Surgical Management of the Radiated Chest Wall and Its Complications

Dan J. Raz, MD[a,*], Sharon L. Clancy, MD[b], Loretta J. Erhunmwunsee, MD[a]

KEYWORDS

• Chest wall • Radiation • Osteonecrosis • Sarcoma • Breast cancer

KEY POINTS

- Radiation to the chest wall is common before resection of tumors.
- History of radiation does not necessarily change the surgical approach of soft tissue coverage needed for reconstruction.
- Osteoradionecrosis can occur after radiation treatment, particularly after high-dose radiation treatment. Radical resection and reconstruction is feasible and can be lifesaving.
- Radiation-induced sarcomas of the chest wall occur most commonly after radiation therapy for breast cancer.
- The most effective treatment is surgical resection. Tumors not amenable to surgical resection are treated with chemotherapy, with low response rates.

Radiation therapy to the chest wall is common, and is most commonly administered for treatment of primary or recurrent breast cancer. Radiation therapy may cause both early and late radiation tissue injury. Radiation therapy causes tissue damage primarily by means of reactive oxygen species–mediated damage to differentiated soft tissue cells, soft tissue progenitor cells, and vascular endothelial cells. These changes lead to fibrosis, an abnormal response to tissue injury, and tissue death.[1] In addition, cytokine and chemokine release after irradiation perpetuate a chronic inflammatory response that can cause ongoing tissue injury. A host of proinflammatory cytokines, including interleukin (IL)-1, IL-6, transforming growth factor beta, and tumor necrosis factor alpha, contribute to the chronic inflammation and tissue damage observed after radiation therapy.[1–4]

A spectrum of chest wall injury can be seen after radiation treatment. Skin toxicity, including hyperpigmentation, telangiectasias, and dryness, is common.[5,6] Soft tissue edema and minor fat necrosis are fairly common. Rib fractures can occur and may lead to acute and chronic pain. Symptomatic chest wall tissue injury with impending or early skin ulceration may benefit from hyperbaric oxygen treatment (Hbo_2).[7,8] Hbo_2 involves administration of pure oxygen in a pressurized chamber, typically greater than 2 atm, dosed as daily or twice-daily sessions. Hbo_2 increases the partial pressure of oxygen in the soft tissues and has been shown to speed healing of radiation-induced injury. The most common use of Hbo_2 for treatment of radiation-associated tissue injury is for osteoradionecrosis of the mandible in the setting of head and neck cancer; however, Hbo_2

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[a] Division of Thoracic Surgery, City of Hope, MOB 2001B, 1500 East Duarte Road, Duarte, CA 91010, USA;
[b] Division of Plastic Surgery, City of Hope, MOB 2001B, 1500 East Duarte Road, Duarte, CA 91010, USA
* Corresponding author.
E-mail address: draz@coh.org

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treatment of chest wall wounds has also been used with some reported success.[7,9,10]

At the other end of the spectrum of radiation-induced soft tissue injury are severe osteoradionecrosis and radiation-induced sarcoma.[5,11] Osteoradionecrosis presents with ulceration and sometimes extensive soft tissue changes. When left untreated, full-thickness necrosis ensues and superimposed infection can occur. Soft tissue biopsy is recommended to rule out recurrent breast cancer, because this may change the treatment approach with regard to determining the goals of surgery and use of preoperative therapies. Radiation-induced sarcomas should similarly be biopsied with core needle biopsy to exclude recurrent breast cancer.

This article focuses on surgical resection of the chest wall after radiation therapy. It concentrates mainly on treatment of osteoradionecrosis and radiation-induced sarcomas, although it briefly discusses surgical resection of recurrent cancers in the setting of radiation therapy.

SURGICAL RESECTION OF THE IRRADIATED CHEST WALL

In addition to surgical resection for osteonecrosis and radiation-induced sarcoma (discussed later), surgical resection of recurrent breast and chest wall sarcoma after radiation therapy is sometimes necessary.[12–14] Locoregional recurrence of breast cancer in the chest wall occurs in approximately 9% of patients undergoing breast conservation therapy.[14] Multimodality treatment, including chemotherapy, radiation, and surgery, is typically used. Although there is some controversy regarding the benefit of surgery compared with systemic therapy and radiation therapy in estrogen receptor–negative breast cancer, surgical resection is often performed after radiation therapy has already been administered to the chest wall. In general, resection margins should encompass all skin with radiation changes to ensure proper wound healing. Surgical margins should be appropriately wide. Although the authors recommend and routinely use intraoperative frozen section analysis, margin determination can be challenging at bony margins where frozen section is not possible. In addition, frozen section analysis of breast cancer at soft tissue margins can sometimes miss infiltrating breast cancer cells that are identified on permanent pathology.[15–17] Reconstruction of the chest wall is described elsewhere. Soft tissue coverage should factor in the size of the defect, the radiation field, and the quality of the soft tissue at any potential flap vascular pedicle. Rotational myocutaneous flaps, such as latissimus dorsi flaps, are commonly used but close attention should be directed to whether the vascular pedicle was included in the radiation field and, if so, whether the vessels are patent and what the quality of the soft tissue surrounding those vessels is.[18] These considerations can affect the blood flow to the flap after reconstruction, even when vessels are patent, through kinking of the pedicle when rotated through fibrotic tissue. Similarly, free flaps should be implanted into vessels free of radiation whenever possible. Use of the omentum, which is tunneled subcutaneously, provides excellent soft tissue coverage in an irradiated field and is covered with skin grafting. The downsides of omental flaps are the need for laparotomy (or laparoscopic harvest), risk of symptomatic ventral hernia, and inferior cosmetic result. In addition, the omentum may not provide sufficient coverage in very thin patients. Selection of coverage should be individualized based on the size of the defect, extent of radiation changes, and body habitus.[19]

OSTEONECROSIS OF THE CHEST WALL

Aside from skin changes and soft tissue edema, chest wall necrosis is rare with standard doses of radiation therapy (typically 4000–5000 cGy). Although there is not much evidence on the factors contributing to chest wall osteoradionecrosis, delivery of high-dose radiation, either planned or unplanned, because of incorrect planning, dose calculation, or machine calculation, is likely to be responsible.[20] Patients typically present with slowly worsening skin ulceration and full-thickness necrosis that involves pathologic rib fractures, which cause discomfort and chest wall instability. Tissue necrosis often progresses with time because of a combination of ongoing microvascular compromise, inflammation, and infection. Localized infection in the skin, soft tissue, and bone is common because of the loss of the normal skin barrier and compromised microvascular circulation, which prevents an effective immune response. When allowed to progress without treatment, loss of necrotic soft tissue and ribs exposes the thoracic viscera, which results in empyema. Both soft tissue infection and empyema may result in septicemia, which may be fatal if left untreated. Quality of life is poor because of fatigue from chronic wound infection, the foul smell that often accompanies infection, and body image issues related to the nature of the wound.

It is important to biopsy the edges of the wound to rule out recurrent cancer. At times, it can be difficult to distinguish osteoradionecrosis from recurrent cancer, and both may be present.