Radiographic Occult bone trauma: Case Presentation and Literature Review

Ana Cristina Manzano Díaz[1]

Carlos Alejandro García González[2]

Summary

This article presents 13 cases of patients with bone trauma at the time of the consultation, occult in the conventional radiographs and later evident in magnetic resonance imaging (MRI),. Medical records of these patients, in cases where X-rays or CT had been reported as normal, were reviewed Persistent pain, with functional impairment, unresponsive to medical treatment was the most common feature leading to clinical indication of MRI.

Key Words (MeSH)

Occult Fracture

X-rays

Magnetic resonance imaging

Wounds and injuries

Introduction

[1] MD Radiologist. Departamento de Radiología, Hospital Universitario de San Ignacio-Pontificia Universidad Javeriana, Bogotá, Colombia.

[2] Radiologist Resident-IV, Departamento de Radiología, Hospital Universitario de San Ignacio-Pontificia Universidad Javeriana, Bogotá, Colombia.

Some bone lesions caused by acute trauma or unusual mechanical load are not detected on conventional radiographs, either because they are unapparent or due to diagnostic error. Magnetic resonance imaging(MRI) has been proved to be a useful tool to diagnose these occult X-rays lesions, due to its high spatial resolution and ability to discriminate different types of tissue (1). This diagnostic method is indicated for stress fractures, avulsion or hidden fractures (2). Patients in which MRI has been performed for suspected meniscal injury, avascular necrosis or rotator cuff lesions, may show radiographic hidden bone lesions such as intraosseous trabecular disruption, edema, hemorrhage or stress lesions of the tibial plateau, femoral condyles, acetabulum, proximal humerus, among others (3).We present 13 cases of patients with trauma whose bone lesions were unapparent on conventional radiographs, but evident in magnetic resonance imaging (MRI).

CASE PRESENTATION

Case 1

Occult fracture of the scapular glenoid. 69 y.o patient with blunt trauma to his right shoulder. He comes back five months later due to persistence of pain (Fig. 1).

Case 2

Occult fracture of the humeral head. 45 y.o. patient with direct trauma to his right shoulder. Three months later he complains of persistent pain and rotator cuff syndrome (Fig. 2).

Case 3

Avascular necrosis of the lunate. 60 y.o patient presents with hyperextension trauma to the wrist. One month later she comes in due to persistent pain (Fig 3).

Case 4

Occult fracture of the scaphoid. A 45-year-old patient with hyperextension trauma to the wrist. Several months later complains of persistence of pain. (Fig.4)

Case 5

Occult fracture of the inferior pubic ramus 73 y.o.woman hit by a car, whose initial emergency consultation was diagnosed with soft tissue injuries of the pelvis. 8 days later due to persistent pain in right hip she comes back to the emergency room where a CT scan is ordered..(Fig. 5).

Case 6

Occult fracture of the acetabulum. 79 y.o. patient with left hip injury. He came back ten days later as he remains symptomatic, and an MRI was performed (Fig.6).

Case 7

Occult fracture of the patella.. 27 y.o patient with blunt trauma to his right knee. The patient continued with pain, so MRI were performed,(Fig. 7).

Case 8

Occult fracture of the tibial spine 29 y.o. axial trauma to his knee. Due to the persistent pain and functional limitation, MRI was performed (Fig. 8).

Case 9

Occult fracture of the tibial plateau. 30 y.o. patient with right knee injury occurred in a traffic accident. 15 days later, he refers persistent pain, so an MRI was performed. (Fig. 9).

Case 10

Occult fracture of the fibula. 42 y.o. patient presents with blunt trauma to his knee after in a motor vehicle accident. The initial radiograph showed no fractures. The patient consulted again one month later due to persistent pain and limp (Fig. 10).

Case 11

Occult fracture of the talus 48 y.o. patient presents with trauma to his heel after falling from a 1 meter distance. Pain and functional impairment persist (Fig. 11).

Case 12

Bone contusion of the calcaneus. A patient with 53 years old who has a blunt trauma (axial load) of the foot. He had a consultation a month later due to persistent pain (Fig. 12).

Case 13

Stress fracture of the talus. A patient with 56 years old with persistent pain in the ankle and no history of obvious trauma. T1 sagittal MRI of the ankle showed a stress fracture of the talus (Fig. 13).

Discussion

Traumatic bone injuries that are occult to conventional X-rays are: bone contusion, stress fractures and fractures.

Bone contusion

Bone contusion or “bruising of the bone" is a trabecular bone injury that can result in pain and functional impairment (1). It is invisible on conventional radiographs, as it represents bone marrow edema and microfractures, without interruption of the cortex In MRI bone contusions are readily evident as bone marrow edema and hemorrhage and appear hyperintense on T2 weighted-fat suppressed images,(1) (Case 5). It can be seen as early as 1 to 30 hours after the injury (4), The average time of clearance of a bone contusion is 42 weeks (5).

