ELSEVIER

Canadian Association of Radiologists Journal xx (2014) 1–6

CANADIAN ASSOCIATION OF RADIOLOGISTS JOURNAL

www.carjonline.org

Musculoskeletal Radiology / Radiologies musculo-squelettique

Atypical Femoral Fractures: A Teaching Perspective

Aliya A. Khan, MD, FRCPC, FACP, FACE[a,*], William D. Leslie, MD, MSc, FRCPC[b], Brian Lentle, MD, FRCPC[c], Sian Iles, MD, FRCPC[d], Stephanie M. Kaiser, MD, FRCPC[e], Heather Frame, MD, FCPC[f], Steven Burrell, MD, FRCPC[d], Angela M. Cheung, MD, FRCPC, PhD[g]

[a]*Department of Medicine, McMaster University, Hamilton, Ontario, Canada*
[b]*Department of Medicine, University of Manitoba, Winnipeg, Canada*
[c]*Department of Radiology, University of British Columbia, Women's Health Centre, Vancouver, British Columbia, Canada*
[d]*Department of Radiology and Nuclear Medicine, Dalhousie University, Halifax, Nova Scotia, Canada*
[e]*Department of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada*
[f]*Assiniboine Clinic and Mature Women's Center, Department of Obstetrics and Gynecology, Faculty of Medicine, University of Manitoba, Winnipeg, Manitoba, Canada*
[g]*Department of Medicine, University of Toronto, University Health Network, Toronto, Ontario, Canada*

Abstract

This article provides an overview of atypical femoral fractures with a highlight on their radiographic findings. Potent antiresorptive agents such as bisphosphonates or denosumab have been associated with the development of such fractures. However, at this time, a causal association has not been conclusively established. Atypical femoral fractures are insufficiency fractures, which frequently present with bone pain. Early identification of characteristic radiographic features and withdrawal of antiresorptive therapy may prevent the development of completed atypical femoral fractures.

Résumé

Cet article donne un aperçu des fractures fémorales atypiques en soulignant les observations radiographiques qui y sont liées. Les bisphosphonates et d'autres inhibiteurs de la résorption osseuse comme le dénosumab pourraient contribuer à l'occurrence de telles fractures. Cependant, en ce moment, aucune relation de cause à effet n'a été établie de manière concluante. Les fractures fémorales atypiques correspondent à des fractures par insuffisance, qui s'accompagnent fréquemment de douleur osseuse. L'identification précoce d'éléments radiographiques caractéristiques et le retrait d'un traitement par des inhibiteurs de la résorption osseuse pourraient prévenir les fractures fémorales atypiques.

Key Words: Atypical femoral fractures; Imaging; Bone scan; Computed tomography; Bisphosphonates

Clinical Context

Fragility fractures, particularly those that affect the proximal femur, are major features of untreated osteoporosis. However, in recent years, atypical femoral fracture (AFF) have been identified as a distinct fracture located along the femoral diaphysis from just distal to the lesser trochanter to just proximal to the supracondylar flare. Specifically excluded are fractures of the femoral neck, intertrochanteric fractures with spiral subtrochanteric extension, pathologic fractures associated with primary or secondary bone tumours, and periprosthetic fractures. To satisfy the American Society of Bone and Mineral Research 2013 criteria case definition of an AFF, at least 4 of the 5 major features listed below must be present. None of the minor features listed below are required but, when present, can support the diagnosis of an AFF [1,2]:

* Address for correspondence: Aliya A. Khan, MD, FRCPC, FACP, FACE, Medicine, McMaster University, 209-331 Sheddon Avenue, Oakville, Ontario L6J 1X8, Canada.

E-mail address: draliyakhan@gmail.com (A. A. Khan).

0846-5371/$ - see front matter © 2014 Canadian Association of Radiologists. All rights reserved.
http://dx.doi.org/10.1016/j.carj.2014.01.002

