Breast Intervention and Breast Cancer Treatment Options

Olive Peart, MS, R.T.(R)(M)

Breast cancer is the second leading cause of death among women in the United States. Although controversy has emerged in recent years regarding the diagnosis and treatment of this disease, it remains important to detect and treat breast cancer before it has metastasized. This article provides an overview of breast biopsy techniques, biopsy specimen imaging, and treatment options for breast cancer patients, including surgery, radiation therapy, chemotherapy, and molecular treatments. Finally, breast reconstruction options are presented.

After completing this article, the reader should be able to:

- Differentiate between cytologic and histologic sampling.
- Explain the advantages and disadvantages of biopsy methods.
- Describe the staging process for breast cancer.
- Discuss treatment options for breast cancer and their risks and indications.

Imaging techniques are used to diagnose lesions, calcifications, or architectural distortion of the breast parenchyma that could be considered suspicious. However, regardless of the imaging method, cancer cannot be diagnosed without a biopsy. With a positive biopsy, the health care provider’s action plan becomes critical in preserving and enhancing the patient’s quality of life.

Overview of Breast Imaging Techniques

Mammography is the preferred method of detecting breast cancer. Although other modalities can enhance the diagnostic information obtained, they cannot replace the mammogram, which can be analog, digital, or tomosynthesis imaging. Mammography can detect lesions that are irregularly shaped, lobulated, partially obscured, obstructed, or spiculated. Definite areas of architectural distortion and calcification also can be identified easily on mammograms.¹

After identifying an area of concern, the next step is to obtain supplemental projections or use adjunct imaging modalities to define the area of suspicion or verify the presence of an abnormality. Supplemental mammography imaging includes the use of any projection or technique that provides further information concerning the area of suspicion. Useful projections are spot compression or magnification images to assess calcifications or lesion margins, tangential projections to rule out skin lesions or calcifications, 90° lateromedial or mediolateral projections or the exaggerated craniocaudal projection to localize the lesion, and rolled positions to remove areas of overlap.²,³

If mammography cannot provide additional information, adjunctive modalities become critical. Ultrasound imaging can be used to evaluate the content of circular or oval lesions, image dense breasts, and assess implants to detect leaks without radiation or biological risks. However, ultrasonography is operator dependent, and it cannot be used to image microcalcifications.⁴,⁵

Magnetic resonance (MR) imaging can be used as an adjunct screening...
tool for patients with a lifetime breast cancer risk of at least 20%, patients who received chest wall radiation between the ages of 10 and 30 years, and patients with the BRCA1 and BRCA2 genetic mutations. MR imaging is becoming the preferred method for evaluating implants and dense breasts, and it is invaluable for assessing nonpalpable lesions not identified on mammography. MR also can help in mapping the tumor extent and detect multifocal or multicentric disease. After a diagnosis, MR can be used:
- In the staging process to determine the feasibility of breast-conserving surgery vs mastectomy.
- To assess the spread of cancer to the lymph nodes.
- To evaluate the effectiveness of treatment.
- To evaluate margins for residual cancer.

Most of the risks of MR imaging are associated with its magnetic properties. Patients must be screened for implanted or embedded metallic objects before entering the MR suite because injury can occur if an object is moved or dislodged by the magnet. MR imaging cannot be used to evaluate microcalcifications, and it poorly visualizes the axillary nodes. The financial cost of MR imaging and its lower specificity results in a high false-positive rate, which limits this technology as a screening tool. However, MR imaging of the breast has a sensitivity of 100% and a specificity of 91.7% for detecting breast cancer, compared with a sensitivity of 80.7% for mammography. The positive predictive value of MR imaging vs mammography is 40% vs 8.7%, and the overall accuracy of MR imaging is 92.2% vs 78.3%.

Molecular breast imaging technologies can detect defects at the cellular level by looking at biological activity using radiopharmaceuticals with a relatively short half-life. Positron emission tomography and positron emission mammography use fluorodeoxyglucose as contrast media. This radiopharmaceutical helps determine sites where there is a high rate of glucose metabolism. This nuclear medicine technology can be used to evaluate ambiguous mammograms and can provide useful information on metastasis to bone or soft-tissue areas. Positron emission tomography or positron emission mammography also are specific in detecting fibrotic scar tissue and necrosis, and they can assess the potential aggressiveness of breast cancer. However, the technology is affected by inflammation, infection, and the patient’s blood glucose levels. In addition, nuclear medicine scans are not accurate in detecting tumors smaller than 1 cm.

Breast-specific gamma imaging uses the radiopharmaceutical technetium Tc99m sestamibi, which has an affinity for cancer cells and accumulates in malignant lesions, which have a higher metabolic rate than benign tissue. The technology can be used to assess axillary node involvement, map lesions to optimize surgical planning, image dense breasts and implants, and evaluate scarring due to radiation or surgery. Although breast-specific gamma imaging is less expensive than MR imaging, the high radiation dose limits its use.

Lymphoscintigraphy, or sentinel lymph node mapping, is used to track the spread of cancer from the breast. It is indicated for patients considering axillary node dissection to reduce the number of nodes removed. A radiopharmaceutical is injected directly into the tumor bed, after which the patient is taken for surgery. A Geiger counter is used to locate the first few lymph nodes on the chain that drains the breast so they can be removed.

Histologic vs Cytologic Analysis

If a lesion is found on a mammogram, it should be evaluated properly to rule out malignancy, using multiple modalities if necessary. However, if malignancy cannot be ruled out, or if the finding has a high probability of malignancy, only a histologic or cytologic analysis can be used to confirm that the finding is malignant. Histologic or cytologic analysis results from interventional procedures for which the patient must be informed and fully prepared. The type of intervention performed depends on several factors, such as how suspicious a lesion is and its size, shape, and location as well as the number of lesions present. Other factors that determine the type of biopsy performed include the patient’s medical history, patient’s preference, training of the radiologist or surgeon, and type of facility where the biopsy is being performed.

Radiologists often use the Breast Imaging-Reporting and Data System (BI-RADS) to guide the choice of interventional procedure. The BI-RADS categorizes lesions according to their suspiciousness and recommends...
a fine-needle aspiration, fine-needle biopsy, or a core biopsy on category 4 lesions. Occasionally a category 3 lesion will be recommended for biopsy, although the routine procedure is short-term follow-up. Because category 5 lesions generally are highly suggestive for malignancy, the minimal biopsy should be performed only if the protocol is to confirm a malignancy using a frozen section and then to perform a one-stage therapeutic operation. Otherwise, performing a minimal biopsy only adds an unnecessary surgical step in a patient’s treatment plan. If the minimal invasive biopsy leads to inconclusive results, a surgical biopsy is suggested. A surgical biopsy also is recommended if the cytologic or histologic findings are inconsistent with the imaging.\textsuperscript{2,14-17}

A cytologic analysis is performed after the removal of cell samples from the site with a 22- to 25-gauge needle. The cells are smeared on glass slides, air dried, and then stained. Routine cytology reports can be obtained within 24 to 48 hours.\textsuperscript{2}

A histologic analysis is performed on macroscopic tissue samples. The tissue specimen is obtained using core biopsy or open surgical techniques and preserved by fixing in a 10% formaldehyde solution. To harden the specimen, it is dehydrated, defatted, and embedded in warm paraffin. After cooling, the embedded tissue can be sliced as thin as paper, stained, and protected before being viewed under a microscope by a pathologist. Accurate results can be obtained in 3 to 5 days. However, preliminary results can be given in approximately 10 minutes. This is particularly useful during an open surgical biopsy when the surgeon removes a specimen while the patient is under anesthesia. The section is frozen, sliced, stained, and viewed under a microscope. If a malignancy is found, the information can be immediately conveyed to the surgeon.\textsuperscript{16}

**Breast Interventional Procedures**

**Cyst Aspiration**

An aspiration can be indicated to confirm suspicion of a cyst or relieve pain associated with a cyst by aspirating its contents. Aspirations can be performed free hand on palpable lesions or using ultrasound guidance and typically are performed using an 18-gauge needle.\textsuperscript{1}

One advantage of ultrasound-guided aspiration is that the patient can lie comfortably on the table during the procedure. Another advantage is that real-time imaging allows the radiologist to manipulate both the needle and the transducer as needed to obtain material from different parts of the lesion. If the lesion is found to be a simple cyst, the general recommendation is for routine follow-up. Lesions filled with nonbloody fluid and lesions that collapse during aspiration generally are considered normal. Lesions that are considered suspect might be solid, have cystic and solid components, or be indeterminate complex masses. Lesions with low-level internal echoes and those with fluid debris or sponge-like clusters of cysts with thickened walls need further study. In general, normal aspirates can include secretory, inflammatory, benign epithelium, or apocrine cells. If bloody fluid is aspirated, the lesion must be further evaluated by cytologic examination or biopsied.\textsuperscript{1,2}

**Stereotactic Localization**

If a lesion is nonpalpable, yet visualized on imaging, stereotactic imaging can be used to locate the exact coordinates of the lesion before a biopsy is performed. Stereotactic localization can be used on calcifications as well as circular, oval, or lobulated lesions. The technique is performed using either a dedicated prone table or a standard mammography unit with an add-on attachment.\textsuperscript{1,2}

The add-on unit images the patient in the upright position. These units are relatively inexpensive compared with dedicated prone units and do not require a dedicated biopsy room. Add-on units can image the posterior breast and axillary area better than the older prone units, but staff has less space in which to work. In addition, because the patient is upright and can see the insertion of the needle, there is a greater risk of a vasovagal reaction. Patient motion also can compromise the image with add-on units.\textsuperscript{1,2}

The prone units are dedicated procedure units where the breast of interest extends through a hole near the middle of the table. Some units allow both the ipsilateral arm and the breast of interest to extend though the hole, thus allowing access to far posterior lesions and allowing 360° tube rotation around the breast. The mammography unit and needle guidance device are located under the table. The table can be raised or lowered to suit the radiologist’s preference, and both the
radiologist and technologist can remain seated during the procedure. The prone unit is more expensive, but there is less chance of a patient having a vasovagal reaction. In addition, these units essentially have only one use and might leave a room idle. Manufacturers have created a blended technology where a regular mammography unit can be converted to a prone biopsy unit as needed.\textsuperscript{1,2}

Whatever the equipment used for stereotactic imaging, angled images are obtained to triangulate the depth of a lesion within the breast and calculate its position in 3 dimensions. The horizontal (x-axis) and vertical (y-axis) dimensions are calculated with the nonangled radiograph. The tube is then angled 15° to the left and right along the x-axis to obtain 2 scout images that are used to calculate the lesion’s depth (z-axis). The stereotactic unit moves automatically for imaging and generates coordinates used to position a biopsy probe within the breast.\textsuperscript{2}

During the stereotactic procedure, appropriate placement of the needle is confirmed with prefire images. After confirmation of needle placement or adjustment, postfire images confirm that the biopsy needle traversed the area of interest. The breast must be compressed during the procedure because minimizing patient motion is critical. Any patient movement after prefire imaging will result in failure to obtain adequate samples of the lesion.\textsuperscript{3} After removal, the sample can be sent for cytologic or histologic analysis, depending on the type of sample removed. A radiopaque marker often is placed in the original site after sampling to identify the site of the microcalcifications or lesion.

