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# Oncologic Considerations for Timing of Breast Reconstruction and Prophylactic Mastectomy in Breast Cancer Patients

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## Abstract

**Background:** In an era of more conservative breast cancer treatment, a recent trend has led to an increased rate of mastectomy as risk-reduction surgery or as a component of achieving symmetry in reconstruction. This article aims to review the most up-to-date information regarding: the safety of Skin-Sparing (SSM) and nipple-sparing mastectomies (NSM) as compared to traditional modified radial mastectomies as well as their patterns of recurrence, and the recurrence and second malignancy rates of breast cancer after Breast Conservation Therapy (BCT) and mastectomy based on different cancer biologies.

**Methods:** PubMed and Ovid databases were queried online. Articles were reviewed for pertinent information, along with their references to capture all possible variables in decision making about reconstruction in newly diagnosed breast cancer patients.

**Results:** Patients with low-penetrance gene mutations, no family history, or luminal A type breast cancers should be counseled that their risk of local recurrence or contralateral breast cancer is low. These patients are ideal candidates for BCT or mastectomy with immediate reconstruction of the ipsilateral breast alone and this can occur at any time during the treatment process. Women with high-penetrance gene mutations; a strong family history—defined as 3 or more relatives with positive history; luminal B, HER2, or triple negative tumor types; or high anxiety about future risk of breast cancer, should be advised to consider contralateral risk-reduction mastectomy. These patients may have life-saving benefits from timely radiation or chemotherapy and may need to consider delaying or staging prophylactic and reconstruction surgeries until completion of systemic oncologic therapies.

**Conclusion:** Breast cancer treatment and reconstruction has evolved drastically in the past 100 years. However, as new treatment modalities have developed and pooled data is made available, differences have been teased among the various cancer subtypes and patient populations. Oncologic treatment and reconstruction must be based on each patient's individual situation and desires. An algorithm is included to assist in the decision-making process of the breast cancer patient.

**Keywords: Breast; Breast cancer; Breast reconstruction; Chemotherapy; Contralateral breast cancer; Lumpectomy; Mastectomy; Metastasis; Oncology; Radiation; Recurrence; Risk reduction**

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## Abbreviations

LR: Local Recurrence; DR: Regional/Locoregional Recurrence; DM: Distant Metastasis; DFS: Disease-Free Survival; OS: Overall Survival

## Background

After the National Institute of Health (NIH) issued consensus statement endorsing Breast Conserving Therapy (BCT) in 1991, mastectomy rates in the United States fell dramatically. However, a recent increased trend in the use of mastectomy has been observed nationally [1], which is mostly patient-driven. This trend has led to a paradox where the surgical management of invasive breast cancer is less radical, with the majority of women opting for breast-conserving surgery, while amputation of the breast is used for breast cancer prevention. Since its inception in the early 500s, there have been improvements in mastectomy techniques, from the radical mastectomy to the Modified Radical Mastectomy (MRM), to the Skin-Sparing Mastectomy (SSM), and most recently to the Nipple-Sparing Mastectomy (NSM). While offering a superior cosmetic

