Knee Subchondral Insufficiency Fractures Have Above Normal Bone Density For Age and Sex

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ABSTRACT INTRODUCTION:
The term insufficiency fracture implies bone that is inadequate to sustain a force or repeated forces that would be within the physiologic limits of normal bone. The term insufficiency fracture is often applied to subchondral bone changes seen on knee magnetic resonance images (MRIs) (Figure 1). These are typically located in the medial femoral condyle or medial tibial plateau. The patients are usually over 50 and have a sudden, non-traumatic onset of severe knee pain that continues for weeks or months. T2 weighted images typically show a curved subchondral line of low signal that makes a shallow arc of up to 1.5 cm from articular surface to articular surface. The proximal bone edema may involve the entire femoral condyle or tibial plateau. Subsequent radiographs may show a dense line of bone that is similar to the original MRI pattern. Radiographs are sometimes interpreted as spontaneous osteonecrosis of the knee (SONK), a term first popularized by Ahlback, Bauer, and Bohne1. There is literature indicating that these patients are osteoporotic and prone to this disorder. Our clinical experience did not support this view. Our hypothesis was that these patients have normal bone density for age and sex and no evidence of a systemic bone metabolic disorder.

METHODS:
In an IRB approved retrospective study 35 knees in 32 patients with an MRI diagnosis of knee insufficiency fracture located in the knee were reviewed. Because inclusion required a bone density based on dual x-ray absorptiometry (DEXA) there were 26 women and 6 men. DEXA is more commonly obtained in women than in men. The lowest of the hip and spine scores was used to determine osteoporosis (T score = -2.5), osteopenia (T score between -1.0 and -2.5), or normal > -1.0. Z scores are based on norms for age and sex. All MRI examinations were done at Henry Ford and included single proton density, coronal T2W1 with fat saturation, and axial T2W1 fat saturation sequences. The images were interpreted by both a musculoskeletal board certified radiologist and fellow. Assessment included meniscal extrusion or tear, articular cartilage loss using the Noyes grading system2, body mass index (BMI = weight/height), and risk factors for avascular necrosis.

RESULTS:
The age range was 48-94 (avg. 69.3). There were no knee injuries in this series. Surprisingly, 43% of the 32 patients had a normal T score. Of the 57% who were below normal, 40% of the overall population was osteopenic and only 17% osteoporotic. More strikingly, the average Z scores were so far below normal as to suggest there was something unusual about this population and that this phenomenon was not systemic or locally insufficient bone. Although focal displaced fractures can eventually occur these are the result of the process and not the cause of it. The relationship of SONK to insufficiency fractures appears to be one of stage and degree of severity of bone response. Once the condition begins it is likely that it is the continued weight bearing on the affected knee that leads to the inability of the subchondral fracture to heal. In essence, a non union is created with a potential loss of blood supply to the isolated fragment. It is not surprising that the terms insufficiency fracture, SONK, osteochondral fracture, and others are applied to the possible outcome of this sequence of events.

SUMMARY:
The term insufficiency fracture implies inadequate bone giving way to forces that should normally be accepted by the articular surface. Subchondral insufficiency fractures appear to be a specific metabolic response stemming from articular cartilage degradation. Further investigations should be directed at the cytokine variations that are specific to this patient population. This could lead to a better understanding and use of terminology for this subgroup of osteoarthritis responses.

REFERENCES:

Figure 1. Classic MRI pattern of curved line of minimal Signal on both T1 and T2 weighted images