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Prayer's fracture: rare cases of knee insufficiency fracture in non-weight-bearing femoral condyle

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ABSTRACT

Insufficiency fractures are a relatively common sub-type of stress fractures and occur as a result of decreased bone resistance due to underlying conditions such as osteoporosis. Insufficiency fractures of the knee most commonly occur at the central weight-bearing zone of the medial femoral condyle. We present five unusual cases of insufficiency fractures occurring at the posterior non-weight-bearing zone of condyles. After investigating commonalities between these patients, we discovered that all of these patients performed the daily practice of prayer rituals that include high knee flexion. We have chosen to coin this type of fracture a “Prayer's fracture”. Considering the mechanics of high knee flexion, transient changes in the weight-bearing zone of knee explain the unusual location of this fracture. We describe these cases, the characteristic imaging appearance, and the probable biomechanics that we believe predispose patients to this type of injury.

1. Introduction

Insufficiency fractures are a sub-type of stress fractures that most commonly affect the vertebral column, pelvis, femoral head and the knee [1]. These fractures are associated with significant disability and poor recovery [1–3]. One of the earliest reports on knee insufficiency fracture (KIF) appeared in 1968 by Ahlback et al., who described the imaging presentation, natural history and treatment of the so called ‘spontaneous osteonecrosis of the knee’ in a cohort of elderly patients with unprovoked knee pain [4]. The more commonly accepted nomenclature of this entity has been changed to subchondral insufficiency fracture [5].

Even though KIF was recognized decades ago, its exact pathophysiology, epidemiology and treatment are still under debate. KIF most commonly occurs in women, with a female to male ratio ranging from 2.1 to 5.5:1 in advanced cases [6]. This female predominance has been questioned lately [6]. However, it has been shown that women are at increased risk of progressive disease and on average ten years older at presentation when compared to their male counterparts [7]. Unlike fatigue fractures, KIF occurs under physiologic loads when the mechanical resistance of bone is decreased [8,9]. A number of underlying conditions have been proposed as predisposing factors for decreased bone resistance, such as post-menopausal osteoporosis, steroid use, rheumatoid arthritis and diabetes [1,8,9]. While vascular and traumatic injuries have been suggested as other probable etiologies, a multifactorial pathogenesis is also proposed [5,10–12].

Clinical presentation of KIF includes a new-onset of knee pain, particularly during physical activity, which remits during rest [1,8]. Due to non-specific nature of this presentation, magnetic resonance imaging (MRI) is often required. The diagnosis is best made on coronal or sagittal planes and the fracture presents as subchondral hypo-intense lines on T1-weighted sequences [1,5,11,13]. In acute setting, there is often bone marrow edema surrounding the fracture site on T2-weighted or STIR sequences [1,5,11,13].

KIF most commonly occurs at the medial femoral condyle; involvement of the lateral femoral condyle or tibial plateau are seen, however are much less common [14–18]. Due to everyday biomechanical stresses, these fractures often occur at the central weight-bearing portion of medial femoral condyle, although mesial or lateral surfaces are occasionally involved [6,7]. However, to the best of our knowledge, insufficiency fracture at the non-weight-bearing surfaces of femoral condyles has not been reported in the literature. Therefore, five cases of insufficiency fracture at posterior aspect of the femoral condyles are presented here.

2. Case report

Our case series consists of four women and one man who were 62,

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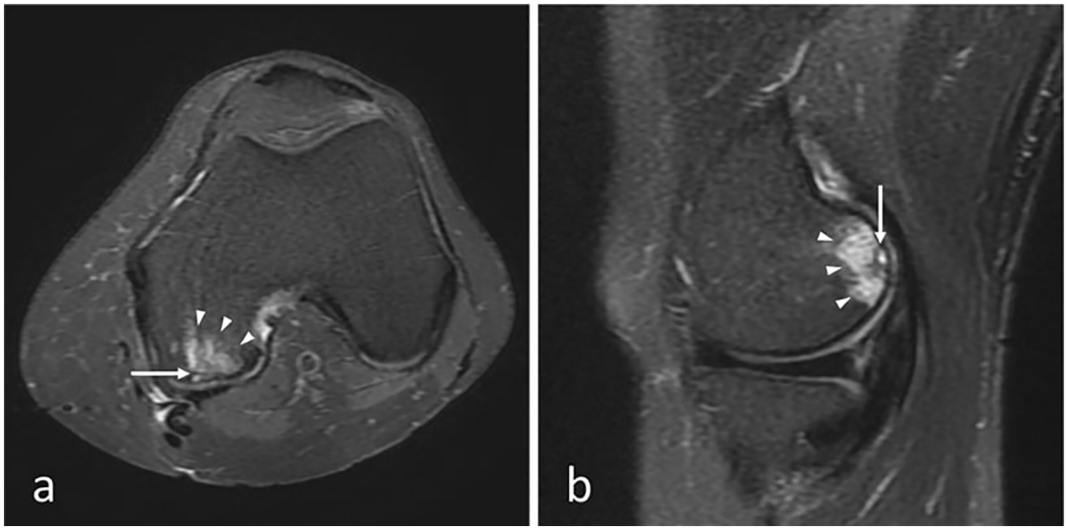