**Table 1:** Studies which examined recurrence and survival rates after MRM, SSM, or NSM.

| First Author | Year | Sample Size | Population | Follow up (months) | Local Recurrence (LR) | Regional/ Loco-regional Recurrence (DR) | Distant Metastasis | Disease-Free Survival (DFS) | Overall Survival (OS) | Contralateral Breast Cancer (CBC) | Results |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Greenway [5] | 2005 | 1247 | Stage 0-II | 49 | MRM 1.5% SSM 1.7% ($p > 0.80$) | MRM 5.4% SSM 7% ($p > 0.80$) | MRM 11.6% SSM 7.1% ($p <$ **0.05**) | N/M | N/M | N/M | SSM does not adversely affect the rates of local, regional, and systemic failure. |
| Gerber [6] | 2009 | 238 | Operable patients | 101 | MRM 9.2% SSM 8.3% NSM 10% ($p = 0.957$) | MRM 3.1% SSM 2.1% NSM 1.7% ($p = 0.827$) | MRM 26.2% SSM 25.0% NSM 23.3% ($p = 0.916$) | MRM 88.5% SSM 89.2% NSM 88.3% ($p = 0.993$) | N/M | MRM 3.8% SSM 2.1% NSM 5% ($p = 0.731$) | NSM is a safe procedure with long follow-up. |
| Kim [7] | 2010 | 2510 | Stage 0-IIIa | 63 | MRM 0.9% SSM 0.8% NSM 2% ($p = 0.27$) | N/M | N/M | MRM N/M SSM 87.2% NSM 89% ($p = 0.695$) | MRM N/M SSM 95.8% NSM 97.1% ($p = 0.669$) | N/M | LR for NSM is similar to that for SSM and MRM |
| Boneti [8] | 2011 | 293 | Mastectomy with recon. | 32 | SSM 5% NSM 4.6% ($p = 0.89$) | N/M | N/M | N/M | N/M | N/M | NSM has better cosmetic results, allows immediate reconstruction, and has similar complication and LR rates in comparison with SSM. |
| Yi [9] | 2011 | 1810 | Stage I-III | 53 | MRM 1.4% SSM 0.6% ($p = 0.11$) | MRM 1.3% SSM 1.5% ($p = 0.7$) | MRM 6.9% SSM 4.8% ($p =$ **0.05**) | MRM 92.7% SSM 95.2% ($p =$ **0.01***) | N/M | N/M | *No significant difference in DFS between MRM and SSM after adjusting for clinical TNM stage. |

and quality of life result for the patient [2], NSM has been questioned with regards to its equivalence from an oncologic standpoint. Some believe that leaving the Nipple-Areola Complex (NAC) behind, even in prophylactic cases, increases the risk of also leaving residual ductal tissue, thus decreasing the therapeutic benefit of mastectomy. This notion is not supported in the literature; however, where in fact the data shows that LR rates after NSM is equivalent to MRM or SSM [3]. The Early Breast Cancer Trialists' Collaborative Group's (EBCTCG) 2005 study showed that MRM has a locoregional recurrence (LR) of less than 10% at 5 years, with 90% of recurrences occurring within the first three years after surgery [4]. As time from diagnosis and treatment of the primary breast tumor increases, it is increasingly likely that any second tumor is a new primary cancer rather than a recurrence. The most common site of recurrence is in the chest wall skin. Recurrence generally portends a poor prognosis, and the earlier the recurrence the worst the survival. The writers sought to propose a reasonable standard on how to choose patients for unilateral versus bilateral reconstruction and how to determine the type and timing of reconstruction relative to respective treatments. In order to arrive at these conclusions, two important issues were reviewed: 1) the safety of SSM and NSM and their likely patterns of recurrence and, 2) the recurrence and second malignancy rates of breast cancer after BCT and mastectomy based on different cancer biologies.

## Materials and Methods

PubMed and OVID databases were searched using the following search terms: "factors associated with breast cancer recurrence", "breast cancer recurrence by subtype", "contralateral breast cancer", "prophylactic mastectomy", "modified radical versus nipple sparing versus skin sparing mastectomy", and "immediate versus delayed reconstruction". Studies from January 1, 1985, to August 1, 2016, were reviewed. References of included articles were also evaluated for further relevant studies to capture all possible sources. A simple algorithm was developed based on the pooled data from these studies to provide recommendations for surgeons to navigate the breast cancer patient.