Stereotactic localization is not recommend if the breast is compressed to less than 2.5 cm to 3 cm because a long-throw needle (ie, the distance the needle travels in the breast > 2 cm) will hit the detector plate of the stereotactic unit or penetrate the skin on the other side of the breast.\textsuperscript{2}

**Preoperative Needle Localization**

If stereotactic technology is not available, a preoperative needle localization technique can be used to locate any nonpalpable lesion or calcification within the breast. This procedure is done prior to a surgical incisional or excisional biopsy. The localization wire is placed in the breast using either mammographic or sonographic guidance. Typically, the patient is positioned with the area of interest under an open field or alphanumeric grid in the compression plate (see Figure 1).

After the skin is cleaned, the localization needle tip is inserted directly over the lesion. Care is taken not to penetrate to the opposite side of the breast. With the needle in place, the technologist takes an image. Compression is released without disturbing the needle and the second image is taken 90° to the first. (If the first image is in the craniocaudal projection, the second is taken in the mediolateral and vice versa.) These 2 images are used to triangulate the lesion’s location and position the needle accurately. The needle should be...
placed directly in the lesion with at least 5 mm of the wire within the lesion. Additional images can be taken as needed to confirm any re-placement of the needle. Once the final position of the needle is resolved, a guidewire is inserted through the needle. Most localization wires have a hook or curved end, which should be placed approximately 1 cm beyond the lesion (see Figure 2). The approach to the lesion should be parallel to the chest wall to minimize complications and, in general, the shortest approach should be used to reduce the risk of missing the lesion. After the needle localization procedure, the patient is sent to surgery for removal of the guidewire and the lesion.1,2

**Fine-Needle Aspiration or Biopsy**

Different fine-needle techniques can be used to obtain cellular material for cytologic analysis. Fine-needle aspiration removes the liquid content of a cyst. The technique can be performed solely to relieve pain and the aspirate discarded. The terms fine-needle biopsy (FNB) and fine-needle aspiration biopsy (FNAB) often are used interchangeably. When an FNAB is performed, the aspirate and any cellular material are sent for cytologic analysis. This technique can be used to diagnose both cystic and solid lesions such as fibroadenomas. If the lesion is not palpable, the needle can be guided to it under ultrasound guidance or mammographically using stereotactic breast localization. Fine-needle biopsy can reduce the need for surgical breast biopsy, but the accuracy of FNAB is dependent on the individual performing the procedure—the radiologist or surgeon—and the skill of the cytologist. Better specimens are obtained for cytologic assessment using smaller-gauge needles (eg, 22-, 23-, or 25-gauge). The needle length used depends on the depth of the lesion in the breast.1,2

FNAB requires aseptic but not sterile technique. The skin is cleaned with alcohol or Betadine, and a local anesthesia such as lidocaine is administered along the course of the proposed needle tract. FNAB collects cellular material that is then transferred to a glass slide where it is smeared, fixed, and stained. The slide is examined by a cytopathologist or cytotechnologist for diagnosis. In most cases, the cytopathologist or cytotecnologist is present during the FNAB procedure to verify adequate specimen collection. Care also must be taken in preparing the FNAB slides. The aspirated material must be spread evenly on the slides. Slides heavily stained by blood or other fluid are difficult to interpret, and if there is a delay in fixing the smear, it will become air-dried and impossible to interpret. FNAB provides cytologic rather than histologic specimens, and without a skilled cytopathologist or cytotecnologist, there is a higher probability of false-negative readings and a higher rate of insufficient specimen sample. Postprocedure patient care after FNAB is minimal. The skin is cleaned with alcohol, and bandages can be applied. Postbiopsy imaging of the site should be performed within 6 months to check for a missed lesion.1,2

**Core Biopsy Methods**

The core biopsy method is the most commonly performed, minimal invasive technique. It is inexpensive, easy to perform, and highly accurate for many lesions. Core biopsy removes tissue vs cells as with FNAB, and the tissue samples are obtained using an 11-gauge or larger needle. To yield adequate specimens, at least 5 core samples are needed to assess a lesion, and at least...
10 are needed to assess calcifications. Core biopsy is an outpatient procedure.\textsuperscript{1,3}

The core samples can be obtained using a gun-needle combination or a vacuum-assisted device (see Figure 3). Gun-needle combinations are available as disposable and nondisposable, as well as long throw and short throw (ie, the distance traveled by the needle is < 2 cm). The length of the throw selection is determined by the breast's size and the lesion's location. Because of the larger needle size, core biopsy requires a 1- to 1.5-inch incision and sometimes requires stitches after the procedure.\textsuperscript{1,3}

In the vacuum-assisted procedure, after numbing the skin, a quarter-inch incision is made to allow the insertion of the device's hollow probe. The probe is guided into place using mammography, ultrasonography, or MR imaging. Once in place, a cylinder of tissue is suctioned through a hole in the side of the probe. A rotating knife inside the probe cuts the tissue sample from the breast. Several samples can be taken from the same incision. No stitches are needed, and there is minimal scarring. This method usually removes more tissue than a regular gun-needle core biopsy.\textsuperscript{1,3}

The core biopsy also can be performed using an automatic or mechanical core “gun.” The gun-needle combination is designed to move a cutting needle rapidly through the breast. It has an inner needle with a trough extending within it. One end is covered by a sheath and attached to a spring-loaded mechanism. When the mechanism is activated, the needle moves forward, filling the trough with breast tissue. The outer sheath instantly moves forward to cut the tissue and keep it in the trough. It takes only a fraction of a second to obtain a sample, but the needle must be withdrawn to collect the tissue for each sample. Because each reinsertion results in additional destruction of breast tissue and hemorrhage into the area of biopsy, a small lesion can withstand only a limited number of insertions.\textsuperscript{1,3}

Tissue samples from the core biopsy are sent for histologic analysis. In addition, most radiologists recommend radiographing the specimen using magnification technique. After the core biopsy, compression should be maintained at the incision site for 5 minutes to achieve hemostasis and to minimize hematoma formation. An ice pack can be applied to minimize swelling. The skin at the incision site should be closed with closure strips to minimize scarring. After a core biopsy, patients should be instructed to keep the wound dry and to leave the dressing on for at least 3 days. They should avoid strenuous activity for at least 1 to 2 days after the procedure.\textsuperscript{1,3}

Ultrasound Guidance

Core biopsy can be performed using either ultrasound or MR imaging guidance. Ultrasonography is a highly accurate way to evaluate suspicious masses in the breast. If the lesion can be localized using ultrasonography, it can be biopsied with ultrasound guidance, which is a faster method and uses no ionizing radiation. Many radiologists prefer to do free-hand positioning of the needle within the breast, although there are needle-guidance systems available. Whatever the method used, the same person must control both the transducer and the needle. The procedure can take less than 1 hour and most patients are able to resume their usual activities later the same day, although athletic activities should be avoided on the day of the biopsy. The patient should be positioned either supine or turned slightly to the side. The patient’s ipsilateral arm should be raised, with the hand underneath her head. The ultrasound probe then is used to locate the lesion. If the lesion is in the lateral aspect of the breast, the patient should be in the oblique position for the examination. If the lesion is in the medial aspect of the breast, the patient should be supine.\textsuperscript{1,3}

Advantages of the free-hand system include the ability to approach the lesion with the needle parallel to the chest wall, thereby avoiding puncturing the chest as well as eliminating the
expense of added equipment. Depending on the probe configuration, the geometry of the acoustic beam, and the route of the needle entry, a small portion of the needle might be visible as an echogenic dot or, if the needle entry is aligned with the acoustic beam and is nearly perpendicular, the entire shaft including the needle tip might be visible. Because of the throw of most core biopsy needles, the skin entrance site should be farther from the lesion and the transducer than in the case of FNAB, and the needle tip should always run parallel to the chest wall to avoid puncturing the pleura.1,3

Local anesthetic is injected to be sure that the patient feels no discomfort during the procedure. Ultrasonography can be used to guide the injection of anesthetic along the route to and around the lesion. Typically, a 4-mm or shorter incision is made in the skin at the site where the biopsy needle is to be inserted. The radiologist then guides a hollow core biopsy needle or the vacuum-assisted needle directly into the mass and obtains specimens using ultrasound guidance. Usually a minimum of 5 to 10 samples are taken using the core biopsy method, or at least 12 when using the vacuum device. The needles are angled differently for each core to obtain core samples from different parts of the lesion.1,3

Pre- and postfire images are always obtained to document the position of the needle relative to the lesion. It is not usually necessary to close the tiny skin incision with sutures, but a small compression dressing can be applied.

Ultrason-guided biopsy cannot be used if the lesion cannot be visualized with ultrasonography. Also, calcifications within a cancerous nodule are not shown as clearly with this modality compared with radiography. Another drawback of ultrasonography is that it cannot easily be used for deep lesions or large breasts because the 12 to 16 MHz transducers required for the necessary resolution in breast ultrasonography do not penetrate well beyond 3 cm to 4 cm.1,3

Magnetic Resonance Guidance

If a suspicious area is detected only on MR imaging or is not seen clearly on ultrasonography or mammography, the radiologist might recommend an MR-guided breast biopsy. As with ultrasonography-guided minimally invasive biopsies, the MR biopsy is less costly than surgical biopsy and leaves little to no scarring.