88% of bone contusions in the knee disappear in 16 months, but can be present up to two years later (6).Diffusion images are more sensitive than spin-echo techniques to quantify edema. There are many causes of bone morrow edema , including bone contusion , which is

one of its few reversible causes. (7). Differential diagnosis include infiltrative, neoplastic, rheumatologic diseases, , transient osteopenia, etc.

A history of trauma is the main diagnostic key. Close follow-up of patients is advisable to rule out complications, since bone contusions can precede fractures or articular collapse. No bone contusion should be considered innocuous (8). Bone contusions are produced by direct blow, axial compression of adjacent bones or tensile forces in an avulsion injury.

Location of the bone contusion can predict the mechanism of trauma and associated lesions. Trauma in sports involving knee flexion and valgus forces present bone contusions of lateral femoral condyle and lateral tibial plateau associated with anterior cruciate ligament tears(9).

In wrist trauma ,bone contusions are common, occurring in up to 63% of patients with normal radiographs and persistent pain. The most frequently fractured bones are scaphoid, the lunate and the triquetrum, respectively (10).

Stress Fractures

Stress fractures are injuries resulting from repetitive mechanical forces on normal bone. Early findings include bone marrow hyperemia, hemorrhage and edema. If a biopsy should be performed in stress fracture in early stages, it could suggest a neoplasm, due to the presence of immature cells in the repairing process (1). MRI also can detect bone marrow edema and the fracture line ill be identified while a bone scan shows nonspecific uptake (1). X-rays are normal, in particular at this stage, while T2 weighted images are highly sensitive to identify bone edema and T1 and T2 weighted images identify the fracture line extending

through bone marrow and cortex.(Fig. 13). As time passes by, up to six weeks for diaphyseal lesions and four weeks for metaphyseal fractures, The fracture can be identified only involving one cortex and may or may not be associated with periosteal reaction and some endosteal bone formation (2).

Fractures

A radiographically occult fracture is one that was initially unapparent on the X-ray or unnoticed by the observer (2). These may be incomplete or non-displaced fractures (1) usually involve epiphysis and metaphysis, unlike stress fractures which occur mostly at the metaphysis. On MRI it presents as a low-signal linear lesion (best visualized in spin -echoT1 and T2 weighted images), surrounded by a large area, of poorly defined, bone marrow edema (2) (cases 1-8).The fracture is continuous with the cortex and extends into the bone with a perpendicular orientation to the cortex and the trabeculae that underwent the abnormal weight or force of the trauma. Ill-defined low signal areas on T1 weighted images or cortical irregularity may represent an osteochondral injury (2). All occult fractures have a good clinical outcome and, on average, patients reintegrate to daily physical activity in three months time (6).

In the hand and wrist, the most common fracture occurs in young adult scaphoid, with a high complication rate of non-union, delayed union or avascular necrosis of this bone (11).

If the initial radiograph is normal and clinical suspicion is high, a CT scan or MRI must be performed(2). In many clinical settings the diagnosis may take up to two weeks or more

before the fracture becomes apparent in the x-ray, due to bone resorption (2). Treatment consists of six months of immobilization (11-14) (cases 3 and 4).

In the shoulder, occult fractures of the greater tuberosity are the most frequent and simulate rotator cuff lesions which, additionally, may even coexist.

They are usually unapparent when there is no displacement of fragments (15) (cases 1 and 2). The knee is the joint most often injured (2). Radiographic occult bone lesions of the knee have an incidence of 16% in MRI (8). They are usually located on the femoral condyles and the tibial plateau. They may extend vertically and rarely cross growth plates (15). Avulsion fractures of the lower pole of the patella occur mainly in the immature skeleton of patients that practice vigorous knee extension. (2). MRI identifies a non-displaced fracture. Lesions of the posterior lateral complex, the biceps tendon and lateral collateral ligament, are associated with avulsion fracture of the fibular head (2) (cases 7-10).

In the hip, the incidence of occult fractures is 2% - 10% in patients with persistent post-traumatic pain (11). In elderly patients it is easily detected on MRI, whereas a CT scan may be normal in the first days after trauma (1). Some centers perform a single T1 weighted coronal image, when an occult fracture is suspected in the hip. Cost is lower compared to other more complex protocols and may be diagnostic on its own. (13) (Cases 5 and 6).In conventional radiographs, the obturator fat plane sign can indicate an occult fracture of the acetabulum (14). It also should be suspected in elderly patients with mild trauma to the hip and posttraumatic pain (15). A MRI of the hip is much more sensitive than conventional radiograph and CT scans to diagnose occult fractures of the hip(16).