## Results

### Safety of SSM and NSM and likely patterns of recurrence

While no universal consensus exists regarding selection criteria for NSM, suggested parameters include: tumor size less than 3 cm, tumor edge more than 2 cm to 3 cm from NAC, lack of clinical involvement of the skin or NAC, absence of bloody nipple discharge, clinically negative axillary nodes, and clean margins beneath the NAC. Multiple studies have compared the outcomes of SSM and NSM compared to the gold-standard MRM with no untoward effects observed in the newer techniques [5-9]. The senior author's published 15-year data includes 1,247 patients with stage 0-II breast cancer who underwent mastectomy. SSM was performed on 225 patients, while the remaining 1,022 patients had MRM, with an average follow up of 4 years. Their results showed no difference in local, regional, or distant disease recurrence. Gerber et al. [6] compared outcomes including

**Table 2:** Studies which examined recurrence and survival rates after mastectomy or BCT, based on molecular subtype.

| First Author | Year | Sample Size | Population | Follow up (months) | Local Recurrence (LR) | Regional/ Locoregional Recurrence (DR) | Disease-Free Survival (DFS) | Overall Survival (OS) | Results |
|---|---|---|---|---|---|---|---|---|---|
| Voduc [14] | 2010 | 2985 | Stage I-III w/ biochemical testing | 144 | N/M | N/M | N/M | N/M | Luminal A tumors had the best prognosis and the lowest rate of LR and RR. |
| | | | BCT | | Luminal A 8%<br>Luminal B 10%<br>Luminal-HER2 9%<br>HER2-enriched 21%<br>Basal-like 14%<br>TN 8% | Luminal A 3%<br>Luminal B 8%<br>Luminal-HER2 5%<br>HER2-enriched 16%<br>Basal-like 14%<br>TN 7% | N/M | N/M | HER2-enriched and basal-like subtypes demonstrated an increased risk of LR and RR. |
| | | | Mastectomy | | Luminal A 8%<br>Luminal B 14%<br>Luminal-HER2 20%<br>HER2-enriched 17%<br>Basal-like 19%<br>TN 13% | Luminal A 4%<br>Luminal B 12%<br>Luminal-HER2 20%<br>HER2-enriched 12%<br>Basal-like 20%<br>TN 7% | N/M | N/M | Luminal B, luminal-HER2, HER2-enriched, and basal-like subtypes were all associated with an increased risk of LR and RR. |
| Wang [13] | 2011 | 2118 | Stage I-III invasive BC | 68 | Luminal A 12.7%<br>Luminal B 15.7%<br>HER2 19.1%<br>Basal-like 20.9%<br>Unclassified 13% | N/M | Luminal A 87.3%<br>Luminal B 84.3%<br>HER2 80.9%<br>Basal-like 79.1%<br>Unclassified 87% | Luminal A 94.2%<br>Luminal B 92.6%<br>HER2 88.7%<br>Basal-like 87.9%<br>Unclassified 89.6% | No statistical difference in DFS between different surgeries. |
| Cruz [15] | 2013 | 362 | Invasive BC divided in 5 groups based on IHC | 58 | Luminal A 6.7%<br>Luminal B 20.5%<br>Luminal-HER2 19.4%<br>HER2-enriched 26.8%<br>TN 38.7%<br>($p$ < **0.0001**) | Luminal A 15.1%<br>Luminal B 30.1%<br>Luminal-HER2 28.4%<br>HER2-enriched 34.1%<br>TN 40.3%<br>($p$ < **0.004**) | Luminal A 93.3%<br>Luminal B 79.5%<br>Luminal-HER2 80.6%<br>HER2-enriched 73.2%<br>TN 61.3% | N/M | Luminal A tumors have best prognosis and the lowest rate of LR and DR; TN and HER2-enriched tumors had higher relapses rates and worse DFS. |
| | | | BCT | | Luminal A 4.5%<br>HER2-enriched 36.4%<br>TN 42.9% | Luminal A 9.1%<br>Luminal B 21.9%<br>TN 21.4% | Luminal A 93.9%<br>Luminal B 75%<br>Luminal-HER2 79.3%<br>HER2-enriched 72.7%<br>TN 64.3% | N/M | |
| | | | Mastectomy | | Luminal A 9.4%<br>Luminal B 24.4.3%<br>HER2-enriched 23.3%<br>TN 37.5% | Luminal A 22.6%<br>HER2-enriched 40%<br>TN 45.8% | Luminal A 73.6%<br>Luminal B 53.7%<br>Luminal-HER2 57.9%<br>HER2-enriched 50%<br>TN 45.8% | N/M | |

