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Case report: ischial stress fracture non-union in a college football player

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ABSTRACT

Stress fractures are common injuries associated with repetitive high-impact activities, often in high-level athletes and military recruits. Although predominantly occurring in the lower extremities, stress fractures may occur wherever there is a sudden increase in frequency or intensity of activity, thereby overloading the yield point of the local bone environment. Ischial stress fractures are a rarely diagnosed cause of pain around the hip and pelvis. Often, patients present with buttock pain with activity, which can be misdiagnosed as proximal hamstring tendonitis or avulsion. Here, we report a case of a college football player who was diagnosed with an ischial stress fracture which went on to symptomatic non-union after extensive conservative management. We treated his ischial non-union with open reduction internal fixation utilizing a tension band plate and screws. This interesting case highlights an uncommon cause of the relatively common presentation of posterior hip pain and describes our technique for addressing a stress fracture non-union in the ischium.

INTRODUCTION

Hip pain is a common presentation in the adolescent athletic population [1]. The hip itself has a complex regional anatomy, often exhibiting similar symptoms for different injury patterns originating from intra-articular, extra-articular or intra-pelvic etiologies. Age, sex, sport/activity level, previous injury, genetics and environmental factors all play an important role in determining the type of injury incurred [1–4]. As such, the treating clinician must be able to perform a thorough history and physical examination while maintaining a broad differential of potential diagnoses.

While most injuries such as muscle strain may be treated with rest and analgesics, more serious causes of hip pain such as stress fractures may have similar presentations with negative radiographs, making early diagnosis challenging [5–10]. Common pain presentations which do not resolve in the expected course should alert the treating clinician to evaluate with more advanced studies such as ultrasound, magnetic resonance imaging (MRI) and/or computed tomography (CT) in select cases [1, 11, 12].

Stress fractures are common injuries associated with repetitive high-impact activities, often occurring in high-level athletes and military recruits**.** A sudden activity increase resulting in repetitive, cyclical loading on normal bone leads to local cortical disruption and microfracture [5–10]. Female athletes exhibiting the 'female athlete triad' of low energy availability (imbalance between nutrition intake and energy expenditure), amenorrhea/oligomenorrhoea and decreased bone mineral density are particularly susceptible [3, 5–9, 13–15]. While stress fractures most commonly occur in the foot or lower leg, fractures of the femoral neck, pelvis and sacrum have all been described in the literature and must be included as potential causes of hip pain [16–23]. Timely diagnosis and treatment is crucial to avoid fracture propagation or development of symptomatic non-union [7, 23–26]. This was the case in our patient, an otherwise young, healthy, male athlete who presented with pain that was initially thought to be caused by a proximal hamstring tendonitis or strain.

CASE REPORT

We report a clinical case of a 22-year old male collegiate football player with a 2-year history of left posterior hip and buttock pain in the region of a previously diagnosed proximal hamstring tendon strain. His symptoms were exacerbated during sports and squats and resolved with rest. Physical examination revealed symmetric flexion, internal rotation and external rotation compared with the uninvolved extremity. He had no pain with impingement testing or ambulation. Previous treatments were directed toward the presumed diagnosis of proximal hamstring strain and included physical therapy, non-steroidal anti-inflammatory drug medications and cessation of sporting activity. This non-surgical management provided partial relief, but his pain returned during attempts to resume football. While he had been told that prior imaging demonstrated no pathology outside of proximal hamstring tendinosis, upon presentation to our clinic, radiographs and CT scan showed periosteal thickening with a solid black line through the posteromedial cortex at the ischium near the ischial spine. These findings were consistent with chronic stress fracture and non-union. MRI was obtained of the left hip and pelvis which demonstrated increased edema within the non-weight bearing portion of the ischium, extending proximally to involve the posterior column (Fig. 1A–E). As the patient had failed multiple attempts at non-operative management over a prolonged period of time, surgery was indicated and he elected to proceed with surgical intervention.

The patient underwent open reduction, internal fixation of his left ischial stress fracture through a standard Kocher–Langenbeck posterior approach. Our institution routinely utilizes spinal anesthesia with neuromonitoring to assess the sciatic nerve during the approach and fixation [19]. After take-down of the piriformis and short external rotators, the non-union site was identified over the ischium at the lesser sciatic notch adjacent to the ischial spine. An osteotome was used to open the immature woven bone posteriorly and the non-union was debrided back to healthy bleeding bone. The fracture was then fixed using a 7-hole 3.5-mm pelvic reconstruction plate and screws as a tension band, with a 3.5-mm interfragmentary screw placed across the stress fracture site. Demineralized bone matrix graft was placed around the edges of the fracture site (Fig. 2A–C). The piriformis and external rotators were reattached to the posterior aspect of the femur using intraosseus bone tunnels.

The patient was ambulatory on postoperative day 1 with crutches. He was made foot-flat weight bearing on the operative extremity for a period of 6 weeks, and allowed full range of motion of the hip and lower extremity. After 6 weeks, his weight bearing was progressively advanced to full over the next 4 weeks. Postoperative radiographs obtained at 10 weeks showed maintenance of fixation with evidence of fracture consolidation (Fig. 3). He was cleared for return to summer football workouts at his 10-week post-operative visit, and he played the entire fall season without difficulty. He noted that the operative hamstrings did seem to fatigue easier during his football season, but he was able to play without impairment. At 1 year post-op, he had no complaints, and noted that he had returned to near-symmetric strength. He had plans to play football for one more collegiate season the following year.

DISCUSSION

The hip can be affected by injuries arising from osseous, ligamentous, muscular and neurologic structures. The interaction and function of these structures overlap such that injuries in one location or layer exhibit similar physical findings to another, which can create a diagnostic challenge in patients presenting with 'hip' pain [1–4, 27, 28].