MR breast biopsy can be performed using an open breast coil, which allows easy access to the breast. MR biopsy also is possible with full-field (ie, closed) magnets by immobilizing the breast within a guidance device, obtaining the MR images, then placing the needle according to coordinates generated using the MR images. Guided by MR imaging, the radiologist generally places an introducer, a biopsy needle within a vacuum-powered instrument, into the suspicious area and removes a sample. Generally, a 9-gauge stainless steel core needle is used to remove a small, cylindrical tissue sample, which is sent to a laboratory for analysis. The needle used must be MR-compatible and there are now new MR pulse sequences that significantly reduce artifacts from the needle. Many of the newer biopsy systems employ stereotactic guidance with a biopsy grid that precisely maps the location of the lesion. Many also use plastic localizing markers to allow pinpoint accuracy in identifying, localizing, and confirming the lesion’s position.1,3

Open Surgical Biopsy

An open surgical breast biopsy, sometimes called a partial mastectomy, is needed if the results of an FNAB or core biopsy are inconclusive, the lesion is located very close to the chest wall or immediately behind the nipple, or if the lesion or lesions are so hard that the radiologist cannot obtain an adequate sample. In addition, the open surgical biopsy is the next step after the wire localization.1,3

The surgical biopsy requires full sterile techniques. The procedure is generally performed as a same-day surgery with the patient given a general anesthetic. There are few complications, and most patients report pain at the site for only 1 to 2 days. Generally, aftercare treatment includes taking pain medication and using a cold pack.

There are 2 types of surgical biopsies. In an incisional biopsy, a sample of the lesion is removed for histologic testing while the patient is still under anesthetic. If the lesion is malignant, an excisional biopsy can be performed in which the entire lesion is removed, leaving clean margins.
**Comparison of Breast Biopsy Techniques**

Complications and the severity of biopsy adverse effects depend on the method used. In the case of needle localization, inaccurate placement or displacement of the wire can occur. With any breast biopsy, patients can develop an unexpected allergic reaction to local anesthetic, and there is a risk of bleeding, hematoma, or infection whenever the skin is penetrated. Infection requiring antibiotic therapy is rare. To avoid excessive bleeding, patients on aspirin or blood thinners are advised to stop their medication 5 days prior to the procedure.\(^1,2\)

The open surgical biopsy has the lowest false-negative rates (0.5%) but is the most invasive. Between 20% and 30% of breast cancers in the United States are still diagnosed surgically. The reported false-negative rate for malignancy with core biopsy is in the range of 2% to 6.7%, with a mean rate of 4.4%. False-negative findings are more likely to occur with microcalcifications. Stereotactic core-needle biopsy using a 14-gauge needle has a 90.5% sensitivity rate and a 98.3% specificity in diagnosing breast masses, compared with 62.4% and 86.9%, respectively, for fine-needle aspiration.\(^3,18,19\) A common error in core biopsy is understating the multifocality of the cancer. For example, a ductal carcinoma in situ could be diagnosed with a core biopsy, but invasive cancer might be found with excisional biopsy. The best core samples are obtained using a long-throw gun and taken with a 14-gauge needle. Insufficient sampling is reduced if at least 5 samples are taken when biopsying masses. The 14-gauge automatic needle has 2 main limitations: If multiple specimens are obtained, the later samples are contaminated with blood, and retrieval of calcifications is difficult if the calcifications are not along the line of fire of the needle or are located in small lesions.\(^18-20\)

FNAB is less expensive, less invasive, and faster than core biopsy, although it is more likely to lead to error due to insufficient sampling. The false-negative rate for the FNAB can range from 5% to 20% and is lower for experienced operators. The false-negative rate can be further reduced by using smaller-gauge needles and by increasing the number of aspirates obtained. The most substantial limitation for FNAB is the high rate of insufficient sampling. Rate of insufficient samples for FNAB under stereotactic guidance is higher and can reach 39.9% when compared to ultrasound guidance (8.5%). Rates are also higher for calcifications (46.1%) vs masses (26.6%). The rates for all types of lesion (masses and calcifications) are higher if there is no on-site cytopathologist (31.2% vs 14.5% with an on-site cytopathologist).\(^2,18,19\)

Ultrasound-guided biopsy performed using any of the biopsy methods is faster and less expensive than stereotactic biopsy. It also takes less time than surgical biopsy and causes less tissue damage. Ultrasoundography offers real-time visualization of the needle, which means the motion of the biopsy needle can be tracked. It also delivers no ionizing radiation. Ultrasoundography enables better biopsy of the axillary and chest wall areas that are difficult to biopsy using radiographic guidance. Most palpable lesions are best biopsied with ultrasound guidance, whereas calcifications are best biopsied mammographically. The exception is a cluster of cysts, which is difficult to evaluate using ultrasoundography. Palpable lesions, however, must be suspicious or indeterminate on ultrasoundography to warrant an ultrasound biopsy.\(^1,4\)

**Specimen Radiography**

The specimen is the breast tissue removed during a surgical or core biopsy. A specimen radiograph should be performed after every biopsy to confirm that the lesion was removed and that the margins are clean (see Figure 4). When imaging the specimen after a surgical biopsy, speed and efficiency are important because the patient might be under general anesthesia. If possible, the mammographer should use compression, and magnification is recommended for calcifications. If microcalcifications are present in a specimen, they should be counted and noted. The radiologist should indicate where the pathology is located on the specimen, as this will help the pathologist evaluate the lesion. This is especially important in patients with an extensive area of suspicion. If the tumor is close to the margins of the specimen or if the margins are positive for cancer, additional tissue must be excised before the incision is closed.\(^1\)

**Breast Cancer Treatment Options**

Breast cancer is not a medical emergency and most women are advised to consult more than one doctor, thereby getting a second opinion, before proceeding
with any treatment option. Breast cancer can be treated with surgery, radiation, or drugs (chemotherapy and hormonal therapy). Many oncologists use one or more of these combinations, depending on the type and location of the cancer, whether the disease has spread, and the patient’s overall health status.21

Before treatment begins, the cancer must be staged and its size and location determined. It is essential to conduct tests for estrogen or progesterone receptors and tests to determine whether the cancer overexpresses any protein genes such as ERBB2 (formerly HER2 or HER2/neu) before treatment starts. Staging and treatment involve a multidisciplinary approach and the team of professionals must carefully coordinate communication to ensure quality patient care. The professional team can include a radiologist, surgeon, oncologist, dosimetrist, radiation therapist, radiation physicist, pathologist, reconstructive or plastic surgeon, gynecologist, and an oncology social worker.21-23

Once treatment begins, the patient should follow a strict schedule and complete all treatment. Studies have shown that once radiation treatment begins, delayed or incomplete treatment often leads to worse outcomes and higher recurrence rates.

As many as 20% of older women experience delayed or incomplete radiation treatment after breast-conserving surgery, and this can adversely affect disease-free survival. Delaying treatment by 8 weeks or more significantly increased the odds for recurrence or new breast malignancies in patients with early breast cancer. Patients whose radiation therapy was delayed 12 or more weeks after surgery, or 8 or more weeks after chemotherapy, were more than 4 times more likely to experience a subsequent breast cancer event, regardless of stage. For all patients, not completing radiation therapy was not associated with an increased risk for recurrence or relapse, but among those with stage I disease, an incomplete radiation therapy regimen was associated with worse overall survival.21,24

Even after the cancer has been removed and treatment completed, the patient will continue with follow-up visits to an oncologist. Some patients will also be placed on long-term tamoxifen treatment and will be monitored carefully. Pregnancy after breast cancer treatment is no longer ruled out, and studies have confirmed that pregnancy does not increase the risks for recurrence of breast cancer.21 With better detection and treatment options, the 5-year survival rate after breast cancer diagnosis has been steadily improving (see Table 1).25

Table 1

<table>
<thead>
<tr>
<th>Breast Cancer Survival Rates by Stage25</th>
<th>5-year Survival Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 0</td>
<td>100</td>
</tr>
<tr>
<td>I</td>
<td>100</td>
</tr>
<tr>
<td>II</td>
<td>93</td>
</tr>
<tr>
<td>III</td>
<td>72</td>
</tr>
<tr>
<td>IV</td>
<td>22</td>
</tr>
</tbody>
</table>
Staging Breast Cancer
Breast cancer is classified in stages 0 to IV. A patient’s stage depends on the extent of the primary tumor, the spread of the cancer to regional lymph nodes, and whether distant metastasis has occurred. In staging, lower numbers represent less spread of the cancer. In the TNM staging system, the tumor, represented by the letter \( T \), describes the size of the lesion. The lymph node involvement, represented by \( N \), indicates the number of nodes involved.\(^\text{26}\)

After a tumor is removed from the breast, the specimen is further examined for antibodies, enzymes, and proteins. This provides information on the prognosis and guides the choice of therapeutic options. Cancer cells might contain estrogen or progesterone receptors. Breast cancers that have estrogen receptors often are referred to as ER-positive (or ER\(^+\)) cancers, while those containing progesterone receptors are called PR-positive (or PR\(^+\)) cancers. About 2 out of 3 breast cancers have at least one of these receptors. One widely known marker is the growth-promoting protein called human epidermal growth factor 2 (HER2). Cancers with this marker can be treated with the drug trastuzumab (Herceptin). About 1 out of 5 breast cancers have too much of this protein. The \( \text{ERBB2} \) gene instructs cells to make this protein, and tumors with increased levels of HER2 are referred to as HER2-positive.\(^\text{10,20,25}\)

Mastectomy
Mastectomy is a surgical procedure in which the entire breast is removed. During the procedure an incision is made along the perimeter of the breast close to the tumor, and the underlying tissue is cut free and removed. There are different types of mastectomies.

In the radical mastectomy, the entire breast, lymph nodes, and chest wall muscles under the breast are removed. It is a very disfiguring, deforming, and debilitating procedure and is not commonly performed.\(^\text{26,27}\)

The modified radical mastectomy removes the entire breast, including the nipple and areolar region and some of the underarm lymph nodes. This is the most common mastectomy procedure performed today. The modified radical mastectomy generally requires a hospital stay of 3 to 8 days depending on the body’s rate of healing. This surgical procedure can take 2 to 3 hours. The incision is closed with stitches or clips, which are removed within a week of the surgery. After the surgery, a draining tube often is placed in the breast to remove blood and lymph fluids, which accumulate during the healing process. Drainage tubes are removed after 2 weeks.\(^\text{21,26}\)

In a skin-sparing mastectomy, the nipple and areola complex, existing surgical or biopsy scar, and all of the breast parenchyma are removed. By retaining most of the skin, skin-sparing mastectomy simplifies the reconstruction process and improves the cosmetic appearance of the breast. Preserving the areola is possible in selected cases. This process is contraindicated for some patients, however.\(^\text{21,26}\)

Another procedure, the quadrantectomy or partial mastectomy, is an option for some women. This surgery removes a quarter of the breast, including the tumor, with clear margins of up to 2 to 3 centimeters of breast tissue, skin, and some chest wall muscle. As in a mastectomy, the lymph nodes in the axilla will be removed to check for cancer spread.\(^\text{21,26}\)

The mastectomy generally proceeds normally for most patients; however, complications can occur, including hematoma or microhematoma, which appear on a mammogram as mixed-density oval or circular calcifications. Patients also can develop an infection that requires treatment. In addition, clear fluid (seroma) can become trapped in the wound.\(^\text{26}\)