LR, DR, distant metastasis (DM), and Disease-Free Survival (DFS) on 238 operable patients grouped into MRM, SSM, or NSM. Their results showed no difference in any of their outcomes over the 8-year study period. There was also no difference noted in contralateral breast cancer rates for any of the three mastectomy types. A study from Korea [7] encompassed 2,510 patients who underwent MRM, SSM, or NSM over a 5 year period. All patients were offered NSM unless there was tumor involvement of the nipple-areola complex. This group found that NSM is a suitable alternative to MRM and SSM in most patients and has equal LR, DFS, and OS rates. Boneti et al. [8] looked at local recurrence rates between SSM and NSM in 293 patients over an average follow up of 32 months. Four patients (2.5%) initially planned for NSM were converted to SSM based on finding of NAC involvement on intraoperative touch preparation evaluation. They noted no statistically significant difference in LR rates and complication rates between the two groups. There were no recurrences at the NAC in the NSM group. MD Anderson [9] compared local, regional, and systemic recurrence as well as survival rates among 1,810 patients treated with either MRM or SSM with more than 4 year follow up. They found no significant differences in recurrence between MRM and SSM as well as no significant difference in DFS after adjusting for clinical TNM stage. Local recurrence rates were 1.4% and 0.6%, DR rates were 1.3% and 1.5%, and distant metastasis rates were 6.9% and 4.8%, for MRM and SSM, respectively. DFS was 92.7% for MRM and 95.2% for SSM, which was a statistically significant difference among all-comers; however the slightly increased survival in the SSM group was not significant when adjusting for cancer stage. The above data shows no difference in recurrence rates or survival rates with skin-sparing and nipple-sparing mastectomy as compared with traditional modified radical mastectomy. More detailed data and numbers are available for review in Table 1.

## Recurrence and second malignancy rate of breast cancer after BCT and mastectomy

Multiple studies have demonstrated that BCT coupled with

**Table 3**: Lifetime breast and other cancer risk by gene mutation.

| Gene | Disease/Syndrome | Chromosome | Lifetime Breast Cancer Risk | Lifetime Cancer Risk | Cancer Types |
|---|---|---|---|---|---|
| BRCA1 | Hereditary Breast and Ovarian Cancer (HBOC) syndrome | 17q21 | 80% | 40-80% | Ovarian |
| BRCA2 | Hereditary Breast and Ovarian Cancer (HBOC) syndrome | 13q12.3 | 50% | 20-85% | Prostate; Ovarian; Pancreatic |
| TP53 | Li-Fraumeni syndrome | 17p13.1 | 50-90% | 56-90% | Sarcoma; Leukemia; Brain; Adrenal; Lung |
| PTEN | Cowden syndrome | 10q23.3 | 25-60% | 25-50% | Endometrial; Thyroid |
| STK11 | Peutz-Jeghers syndrome | 19p13.3 | 50-90% | 32-54% | Ovarian; Cervical; Testicular; Bowel; Colon |
| CDH1 | Hereditary Diffuse Gastric Cancer (HDGC) | 16q22.1 | 39-52% | 60-80% | Ovarian; Gastric; Colorectal; Thyroid |
| ATM | Ataxia telangiectasia | 11q22-q23 | | 15-20% | Ovarian; Leukemia; Lymphoma |
| CHEK2 | CHEK2-related | 22q12.1 | | 25-37% | Ovarian; Colorectal; Bladder; Brain; Sarcoma |
| PALB2 | PALB2-related | 16p12.2 | 35% | 20-40% | Ovarian; Pancreatic |

radiotherapy is as effective as mastectomy alone [10-12]. BCT has a local failure rate which typically has a flat hazard, 1% per year for invasive cancer and 1.5% per year for DCIS. In contrast, mastectomy has rate of local-regional failure in as many as two-thirds of patients, manifested temporally near the peak incidence of systemic failure. Molecular group typing of invasive breast cancers has become a useful way of addressing which systemic therapies to use and identify the patterns of systemic failure.