It also avoids unnecessary hospitalizations and delays in definitive treatment (17). There are evidence-based algorithms for diagnoses of occult fractures that take into account the risk factors and type of trauma. Identified risk factors include: female gender, women with osteoporosis, alcoholism, malnutrition, endocrine diseases, advanced age, steroid use, inactivity and poor calcium intake (18).

In the foot and ankle, talar fracture often occurs at its neck or dome, in dorsiflexion or inversion trauma. Scaphoid fractures occur in athletes and are usually due to stress. Diagnosis can take up 4 months (7) (cases 11 and 12).

In a recent cost analysis segment study 204 pediatric patients with trauma and normal initial radiograph were followed up. 13% had fractures and, of these, 29% had not been adequately treated. Half of the patients didn´t have fractures and were treated as if they had. The cost of performing magnetic resonance in a limited trauma protocol (only one T1 and T2 weighted images carried out in five minutes) is comparable with the direct costs of inadequate in these patients and can be much less than the cost of a definitive treatment. If a limited trauma protocol MRI is performed, to these patients there would be appropriate immediate treatment , especially important in children with hidden Salter-Harris fractures , without wasting resources (19).

Conclusion

The persistence of musculoskeletal pain that does not improve with the conservative treatment, it is the most common situation that leads to patient consulting again to explore its causes. Disabling or persistent pain in patients should be studied with MRI to rule out

occult bone lesions. Our series of cases points to take special care in detecting hidden hip fractures in elderly patients, and knee fractures in young patients. We suggest evaluating the cost-effectiveness of MRI, perform a unabbreviated trauma protocol, for evaluation of occult fractures in a special group of high risk patients instead of waiting for persistent chronic pain.

References

1. Anderson M. Magnetic resonance imaging of radiographically occult bony trauma. West J Med. 1996 Jul-Aug;165(1-2):58.
2. Ahn JM, El-Khoury GY. Role of magnetic resonance imaging in musculoskeletal trauma. Top Magn Reson Imaging. 2007 Jun;18(3):155-68.
3. Berger PE, Ofstein RA, Jackson DW, Morrison DS, Silvino N, Amador R. MRI demonstration of radiographically occult fractures: what have we been missing? Radiographics. 1989 May;9(3):407-36.
4. Blankenbaker DG, De Smet AA, Vanderby R, McCabe RP, Koplin SA. MRI of acute bone bruises: timing of the appearance of findings in a swine model. Am J Roentgenol. 2008;190(1):W1-W7.
5. Boks SS, Vroegindeweij D, Koes BW, Bernsen RMD, Hunink MG, Bierma-Zeinstra SMA. MRI follow-up of posttraumatic bone bruises of the knee in general practice. Am J Roentgenol. 2007;189(3):556-62.

6. Boks SS, Vroegindeweij D, Koes BW, Hunink MG, Bierma-Zeinstra SM. Follow-up of occult bone lesions detected at MR imaging: systematic review. Radiology. 2006;238(3):853-62.

7. Blum A, Roch D, Loeuille D, Louis M, Batch T, Lecocq S et al. [Bone marrow edema: definition, diagnostic value and prognostic value]. J Radiol. 2009 Dec;90(12):1789-811.

8. Vannet N, Kempshall P, Davies J. Secondary collapse of lateral femoral condyle following bone bruise: a case report. Acta Orthop Belg. 2009 Oct;75(5):695-8.

9. Sanders TG, Medynski MA, Feller JF, Lawhorn KW. Bone contusion patterns of the knee at MR imaging: footprint of the mechanism of injury. Radiographics. 2000 Oct;20 Spec No:S135-51.

10. Pierre-Jerome C, Moncayo V, Albastaki U, Terk MR. Multiple occult wrist bone injuries and joint effusions: prevalence and distribution on MRI. Emerg Radiol. 2009;17(3):179-84.

11. Ahn JM, El-Khoury GY. Occult fractures of extremities. Radiol Clin North Am. 2007 May;45(3):561-79.

12. Lynch TC, Crues JV, Morgan FW, Sheehan WE, Harter LP, Ryu R. Bone abnormalities of the knee: prevalence and significance at MR imaging. Radiology. 1989;171:761.

13. Quinn SF, McCarthy JL. Prospective evaluation of patients with suspected hip fracture and indeterminate radiographs: use of T1-weighted MR images. Radiology. 1993;187(2):469-71.

14. Mouzopoulos G, Lasanianos N, Mouzopoulos D, Tzurbakis M, Georgilas I. Occult acetabulum fracture: a case report. Emerg Radiol. 2008 Nov;15(6):437-9.

15. Kakar R, Sharma H, Allcock P, Sharma P. Occult acetabular fractures in elderly patients: a report of three cases. J Orthop Surg (Hong Kong). 2007 Aug;15(2):242-4.

