncoplastic surgery combines oncologic principles with plastic surgery techniques to enhance the cosmetic outcome. The process includes tumor removal, correction of the tissue defect, reconstruction with rearrangement of the breast parenchyma, and contralateral symmetry procedures. Oncoplastic techniques focus on the following:

- Incision placement
- Nipple location
- Correction of ptosis

### Table 3

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>pCR (%)</th>
<th>BCT Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Neoadjuvant</td>
</tr>
<tr>
<td>Powles\textsuperscript{73}</td>
<td>212</td>
<td>10</td>
<td>87</td>
</tr>
<tr>
<td>NSABP B-18\textsuperscript{39,40}</td>
<td>1523</td>
<td>9</td>
<td>68</td>
</tr>
<tr>
<td>EORTC 10902\textsuperscript{74}</td>
<td>698</td>
<td>2</td>
<td>34</td>
</tr>
</tbody>
</table>

*Abbreviation:* EORTC, European Organization for Research and Treatment of Cancer.
A clear understanding of rearrangement techniques based on pedicled breast parenchymal flaps

One particularly rewarding technique associated with high patient satisfaction is the incorporation of tumor excision with a reduction mammoplasty. Perhaps the most important part of the oncoplastic process is the preoperative planning and delineation of the extent of disease as significant rearrangement of breast tissue may preclude the ability to re-excite a positive margin. Marking the tumor bed with clips remains important for future localization.

RADIATION THERAPY AND BCT

Radiation therapy plays a crucial role in successful BCT and has long been recognized to reduce LR risk by approximately 50%. The 2005 Early Breast Cancer Trialists’ Collaborative Group’s (EBCTCG) overview analyses demonstrated the influence of local control on long-term survival. The meta-analysis evaluated 42,000 women participating in 78 trials comparing radiotherapy with no radiotherapy, more surgery versus less surgery, and more surgery versus radiotherapy. Specifically with regard to BCT, the EBCTCG collectively analyzed data from 10 trials of 7300 women and found the risk of LR at 5 years to be significantly reduced from 26% after lumpectomy alone to 7% after lumpectomy with radiation therapy, an absolute reduction of 19%. Importantly, however, for the first time, the 2005 meta-analysis demonstrated a significant reduction in the 15 year risk of death from breast cancer from 35.9% among those not having postlumpectomy radiation therapy to 30.5% among those receiving radiation therapy ($P = .0002$ [two-tailed]). The EBCTCG concluded that one breast cancer death at 15 years could be prevented for every 4 LRs avoided.

The EBCTCG recently updated this data in 2011, expanding their analysis to 17 randomized trials of 10,801 women undergoing breast-conserving surgery with and without radiotherapy. This meta-analysis again confirmed that radiation therapy resulted in an overall absolute reduction in LR of 15.7% at 10 years compared with those not receiving radiation (19.3% vs 35.0%, $P < .00001$ [two-tailed])43; this translated into an absolute reduction in breast cancer death of 3.8% at 15 years, again reaffirming that preventing 4 LRs at 10 years saves one breast cancer death at 15 years. When the data were analyzed according to nodal status, the absolute reductions in LR and improvements in survival gained from radiation therapy were more profound in those with node-positive disease (Table 4). Further review of the node-negative patients according to patient and tumor characteristics was performed in an attempt to identify groups gaining higher benefit from radiation therapy. The investigators found the proportional benefit of radiation to be similar among all groups (about 50% relative reduction in LR), whereas the absolute benefits varied by characteristic, with greater absolute benefit in younger women, higher grade, or larger tumors, and in estrogen receptor (ER)-positive patients not receiving tamoxifen.43 More importantly,

<table>
<thead>
<tr>
<th>Table 4</th>
<th>EBCTCG local recurrence at 10 years and survival rates at 15 years: meta-analysis of the effects of radiation therapy (XRT) after BCT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Any First Recurrence at 10 y</td>
</tr>
<tr>
<td>N</td>
<td>BCS</td>
</tr>
<tr>
<td>pN0</td>
<td>7287</td>
</tr>
<tr>
<td>pN+</td>
<td>1050</td>
</tr>
</tbody>
</table>
the large sample size of these meta-analyses offered adequate power and long-term follow-up to detect a small but clinically relevant detrimental influence of LR on breast cancer survival. These data validate the importance of local control and demonstrate that optimal local control is achieved through multiple treatment modalities.