Wang et al. [13] classified 2,118 Chinese stage I-III breast cancer patients with immunohistochemistry data into five categories: luminal A (ER/PR+, HER2-); luminal B (ER/PR+, HER2+); HER2 over expressing (ER/PR-, HER2+); basal-like (ER/PR -, HER2-, CK5/6+ and/or EGFR+); and unclassified (ER/PR-, HER2-, CK5/6-, EGFR -). They found that rates of LR were lowest in luminal A and unclassified at 12.7% and 13%, respectively, followed by luminal B with 15.7% LR, and worst in HER2 over expressing and basal-like subtypes with rates of 19.1% and 20.9%, respectively. There were no significant difference in Disease-Free Survival (DFS) between the BCT and mastectomy; however no subgroup analysis is mentioned. A meta-analysis by Lowery et al. [14] using data from fifteen previously published studies, including a total of 12,592 patients, showed that HER2 + and triple negative tumors had the highest risk of Locoregional Recurrence (LR) after BCT or mastectomy. Interestingly, HER2 + had a higher risk of LR compared to TN tumors following BCT, but not mastectomy. The authors assert that breast cancer subtype should be considered when deciding on treatment modalities.

## Comparing BCT vs. mastectomy- subgroup analysis

In Canada, Voduc et al. [15] examined 2,985 patients with stage I-III breast cancer treated with BCT, mastectomy alone, or mastectomy with radiation. Patients were classified by tumor immunohistochemistry markers as follows: luminal A (ER/PR+, HER2-, Ki-67<14%); luminal B (ER/PR+, HER2-, Ki-67 ≥ 14%); luminal-HER2 (ER/PR+, HER2+); HER2 enriched (ER/PR-, HER2+); basal-like (ER/PR-, HER2-, CK5/6+ and/or EGFR+); and TNP-nonbasal (ER/PR-, HER2-, CK5/6-, EGFR-). The results from the overall study reiterated that patients with luminal a tumors have the best prognosis, with lowest rates of LR and DR, with all other tumors having statistically significant higher rates. For BCT patients, HER2 enriched and basal-like subtypes had the highest rates of LR and DR. Predictors of LR included age <40 years and HER2 enriched subtype; however, anthracycline-based chemotherapy was protective of LR. Age <40 years, more than 3 positive lymph nodes, and Her2 enriched or basal-like subtypes were predictors of DR. Meanwhile, in the mastectomy group, all non-luminal A tumors exhibited greater risk of LR and DR. Predictors of LR were tumor size >5 cm, positive lymph nodes, and all non-luminal A subtypes except for TNP-nonbasal; protective effects were found with chemo- and hormonal therapy. Similarly, non-luminal a subtypes, with the exception of TNP-nonbasal, was all predictors of DR. A study by Cruz et al. [16] sought to identify which patients were at increased risk of breast cancer relapse, both locoregional (LR) and Distant Recurrence (DR). They divided patients into five groups based on tumor marker histology: luminal A (ER/PR+, HER2-, Ki-67<14%); luminal B (ER/PR+, HER2-, Ki-67 ≥ 14%); luminal HER2 (ER/PR+, HER2+); HER2 enriched (ER/PR-, HER2+); or triple negative (ER, PR, and HER2-). Among all patients, luminal A tumors have the best prognosis with the lowest rate of LR and DR—6.7% and 15.1%, respectively—while triple negative tumors have the worst prognosis with the highest rate of LR and DR—38.7% and 40.3%, respectively. Predictors of LR were tumors >5 cm, N2 or N3 lymph node stage, and triple-negative tumors; predictors of DR were tumors >5 cm, N2 or N3 lymph node stage, and local radiotherapy. In mastectomy patients, hormonal therapy with Tamoxifen was associated with reduced DR rate. Early data from aromatase inhibitor use in ER+ post-menopausal patients suggest that these agents have even a stronger effect on LR and DR [17].