Lumpectomy
Lumpectomy is the most breast-conserving surgery available. Lumpectomy is the removal of the breast cancer tumor and the surrounding margins of normal breast tissue. A lumpectomy can be followed by 6 weeks of radiation therapy to ensure that all the cancer cells in the remaining breast have been destroyed. Radiation treatment usually begins one month after surgery, giving the breast time to heal. Other options included with the lumpectomy are chemotherapy to control the systemic spread of breast cancer or a 5-year or longer treatment with the drug tamoxifen.\(^\text{21,26}\)

A number of factors determine whether a patient should have a modified radical mastectomy vs a...
lumpectomy. Some of these factors include tumor size, tumor type, and cancer stage. Other patients might not have clear choices or might choose the modified radical mastectomy on the basis of anecdotal evidence rather than on survival statistics. Breast conservation should be performed only if the treatment provides a cure rate equal to that obtained from a mastectomy. Indications for lumpectomy can include stage I or II ductal carcinoma in situ in which the cancer is still confined to the ducts. Poor candidates for lumpectomy include patients with 2 or more areas of cancer in the same breast (ie, multicentric disease), especially if the cancerous areas are widely separated. Women who have already undergone radiation in the breast or chest area cannot have another lumpectomy with radiation because repeated radiation treatment to the same area is contraindicated. Women whose previous lumpectomy did not completely remove the cancer cannot repeat the procedure. Radiation is not recommended in the early stages of pregnancy; therefore, if radiation is to follow a lumpectomy, women who are pregnant at the time of the lumpectomy will need an alternative procedure or might need to reconsider the pregnancy. The tumor size in relation to breast size is important because this can rule out breast conservation treatment. In some patients, the cosmetic result will not be acceptable and could result in breast deformity. Also, women with large cancers in small breasts or a cancer more than 5 cm in diameter typically have poor cosmetic results after a lumpectomy.1,26

Patients considering breast conservation surgery who need radiation treatment must remember that the radiation treatments last several weeks. If the patient cannot travel to a radiation treatment facility or undergo the full treatment, she cannot have breast conservation surgery.

After the lumpectomy, the pathologist must check the tumor margins to make sure the surgeon removed the entire cancerous tumor. There should be no cancer present in the outermost edges of the specimen sample. Preliminary checks are usually made while the patient is still in the operating room, but the final result might not be available until days later. If the final results reveal positive margins, then additional surgery is necessary.1,3,21,26

Lumpectomy can be performed using a local anesthetic and sedation, or general anesthesia depending on the extent of the surgery needed. The surgeon makes a small incision over or near the site of the lesion, then excises the lesion plus a margin of at least 1 cm of normal surrounding breast tissue. In addition to a lumpectomy, a sampling of the axillary nodes or an axillary lymph node dissection is necessary to determine whether the cancer has spread outside the breast.1,3

Seroma usually fills the surgical site after the operation and helps to naturally remold the breast shape. Gradually, the seroma is absorbed and the body replaces it with scar tissue over a period of months. Patients usually require a 1- to 2-day hospital stay and most can resume normal activity in 2 weeks. The extent of breast soreness depends on the amount and location of tissue removed during surgery and the type of axillary dissection done. In rare instances, the seroma will recur after the lumpectomy, but this is easily aspirated on an outpatient basis.

Applying compression can reduce the risk of repeated seroma, or an injection of ethanol or an autologous fibrin clot can be used to fill and harden the space. A newer technique is an injection of a fibrin sealant during the lumpectomy to reduce accumulation of serous fluid. The fibrin sealant, fibrogen, is a protein from the blood that forms a clot when combined with thrombin, another blood-clotting protein.1,3,21

**Lymph Node Biopsy**

Lymph node biopsy or axillary lymph node dissection is a surgical procedure in which some or all of the lymph nodes are removed for testing. The procedure, called a lymphadenectomy, usually follows a lumpectomy or mastectomy to determine whether the cancer has spread to areas outside the breast. Complications of lymph node biopsy include infection, abnormal sensations, fluid collection in the axilla, and lymphedema.1,3,28

Researchers have concluded that the lymph node biopsy is unnecessary and the minimally invasive procedure called sentinel node biopsy, in which only 1 to 4 axillary nodes in the chain draining from the breast are removed, should be the treatment of choice. The sentinel node biopsy generally results in fewer complications than lymph node biopsy. To identify the sentinel node, the oncologist gives the patient an injection of a radioisotope, which sometimes is used with a blue dye.
A sentinel node biopsy plus radiation, chemotherapy, or both is an appropriate treatment for patients with early breast cancer (stage I or II) who have no palpable adenopathy and 1 to 2 sentinel lymph nodes containing metastases. The rationale is that chemotherapy and radiation therapy are both designed to kill cancer cells exiting the breast through the lymph system.1,23-25,28

Overview of Radiation Therapy for Breast Cancer

Radiation therapy has been used to treat cancer since shortly after the discovery of x-rays in 1895. As technology advanced, it provided the ability to produce a consistently high-energy beam, and in the 1950s the use of the linear accelerator (LINAC) became the mainstay for treatment delivery.21 Radiation therapy is practiced by exposing a specific body area, in this case the breast and torso, to high-energy radiation to destroy cancer cells, while at the same time limiting other parts of the patient’s body from radiation exposure. Radiation therapy can be administered either externally or internally. External-beam radiation therapy (EBRT) usually is given once a day for 6 to 7 weeks, while internal radiation, or brachytherapy, usually is given for 1 to 5 days. Some oncologists suggest that following a lumpectomy, giving a boost—a short, localized course of radiation—can be beneficial, especially for younger women (ie, aged younger than 40 years) with early stage breast cancer.21-23

Radiation therapy can be used to treat breast cancer in 2 ways: primary or adjuvant. Primary radiation is the use of radiation alone to treat breast cancer. Adjuvant radiation therapy uses radiation with surgery, chemotherapy, or both to treat possible residual cancer. If the patient is receiving chemotherapy, the chemotherapy is usually given before the radiation treatment starts.27,29,30

External-Beam Radiation Therapy

Therapeutic radiation uses photons, made up of x-rays or gamma rays, or particulate radiation, such as electrons or neutrons. All of these are ionizing forms of electromagnetic radiation. High-energy photons are created from radioactive sources such as cobalt, cesium, or LINACs. The energy of the photons is expressed in electron volts and typically is used in megavolt energy ranges, whereas diagnostic imaging is in the kilovolt range.21,29

After performing a physical examination and reviewing the patient’s medical history and other pertinent data, the radiation oncologist discusses the available treatment options with the patient before treatment begins. The oncologist also might request further diagnostic testing.27,29

EBRT usually is delivered with a LINAC, which focuses and directs the radiation beam to the area designated for treatment. For breast cancer, LINAC-based EBRT is the most common type of radiation treatment administered. It involves the use of high-energy rays to destroy cancer cells in and around the breast tissue, including the chest wall, axilla, and lymph nodes. Higher energy photon beams penetrate deeper into the tissue. The oncologist determines the total dose of radiation to be given and the medical dosimetrist plans how that dose should be administered while limiting the dose to healthy tissue.21,29

Most of the biologic effects of ionizing radiation are thought to be caused by the improper repair of damage to DNA in the cells. DNA stores genetic information on cell growth, division, and function. Radiation destroys cancer cells in the treatment volume by damaging the cells’ DNA. There also is damage to the DNA of normal cells, although normal cells usually can repair themselves between treatments.

Pretesting identifies the specific area of the body to be treated, limiting the amount of radiation to healthy tissue. The treatment planning team, including the radiation oncologist, medical dosimetrist, medical physicist, radiation therapist, or a combination of these professionals, constructs a treatment plan around the information gathered from the pretreatment simulation. This information, usually in the form of volumetric imaging scans, is used to develop the treatment angles, dose distribution, and optimal field shape design. Computed tomography scans of the area can be taken and digitally reconstructed radiographs are created. The digitally reconstructed radiograph is a static 2-D image using reconstructed 3-D image scan information.

The digitally reconstructed radiograph is used to verify and document that the patient setup matches the treatment plan and the patient is being treated correctly.21,29 Beam-shaping blocks and multileaf collimators
often are used to protect normal tissues outside of the
area of interest from receiving radiation. In addition,
no one is permitted to be in the treatment room while a
treatment is being delivered, so the radiation therapist
monitors the patient via closed-circuit television and
with a 2-way intercom.\textsuperscript{21,27,29}

EBRT usually begins 4 to 6 weeks following surgery
to allow the patient to heal. EBRT takes only a few
minutes to administer after the patient is in the correct
position. Treatment usually is given 5 times per week for
a total of 25 to 28 days to the entire breast, with 4 to 8
treatments given to the tumor bed only. Generally, these
treatments are given with the same LINAC but using an
electron beam instead of a photon beam. The electron
beam penetrates only superficially.\textsuperscript{27,29}

Although the patient does not feel anything while
the radiation beam is on, adverse effects can develop.\textsuperscript{30}
Some of these include damage to the skin and tissue.
Because this damage is unpredictable, some surgeons
prefer that women delay reconstruction until after
radiation therapy is completed. This minimizes the
risks of unfavorable cosmetic outcomes such as the for-
mation of scar tissue around the implant, a condition
known as capsular contracture that can lead to hard and
painful breasts. However, this practice is controversial
and other surgeons maintain that if reconstruction is
performed immediately, women fare better emotionally
than if reconstruction is delayed.\textsuperscript{2,27,29,30}

Adverse effects of radiation can present early or late.
The early effects usually occur 3 to 4 weeks into treat-
ment and often resolve completely 4 to 6 weeks after
treatment is complete. Later effects can take months or
years to develop and are often permanent. Interruptions
to radiation therapy are limited as much as possible to
avoid altering the outcome of the treatment. Adverse
effects might include\textsuperscript{30}:

\begin{itemize}
  \item Fatigue.
  \item Swelling.
  \item Heaviness in the breast.
  \item Sunburned appearance.
\end{itemize}

Following completion of radiation treatments, the
patient also might experience firmness of the breast,
enlargement due to fluid build-up, decreased size due to
tissue changes, and an increase or decrease of the skin’s
sensitivity.