Investigations into partial breast irradiation options by external beam, catheter-based, and interstitial-based options are ongoing. Indications vary according to the American Brachytherapy Society and the American Society of Breast Surgeons but generally consider eligibility to be women more than 45 years old, invasive ductal carcinoma or DCIS less than 3 cm, and node negative disease. The NSABP B-39 trial is currently randomizing 4300 women with tumors less than 3 cm and 0 to 3 positive lymph nodes treated with lumpectomy to whole-breast or partial-breast irradiation. The trial is evaluating LR as well as cosmesis and is expected to reach accrual in late 2012.

**LR AFTER BCT**

LR after BCT can be described as (1) a true recurrence, one within the primary tumor bed; (2) a marginal miss, one within the same quadrant just outside of the tumor bed; and (3) an elsewhere recurrence, one in a separate quadrant of the breast. Generally, true recurrences and marginal misses account for 46% to 91% of all LRs and tend to occur earlier than elsewhere recurrences.44 As time lengthens from diagnosis and treatment of the original breast cancer, it becomes more likely that the second tumor is in fact a second primary cancer and not a recurrence. This distinction is made clinically but to date does not affect treatment recommendations. Regardless, the EBCTCG demonstrates that more than 75% of all recurrences occur within 5 years.42 Risk factors for LR include positive margins, young age, ER-negative receptor status, larger tumor size, positive nodes, and lymphovascular invasion.45,46 Histologic tumor type and family history are not associated with increased rates of LR. Systemic therapy, especially targeted therapy, reduces the risk of LR. For example, the adjuvant trastuzumab trials demonstrate that patients receiving trastuzumab had a 50% reduction in LR.47 Similarly, Mamounas and colleagues48 evaluated LR in estrogen-positive patients enrolled in NSABP B-14 and NSABP B-20 according to the 21-gene recurrence score assay (Oncotype DX, Genomic Health, Redwood City, CA, USA). At 10 years, tamoxifen significantly reduced the risk of LR in the low-risk group from 10.8% to 4.3% (P < .001). The addition of chemotherapy further reduced LR to 1.6% in that group (P = .028).

Mammography identifies in breast tumor recurrences in 14–47% of patients while physical examination finds 19–60%. Most local recurrences however are found by a combination of both mammography and physical exam. No guidelines exist for the use or MRI for post–breast conservation surgery surveillance, but it should be considered as a problem-solving tool if physical examination findings and mammographic findings are discordant. When tumor recurrence is identified, staging studies should be performed to rule out the presence of synchronous distant disease, which would change the priority for local management. In patients who have previously received radiotherapy, mastectomy is the standard of care surgical treatment option for breast tumor recurrence. Limited studies have evaluated the potential for repeat BCT but all have demonstrated high rates of second LR ranging from 14% to 48%.49,50 The disease-free interval from original diagnosis to LR influences long-term survival, with those developing early LR (within 2 years) having significantly worse survival.51

**MASTECTOMY**

Approximately 30% to 40% of women in the United States are not candidates for BCT or choose mastectomy. Technically, there are many types of mastectomy, including...
RM, modified radical, TM, simple, skin-sparing (SSM), nipple-sparing (NSM), subcutaneous, and prophylactic mastectomy (PM). Today, patients commonly undergo a TM or simple-mastectomy in conjunction with sentinel node biopsy for lymph node evaluation. Definitions of mastectomy types are as follows:

