A subtrochanteric femoral fracture 15 years after radiotherapy: a case report

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ABSTRACT
Pathological fracture is a rare but serious complication of radiotherapy. We report on a 44-year-old man who presented with a subtrochanteric femoral fracture 15 years after radiotherapy for a soft-tissue sarcoma in the thigh. We discuss its potential causes, a scoring system to identify high-risk patients for prophylactic intramedullary nailing of the femur, and radiographic signs to identify an impending insufficiency fracture.

Key words: fractures, spontaneous; hip fractures; radiotherapy; sarcoma

INTRODUCTION
Radiotherapy and chemotherapy decrease the rate of local recurrence of soft-tissue sarcoma. Although radiation-induced, pathological fractures are rare, the associated complications result in high morbidity. The fracture rates vary from 1.2 to 6.4%, with the femur being the most commonly affected.1-7 Risk factors include age, gender, radiation dose, periosteal stripping, anatomic location, and chemotherapy.8 The median time to pathological fracture after combined modality treatment is 4 years, with 68% occurring within 5 years.8 The rate of non-union is high. Therefore, bone grafting, vascularised fibular grafting, and prophylactic endoprosthetic replacement are recommended.8,9 We report a 44-year-old man who developed a subtrochanteric femoral fracture 15 years after radiotherapy for a soft-tissue sarcoma in the thigh.

CASE REPORT
In June 2011, a 44-year-old man presented with a 2-month history of pain over the lateral aspect of the left thigh after a jerking motion of his body with no direct trauma. The pain subsequently subsided but became progressively worse in the following weeks. 15 years earlier, he had undergone resection and low-dose (65 Gy) brachytherapy at a dose rate of 45 cGy/hr for a soft-tissue sarcoma in the left

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thigh. He had been followed up yearly for 5 years. On examination, the hip was mildly swollen and the overlying skin was erythematous. There was no focal tenderness over the hip or thigh region. Hip flexion and both external and internal rotation was limited by pain. A fixed flexion deformity was found, but there was no shortening. The Trendelenburg test was negative. According to the Medical Research Council grading for muscle power, hip flexion and abduction were graded as 3. Distal pulses were present and the neurological status was intact.

Radiographs revealed a subtrochanteric fracture of the left femur, with underlying lytic changes (Fig. 1). Magnetic resonance imaging detected a focal T1-hypointense, T2-hyperintense, indeterminate, enhancing lesion in the proximal femoral shaft, a pathological fracture, and angulation. The signal abnormality extended for a length of 4.8 cm across the fracture (Fig. 2). A bone scan showed increased osteoblastic activity at the fracture site, for which an underlying pathological process was not excluded (Fig. 3). A diagnosis of a radiotherapy-induced subtrochanteric fracture with osteonecrosis was made.

The patient refused surgery and was treated with a hip brace and non-weight bearing on crutches. Four months later, there was no improvement in pain. Radiographs showed non-union of the fracture (Fig. 4). He then consented to undergo open reduction and internal fixation with bone grafting.

A posterolateral approach was used. An atrophic non-union with extensive fibrous tissue was noted. Exposure was difficult as the anterolateral compartment of the left thigh was contracted, owing to extensive scarring and adherence to the fracture site, thereby holding the fracture fragments together. The tissue plane was very vascular with numerous muscular perforators. The fracture site was osteotomised and freshened, and bone chips with the surrounding soft tissue were sent for histology,
which revealed focal necrotic bone and fibrous tissue, with reactive new bone formation. No malignancy was identified. An 8-hole proximal femur locking compression plate was inserted, and the fracture site was packed with local bone grafts. Bleeding vessels were transfixed with Vicrl 2.0 sutures, and the wound was packed with surgicell and gelfoam.

The patient was discharged after 7 days. Weight bearing on his left limb was not allowed for a month. At month 1, the sutures were removed. There was tenderness over the fracture site and partial weight bearing was allowed. At month 2, callous formation was noted (Fig. 5), and the patient was ambulating well. At year 1, the patient was pain-free, ambulating well, and living an active lifestyle.

**DISCUSSION**

Radiotherapy may cause bone growth disturbances in the immature axial or appendicular skeleton, and pathological fractures, neoplasms, and osteonecrosis...
in the mature skeleton.\textsuperscript{10} Radiation damages bone cells (osteoblasts, osteocytes, and osteoclasts), mesenchymal stem cells, bone marrow cells, and nutrient vessels, with secondary resorption of the bone matrix and disruption of neoangiogenesis. Radiographically detectable osteopaenic changes usually arise 1 to 3 years after radiotherapy, with the median time to fracture being 4 years.\textsuperscript{8,11–13} The changes include mottled areas of bone with osteopaenia, coarsening of trabecular architecture, and areas of focally increased bone density. These are known as radiation osteitis.\textsuperscript{13} Radio-osteonecrosis can cause ill-defined cortical destruction without sequestration and cortical irregularity. Osteitis, radio-osteonecrosis, and the associated suppression of local bone turnover result in bone fragility and pathological fractures. Areas of bone resorption indicate both a reparative process and mechanical weakness in the bone architecture. Neoangiogenesis is also affected, and callus formation is delayed or missed.

In our patient, partial necrosis of the bone may have occurred before the pathological fracture. Therefore, higher frequency and longer follow-up as well as prophylactic internal fixation for impending fatigue insufficiency fractures should have been performed.

A scoring system to enable decision making for prophylactic stabilisation of the femur after radiotherapy and surgical resection of a soft tissue sarcoma of the thigh is devised.\textsuperscript{8} Factors such as gender, radiation dose, periosteal stripping (cm), and tumour location (the anterior compartment having a higher risk) are included, and the odds ratio of developing a pathological fracture of the femur calculated. The decision for prophylactic intramedullary nailing is based on such a ratio. Age, gender, and tumour size are the most significant prognostic factors.\textsuperscript{8}

Identifying high-risk patients for pathological fractures decreases potential morbidity and hospital-associated costs. Early radiographic changes in the affected bone can indicate an impending insufficiency fracture. The ‘dreaded black line’—a linear radiolucency through the cortex—suggests an impending, fatigue insufficiency fracture. The ‘dreaded black line’ (p<0.005) and focal cortical radiolucency (p<0.011) are predictors of a complete insufficiency fracture in patients on long-term bisphosphonate therapy.\textsuperscript{14} No study has yet specifically identified pathognomonic radiographic signs of impending insufficiency fractures in post-radiotherapy patients. The combination of radiotherapy and extensive soft-tissue clearance results in a high rate (45%) of non-union.\textsuperscript{8} High-risk patients warrant prophylactic intramedullary nailing.\textsuperscript{6,15,16}

**DISCLOSURE**

No conflicts of interest were declared by the authors.

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**REFERENCES**