During the treatment period, patients are advised to\textsuperscript{30}:

\begin{itemize}
  \item Wear loose-fitting clothing.
  \item Wear a bra that is not too constricting.
  \item Wear material that breathes.
  \item Avoid exposing the treatment area to sunlight.
  \item Avoid extreme temperatures to the treatment area
      (eg, hot water, heating pads, warm compress, and
      ice packs).
  \item Avoid using lotions or powders on the treated area.
\end{itemize}

Intensity-Modulated Radiation Therapy

Of the EBRT options available, intensity-modulated
radiation therapy (IMRT) is increasingly used. It can
minimize the dose to a patient’s pleura, lungs, and even
the sternum more than ever before, delivering a more
precise dose to the target area.\textsuperscript{2,21,31}

With reduced doses to normal tissue, IMRT can pro-
provide higher treatment doses to the target volume while
limiting adverse effects. However, different parameters
factor into the way a treatment is administered, such as
the size, location, and type of cancer; the patient’s general
health; and other medical therapy the patient is receiving.
In general, women who received IMRT have reported
fewer adverse effects compared with those undergo-
ing traditional EBRT, including less swelling and skin
color changes. Research shows that 41% of women who
received IMRT had reddened or itchy skin compared
with 85% of women receiving conventional radiation.
Also, only 1% of women receiving IMRT have breast
swelling, compared with 28% of women receiving con-
ventional treatment. Changes in skin color were reported
in 5% of the women undergoing IMRT, compared with
50% of those who had conventional treatment.\textsuperscript{21,30,32}

Internal Radiation or Partial Radiation

Internal radiation, called \textit{brachytherapy}, also has
been used in the treatment of breast cancer. Instead of
using an external radiation beam, a radioactive source
is placed internally. Brachytherapy can be used to
deliver high doses of radiation to small areas. However,
the patient must meet specific criteria to be eligible to
receive brachytherapy to the breast.
Brachytherapy generally is used to give treatments over 3 to 5 days, instead of 6 to 7 weeks as with EBRT. The idea is to apply a more intense dose of radiation to the tumor bed, rather than to the entire breast. This is called accelerated partial breast irradiation, and it can be delivered using a few different methods.\(^{31,32}\) For example, a balloon is inserted into the tumor bed and inflated to fill the cavity following a lumpectomy procedure. Treatments are usually done on an outpatient basis, given twice a day for 5 days, with 4 to 6 hours between treatments. Each day the patient usually receives a scan, often a computed tomography scan, to evaluate changes to the tumor bed regarding air in the cavity, the balloon placement and volume, and correct distance from the edge of the device to the skin surface and chest wall. Small corrective actions can be made to ensure dose accuracy and homogeneity.\(^{21,31,33,34}\) The device or balloon remains in place for the entire course of treatment.

During each treatment, a tiny radioactive seed that is attached to a guidewire is inserted into the balloon via a catheter. The radioactive seed is maneuvered to various points within the balloon, delivering radiation in a prearranged pattern to shape the overall treatment. After the course of treatment is complete, the balloon is deflated and removed from the patient’s breast. The use of this method means the radiation is in the breast only during the short treatment sessions, and the patient is not considered radioactive as with other radiation used internally for medical purposes. Several devices currently on the market can be used to perform accelerated partial breast irradiation, offering optimal conformity of treatment delivery.\(^{21,31,33,35}\)

### Chemotherapy

Chemotherapy uses a variety of drugs and can be used to stop the spread of cancer to other parts of the body, slow the growth of cancer, kill cancer cells that might have spread beyond the breast, or relieve symptoms of cancer. Chemotherapy can be given before or after cancer surgery, with or without other treatments, and is often a combination of drugs. Neoadjuvant chemotherapy is given before surgery to help shrink the cancerous tumor. Adjuvant chemotherapy is chemotherapy given in addition to another breast cancer treatment (eg, mastectomy).\(^{33}\)

More than 90 chemotherapy drugs are available. Alkylating agents work directly on the DNA to prevent cancer cells from reproducing. These drugs work on all phases of the cell cycle. Nitrosoureas act similar to alkylating agents. They interfere with enzymes that help repair DNA. Antimetabolites are drugs that work during the synthesis (S) phase of the cell cycle and interfere with DNA and ribonucleic acid growth. Antitumor antibiotics interfere with DNA by stopping enzymes and mitosis or by altering the membranes that surround cells. They are not the same as the antibiotics used to treat infection and work in all phases of the cell cycle. Mitotic inhibitors stop mitosis or keep enzymes from making proteins needed for cell reproduction. They are plant alkaloids or compounds derived from natural products and work during the mitosis (M) phase of the cell cycle. Corticosteroid hormones are steroids and natural hormone-like drugs used to kill cancer cells or slow their growth. Many are used with other drugs to increase their effectiveness. Sex hormones are drugs that alter the action or production of the female or male hormones and are used to slow the growth of cancer cells that are hormone-receptor positive.\(^{21,23}\)

Most physicians prefer a combination of lower doses of multiple drugs vs a high dose of one powerful drug. Low-dose drugs are associated with fewer adverse effects. Chemotherapy is considered a systemic form of cancer treatment because the drug is distributed throughout the entire body via the bloodstream. Chemotherapy drugs therefore affect all tissues and organs in the body. These drugs tend to attack cells that are quickly dividing, whether cancerous or not.\(^{21,25}\)

Generally, chemotherapy regimens are tailored for the individual patient and can vary tremendously. The type of treatment will depend on the patient’s age, overall health, cancer stage and grade, past or future treatments, and other health problems. Some patients receive chemotherapy as the only form of treatment because chemotherapy can be used to cure their type of cancer by totally destroying the cancerous cells in the body. However, chemotherapy also can be used to control the cancer and extend the patient’s life by stopping the cancer from growing and spreading, or as a palliative treatment to relieve symptoms caused by the cancer.
by the cancer. If chemotherapy is a part of a combined treatment, it is given first, before radiation or hormonal treatment.\textsuperscript{21,23}

Some chemotherapy drugs are given orally as tablets or liquids or applied to the skin as creams or lotions. Chemotherapy also can be given as an intramuscular injection or injected directly into the cancerous area. Chemotherapy courses can be given daily, weekly, monthly, or using other scheduling options, depending on the patient’s response to the drug. Generally, the treatment lasts 3 to 6 months, but most chemotherapy sessions include built-in rest cycles to give the healthy cells recovery time.\textsuperscript{21,23}

Most chemotherapy for breast cancer is given intravenously through a semipermanent catheter or vascular access device implanted into a large vein in the arm, hand, or subclavian vein. A vascular access device is useful for giving several drugs at once, for long-term therapy, and for continuous infusion chemotherapy. The peripherally inserted central catheter and the implantable venous access port (eg, Port-A-Cath, Smith Medical) are examples of vascular access devices. The peripherally inserted central catheter is placed in the arm and threaded through the vein near the heart. No surgery is needed for this type of placement. The Port-A-Cath requires surgery to implant a catheter under the skin to provide continuous access to a large central vein.

Chemotherapy causes the most damage to bone marrow and blood cells, cells of the hair follicles, and cells in the reproductive and digestive tracts. Adverse effects from chemotherapy vary depending on the strength of drugs used, the dosage, and the duration of treatment. Some patients experience few adverse effects, whereas others experience many common adverse effects. The closer a woman is to menopause when she undergoes chemotherapy, the more likely she is to experience premature menopause. Symptoms include hot flashes, vaginal dryness, and irregular menstrual cycles. Some chemotherapy drugs also can cause birth defects; therefore, a woman should not be pregnant while on chemotherapy treatment.\textsuperscript{21,23}

The main adverse effects from chemotherapy are nausea and vomiting, which often are caused by irritation to the lining of the stomach and duodenum, which in turn triggers the vomiting center in the brain. Patients also can experience mouth sores, taste changes, and decreased appetite. Diarrhea occurs because the rapidly dividing cells in the digestive tract are damaged, and constipation is due to loss of motility, poor diet, and certain medications. Other adverse effects can include hair loss (alopecia), which is generally temporary and occurs because hair follicles are weakened by the chemotherapy drugs, causing hair to fall out at a much faster rate than normal hair growth. Hair loss can occur 2 to 3 weeks after treatment begins, but grows back at the end of treatment, sometimes with a change in texture. Some patients also report tingling or burning sensations, numbness in the hands and/or feet, and skin irritations including redness, itching, peeling, or acne, and dark, brittle, or cracked fingernails, toenails, or both.\textsuperscript{21,23}

Chemotherapy affects the bone marrow that makes blood cells, including red blood cells, white blood cells, and platelets (see Table 2). A low white cell count, called leukopenia, makes the body more susceptible to infections. Patients undergoing chemotherapy need careful monitoring of their immune system because white cells are an essential component of the body’s immune system. Red blood cells bring oxygen to the tissue. A reduction in red blood cells causes anemia, which is associated with fatigue, dizziness, headache, irritability, and increased heart rate or breathing. Platelets help to prevent unnaturally long bleeding. Low platelet count is referred to as thrombocytopenia.

### Table 2

<table>
<thead>
<tr>
<th>Blood Cell Characteristics\textsuperscript{36}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Red</td>
</tr>
<tr>
<td>Platelets</td>
</tr>
</tbody>
</table>
Symptoms include the tendency to bruise easily or develop large and small bruises. Patients also can bleed longer than usual after cuts or have nosebleeds or bleeding gums. Severe cases of thrombocytopenia can cause internal bleeding.

