Staged Chest Wall Reconstruction for Radiation-induced Costochondritis

Byeong Seok Kim, MD*
Hong Il Kim, MD, PhD*
Jong In Kim, MD, PhD†
Jin Hyung Park, MD, PhD*
Hyung Suk Yi, MD, PhD*
Yoon Soo Kim, MD*
Hyo Young Kim, MD*

Summary: Costochondritis after breast reconstruction and radiation therapy is rarely reported. Moreover, it is difficult to diagnose using computed tomography and magnetic resonance imaging; as such, wound debridement and reconstruction must be performed in several stages. A 51-year-old woman was diagnosed with invasive cancer of the right breast, and she underwent nipple sparing mastectomy and direct-to-implant breast reconstruction in November 2007. Thirteen years later, in September 2020, she experienced pain and swelling on her right breast. Incisional drainage and implant removal were performed in another clinic; however, the infection was not controlled. An implant-induced infection was suspected, and debridement was performed to a level where fresh tissue appeared in the upper layer of the intercostal muscle. Antibiotics and open dressing were used for 10 days; however, yellowish debris was noted, and third to fifth ribs and costal cartilages turned dark brown. Radiation-induced costochondritis was diagnosed based on clinical findings from the intraoperative field, wound course, and cartilage biopsy. Radical chest wall resection and reconstruction was performed using Teflon (Dupont/Chemours, Wilmington, Del.) and latissimus dorsi musculocutaneous flap. The patient was discharged 2 weeks after surgery without any complications. Costochondritis should be clinically diagnosed while performing the first debridement in staged operation. Radical chest wall resection is essential with chest wall reconstruction using Teflon and a latissimus dorsi musculocutaneous flap. *(Plast Reconstr Surg Glob Open 2021;9:e3718; doi: 10.1097/GOX.0000000000003718; Published online 5 August 2021.)*

Radiotherapy is widely used in patients with breast cancer to lower the risk for local cancer recurrence. Its range of usage has become wider with advances in the development of radiotherapy equipment and technology. However, radiotherapy can induce fibrosis and endothelial sclerosis of the skin and subcutaneous vessels.[1] In recent studies, the relative risk for skin and nipple necrosis, and reconstruction failure has been reported to be three times higher in patients treated with radiotherapy after breast reconstruction than in those who were not.[2]

Generally, intravenous antibiotics are administered as salvage treatment for infection(s) caused by a breast implant, although, if/when this fails, implant removal and irrigation are performed and delayed replacement is recommended.[3] However, if infection occurs long after breast implant insertion and/or radiotherapy, costochondritis must be considered in the differential.[4] It has been reported that costochondritis can occur up to 20 years after radiotherapy.[5] If the perichondrium is infected or necrotized after radiotherapy, costal cartilage acts as a medium for colonization of bacteria or chronic infection, thus accelerating the process of osteomyelitis.[6] Mistreated osteomyelitis can lead to septic conditions, bronchocutaneous fistula, pleuritis, and/or pericarditis, which are life-threatening complications.[5]

We report a case involving a patient who experienced breast infection 13 years after total mastectomy and immediate breast reconstruction with direct-to-implant and following radiotherapy. The patient underwent staged operation and experienced successful resolution with reconstruction using polytetrafluoroethylene (PTFE, Teflon, Dupont/Chemours, Wilmington, Del.) and latissimus dorsi musculocutaneous flap after radical chest wall resection.