Voogd et al. [18] pooled data from two European Randomized Clinical Trials (RCT) encompassing 1,772 stages I and II breast cancer patients who underwent BCT or mastectomy and documented LR and DR. For both groups, vascular invasion was predictive of LR, while tumor size, nodal status, histologic grade, and vascular invasion were predictive of DR. For the BCT group, age <35 years and extensive intraductal component were predictive of LR, age <35 years and microscopic involvement of resection margin were predictive of DR. Overall, these three large studies show that, regardless of treatment type, predictors of LR and DR are: age <35 years and possible even <40 years, tumor size >5 cm, ≥ 4 positive lymph nodes, and triple negative (ER/PR-, HER2-) immunohistochemistry. Detailed numbers for all the studies comparing breast conservation therapy to mastectomy are in Table 2. Protective effects were found with use of chemotherapy and hormonal therapy. Luminal A (ER/PR+, HER2-, Ki67<14%) tumor subtypes consistently had the best prognosis.

## Contralateral breast cancer (CBC)

A risk factor for increased contralateral breast cancer is in patient with a strong family history of breast cancer without a BRCA gene mutation, referred to as familial non-BRCA breast cancer. Tilanus-

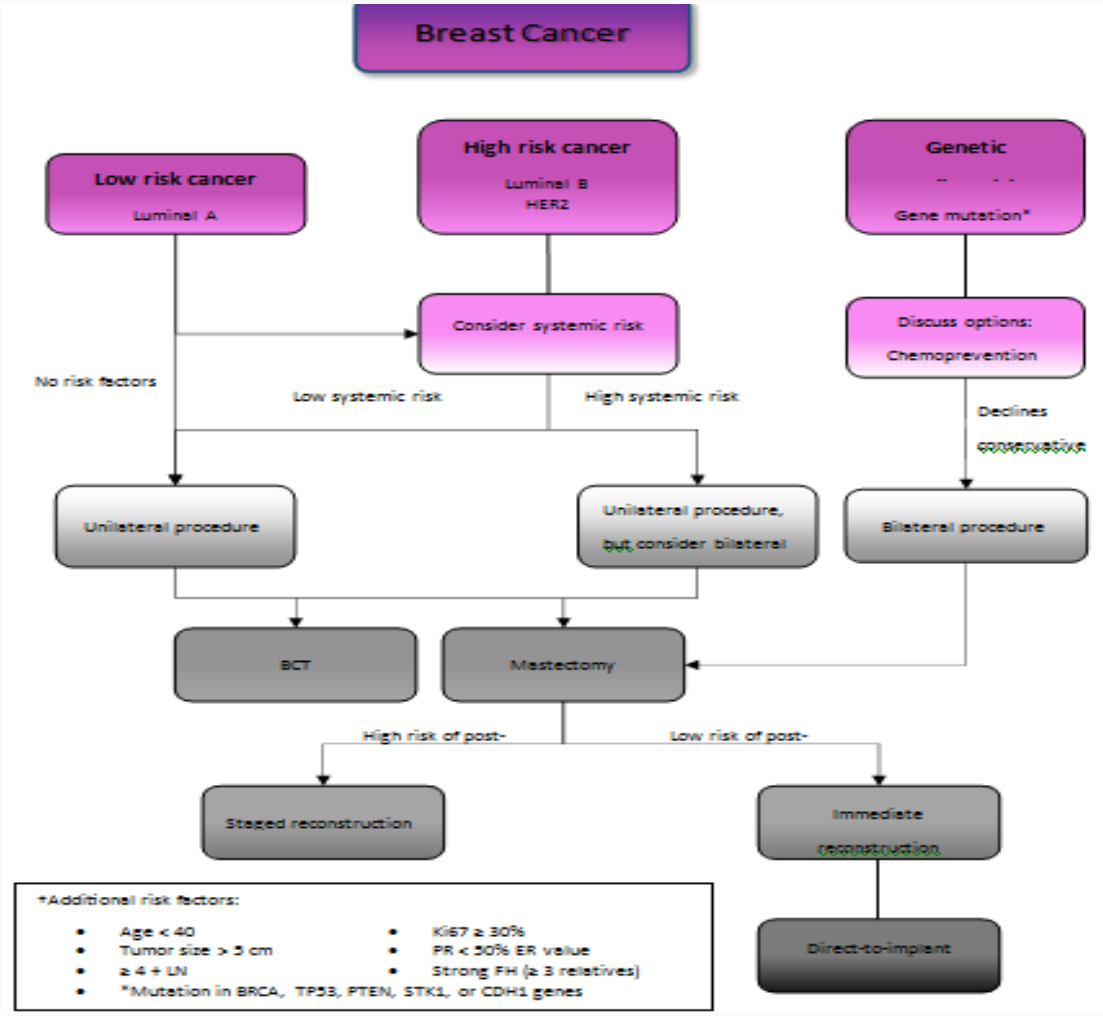


**Figure 1:** Need for prophylactic surgery and/or reconstruction.

Linthorst et al. [19] looked at 265 families with 3 or more members afflicted with breast cancer compared with a sporadic breast cancer group and found CBC rates higher in the former. LR rates were not significantly different at 14.2% and 17% while CBC rates were 5.9% and 10.1% ($p$=0.002) for sporadic and familial cases, respectively, indicating a higher rate of contralateral breast cancer in patients with a strong family history of breast cancer.

