Case Report & Literature Review

Treatment of Radiation-Induced Soft-Tissue Fibrosis and Concomitant Acetabular Osteonecrosis: A Case Report

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Radiation therapy is used for a variety of soft-tissue sarcomas. Complications from radiotherapy to the pelvis are well known, with most literature reports[1,2] focused on consequent bony changes, including postradiation necrosis of acetabulum, osteoporosis, bone-marrow fibrosis, microfractures, and secondary osteosarcoma. Massin and Duparc[3] retrospectively studied the largest series of cases (N = 71) of postradiation osteonecrosis of the pelvis. All patients had some form of radiation osteitis, such as atraumatic femoral neck fracture, osteonecrosis of femoral head or acetabulum, and radiation osteitis of the entire pelvis.

Similarly, radiation necrosis of soft tissues has been well described. The fibrosis, necrosis, ulceration, and fistula formation within the dermal layer—which occur after radiotherapy—lead to what may be described as the classic "radiation wound."[4] Early and late infections, including cellulitis and abscess formation, are also known complications of radiotherapy. Effects on muscle, which result in shortening, contracture, and decreased range of motion (ROM) of the involved joints, are less often discussed.

Wound closure after tumor extirpation is difficult. Tissue transfers can augment wound closure, but complication rates remain high. Recently, Pu and Thompson[5] reported 2 cases of chronic wound drainage associated with pyarthrosis of the knee joint after radiation therapy. Both patients required soft-tissue reconstruction with free tissue transfers for limb salvage.

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There have been no published reports of combined joint-and-soft-tissue reconstruction for radiation-induced osteonecrosis and concomitant soft-tissue necrosis. The challenging problem of combined soft-tissue injury and joint destruction requires joint reconstruction and free tissue transfers. In this report, we present the case of a complex hip reconstruction for primary arthroplasty failure caused by postradiation necrosis of the hip with extensive soft-tissue necrosis.

Case Report

A 61-year-old man presented to our institution with a chief complaint of left hip pain and motion limitation. Within the previous 5 years, he had been treated at another institution for a proximal femur adenoma of unknown origin. Treatment consisted of a cemented hemiarthroplasty followed by radiation therapy to the left hip. The patient did well until 3 months before presentation, when left hip pain began increasing and ROM began decreasing.

During the physical examination, the patient could not ambulate without crutches, secondary to pain. There was significant skin and soft-tissue fibrosis extending distally and circumferentially 25 cm from the anterior superior iliac spine. Hip joint motion was minimal.

Plain films showed proximal and medial migration of the bipolar head into the fractured inner table of the acetabulum (Figure 1). A computed tomography scan of the pelvis and the acetabulum showed thickening and distortion of the soft tissues of the left upper thigh, with sclerosis in the left acetabulum and ilium. Fracture lines through the central aspect of the acetabulum and the inferior pubic ramus were associated with moderate protrusion of the bipolar head with superior displacement.

At surgery, the previous skin incision was used, and dissection was carried down to the fascia lata. There was extreme immobility of all soft-tissue planes. All fibrosed tissue, including part of the fascia lata, was excised, leaving a soft-tissue defect of approximately 20x20 cm. The hip was dislocated anteriorly, and the bipolar components were removed. A nonunion of the acetabulum was identified with bone loss of the medial wall. Crushed cancellous allograft was used to pack and reverse-ream the acetabular defects. A recovery reconstruction cage was impacted into the acetabulum and hooked inferiorly in the obturator foramen. The superior phalange was laid across the ilium, and the cup was secured with 5 dome screws and 4

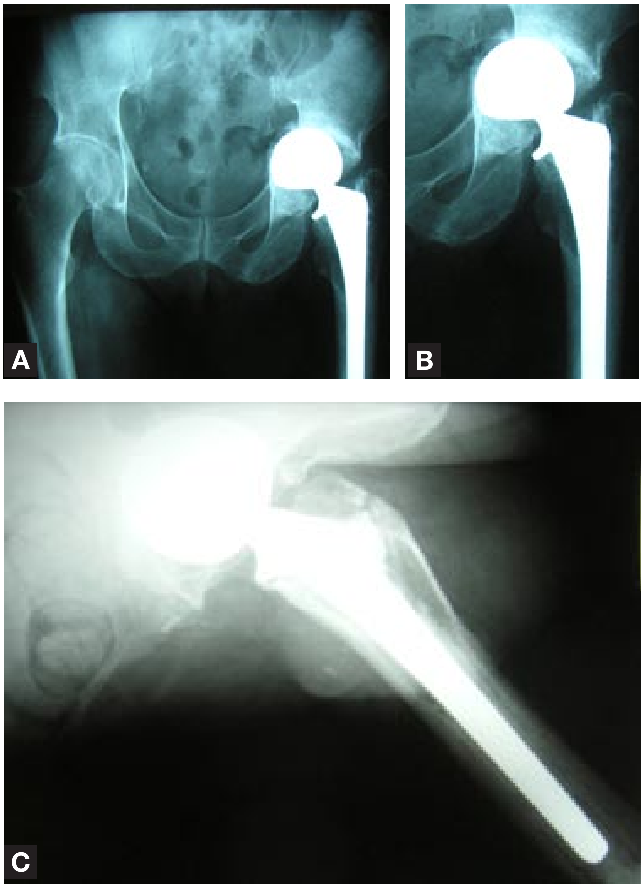

Figure 1. Anteroposterior pelvis **(A),** anteroposterior left hip **(B),** and frog-leg lateral **(C)** views of the left hip at presentation show proximal and medial migration of the bipolar head with fractures of the inner table of the acetabulum.

screws through the superior phalange. An all-polyethylene cup was cemented into the acetabulum, and a 28-mm head was impacted onto a cemented femoral stem. The hip was relocated and taken through ROM. The hip had a stable arc of motion of 90° flexion, 10° extension, and 10° internal and external rotation.