- TM or simple mastectomy: removal of the breast, overlying skin, and the nipple and areolar complex
- SSM: same as TM or simple mastectomy but sparing as much skin as possible and the inframammary fold for immediate reconstruction
- NSM: SSM technique also saving the nipple and areolar complex
- Subcutaneous mastectomy: subtotal removal of the breast tissue leaving behind 1 to 2 cm of breast tissue on the mastectomy flaps and the nipple and areolar complex

Although subcutaneous mastectomy is rarely performed in modern breast surgery, understanding that this technique was historically used for prophylaxis in women at elevated risk for breast cancer is important. The term prophylactic mastectomy incorporates any of the previously mentioned techniques and implies the procedure is being performed in a healthy breast to reduce the future risk of cancer.

**TECHNIQUE**

Incision placement varies on whether or not reconstruction will be performed. In general, however, the incision is performed in an elliptical fashion, incorporating the nipple and areolar complex, and positioned horizontally or obliquely across the chest. Ideally, the incision removes all prior surgical or biopsy scars. Mastectomy flaps are raised to the level of the clavicle superiorly, the sternal edge medially, the inframammary fold or rectus fascia inferiorly, and the latissimus dorsi muscle laterally, leaving behind only a small amount of subcutaneous fat and blood vessels in the subdermal plane on the skin flap. Mastectomy flaps are commonly raised using electrocautery or scalpel dissection. The key to either technique is maintaining adequate retraction of the breast gland with the nondominant hand to identify and maintain the plane of dissection. The flaps are raised in a medial-to-lateral direction as an assistant holds tension on the skin flaps with hook retractors. Some prefer to perform tumescent mastectomy over simple electrocautery or scalpel dissection using a tumescent solution of saline, lidocaine, and epinephrine to infiltrate the subcutaneous fat just below the dermal layer. In this technique, a 60-mL syringe of fluid is injected in the subcutaneous plane across the length of the mastectomy incision to aid in separating the mastectomy plane from the subcutaneous fat. Then with ample retraction of the skin edges toward the operator, the surgeon uses sharp dissection, either with a scalpel or scissors, to create the mastectomy flaps and define the borders of the breast. Regardless of the surgical technique, it is important to recognize that significant interdigitation of the breast tissue and subcutaneous fat exists and the goal is to leave as little breast tissue behind as possible while maintaining viability of the flaps. Of note, not all skin flaps will be of equal thickness because thin women will naturally have thinner mastectomy flaps than obese women. Removal of the breast from the chest wall incorporates the pectoralis major muscle fascia posteriorly and is most easily performed staying parallel to the pectoralis muscle fibers. The mastectomy specimen is oriented by placing a stitch in the axillary tail. In the absence of reconstruction, the cosmetic goal should be to leave the chest wall as flat as possible to allow ease of external prosthesis fitting. Once excess
cutaneous deformities (dog-ears) are eliminated, a closed suction drain should be placed and the tissues closed with interrupted dermal sutures followed by a running absorbable suture for the skin.

**SPECIAL CONSIDERATIONS: SSM**

Toth and Lappert originally described SSM in 1991. In this initial publication, they defined SSM as the removal of the breast through a smaller incision incorporating the nipple and areolar complex, all biopsy incisions, and allowing access for axillary node dissection. The SSM incision maintains the native skin envelope, limiting skin differences during reconstruction; maintains the natural inframammary fold; and allows for immediate breast reconstruction at the same stage. The investigators concluded SSM offered superior cosmetic results. Using these principles, breast surgeons and plastic surgeons will develop small elliptical or circular incisions around the nipple and areola or even perform mastectomy through a Weiss pattern or reduction mammoplasty incision.