Fig. 1. Axial (a) and sagittal (b) views of proton density MRI with fat saturation showing subchondral insufficiency fracture (arrow) with marrow edema (arrow heads) in posterior non-weight-bearing zone of the medial femoral condyle in a 62-year-old female.

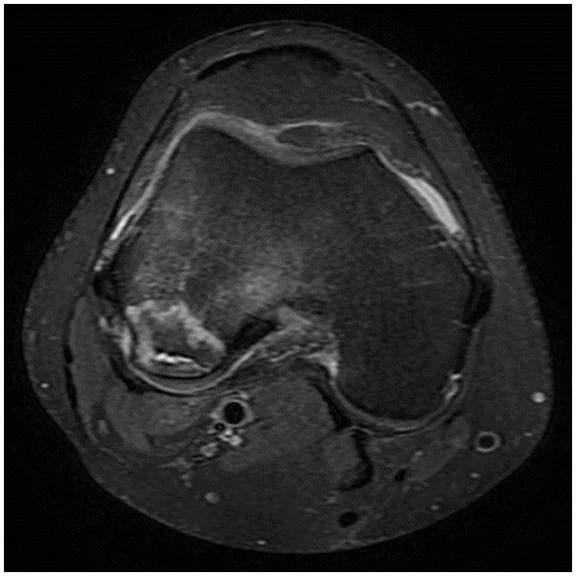

Fig. 2. Axial proton density MRI with fat saturation showing insufficiency fracture with associated marrow edema in posterior non-weight-bearing zone of lateral femoral condyle in a 67-year-old female.

67, 57, 50 and 69 years old at presentation. The patients were referred for MR imaging following unilateral sub-acute knee pain. Upon review of the patient's medical records, none of these patients had a past surgical or medical history significant for knee trauma, surgery, medication use, arthritis or systemic diseases, except for the third case who had a history of diabetes and diabetic neuropathy. In each one of these cases, MR images revealed subchondral fracture lines at the non-weight-bearing zone of the femoral condyles, accompanied by surrounding marrow edema (Figs. 1–5). These fractures were best depicted on axial and sagittal series. The fracture site was located in the medial condyle in one patient and the lateral condyle in others. Other MRI findings included low-grade strain of the biceps femoris, mild patello-femoral osteoarthritis and small unruptured Baker's cyst each in one patient, and trace joint effusion in the supra-patellar recess in two patients.

Upon further investigation, we discovered that all five patients were Muslims and regularly practiced daily prayer rituals. Based on this commonality between these patients, we hypothesized that the unusual posterior location of these fractures was due to the repetitive kneeling movement these patients perform during daily prayers.

3. Discussion

Insufficiency fractures occur when bone resistance is decreased as a result of imbalance between the subchondral mechanical endurance and the external forces. While the central weight-bearing zone at the medial femoral condyle is well-recognized as the predominant location of knee insufficiency fractures, an unusual presentation at the non-weight-bearing zone is described here [6,7]. Besides the clinical presentation and imaging appearance, Muslim religious practice which includes repetitive kneeling was the common denominator in the cases presented in this paper. Taking into account this shared lifestyle feature, we call this rare entity the “Prayer's” fracture.

Patient's cultural background and certain occupational, recreational and athletic activities need to be taken into consideration in diagnosis and treatment of knee pathologies. Repetitive activities that involve kneeling in maximum flexion may explain the unusual presentation of Prayer's insufficiency fracture. The posterior surface of femoral condyle is typically not the subject of mechanical loads in everyday activities, which in part explains the rarity of the cases described here. Kinematic testing of maximal knee flexion, which is regularly performed in Muslim prayers, has shown that the articular contact points between the femoral condyles and tibial plateau progressively shift posteriorly in this movement. During knee flexion, posterior rolling and anterior gliding movements of femoral condyles are responsible for this posterior translation [19]. As a result, the weight-bearing joint surface approximates the posterior tip of the condyles in high knee flexion [19]. This pattern is consistent with the location of fractures observed in this small case series. Additionally, in vivo and cadaveric studies have revealed that kneeling position significantly increases the size of articular contact area and magnitude of peak contact pressures in both medial and lateral compartments [20,21].