Several drugs are available to counter the adverse effects of chemotherapy. For example, patients with low blood cell counts during chemotherapy can be given medication to help raise their blood cell or platelet counts, or they can be given a transfusion. Vasomotor symptoms can be managed with steroids or antidepressant drugs. A less-invasive treatment for some of the adverse effects of chemotherapy is acupuncture, which can be used to manage hot flashes, night sweats, and other vasomotor or related symptoms.21,23

Hormone Treatment

The idea of molecular treatment is to determine the exact genetic profile of the altered cancer cells and design a treatment plan based on the nature of these cells or subcells. This involves addressing each patient’s unique biology and disease structure, leading to a higher level of treatment efficiency and more successful outcomes.21,37-39

The earliest attempt at molecular treatment in cancer therapy was the drug tamoxifen. Tamoxifen has been used since the 1970s to treat patients with estrogen-receptor positive breast cancer. It is an antiestrogen drug called a selective estrogen receptor modulator. These modulators are drugs that block estrogen and can lower the risk of breast cancer recurrence in postmenopausal women after surgery. Tamoxifen prevents estrogen from latching onto tumor cell receptors and directing them to multiply. This slows or stops the growth of cancer cells in the body.40

Tamoxifen can be used after surgery and when cancer recurs after treatment because it helps to prevent new cancers from developing in women who have already been treated for breast cancer. Tamoxifen also is used to shrink large tumors so that they can be removed. Although tamoxifen does not prevent recurrence of estrogen-receptor negative breast cancer, it could make these cancers more detectable. In one study, ER− cancers were detected 77.4% of the time in a placebo group compared with 94.7% of the time in a group receiving tamoxifen.21,40-42

A study by the National Cancer Institute found that compared with the women on placebo, those taking tamoxifen had almost 50% fewer cases of invasive breast cancer. However, the benefits of tamoxifen were found to be negligible after 5 years.40,41

Tamoxifen is recommended for women at high risk for breast cancer, including women aged older than 60 years or women aged 35 to 59 years who have increased risk factors for breast cancer. Because of the adverse effects of tamoxifen, the breast cancer risks should be higher than average before a woman should consider taking tamoxifen. Increased risk factors can include a BRCA gene alteration, a previous history of breast cancer, family history of breast cancer, an atypical breast biopsy, not having had any children, having a first child at age 30 or older, starting menstrual periods before age 12, or going through menopause after age 50. Tamoxifen can cause depression, fatigue, and dizziness. Some patients experience vaginal dryness, itching, or bleeding and menstrual irregularities. Other adverse effects include loss of appetite, nausea and/or vomiting, weight gain, mild allergic reactions (eg, skin rashes), temporary thinning of the hair, headache (with some people affected by migraines reporting a change in the pattern of their headaches), and visual problems such as blurred or reduced vision.21,39

Tamoxifen has some weak estrogen-like properties and increases a woman’s risk for certain cancers. The drug does not cause a woman to begin menopause, although it can cause some symptoms of menopause such as hot flashes, night sweats, mood swings, and vaginal dryness. In most premenopausal women taking tamoxifen, the ovaries continue to act normally. The drug does not reduce menopausal symptoms and might actually make them worse. The more serious effects of tamoxifen have been linked to increased risks for endometrial cancer, pulmonary embolism, stroke and deep vein thrombosis, blood clots in the lungs, and uterine sarcoma (cancer of the connective tissue of the uterus). In general, blood clots occur more often in people with high blood pressure and diabetes, smokers, and those who are obese. Women who have had a hysterectomy do not have an increased risk for endometrial cancer. Tamoxifen is not recommended for women who have had blood clots or who are prone to developing blood clots; women taking blood thinners;
women with a history of high blood pressure, smoking, obesity, or diabetes; women who are pregnant or planning to become pregnant; women who are breastfeeding; women younger than age 35 years or less than 60 years who are not at increased risks for breast cancer; and women on hormone replacement therapy or raloxifene. Tamoxifen can cause birth defects if taken at the time of conception or during pregnancy, and might affect fertility. Other organs such as bone and the uterine lining also have estrogen receptors and tamoxifen reacts with these, leading to increased bone density and higher risks of uterine cancer. Physicians clearly must weigh the benefits vs the risks of tamoxifen. For example, an older patient might benefit from tamoxifen, but because of a prior history of stroke, tamoxifen would not be recommended.

The benefits of tamoxifen, however, are thought to outweigh the risks in some patients. The prophylactic effects of tamoxifen have been shown to last up to 5 years after treatment ends. Tamoxifen slightly reduces the risk of bone fracture of the hip, wrist, and spine in women who are past menopause, but it does not protect against heart attacks. Despite its benefits, some studies have found that tamoxifen is considered effective only within a 5-year period. However, more recent studies suggest that the benefits of tamoxifen can extend beyond 5 years. Some women have been known to develop a resistance to tamoxifen that might be associated with the function of another gene, PAX2. However, the exact nature of this resistance is still under investigation.

Recently, a number of drugs with effects similar to tamoxifen have appeared on the market. Many of these drugs do not have the dangerous adverse effects of tamoxifen; however, many are not as effective as tamoxifen. Researchers are also measuring how patients are responding to selective estrogen receptor modulators by monitoring a molecule, Ki-67. If Ki-67 diminishes or disappears, the treatment is effective. If Ki-67 remains high during treatment, there is a greater chance of cancer recurrence.

Raloxifene

Raloxifene (Evista) is another selective estrogen receptor modulator considered as a replacement for tamoxifen. Studies by the National Cancer Institute have confirmed that raloxifene has fewer adverse effects while offering similar benefits as tamoxifen. Raloxifene was originally marketed to treat osteoporosis in postmenopausal women and has been approved by the U.S. Food and Drug Administration as a treatment for invasive breast cancer in postmenopausal women since September 2007. Like tamoxifen, raloxifene decreases the risk of developing breast cancer by blocking the effects of estrogen, thereby stopping the growth of the cancer. Raloxifene can result in similar adverse effects as tamoxifen; however, they are not as severe. More common adverse effects of raloxifene are hot flashes, especially within the first 6 months of raloxifene therapy; swollen hands, feet, ankles or lower legs; leg cramps; and joint pain.

Exemestane

Exemestane (Aromasin) is an oral steroidal aromatase inhibitor that offers better protection against tumor development and is associated with fewer adverse effects than tamoxifen. Exemestane lowers the blood levels of estrogen. It works by attaching to the aromatase enzyme and permanently deactivating it. Exemestane is used to treat early breast cancer in postmenopausal women. This drug can cause hot flashes, hair loss, bone or joint pain, fatigue, unusual sweating, nausea, diarrhea, dizziness, and bone loss. Bone loss is of concern for patients with osteoporosis. Some studies recommend giving 2 years of tamoxifen followed by 2 to 3 years of exemestane.

Anastrozole

Anastrozole (Arimidex) also can be used to reduce the recurrence of breast cancer. Trials with anastrozole show that women with hormone receptor-positive breast cancer were 65% less likely to have a relapse or a new tumor than women on tamoxifen. In a study of more than 500 patients, approximately half were assigned tamoxifen and half took anastrozole. Fourteen percent of the patients on tamoxifen had a recurrence of their breast cancer within 3 years vs 5.4% of the patients taking anastrozole. Adverse effects of anastrozole include a higher rate of vaginal dryness, painful intercourse, and loss of interest in sex. It also causes a higher degree of bone demineralization, with possible risks of osteoporosis and osteoporotic fractures.
Trastuzumab and Lapatinib  

More than 75% of breast cancers in the United States are ER+ cancers. However, another class of breast cancers also overexpress ERBB2. About 25% of the population have this overactive gene and do not respond to treatment with tamoxifen or other antiestrogen drugs. Trastuzumab (Herceptin) has been found to be effective therapy for these aggressive cancers. Minor adverse effects of trastuzumab are fever, chills, weakness, nausea, vomiting, cough, diarrhea, and headache. A major adverse effect of trastuzumab is possible damage to the heart muscle.

Another drug, lapatinib (Tykerb), also has been found to be effective in the treatment of HER2 aggressive cancers and cancers that are both HER2 and ER+. Lapatinib is in a class of medications called kinase inhibitors. It is effective in interrupting the HER2 growth receptor pathway. HER2 is essential for early development and later growth of the muscles of the heart. Trastuzumab, by blocking HER2, can increase risks for heart abnormalities. Heart abnormalities have been detected in 2% to 7% of patients taking trastuzumab, and this drug should not be given to patients with heart conditions. Conversely, lapatinib might cause liver damage, which can be severe or life threatening. Although lapatinib results in less damage to the heart than does trastuzumab, it can cause liver damage as soon as several days or as late as several months after the start of treatment. Lapatinib is an effective treatment for patients who do not respond to trastuzumab. 21,41

**Gene Therapy**

Scientists believe that faulty genes are inherited and can become defective during one’s lifetime, especially if the gene is exposed to dangerous chemicals or radiation. Gene therapy involves inserting specific genes into cells to restore a missing function or to give the cells a new function. The theory here is that missing or damaged genes cause certain diseases. Gene therapy is currently under clinical trial. 21,43,44

Examples of gene therapy include replacing the tumor suppressor genes that could help prevent cancer from developing, or stopping oncogenes or other genes important to cancer from functioning. Oncogenes are mutated forms of normal genes that cause cells to divide out of control, leading to cancer. Other genes allow cancer cells to metastasize. Stopping these genes or the proteins they make might prevent cancers from growing or spreading. In addition, genes can be added to make cancer cells more vulnerable to chemotherapy or radiation; other genes can prevent cancer cells from becoming resistant to chemotherapy drugs. However, some patients develop a resistance to the drug, and in others there is no response. 21,43,44

**Prophylactic Surgery**

Prophylactic surgery is used to remove the entire breast when a woman has a very high risk factor for breast cancer. For example, women with mutations in the breast cancer genes BRCA1 or BRCA2 will sometimes consider a prophylactic mastectomy. If surgery is indicated for medical purposes, it is not considered cosmetic intervention. The procedure can take place in an outpatient surgical facility or in a hospital. 21

Any woman considering breast mammoplasty must first have an initial consultation with a plastic surgeon. The surgeon should be certified by the American Society of Plastic Surgeons and this information should be verified as part of the initial evaluation. In general, implants and reconstruction are not recommended for women before 22 years of age because women’s breasts are not fully developed before that age. Breast augmentations or reductions are contraindicated for anyone aged younger than 18 years because, in addition to having immature breasts, the patient might not be mature enough to make an informed decision. Consultation plus mammography to rule out breast diseases is recommended prior to the surgery. The surgeon then determines which surgical technique is best for the woman. 21

**Surgical Reconstruction Using Implants**

After a mastectomy, patients might consider augmentation mammoplasty. The technique of augmented mammoplasty has been in use since the 1950s. This surgical procedure restores the appearance of the breast for women who have had a breast removed because of breast cancer or high risk of breast cancer. Initially, liquid silicone was injected directly into the breast, but these procedures led to severe complications and the procedure was soon discontinued. 21,26 Silicone gel-filled implants were first used in 1962. The technique was to fill a silicone elastomer bag...
with silicone gel. In 1992, the U.S. Food and Drug Administration removed silicone from the public market because of complications such as leakage and rupture and its association with connective tissue disorders and immune disorders. The ban was finally lifted in 2006.

Today, implants often are saline-filled or silicone-filled and come in various shapes and sizes. There are 2 types of shells: textured shells and smooth shells. There also is a thicker silicone implant called a form-stabilizing, or “gummy bear,” implant.¹⁹,²⁶

Both the saline-filled and the silicone-filled implants have an outer shell composed of silicone elastomer. Some implant shells are double lumen, giving an extra protective layer to reduce the risk of ruptures. The saline-filled implants use sterile saline and can be round or anatomically shaped. Generally, during the implant surgery the empty saline sac is implanted. The surgeon later fills it to the desired size. The silicone-filled implant uses a silicone gel, which is less likely to leak in cases of rupture.²¹,²⁶ Implants can be placed in front of the pectoral muscle (subglandular or retromammary implants) or behind the pectoral muscle (subpectoral or retropectoral implants).