### Genes and risk factors

Multiple genes have been implicated with a higher risk of breast cancer. A female in the general population has a lifetime risk of developing breast cancer of approximately 12%, while a similar male has one hundredth of that risk, at 0.1%. Several gene mutations increase this risk significantly, the most commonly discussed being the breast cancer susceptibility genes BRCA1 and BRCA2 [20]. Women carrying a BRCA1 gene mutation carry an 80% risk of developing breast cancer, while those with BRCA2 carry a 50% risk. Cancer risk stratification by gene mutation.

A list of the most common breast cancer gene mutations is presented in Table 3. All of these genes are inherited in an autosomal dominant fashion.

### Breast reconstruction

The two groups in which reconstruction can be grossly divided are autologous reconstruction and implant reconstruction. Post Mastectomy Radiation Therapy (PMRT) is a main factor increasing the complication rate after either reconstruction method. Benediktsson et al. [21] reported that 22 of 107 patients developed significant Baker 3 or 4 contracture following implant reconstruction, with 16 of 22 requiring re-operation. The contracture rate was 41.7% after PMRT, compared with 4.5% without radiation. Similarly, PMRT increases the rate of complications following autologous reconstruction by approximately two to threefold as evidenced by Christante et al. [22] from Oregon Health Sciences University study. In summary, implant and autologous reconstruction appear to have similar complication rates, however, autologous reconstruction patients appear to have an increased satisfaction with their reconstruction and report improved psychosocial outcomes, even in the setting of increased PMRT.

## Discussion

Shockingly, approximately two-thirds of women in the United States do not undergo any form of post-mastectomy reconstruction, influenced by age, race, and geographic location [23]. Two recent studies found that patients with HER2+ or triple negative subtypes were less likely to receive reconstruction, but whether this was secondary to patient or physician bias could not be elucidated [24], and that HER2+ was associated with the lowest rates of BCT among all subtypes, with an increased disparity in BCT rates across