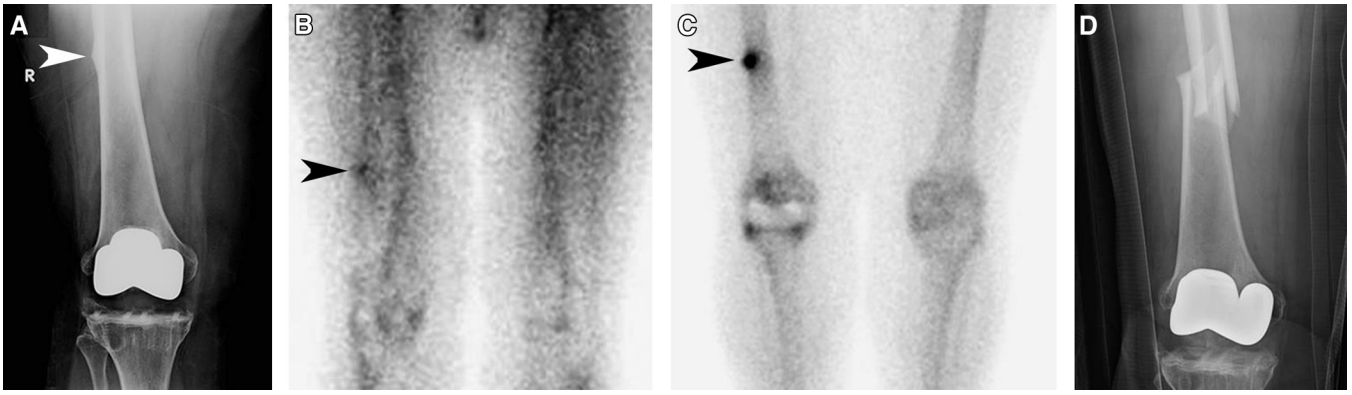

Figure 1. A 75-year-old woman with rheumatoid arthritis and remote total knee replacement underwent a radiograph (A) for "knee" pain, which revealed thickening of the lateral cortex of the distal shaft of the femur (arrowhead). The pain persisted, and a technetium 99m–methylene diphosphonate bone scan was obtained 2 months later to exclude prosthesis loosening and revealed hyperemia (arrowhead) on the pool phase image (B) and intense uptake (arrowhead) on the bone phase image (C) in the lateral femoral cortex, which correlates with the finding on the radiograph. Mild uptake around the prosthesis is not in keeping with loosening. This was reported as suspicious for an atypical femoral fracture in this patient who had been on a bisphosphonate for >4 years. One week later, she completed the fracture (D).

Major features:

1. The fracture is associated with minimal or no trauma, as in a fall from standing height or less.
2. The fracture line originates at the lateral cortex and is substantially transverse in its orientation, although it may become oblique as it progresses medially across the femur (Figure 1).
3. Complete fractures extend through both cortices and may be associated with a medial spike; incomplete fractures involve only the lateral cortex (Figures 1-4).
4. The fracture is noncomminuted or minimally comminuted (Figures 1, 4).
5. Localized periosteal or endosteal thickening of the lateral cortex is present at the fracture site ("beaking" or "flaring") (Figures 1, 2, 4).

Minor features:

1. Generalized increase in cortical thickness of the femoral diaphysis.
2. Unilateral or bilateral prodromal symptoms, such as dull or aching pain in the groin or thigh.
3. Bilateral incomplete or complete femoral diaphyseal fractures.
4. Delayed fracture healing.

AFF are uncommon and account for approximately 1.1% of all femoral fractures [3]. Approximately 80% of AFF cases have occurred in the presence of aminobisphosphonate (ABP) drug therapy, although no such therapy had been used in approximately 20% of individuals with an AFF [4]. The risk of an AFF appears to decrease significantly after cessation of ABP therapy [4]. Although a causal role for ABP therapy has been suggested, a simple cause-and-effect relationship has not been proven. In addition, recently, AFFs have been reported in patients who received denosumab therapy. Again, a causal relationship has not been confirmed, and it is not clear at this time if the denosumab therapy contributed to the development of the AFF (Amgen, oral communication). It is important to recognize that, for patients on ABP therapy, the vast majority of fractures result from the underlying osteoporosis and not from its treatment. Antiresorptive therapy prevents far more fractures than might conceivably result from such treatment [2]. The number needed to harm with an aminobisphosphonate has been estimated at 1 in 2000 and with denosumab is estimated at 1 in 10,000 [2].

Pathogenesis

The pathogenesis of an AFF is not well understood at this time. Bisphosphonates decrease bone remodelling. One hypothesis is that this may lead to accumulation of microdamage and the formation of a stress fracture similar to the fractures seen in athletes or military recruits, which results from repetitive trauma [5]. Because ABPs accumulate on fracture surfaces and make the fracture surface resistant to resorption and repair, microcracks may propagate through the bone and lead to the development of an AFF. Bisphosphonates affect bone mineralization density distribution [5]. Microcrack propagation may be facilitated by increased homogeneity in bone mineral and ultimately leads to an AFF [6,7]. With an increase in the mineralization of the bone, the toughness of the bone is decreased, and this may also contribute to the development of new microcracks [8–10].

Acute traumatic fractures of long bones heal by endochondral ossification, and bisphosphonates have not been shown to affect the healing of long-bone fractures. However, stress fractures heal by bone remodelling and the healing of a stress fracture may be delayed or prevented with bisphosphonate therapy [11–13]. Bone histomorphometry has been evaluated with individuals on long-term bisphosphonate therapy. Markedly suppressed bone formation and a decreased osteoblast surface were noted in patients treated with alendronate for 3-8 years and who had developed spontaneous nonvertebral fractures [14]. A decrease in trabecular connectivity and decreased osteoid on trabecular surfaces with a lack of tetracycline labeling on bone biopsy specimens also was