In general, silicone implants have a more natural feel. They are softer and smoother and less likely to wrinkle or ripple than saline implants. The biggest disadvantage of the saline implant is wrinkles, which can sometimes be seen or felt, especially on thinner women. The smooth-textured saline implants are less likely to ripple. One suggested advantage of textured implants was the lower risks of capsular contracture. However, implants placed behind the pectoralis major muscle are less likely to ripple. In case of rupture, the saline-filled implant deflates and the breast will become noticeably enlarged as the tissue fills with saline. Surgery is needed to remove the silicone shell. The ruptured silicone is often harder to palpate and might not even be noticeable. The U.S. Food and Drug Administration recommends imaging of the breast every 2 years to monitor silicone-filled implants. Saline and silicone implant procedures have similar risks, which can include poor reaction to anesthesia, excessive bleeding, hematoma, breast pain, permanent changes in nipple or breast sensation, infection, scar tissue formation or capsular contracture, and implant leakage or rupture.²¹,²⁶

Breast reconstruction generally is performed by a plastic surgeon after a mastectomy; reconstruction usually is not necessary after a lumpectomy. The surgeon rebuilds the breast contour and can even include a nipple and areola. The goal of breast reconstruction is to provide symmetry to the breasts and to permanently regain the breast contour so that patients will not need an external prosthesis. Breast reconstruction also can involve reduction, enlargement, or reshaping the remaining breast to match the reconstructed breast.²¹,²⁶

Some patients request a nipple and areola to make the new breast look more realistic. Tissue for the nipple and areola is taken either from the removed breast, from the opposite nipple, or from the ear. Tissue for reforming the areola also can be taken from the upper inner thigh. Tattooing is used to darken the areola to match the color of the opposite breast. Saving the nipple from the breast with cancer is often contraindicated because cancer cells can be present in the nipple.²¹,²⁶

**Implant Procedures**

Decisions about reconstruction can depend on the patient’s overall health, the stage of the breast cancer, the size of the natural breast, the amount of tissue available (eg, thin women might not have the excess body tissue to make a flap possible), the patient’s insurance coverage, the type of procedure, and the size of the implant or reconstructed breast.²¹,²⁶ Many women elect to have breast reconstruction during the mastectomy to avoid an additional surgery. Occasionally, women choose to forgo surgical reconstruction and instead choose an external prosthesis; some patients do not want to have an implant in their body, or they do not want an additional surgery to further damage their body.²¹,²⁶

Breast reconstruction can be immediate or delayed. Some women want their breast restored as quickly as possible to avoid returning for another surgery; others do not mind waiting until their cancer treatment is completed. In the one-stage immediate breast reconstruction after mastectomy, the surgeon places the implant where the breast tissue was removed to form the breast contour. Delayed reconstruction, done some time after...
surgery, might be necessary if radiation immediately follows a mastectomy. Delayed reconstruction also could be necessary if the skin is tight and flat. In such cases, a tissue expander is placed under the skin and chest muscle. The tissue expander involves placing a balloon under the skin then injecting a saline solution at regular intervals to fill the expander over time. After the skin is expanded enough, the expander is removed and a permanent silicone or saline implant is put in place. Some saline expanders are left in place as the final implant.

Reconstruction will not affect the recurrence of breast cancer. There are complications with reconstructive healing that interfere with chemotherapy or radiation treatment or both. However, the advantages of immediate reconstruction are that the chest tissues are undamaged by radiation therapy and there is one less surgery needed. After radiation, the first step in implant surgery is stretching the skin with a tissue expander, but this process would be difficult if the skin is damaged by radiation. This leads to a higher rate of complications such as poor healing, skin breaks, and implants that protrude or stiffen.  

Implants can rupture, or scar tissue can form around the implant (capsular contracture). Capsular contracture occurs when the scar or capsule around the implant begins to tighten and squeeze the implant, making the breast feel hard. Capsular contracture can require surgery to remove the scar tissue, or the implant might be removed or replaced.

If the implant is inserted before radiation, the scar tissue around the implant can contract because of the radiation, leading to distortion of the implant. Some surgeons mold a slightly larger breast, knowing that the radiation will tend to shrink the breast tissue. The other option for patients is the use of muscle, skin, and tissue from their own body to create a breast mound. This reconstruction can be performed at the time of the mastectomy, as it will not be reshaped by radiation. This technique is called autologous flap reconstruction.  

**Autologous Reconstruction Surgery**

In autologous tissue reconstruction surgery, skin, fat, and muscle from the abdomen, back, or buttocks are taken to form a new breast. This surgery can be performed at the time of a mastectomy. It can complicate the surgical procedure and extend the length of surgery from 2 hours to up to 6 hours.  

Transverse rectus abdominis muscle (TRAM) procedures can be either pedicle flap or free flap. Pedicle flap surgery involves leaving the flap of tissue attached to its original blood supply. The tissue is tunneled under the skin to the breast area. The free-flap technique removes the flap—including the skin, fat, blood vessels, and muscle—from its original location then attaches the flap to blood vessels in the breast area. This procedure involves the use of microsurgery to reconnect the tiny blood vessels, and requires longer surgery times. Some surgeons recommend the technique because it gives a more natural result.

Flap techniques cannot be offered to patients with diabetes, disease of the connective tissue, or vascular disease, or to those who smoke. In addition, thin women are not ideal candidates for tissue flaps because they do not have sufficient skin and tissue to donate for the reconstructed breast.  

TRAM flap is a technique used to create a breast mound by removing skin, fat, and blood vessels from the abdomen area plus at least one of the abdominal muscles. It is named for the muscle in the area, the rectus abdominis muscle. The procedure results in a tightening of the lower abdomen or a “tummy tuck.” The removed flap, along with the superior epigastric artery, is tunneled under the skin to the breast area. In a muscle-sparing TRAM flap technique, very little of the abdominal muscle is taken. The result is less possibility of the loss of muscle function. This is a free-flap technique, and microsurgery is needed to reconnect the blood supply.

Latissimus dorsi flap surgery involves removal of muscle, fat, blood vessels, and skin from the back, moving them to the chest to create a breast mound. Generally, the flap is tunneled under the skin to the breast. This procedure can occasionally result in weakness in the back, shoulder, or arm.

The deep inferior epigastric perforators flap technique is named for the main blood vessel that runs through the area being removed. This technique uses fat and skin from the abdomen but does not use the muscle to form the breast mound. The procedure is a free-flap one because the tissue is completely detached from the abdomen and moved to the breast.
surgical technique is longer than the TRAM flap techniques. It can take 5 to 8 hours of surgery if both breasts are reconstructed. Deep inferior epigastric artery perforator flap also requires microscopic surgery to connect tiny blood vessels. However, with no muscle removal, the recovery time is shortened and the risk of losing abdominal muscle strength is lower.  

In the gluteal free-flap technique, the gluteal muscles from the buttocks are used to create a breast shape. This procedure is similar to the free TRAM flap and also requires microsurgery to attach tiny blood vessels.  

Women usually find that there are changes in nipple and breast sensation. The reconstructed breast will not have nerve sensation because the nerves cannot be transferred. Although the flap technique does not restore normal sensation to the breast, some feeling might return. Some advantages of autologous tissue reconstruction are that radiation is much better tolerated than with implant reconstruction and patients are less likely to require follow-up surgical intervention. The autologous tissue reconstruction process carries a small risk of weakening the muscles at the site where tissue is removed; however, there are newer techniques such as muscle-sparing autologous tissue reconstruction. Recovery from autologous tissue reconstruction surgery can take up to 2 months. In any of the flap techniques, tissue necrosis of all or part of the flap can occur. In this case, the flap must be removed.

Complications from reconstructive surgery can include anesthesia complications (a risk with any surgery), infections that can result in undesirable cosmetic results, bleeding in patients with poor clotting time, fluid collection resulting in swelling and pain, and excessive scar tissue at the site that can take 1 to 2 years to fade and will never completely disappear. Both saline- and silicon-filled implants can cause a rare form of immune system cancer called anaplastic large-cell lymphoma. This lymphoma grows in the capsule of scar tissue that forms around an implant, causing lumps, pain, and asymmetry from the fluid buildup and swelling. In some cases, removing the implant and scar tissue is the only treatment needed. Other patients need chemotherapy and radiation.  

After a breast surgery, many physicians do not order mammography of the reconstructed breast. Nevertheless, studies show that 8% to 10% of women will have a recurrence in the scar after a mastectomy during the first 5 years. In addition, before the mastectomy, the cancer could have already spread to other areas of the body. Most research suggests that patients should have either visual inspection of the site by an oncologist, or imaging should be done yearly within the first 5 years of the mastectomy. Women also should continue breast self-examination, checking both the natural breast and the reconstructed breast at the same time each month.  

Pain Medication and Pain Management  
Pain receptors are located throughout our bodies in nerve endings in the skin and mucous membranes. When pain receptors are triggered by mechanical, chemical, or thermal stimuli, the pain signal is transmitted through the nerves to the spinal cord and then to the brain. Cancer pain can result from a number of factors, including blocked blood vessels causing poor circulation, bone fractures, metastasis to the bone, cancer invading the neural structures, tumors exerting pressure on a nerve, infection, inflammation or adverse effects from treatments such as chemotherapy or other drugs, radiation therapy, and surgery.  

Pain is commonly associated with advanced cancer; more than 30% of all cancer patients experience pain, and as many as 50% of patients are undertreated for cancer pain. Some studies estimate that 90% of cancer patients experience pain. Although analgesic use should be carefully monitored, there are still reports of reluctance to provide analgesics to cancer patients because of concerns about inappropriate use or dependence on opioids.  

Cancer pain can be acute or chronic. Acute pain might last only a short time and can be the result of surgery or an immediately injury. Chronic pain continues for 6 months or more, and depending on the severity of the pain, patients can have life-altering implications such as diminished activities or dependence on aid for basic functions.  

Pain management depends on the cause of the pain. Nevertheless, all cancer pain, whether acute or chronic, needs to be addressed. Patients also can experience breakthrough pain in which the medication they are taking no longer controls the pain, possibly because of
changes in absorption, metabolism, or elimination of
the drugs. In end-stage cancer, chemotherapy, radia-
tion, or surgery can be used to reduce tumor size if the
tumors are exerting pressure on a nerve.

Newer pain medications are even more potent than
morphine. Patients can be given intrathecal anaesthet-
ics, which are pain-killing drugs injected directly into
the cerebrospinal fluid. Nerve blocks also can be used
to kill or deaden the nerve associated with the pain.
Acupuncture has been found to be effective for some
patients, although studies suggest that the benefits from
the technique are subject to patients’ expectations and
beliefs. 46,47

Conclusion
Cancer care cannot focus solely on eliminating the
tumor. It also must assist with the patient’s psychologi-
cal well-being. The patient’s psychological status can
affect treatment options and even recovery time. A
patient’s suffering can lead to depression, stress, and
other mental and emotional conditions that should
not be ignored. Good oncology care providers often
are proactive in identifying patients’ needs and helping
them find the resources and support they need.

