Types of Radiation Therapy for Breast Cancer Treatment

For many patients with breast cancer, radiation therapy is an important aspect of treatment. Most commonly, radiation is used after surgical removal of breast cancer to kill any remaining cancer cells. Radiation therapy damages DNA and kills cells in a particular area (the "field" of radiation). Radiation oncologists can target radiation to different areas using different techniques. The possible techniques will depend upon the type of surgery and location and extent of the cancer. Here, we will review some of the common forms of radiation therapy for patients with breast cancer.

Patients with breast cancer can be broadly divided into groups: (1) those with local or regional disease, limited to the breast and lymph nodes that drain the breast and (2) those with metastatic disease that has spread to other organs (bone, lung, etc.). This article will focus on patients with local/regional disease, where radiation therapy is often used as a treatment approach after surgery to reduce the chance of breast cancer recurrence. If the patient needs chemotherapy as well, the radiation is typically given after chemotherapy is completed.

The type of surgery plays a large role in determining how radiation therapy is delivered. Surgery for breast cancer is most commonly either a lumpectomy or a mastectomy. Lumpectomy (or partial mastectomy) involves removing the portion of the breast containing the tumor, while sparing the remainder of the breast. Mastectomy involves removal of the entire breast tissue on one side, often with removal of the lymph nodes under the arm (axillary lymph nodes).

Whole Breast Radiation After Lumpectomy

After a lumpectomy, radiation is almost always administered to the entire remaining breast. The exception to this is in some older women with smaller, less aggressive tumors. This helps by reducing the chance the cancer will return at the site of the surgery, as well as in other areas of the same breast. Traditionally, radiation was administered using external beam technique, in which the radiation beams are angled such that they skim the chest wall but cover the whole breast. This type of radiation was most commonly delivered in daily treatments (5 days a week) over several weeks to the whole breast, with an additional week to give an extra dose to the area of the surgery.

In some cases after a lumpectomy, when treating the whole breast with radiation therapy, the physicians will also target some of the lymph nodes under the arm (axillary). This will depend on whether or not there were cancer findings at the time of surgery (in particular, the presence or absence of cancer in the axillary lymph nodes). Patients should discuss with their radiation oncologists whether they may require additional targeting of these axillary lymph nodes.

Partial Breast Radiation After Lumpectomy

Another approach to treating patients after a lumpectomy is to target only the area of the surgical cavity with radiation, rather than the whole breast. The reason for this type of treatment is that most patients that have recurrence of their breast cancer have it in or near the surgical cavity, providing an opportunity to minimize radiation exposure to the remainder of the breast, chest wall, heart and lung. This approach, called "accelerated partial breast irradiation" or APBI, is becoming more commonly used. However, long term follow-up data on this approach is still not available.

APBI is "accelerated" because it involves twice daily radiation doses for a period of 1 week (Monday – Friday), as opposed to several weeks of traditional external beam radiation. APBI can be delivered using external beam radiation, or alternatively, internal radiation (also called brachytherapy). For brachytherapy, which is more invasive than external beam radiation, a balloon or catheters are placed within the surgical cavity to allow the delivery of radiation sources into the cavity. Brachytherapy can even further limit dose to surrounding normal structures like the heart, lung, and chest wall.

Chest Wall and Lymph Node Radiation After Mastectomy
While many patients undergo lumpectomy, many patients with breast cancer have a mastectomy (specifically, a modified radical mastectomy). Unlike after lumpectomy, not all women standardly receive radiation therapy after a mastectomy. Radiation is used in patients where there is particular concern for residual tumor cells. To determine the level of concern, providers will primarily evaluate the tumor size and the number of axillary lymph nodes with cancer cells. In addition, they can consider factors like tumor grade (appearance under the microscope), invasion of lymphovascular spaces within the tumor, surgical margins, and patient age.

If there is a moderate to high risk of the cancer coming back at the chest wall (where the breast tissue previously attached), or in the nearby lymph nodes (axillary, supraclavicular, and/or internal mammary), a radiation oncologist will recommend treatment to those areas to reduce the chance the cancer will recur. Treatment involves daily radiation (5 days a week) for several weeks, using external beam radiation therapy. In this case, the radiation is designed to skim the chest wall to avoid radiation exposure to the lung and, in left-sided situations, the heart. In cases where there has been reconstruction of the breast by a plastic surgeon, the radiation target will include the reconstructed breast.

Still, in some cases, it is difficult to avoid the lung and/or heart with traditional techniques. Some alternative techniques can be used to minimize exposure to normal tissues. This includes treatment in the breath hold position, which maximizes the distance between the heart and chest wall. Another approach would be the use of proton radiation, instead of x-ray (photon) radiation, where the radiation can be designed so that it stops before penetrating heart and lung tissue.

### Side Effects of Radiation Therapy

Generally speaking, the side effects of radiation therapy for breast cancer can be divided into two groups: short-term side effects that happen during and shortly after radiation therapy, and long-term side effects that can happen months or years after radiation therapy.

Radiation therapy is generally very well tolerated. Most patients continue to stay active during their treatment, and many continue to work during the course of therapy. The most common short-term side effects that happen during treatment include mild to moderate fatigue and skin damage and/or irritation. The fatigue is typically tolerable, sometimes requiring an additional few hours of sleep to maintain regular function.

The skin damage usually begins a few weeks after the start of a typical course of 5 weeks of radiation, and appears like a light sunburn. While some women may have no more than a light sunburn, others will have more significant darkening of the skin of the breast, especially in areas where there are skin folds (under the arm, under the breast). These changes can be associated with itching or burning sensation as well. In more severe cases, there will be peeling of the skin, with moist, ulcerated appearance of the exposed skin. This skin injury begins to heal 1-2 weeks after the completion of radiation. There are several approaches that radiation oncologists use to help maximize healing of the skin during and shortly after radiation therapy, including topical creams, gels, and desiccants.

In the long-term, patients can anticipate changes in the texture and color of the skin as well as the shape of the breast that received radiation. These can be mild and minimally noticeable, but in a minority of cases can be more prominent. In situations where radiation was given after breast reconstruction, the radiation can have a mild to moderate impact on the appearance of the reconstructed breast.

In addition to these, there are less common side effects related to radiation. In patients who have had their axillary lymph nodes removed, and also receive radiation to the axillary lymph nodes, radiation can increase the risk of lymphedema (or swelling) of the arm and under-arm. Patients who have sentinel lymph node dissection are much less likely to have lymphedema related to radiation therapy, though the risk is not completely eliminated.

Another uncommon side effect of radiation is brachial plexopathy, or injury to the nerves that supply the arm that can lead to numbness, pain, tingling, and/or weakness of the arm. This is seen more commonly in patients who have radiation to the lymph nodes above the clavicle (supraclavicular lymph nodes), but overall is still rare.

Radiation exposure to the lungs is minimized using different techniques in patients with breast cancer. Nonetheless, there is a small chance of radiation pneumonitis – a condition in which patients develop pneumonia-like symptoms related to radiation-induced lung injury. This typically occurs 1 to 6 months after radiation, and can be treated effectively if brought to the attention of
Injury to the heart is another uncommon but important side effect of radiation. It is thought that radiation can lead to accelerated atherosclerosis (or build-up of clot) in the arteries that feed the heart, putting patients at increased risk for heart attacks and heart disease several years after radiation. Close attention to minimizing radiation dose to the heart, regular exercise and good dietary habits will likely reduce the risk of these cardiac side effects.