Attention was then focused on the soft-tissue reconstruction. The saphenous vein was exposed from the thigh down to the lower third of the calf. An arteriovenous (AV) fistula was created by performing an end-to-side anastomosis of the distal end of the saphenous vein to the superficial femoral artery. The saphenous vein loop was passed laterally under the sartorius muscle. The AV loop was transsected at the edge of the hip wound after adequate flow was noted. The latissimus dorsi muscle was elevated based on the thoracodorsal artery and vein in the usual fashion through a longitudinal incision based on the posterior axillary fold and inset into the defect. Maximal length of the thoracodorsal vessels was obtained by sacrificing the circumflex scapular vessels and using the subscapular artery and vein for the transfer. An end-to-end venous and arterial anastomosis was then performed using the AV fistula. A split-thickness skin graft from the contralateral thigh was harvested and secured over the muscle.

Figure 2. Well-healed soft-tissue graft in left hip at 2-year follow-up.

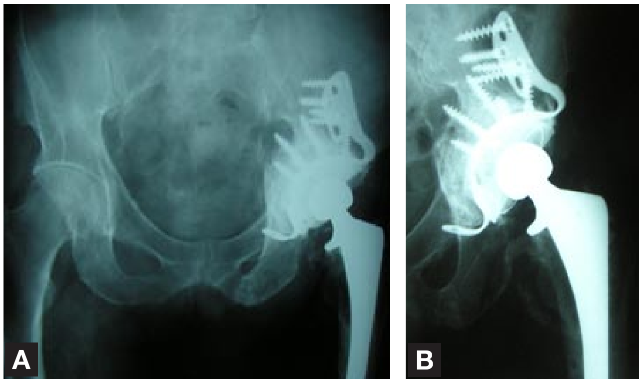

Figure 3. Anteroposterior pelvis **(A)** and anteroposterior left hip **(B)** views at 2-year follow-up show adequate incorporation of allograft and no evidence of hardware failure.

Postoperatively, the wound healed without complications. Warfarin was started for deep vein thrombosis prophylaxis. At 12 weeks, the patient was allowed full weight-bearing. At 2-year follow-up, the soft-tissue graft was well healed (Figure 2), and there was no evidence of hardware loosening or migration (Figure 3). The patient had approximately 10° to 90° of painless hip ROM and was fully ambulatory. There was a 0.75-in leg-length discrepancy, which was treated with a heel lift.

Discussion

Although radiotherapy has shown moderate success in the treatment of several types of sarcomas, it is not without complications. The direct effects of radiation on all tissue types have been well documented.[6] A decrease in capillary filling from necrosis of vessel walls results in fibrosis within the dermis and increased collagen density and irregularity. Destructive avascular changes result in extensive soft-tissue contractures. Bone changes after radiation therapy are also a vascular phenomenon. Early changes include coarsening and disorganization of trabeculae and sclerosis; late changes include osteolysis, mechanical insufficiency, and subsequent fracture. These complications can prevent patients from returning to their preoperative functional level, despite successful tumor eradication.

The management issues associated with our patient's joint-and-soft-tissue reconstruction are unique and were not previously reported. To gain adequate functional recovery, we had to address these issues simultaneously. Joint reconstruction after radiation injury requires special consideration. Massin and Duparc[3] found a high rate of acetabular failure in their earlier revisions when using a conventional cemented polyethylene cup. After converting to cemented polyethylene sockets with metal reinforcement rings, they reduced their acetabular failure rate from 52% to 12%. Radiation injury affects the acetabulum to a larger degree than the proximal femur and requires a reinforcement ring to improve stability. Fixation with cancellous screws into normal bone also improves stability.

The extensive bony reconstruction required through a contracted, poorly vascular soft-tissue envelop ultimately requires significant preoperative planning to allow for adequate soft-tissue closure. The initial exposure of the hip joint requires extensive releases and resection of the contracted tissues. Primary closure of the wound is usually not possible. Previously, transfers of adjacent soft tissues have been fraught with complications, including infection, wound dehiscence, and necrosis.[7] Thorough wound débridement of all damaged tissue, with the creation of a well-vascularized bed, is essential for adequate healing of the extensive joint reconstruction.

The latissimus dorsi muscle is ideal for achieving coverage of large irradiated wounds. Often, this muscle can be used to cover areas exceeding 30x15 cm and fill deep wounds or irregularly shaped areas. It has a long vascular pedicle exceeding 9 cm, particularly when the circumflex scapular artery and vein are ligated and the subscapular artery and vein are used for vascular anastomosis.

In addition, by using the saphenous vein to develop an AV loop with the femoral artery, we were able to perform the vascular anastomosis well outside the area of radiation injury to maximize the success of the muscle transfer. This technique has been well described for wound coverage in areas with poor local vessels, including diabetic foot ulcers and chronic infections.[8,9] AV fistula development minimizes the number of anastomoses required for muscle flap transfer and, therefore, overall operative time—ultimately limiting the potential for thrombosis and flap failure.

Joint reconstruction with radiation-induced soft-tissue fibrosis is a challenging problem requiring the coordinated efforts of an orthopedist and a microvascular surgeon. Adequate prescriptive planning, which allows for stable joint reconstruction and planned free tissue transfer during the same operative procedure, can result in a successful outcome.

Author's Disclosure Statement and Acknowledgement

The authors report no actual or potential conflict of interest in relation to this article.

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