CASE

In November 2020, a 51-year-old woman with an open wound on the right breast was referred to the authors'

clinical institute. She had been diagnosed with invasive cancer of the right breast and underwent total mastectomy and immediate breast reconstruction with direct-to-implant implantation in November 2007. At that time, she underwent chemotherapy and 30 radiation therapy sessions. However, in September 2020, she experienced a sudden heating sensation and swelling in her right breast. Incision and drainage with implant removal and intravenous antibiotics with first-generating cephalosporins were performed in another clinic. Despite the initial treatment, the wound condition worsened and the raw surface of the breast was exposed to turbid discharge, and the heating sensation and tenderness persisted. The patient was then transferred to the authors' institution, where an open wound, measuring 3 × 3 cm, with necrotic tissue in the wound bed was diagnosed (Fig. 1). Laboratory investigations revealed a normal white blood cell count, but an elevated erythrocyte sedimentation rate (89 mm/h) and high-sensitivity C-reactive protein level (2 mg/dL). *Pseudomonas aeruginosa* was cultured from the wound bed. Enhanced computed tomography (CT) revealed only a soft tissue defect and no sign of cancer recurrence on the right breast, and that the thoracodorsal vessels were intact. Ultrasonography and tissue biopsy were performed at the previous clinic and it was confirmed that there was no sign of cancer recurrence. An implant-induced infection and/or capsular contracture were suspected, and two-staged debridement and delayed latissimus dorsi musculocutaneous flap reconstruction under general anesthesia were planned, in addition to intravenous piperacillin/tazobactam 4.5 g three times per day.[3] Necrotic tissue debridement was performed. The third to fifth intercostal cartilages changed to a greenish color, thus prompting suspicion of necrotic changes. The perichondrium was partially excised, and the remaining segment was expected to recover by intravenous antibiotics and wound care.

Antibiotics were used and open dressing using gauze soaked in povidone iodine was performed twice per day for 10 days; however, yellowish debris on the wound bed was noted, and third to fifth ribs and costal cartilages turned dark brown in color (Fig. 2). Radiation-induced costochondritis of the third to fifth ribs and costal cartilages was diagnosed based on clinical findings in the intraoperative field, wound course, and cartilage biopsy.

When planning reconstructive surgery, radical chest wall resection was first performed by a surgeon in the thoracic and cardiovascular surgery department. The pleural cavity was exposed on intercostal space between the infected ribs, and the intrathoracic extension of infected chest wall was evaluated by finger palpation. To preserve lung parenchyma, one lung anesthesia was performed using a double-lumen endobronchial tube. When thoracotomy was performed, it was confirmed that there was no lung adhesion and pleural effusion.[7] After the chest assessment, the cephalad and caudal margins of the resection were one normal rib superiorly and inferiorly and lateral margin was 3 cm from grossly the normal tissue. The ribs were excised using a costotome and guillotine bone cutter and the intercostal bundle was encircled and divided using ties of Prolene (Ethicon Inc, Somerville,


Fig. 1. Preoperative clinical photograph. A 51-year-old woman with an open wound, measuring 3 × 3 cm, on her right breast.