Initial concerns around SSM included oncologic safety and surgical morbidity, both specifically related to the smaller incision, limited exposure, and longer skin flaps. Opponents worried these technical concerns would translate into higher rates of LR and skin flap necrosis. In addition, it was not clear if imaging of the reconstructed breast would be necessary for the residual skin flaps or if the residual skin and reconstructed breast would have to be removed in the event of LR after mastectomy. Although no prospective trials comparing SSM with TM exist, several recent retrospective studies, including a large meta-analysis, have compared SSM with non-SSM, finding no difference in LR (Table 5). Given this, contemporary trends, both in the United States and internationally, demonstrate widespread adoption of the SSM technique, with 27% of mastectomy recipients undergoing SSM in 1997 and 75% having SSM by 2001. Further, Kinoshita and colleagues recently reported no difference in disease-free survival (92% and 95%, SSM and non-SSM, respectively) or overall survival (P = .75) between the two techniques.

**NSM**

NSM was originally described in 1962 by Freeman and colleagues and abandoned because of oncologic concerns and cosmetic complications. Interest in this technique, however, increased again in the early twenty-first century. The newer NSM

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Follow-up (mo)</th>
<th>LR According to Surgery</th>
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<tr>
<td>Yi</td>
<td>1810</td>
<td>53</td>
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<tr>
<td>Boneti</td>
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<td>NSM 25</td>
<td>SSM 38</td>
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<tr>
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<tr>
<td>Gerber</td>
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<td>101</td>
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</table>

*Abbreviation:* CI, confidence interval.

*Meta-analysis with follow-up ranging from 37 to 100 months among 9 studies analyzed.*
techniques remove all the breast tissue, similar to SSM or conventional mastectomy, as opposed to the prior descriptions of NSM, which likened the procedure to that of a subcutaneous mastectomy. Furthermore, cosmetically, most plastic surgeons prefer the native nipple to a reconstructed one primarily because reconstructed nipples frequently lose projection over time. Patient satisfaction echoes these opinions; a retrospective study by Jabor and colleagues\textsuperscript{56} reported more than 50% of women with reconstructed nipples wish they could improve their nipple projection.

Published series describe a variety of incisions, including inframammary fold, circumareolar, omega (circumareolar with medial and lateral radial extensions), lateral radial, and vertical incisions. The appropriate incision depends on the breast size and shape, the degree of ptosis, presence of prior incisions, type of reconstruction, and surgeon comfort, keeping in mind the ability to reach to anatomic boundaries of the breast (the clavicle, sternum, and inframammary fold) and to perform the same oncologic operation as one would perform in a non-NSM setting. Mastectomy flaps are again raised in the mastectomy plane as previously described. The key difference lies in the removal of tissue behind the nipple and areolar complex. The surgeon should carefully follow the breast parenchyma dissection plane to the areola then dissect it from the nipple and areolar complex sharply, understanding that the ductal tissue converges at the nipple. Although this can be done with electrocautery, sharp dissection with scalpel or scissors allows for careful identification of the planes while minimizing thermal injury to the dermis of the areola. Once the retroareolar breast tissue is separated from the skin, the nipple margin on the specimen should be marked for future orientation. The nipple skin is then inverted, and the remaining ductal tissue is cored from the nipple and sent for frozen section analysis in cancer cases. If tumor cells are identified, the nipple and areola should be removed; if negative, however, it is important to inform patients that the remaining skin of the nipple and areolar complex is functionally similar to a full-thickness skin graft. If tumor cells are identified on the final pathological assessment, the nipple and areolar complex (NAC) should be removed as a second procedure. Frequently, this can be performed without anesthesia given the lack of sensation in the mastectomy skin flap and NAC.

Advances in the NSM technique that allow for removal of the breast parenchyma in a similar fashion to that of SSM or conventional mastectomy have voided some of the oncologic concerns. However, many surgeons still question the safety of leaving the nipple behind, especially for prophylactic indications, arguing that the retained nipple increases the risk of leaving ductal tissue behind and, therefore, decreases the therapeutic benefit of PM. In actuality, this risk is likely low. With an intact breast, the risk of a primary breast cancer originating from the nipple is less than 5%; Paget’s disease of the nipple occurs in less than 1% of patients. Available follow-up data suggest that LR rates after NSM are equivalent to SSM or non-SSM, with only a handful of recurrences (about 1%) occurring in the nipple (see Table 5).