At present, all breast cancer detection and treatment
tools have advantages and disadvantages, and because
of the wide variety patients must explore their options
wisely. The good news is that researchers have been
especially excited about the development in recent years
of various targeted therapies. Ideally, targeted ther-
apieties could be tailored to whatever genetic mechanism
is responsible for the patient’s tumor. These therapies
show promise and could result in even more individual-
ized treatments.

Detecting cancers early still offers the best treatment
options and the highest survival rate. This fact is driv-
ing the need to perfect breast cancer detection tools.
However, despite the numerous adjunctive detection
tools available, mammography is still the most compre-
hensive tool in the fight against breast cancer.

Olive Peart, MS, R.T.(R)(M), is an established author,
educator, and radiographer. She has been a program site
visitor with the Joint Review Committee on Education
in Radiologic Technology for more than 7 years. Before
assuming her current position as program director with the
Harlem Hospital Center, School of Imaging Sciences, she
worked as a clinical coordinator and academic instructor
with the Stamford Hospital program in radiography,
Stamford, Connecticut.

In addition to her full-time job, Peart regularly presents
mammography and other radiography-related topics at
seminars throughout the United States and internation-
ally via webinars. Her technical query columns and articles
are often featured in Radiologic Technology. Peart
has authored several textbooks, including The Dangers
of Medical Radiation, Spanish for Professionals in
Radiology, Mammography and Breast Imaging: Just
the Facts, Lange Q&A Mammography Examination,
Mammography and Breast Imaging PREP, and
Radiography Flashcards, a projection reference guide for
radiographic procedures.

In 2014 Peart was selected to be a Technologist Fellow by
the RAD-AID/ASRT Foundation. She joined a RAD-AID
project team on a 2-week mammography teaching assign-
ment in Chandigarh, India.

Reprint requests may be mailed to the American Society
of Radiologic Technologists, Communications Department,
at 15000 Centra1 Ave SE, Albuquerque, NM 87123-3909,
or e-mailed to communications@asrt.org.

© 2015 American Society of Radiologic Technologists

References
1. Peart O. Interventional procedures. In: Mammography
   2012:363-396.
2. American Cancer Society. How is breast cancer diagnosed?
   http://www.cancer.org/cancer/breastcancer/detailedguide/
3. Adam A, Dondelinger R, Mueller P. Interventional radiology
   clip placement facilitates localization of breast cancer after
5. Tirona M. Breast cancer screening update. Edwards
   Comprehensive Cancer Center, Huntington, West Virginia.


Breast Intervention and Breast Cancer Treatment Options

1. The tangential projection is useful for assessing:
   a. calcifications and lesion margins.
   b. lesions deep within the breast.
   c. areas of overlapping tissue.
   d. skin lesions or calcifications.

2. Magnetic resonance (MR) imaging is useful as an adjunct screening tool for patients:
   a. who have a lifetime breast cancer risk of at least 10%.
   b. who received chest wall radiation between the ages of 10 and 30 years.
   c. without mutations of the BCRA1 or BRCA2 gene.
   d. with fatty breasts.

3. MR imaging’s use as a screening tool is limited because of:
   1. cost.
   2. lower specificity.
   3. high false-positive rate.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

4. Lymphoscintigraphy is indicated for patients:
   a. considering axillary node dissection.
   b. with cystic breast disease.
   c. trying to decide on a lumpectomy vs a mastectomy.
   d. considering lumpectomy only.

To earn continuing education credit:
- Take this Directed Reading quiz online at www.asrt.org/drquiz.
- Or, transfer your responses to the answer sheet on Page 564M and mail to ASRT, PO Box 51870, Albuquerque, NM 87181-1870.

New and rejoining members are ineligible to take DRs from journal issues published prior to their most recent join date unless they have purchased access to the quiz from the ASRT. To purchase access to other quizzes, go to www.asrt.org/store.

*Your answer sheet for this Directed Reading must be received in the ASRT office on or before this date.

continued on next page
Directed Reading Quiz

5. Using the Breast Imaging-Reporting and Data System (BI-RADS), a patient with a category 4 lesion would be recommended to have:
   a. aspiration or biopsy.
   b. short-term follow-up.
   c. long-term follow-up.
   d. mastectomy.

6. An advantage of ultrasound-guided aspiration is that:
   a. it can be performed using an 11-gauge needle.
   b. ultrasonography allows real-time imaging.
   c. the radiation dose with ultrasonography is relatively low.
   d. the patient is under anesthesia.

7. If a lesion is nonpalpable, yet visualized on imaging, which of the following can be used to pinpoint the exact location of the lesion before a biopsy?
   a. stereotactic localization
   b. cyst aspiration
   c. histologic analysis
   d. fine-needle aspiration biopsy (FNAB)

8. In the dedicated prone biopsy system, the mammography unit and the needle guidance device are located:
   a. right next to the patient.
   b. above the patient’s head.
   c. under the table.
   d. above the table.

9. According to the article, FNAB is used to diagnose cystic and solid lesions such as fibroadenomas.
   a. true
   b. false

10. In most cases a cytopathologist or cytotechnologist is present during an FNAB to:
    a. aspirate the material for the slides.
    b. ensure that there is enough blood to stain the slides.
    c. confirm that the lesion was removed.
    d. verify adequate specimen collection.

11. A vacuum-assisted biopsy device removes:
    a. cell samples using a suction mechanism.
    b. core samples similar to a gun-needle combination.
    c. core samples using a gun-needle combination.
    d. cell samples with a disposable system.

12. In the core biopsy procedure using the gun-needle combination, each reinsertion of the needle results in:
    1. destruction of breast tissue.
    2. damaged samples.
    3. hemorrhage.
    a. 1 and 2
    b. 1 and 3
    c. 2 and 3
    d. 1, 2, and 3

13. Core biopsy can be performed using which of the following for image guidance?
    1. MR
    2. ultrasonography
    3. computed tomography
    a. 1 and 2
    b. 1 and 3
    c. 2 and 3
    d. 1, 2, and 3

continued on next page
14. An open surgical breast biopsy is needed when the:
   1. results of an FNAB are inconclusive.
   2. lesion is located very close to the chest wall.
   3. lesion is so hard the radiologist cannot obtain an adequate sample.

   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

15. In an excisional biopsy:
   a. the entire lesion is removed, leaving clean margins.
   b. a sample of the lesion is removed for histologic testing.
   c. the margins of the lesion are removed for testing.
   d. the lesion is sampled but not removed.

16. A common error in core biopsy is:
   a. insufficient sampling.
   b. understating the multifocality of the cancer.
   c. overstating the multifocality of the cancer.
   d. false-positive findings of microcalcifications.

17. Which of the following statements is false about FNAB when compared with core biopsy?
   a. FNAB is less expensive.
   b. FNAB is less invasive.
   c. FNAB is faster.
   d. FNAB is less likely to lead to error due to insufficient sampling.

18. The 5-year survival rate for stage II breast cancer is _______
    a. 54
    b. 72
    c. 93
    d. 98

19. Cancer cells that contain estrogen receptors often are referred to as:
   a. HER2.
   b. HER2/neu.
   c. ER-positive.
   d. PR-positive.

20. The modified radical mastectomy is the most common mastectomy procedure performed today.
   a. true
   b. false

21. Complications of mastectomy can include:
   a. hematoma.
   b. carcinoma.
   c. multicentric disease.
   d. enlarged axillary nodes.

22. A lumpectomy could be contraindicated for all of the following patients except those with:
   a. 2 or more areas of cancer in the same breast.
   b. a previous lumpectomy that did not completely remove the cancer.
   c. large tumors in a small breast.
   d. stage 1 or II ductal carcinoma in situ.

23. The sentinel node biopsy procedure:
   a. results in more complications than the lymph node biopsy.
   b. removes only 1 to 4 axillary nodes.
   c. requires that the patient also undergo a lymph node biopsy.
   d. is a highly invasive procedure.

24. In primary radiation therapy treatment, radiation:
   a. is delivered before chemotherapy.
   b. is delivered before surgery.
   c. is used in addition to a hormone treatment.
   d. alone is used to treat breast cancer.
25. Adverse effects of external-beam radiation therapy (EBRT) might include all of the following except:
   a. fatigue.
   b. swelling.
   c. a sunburned appearance of the skin.
   d. dark, brittle, or cracked fingernails.

26. During radiation treatment for breast cancer, patients are advised to:
   a. wear clothing made of material that breathes.
   b. take hot showers and use heating pads.
   c. apply lotion or powder to the treatment area.
   d. wear a tight-fitting bra for support.

27. Compared with patients who receive traditional EBRT, women who undergo intensity-modulated radiation therapy are less likely to report:
   1. itchy skin.
   2. breast swelling.
   3. changes in skin color.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

28. Internal radiation, also known as brachytherapy:
   a. can be used to reduce treatment from 6 to 7 weeks to only 3 to 5 days.
   b. reduces radiation treatment to 10 minutes.
   c. often means a longer treatment that is less convenient for the patient.
   d. applies the radiation from the outside in.

29. Chemotherapy regimens:
   a. are fixed and do not vary from individual to individual.
   b. can be given only for a few days.
   c. are tailored for individual patients.
   d. are not affected by the patient’s age or sex.

30. Symptoms of low platelet count could include:
   a. anemia.
   b. fatigue.
   c. nosebleed.
   d. infections.

31. Tamoxifen is a(n):
   a. antiestrogen drug.
   b. antiprogesterone drug.
   c. chemotherapy drug.
   d. pain medication.

32. One factor that increases risk of breast cancer is starting menopause before 50 years of age.
   a. true
   b. false

33. If a saline-filled implant ruptures, the:
   a. implant will deflate and the breast will become enlarged.
   b. rupture will be imperceptible.
   c. implant will deflate and the breast will become smaller.
   d. tissue will fill with silicone.

34. The free-flap reconstructive technique:
   a. removes skin and fat, then tunnels it under the skin to create a breast mound.
   b. involves the use of microsurgery to reconnect tiny blood vessels.
   c. uses a saline-filled sac to create a breast mound.
   d. involves the use of a silicone shell.

35. Intrathecal anesthetics for cancer pain are injected directly into the:
   a. cerebrospinal fluid.
   b. affected organ or tissue.
   c. nerve root.
   d. a vein.