Culturally specific activities, such as religious practices, are among the factors that affect the susceptibility of individuals to knee pathologies [22,23]. Current literature suggests that there are differences between Muslim and non-Muslim populations with regards to knee kinematics and prevalence of osteoarthritis [22–24]. Muslims often practice their religious rituals (prayers) three to five times a day from an early age. Muslim prayers include repeated activities such as squatting and kneeling, which require higher degree of knee flexion and a greater range of motion when compared to daily activities of non-

Fig. 3. MR images showing insufficiency fracture of the posterior non-weight-bearing zone of lateral femoral condyle in T1-weighted sagittal view (a) and proton density weighted sagittal (b) and axial (c) views.

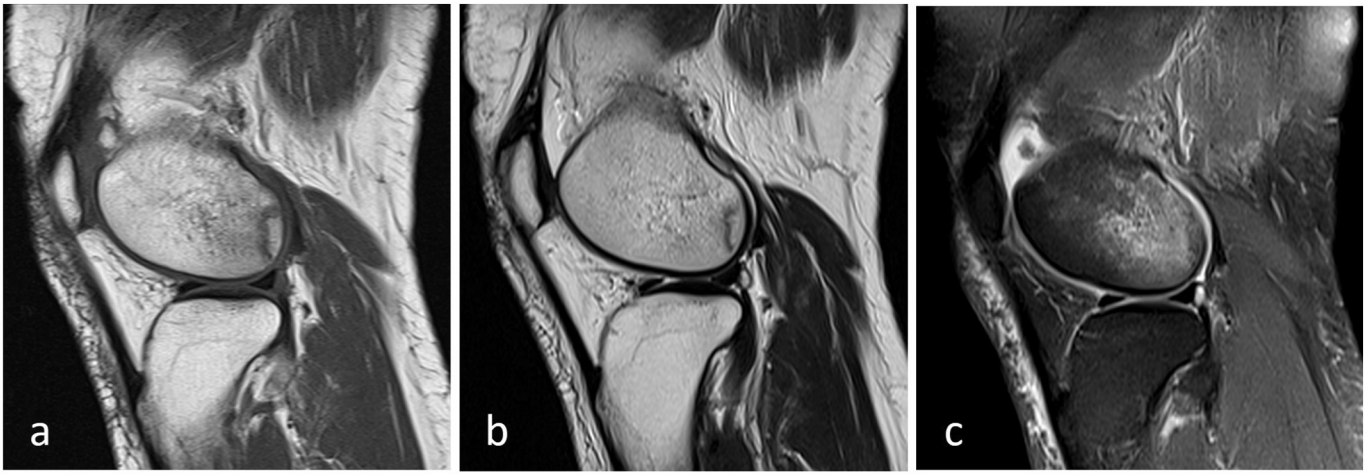

Fig. 4. Sagittal T1- (a), T2- (b) and proton density-weighted MRI with fat saturation (c) showing insufficiency fracture in posterior non-weight-bearing zone of lateral femoral condyle with extensive marrow edema in a 50-year-old female.

Fig. 5. Sagittal T1- (a) and proton density-weighted MRI with fat saturation (b) showing a small insufficiency fracture of the posterior non-weight bearing lateral femoral condyle with mild surrounding marrow edema is a 69-year-old man.

practicing populations [23,25]. Furthermore, it has been suggested that the range of motion in passive knee flexion is greater in Muslim men compared to normative data from Eastern and Western populations [26]. Of note, this finding is not limited to healthy individuals as it has been shown that among patients with knee osteoarthritis, the average knee range of motion was greater in patients practicing prayers when compared to non-practicing controls [27].

4. Conclusions

Although rare, the Prayer's fracture should be suspected in presence of classic MR appearance of KIF in posterior surface of the femoral condyles. Despite the unexpected location, such findings are diagnostic for KIF in the proper clinical setting and it is important for practicing radiologists to distinguish KIF from degenerative changes or osteonecrosis, especially in Muslims practicing daily prayer rituals. Findings of the mechanical studies in kneeling position suggest that this condition may not be exclusive to Muslims, and patients from other Eastern cultures, or those with occupational or recreational activities that involve extreme knee flexion may also be at risk.

Disclosure

Authors declare no conflicts of interest.

Ethical approval

This study was conducted in accordance with institutional ethical standards.

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Declaration of Competing Interest

None.

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