**PATIENT SELECTION FOR NSM**

Patient and tumor factors influence eligibility for NSM. Cosmetically, ideal patients have B- or small C-cup breasts with centrally located nipples. Patients with a large amount of ptosis are not ideal candidates because the position of the nipple can be difficult to correct and the procedure may result in an undesired cosmetic outcome. Patients previously having radiation can have NSM but may have a higher risk for nipple and/or flap necrosis. All patients should be instructed that leaving the NAC intact is purely cosmetic because sensitivity and function is lost in most cases. Oncologically, ideal patients have tumors less than 2 cm located more than 2 cm from the
nipple and areolar complex. Tumors more than 4 cm can involve the nipple in 23% to 100% of cases, and careful selection is required if considering an NSM in patients with a larger tumor burden. Attention to patient selection and applying these guidelines will reduce the likelihood of finding occult tumor cells in the nipple. Historic series have reported that tumors located within 2 cm of the nipple will involve the nipple in 36% to 87% of patients, whereas tumors more than 2 cm away from the nipple will involve the nipple in less than 14% of cases. To predict nipple involvement, Rusby and colleagues developed a nomogram. Although the nomogram is not widely used, importantly their data identified nipple involvement in 24% of patients, suggesting contingency plans for the nipple and areolar complex should be discussed with all patients before surgery.

COMPLICATIONS OF NSM

Aside from LR and standard operative risks, nipple necrosis remains the primary risk of NSM, with total nipple necrosis occurring only rarely. Partial nipple necrosis occurs in approximately 10% of cases and is usually managed by conservative means. Sometimes healing may take several weeks. Given that patients with NSM tend to have immediate reconstruction, the nipple and areolar complex can be positioned on the native pectoralis muscle in tissue expander reconstruction or on native tissues in autologous flap reconstruction helping to aid in the nipple’s recovery.

PM

Mastectomy performed using any of the previously mentioned techniques without a diagnosis of cancer constitutes a PM. As described earlier, recent trends witness a significant increase in PM despite declining rates of contralateral breast cancer around 0.5% annually or less. PM reduces breast cancer risk by 90% to 95% in all cases and offers the largest absolute risk reduction in those women with BRCA mutations and a lifetime risk of breast cancer ranging from 50% to 80%. In general, patients should be informed that there is no medical indication or survival advantage in favor of PM.

RECURRENCE AFTER MASTECTOMY

LR after mastectomy occurs in approximately 5% to 8% of early stage breast cancers, with greater than 90% occurring within 3 years of surgery. LR is associated with stage at presentation, lymphovascular invasion, and tumor grade and is reduced by adjuvant therapy. Physical examination identifies most LR as palpable nodules in the skin and soft tissues. Rarely does LR occur in the muscle or behind a breast reconstruction. No surveillance imaging is necessary after mastectomy to evaluate for recurrence. When LR is identified, workup for distant metastatic disease should be performed because 20% to 30% of these women will present with simultaneous distant metastatic disease. Surgical excision to negative margins followed by radiation therapy remains the standard treatment modality in localized recurrences. This sequence achieves local control in 50% to 75% of patients. Occasionally, chemotherapy may be needed to facilitate surgery. Finally, investigators have evaluated the benefit of major chest wall resection (skin, muscle, ribs) in locally recurrent but advanced disease within the chest wall only and found significant morbidity with recurrence as high as 87% and 5-year overall survival of only 18% to 42%.
SUMMARY

- Mastectomy and breast conservation offer equivalent survival.
- The surgical goal is complete tumor removal.
- Most women with early stage breast cancers are amenable to breast-conserving surgery.
- Surgical therapy coupled with adjuvant systemic and radiation therapies reduce LR.

REFERENCES