16. Lubovsky M, Liebergall Y, Mattan Y, Weil Y, Mosheiff R. Early diagnosis of occult hip fractures. MRI versus CT scan. Injury. 2005;36(6):788-92.

17. Verbeeten KM, Hermann KL, Hasselqvist M, Lausten GS, Joergensen P, Jensen CM et al. The advantages of MRI in the detection of occult hip fractures. Eur Radiol. 2005 Jan;15(1):165-9.

18. Cannon J, Silvestri S, Munro M. Imaging choices in occult hip fracture. J Emerg Med. 2009 Aug;37(2):144-52.

19. Kan JH, Estrada C, Hasan U, Bracikowski A, Shyr Y, Shakhtour B et al. Management of occult fractures in the skeletally immature patient: cost analysis of implementing a limited trauma magnetic resonance imaging protocol. Pediatr Emerg Care. 2009 Apr;25(4):226-30.

Figures

Fig. 1. Occult fracture of the scapular glenoid. (A) The initial radiograph shows no fracture. Coronal spin-echo T1 weighted MRI (b) shows the fracture of the superior aspect of the glenoid (arrow).

Fig. 2 Undisplaced fracture of the greater tuberosity of humerus (Nº 1). (A) The initial radiograph is normal. Coronal spin-echo T2-weighted a low signal fracture line (black arrow) visible also in the PD image. (c).

Fig. 3. Avascular necrosis of the lunate. (A) The initial radiograph shows no abnormality. Coronal spin-echo T2 MRI(B) shows hyperintensity (white arrow) of the lunate medial aspect due a vascular necrosis with cystic degeneration. Note the irregularity of the ulnar insertion of the triangular fibro cartilage, suggestive of tear.

Fig. 4. Occult fracture of the scaphoid. (A) The initial radiograph shows no abnormality. In Coronal spin-echo T1 weighted image (B) shows the fracture of the scaphoid as a low signal line (arrow) and coronal STIR T2 weighted image (c) shows a edema of the body of the scaphoid (arrow).

Fig. 5. Occult inferior pubic ramus fracture . (A) Pelvis radiograph shows no fracture.) A small fracture went unnoticed on the CT scan (b)(arrow). Coronal T2 weighted image (c) shows edema at the fracture site (arrow).

Figure 6. Occult fracture of the acetabulum. (A) Hip radiograph shows no fracture. CT coronal image of the pelvis is normal (b)l.Coronal T2 weighted MRI demonstrates(c) edema and the low signal s fracture line (arrow) in the anterior aspect of the acetabulum,

Fig. 7. Occult fracture of the patella. (A) Conventional radiograph shows intraarticular fluid. Multislice CT scan was (b) read as normal. Coronal spin-echo T2 image (c) shows

edema of the lower pole of the patella (white arrow In retrospect the fractures was apparent on the CT scan, (white arrow) as an avulsion fracture.

Fig. 8. Occult fracture of the tibial spine . (A) Conventional radiograph shows no fracture.) Coronal multislice Ct reformation(B) was read as normal, although there was a subtle fracture of the medial tibial plateau cortex (black arrow). Coronal T2-weighted image showed (c) edema and a nondisplaced oblique fracture (white arrow) of the tibial spine which extends to the cortex of the proximal metaphysis of the tibia.

Fig. 9. Occult fracture of the tibial plateau. (A) Initial radiograph doesn´t show fractures. T2 weighted coronal image (B) shows edema and a low signal line (arrow) in the external tibial plateau.

Fig. 10. Fibular occult fracture . (B) The initial radiograph shows no fracture. MR T2 weighted STIR coronal image h identifies an extensive edema of the head of the fibula (c) a low signal fracture (arrows), on the coronal spin-echo T1weighted image.

Fig. 11. Occult fracture of the talus. (A) The initial radiograph shows no fracture. Sagital spin-echo T1 images (b) demonstrates the talar neck fracture as a low signal line (arrow) and sagittalT2-weighted STIR images (c) shows associated edema (arrows).

Fig. 12. Calcaneus bone contusion (a). The initial radiograph showed no fractures. There is an area of sclerosis in the posterior tubercle of the calcaneus which represents the

fracture. The coronal(b) and sagital (c) STIR T2-weighted images show high signal of the posterior lateral aspect of the calcaneus, representing bone edema.

Fig. 13. Stress fracture of the talus. T1-weighted coronal MRI shows a linear fracture of the talus . (arrows).

Contact

Ana Cristina Manzano Díaz

Hospital Universitario de San Ignacio

Radiology Department

Carrera 7ª No. 40-62, piso 2

Bogotá, Colombia

acmanzano@javeriana.edu.co

Received for evaluation: October 4th, 2009

Accepted for publication: November 17th, 2009