N.J.) sutures. After all of the third to fifth rib segments and parietal pleura were resected and all intercostal bundles were secured, the portion of chest wall was completely free. After completion of resection, 5 × 5 cm chest wall defect was noted and skeletal stabilization was carried out using Teflon. Teflon was molded by 5 × 5 cm to cover the chest wall defect, and the edges were sutured using Prolene suture (Fig. 3). Reconstruction using a latissimus dorsi musculocutaneous flap was planned to cover the 9
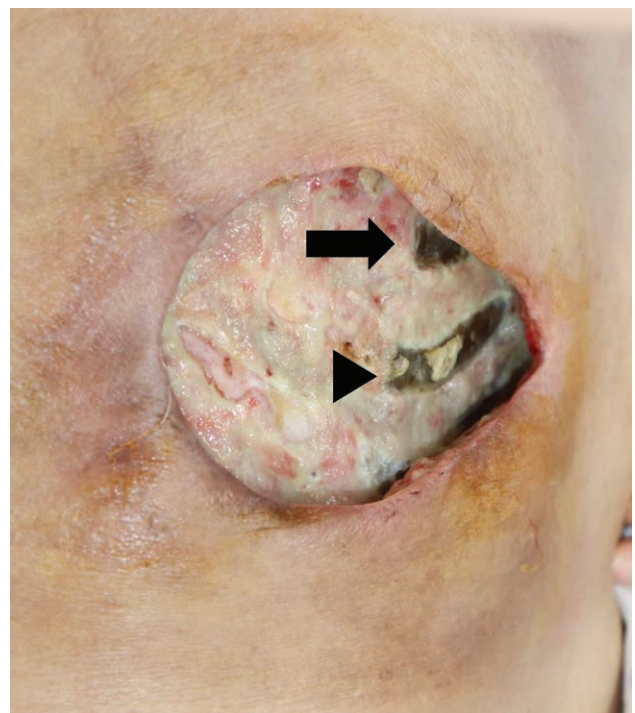
Fig. 2. Preoperative clinical photographs. Ten days after debridement and use of intravenous antibiotics, an open wound, measuring 8 × 6 cm, was exposed, and necrotic changes in the perichondrium were worsened in the third to fifth ribs. Black arrow indicates the third rib, and the arrow head indicates the fourth rib.
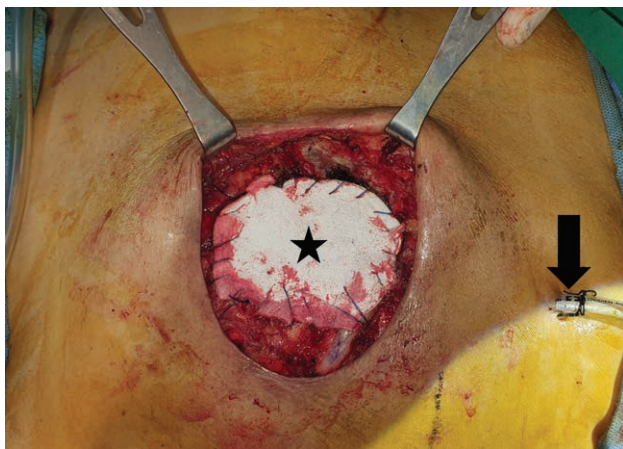
Fig. 3. Intraoperative photograph from the second surgical procedure. Radical chest wall resection included necrotized third to fifth ribs and costal cartilages, performed by surgeon in thoracic and cardiovascular surgery department. The resected chest wall was covered by Teflon and chest tubing was inserted. The star indicates Teflon, and the black arrow indicates the chest tube.

× 10 cm soft tissue defect. With the patient in the lateral decubitus position, a 9 × 10 cm oblique skin paddle was design and incised. Dissection was performed through the superficial fascia and, to maintain a large volume, a deep fatty layer and muscle flap was elevated. The lateral

Fig. 4. Two-months postoperative photograph showing no complications.

border was the serratus anterior muscle and the superior border was the tendinous portion of the humeral insertion. Thoracodorsal nerve transection was not performed. The flap was transposed through a subcutaneous tunnel high in the axilla, and the flap was inset into the chest with the patient supine.[8] A pull-out suture was performed on the medial border using 2-0 Prolene sutures to cover all of the top of the Teflon and fixed with bolsters.

No partial necrosis, swelling, or signs of infection were observed 1 week postoperatively. The patient was discharged without any postoperative complications, and the follow-up outpatient appointment was performed 1–2 months postoperatively as per protocol (Fig. 4).

DISCUSSION

Radiation-induced Costochondritis

Costochondritis and osteomyelitis are rare; however, in addition to simple prosthetic inflammation, they must be considered when a patient presents with delayed infection after breast implant reconstruction. Costochondritis is difficult to diagnose using only CT or magnetic resonance imaging techniques; as such, bone scintigraphy can also be used, although costal cartilage necrosis is not usually revealed.[9] Therefore, debridement and reconstruction must be performed in a staged surgical approach. Generally, the reason for the staged approach is that reconstruction performed after confirming no growth in wound culture can reduce the risk for reconstruction failure due to postoperative wound infection.[4] In our case, the first debridement was performed for diagnostic purposes and we diagnosed radiation-induced costochondritis based on clinical findings and cartilage biopsy. Histological examination revealed necrotic cartilage tissue; therefore, gross findings are important at diagnosis and the intraoperative field must be meticulously checked.