subtypes with lower tumor burden [25]. The issue for most breast and reconstructive surgeons is matching reconstruction type and timing relative to the biology of the breast cancer and the future risk for new events, ipsilateral and contralateral, in the patient. Overall, it appears that for patients with luminal a tumors—regardless of the exact definition—there is a very low risk of local, regional, and distant failure if the patient receives hormonal therapy, as compared to the other subtypes. The data also show that NSM is not only as safe as MRM or SSM in terms of recurrence, but that it is also offers improved cosmetic results and spares the patient an additional procedure for nipple reconstruction during the reconstruction process. Because local recurrence rates and overall prognosis are improved in this group, unilateral procedures and immediate reconstruction are reasonable from both oncologic and reconstructive standpoints. These patients are much less likely to receive chemotherapy and/or radiation and therefore interference of oncology treatment with multi-stage reconstruction is minimal. Patients with luminal B, HER2, and tripe negative subtypes are more likely to have greater immediate and near-future risk for systemic failure. These patients will likely endure longer chemotherapy courses and receive post-mastectomy radiation for node-positive or large tumors. The oncologic community is moving toward neoadjuvant therapy, especially for this group, if nodes are positive or suspicious on initial clinical and radiographic staging. Up-staging after pathology assessment of the surgical resection is more common in these subtypes, making these patients are least well-suited for immediate reconstruction. If tumor size or nodal status is needed to direct systemic or radiation therapy decisions, initial surgical management recommendations include either mastectomy or lumpectomy with sentinel node dissection; the latter is particularly useful in patients considering SSM or NSM where the mastectomy and immediate reconstruction can be delayed until the completion of all oncologic therapy. Because aggressive subtypes presume less reduction in contralateral events from systemic therapy, patients may want to consider prophylactic contralateral mastectomy if there is significant emotional distress or increased risk factors for a future risk of malignancy. From an oncologic standpoint, patients with positive mutations in BRAC1/2, TP53, PTEN, STK11, or CDH1 genes should be considered candidates for contralateral prophylactic mastectomy given the high penetrance of the respective gene mutations. Similarly, women with a strong family history, defined as three or more family members with breast cancer, who develop a breast cancer should be advised that their risk of contralateral breast cancer is substantially higher than the general population and should consider contralateral prophylactic mastectomy. Those with mutations in the ATM, CHEK2, or PALB2 genes, however, which demonstrate low to moderate penetrance, may be better served by either lumpectomy and radiation or unilateral mastectomy only followed by immediate or delayed reconstruction. More recently, reconstructive surgeons have recommended that certain patient population can and should undergo single-stage immediate breast reconstruction with permanent implants, referred to as Direct-To-Implant (DTI) reconstruction [26-29]. The benefits of a single-stage procedure are numerous and documented: it involves one operation, eliminates the need for multiple clinic visits for expansion, and allows the patient immediate return to a normal body image. Until now, many reconstructive surgeons appear to be hesitant to adopt these recommendations, despite the stated advantages. Single-stage reconstruction should be strongly considered in a select patient population of women with low-risk breast cancer—those not expected to require chemotherapy or radiation therapy—who desire to have similar size breasts. To aid in the discussion and consideration of these options and issues, we propose the algorithm in Figure 1 to organize decisions about timing and need for prophylactic surgery and/or reconstruction.

## Conclusion

Breast cancer treatment is an evolving field, but treatment and reconstruction needs to be individualized to each patient to optimize patient satisfaction, care, and return to normal life. As always, a patient's wishes must be included in any discussion to ensure their desires are addressed. It is likely now that far too many patients with low risk tumors (Luminal A) and dramatically reduced contralateral events (by profound effects of Aromatase inhibitors used as systemic treatment also having prevention effects) are undergoing bilateral mastectomy and reconstruction that may not be justified on oncologic grounds. Often this is done under the guise of "symmetry" procedures. Similarly, bilateral procedures done early prior to adjuvant chemo and radiation procedures in high risk cancers can lead to significant delays and potential loss of maximal survival benefits of these aggressive adjuvant therapies. The patients, families, and all members of the treating and reconstruction providers need to be well-informed in making the crucial decisions and sequencing the best alternatives for both survival and long term wellbeing.

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