Although the breast implant was removed 2 months previously and intravenous antibiotics were administered, the wound did not exhibit any improvement; as such, we were aware that it would not be explained by simple prosthetic inflammation. Radiotherapy reduces local recurrence and imparts better survival rates, but it induces ulceration on the skin and osteoradionecrosis and fibrosis, as well as endothelial sclerosis of vessels of the skin and subcutaneously.[1]

Chest Wall Reconstruction

The latissimus dorsi musculocutaneous flap is a "work-horse flap" in anterior chest reconstruction. The thoracodorsal vessel is a long pedicle and has the advantages of being able to take a volume of muscle and skin paddle with many perforators.[8] Therefore, the thoracodorsal vessel may not be intact due to previous surgical procedures and radiation treatment and, when using the latissimus dorsi musculocutaneous flap, it is necessary to check whether the thoracodorsal vessel is intact using enhanced CT. If the thoracodorsal vessel is not intact, other pedicled flaps (eg, transverse rectus abdominis, omentum) or free flaps (eg, deep inferior epigastric perforators, anterolateral thigh) should be used.[10] Thoracodorsal nerve transection was not

performed, and no symptoms such as symptomatic spasticity and involuntary muscle movement were observed at 4-month postoperative follow-up.

The perichondrium is a source of nutrition and a barrier for infection of the rib cartilage due to the absence of lymph nodes and vessels. Therefore, costochondritis cannot be resolved by intravenous antibiotics only and, therefore, radical resection is needed.[6] Chest wall may be reconstructed with only musculocutaneous flaps, such as latissimus dorsi musculocutaneous flap or free flaps but, in post-resection reconstruction of the thorax, PTFE, polypropylene, and acellular dermal matrix (ADM) are used to prevent pneumothorax and paradoxical chest wall motion.[10] In chest wall reconstruction, the indication varies depending on the location and size of the defect. Posterior defects need skeletal reconstruction if more than 10 cm in diameter or more than four to five ribs are resected.[10] For anterior and lateral defects, skeletal reconstruction is needed when more than three adjacent ribs in the anterolateral location are resected or the resulting defect is 5 cm or greater. In our case, after completion of resection, a 5 × 5 cm chest wall defect was noted and a total of three ribs were excised, from the third to fifth ribs. Therefore, we had to perform chest wall reconstruction with prosthetics. PFTE has been widely used for decades, and biomaterials may be more effective than synthetic materials in the infected wound.[10] However, the authors performed debridement to clean most of the wound first. Although the wound condition worsened over time, in the second operation, radical chest wall resection was performed, and infected ribs, cartilages, and parietal pleura were removed. The authors assumed that the wound would become clean again, so a synthetic material, Teflon was used. There is not enough published data to prove the superiority or inferiority of ADM to synthetic graft in chest wall reconstruction and skeletal stability.[10] Also, ADM is more expensive than Teflon, and Teflon is one of the most chemically inert, semi-flexible plastics, and is easily bent, cut, and shaped.[8] Considering these factors, Teflon was used instead of ADM. However, if there is an active infection or the wound healing is expected to be more difficult than other sites, we recommend considering the use of ADM instead of Teflon.

CONCLUSIONS

In conclusion, costochondritis must be considered as a cause of delayed breast infection, and it is difficult to diagnose solely using imaging modalities such as CT or magnetic resonance imaging. Therefore, costochondritis should be clinically diagnosed while performing the first debridement in staged operation. Radical chest wall resection should be performed with chest wall reconstruction using Teflon and a latissimus dorsi musculocutaneous flap.

Hyo Young Kim, MD
Department of Plastic and Reconstructive Surgery
College of Medicine, Kosin University
262 Gamcheonro, Busan 49267
South Korea
E-mail: hose3290@naver.com

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