Our patient exhibited posterior hip pain, which had persisted for over 2 years with the diagnosis of proximal hamstring strain. Posterior hip or buttock pain may result from proximal hamstring tendinopathy, bursitis, avulsion or strain of the posterior structures [19, 27, 29, 30]. While the majority of these injuries may be treated conservatively with activity modification, rest and anti-inflammatory medication, refractory pain over a protracted period of time warrants further investigation into the etiology of the pain. Persistent or atypical hip pain may mimic more threatening problems such as nerve compromise or compression. It is important to elicit any associated back pain or neurologic symptoms in the history, as the conditions associated with these findings carry significant morbidity [31]. Additionally, refractory pain may indicate a stress fracture [1–3, 5, 6], which in some cases requires more aggressive management. This is further complicated by the fact that regular imaging studies will often appear normal, delaying the diagnosis. A careful history of the timing and chronicity of symptoms is more useful than location and pain type. Common pain presentations which do not resolve in the expected course should alert the treating clinician to evaluate with more advanced studies such as MRI or CT [11, 12].

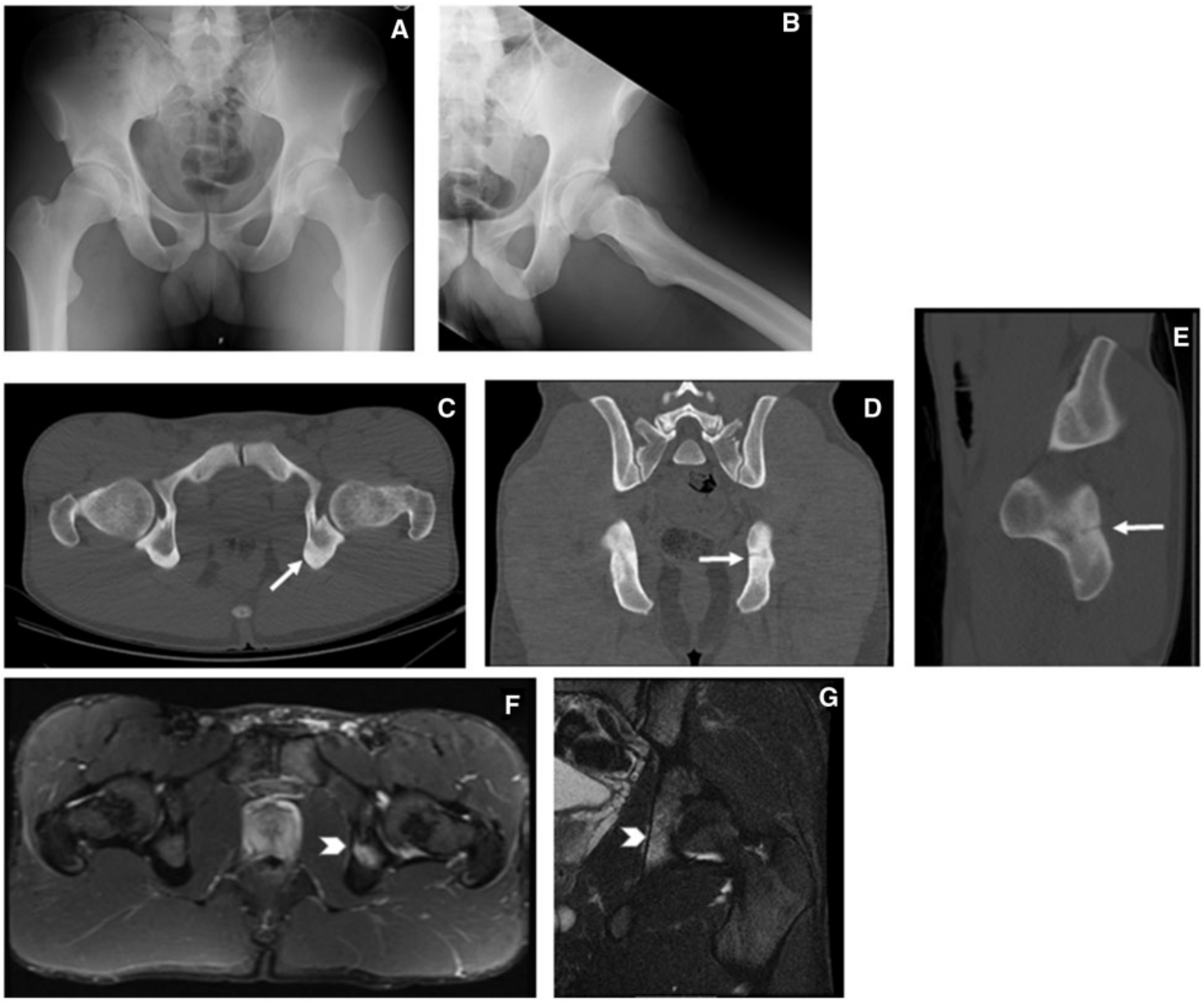

Fig. 1. (**A**) AP pelvis radiograph and (**B**) left hip Dunn lateral radiograph demonstrating a relatively normal appearing ischium. (**C**) Axial, (**D**) coronal and (**E**) sagittal CT revealing a black line and periosteal thickening (arrow) of the ischium representing the stress fracture non-union. MRI of the left hip and pelvis demonstrate in the (**F**) axial and (**G**) coronal plane increased edema (arrow head) in the non-weight bearing portion of the ischium and extending into the posterior column.

Our patient had failed 2 years of conservative management of his posterior hip/buttock pain, and upon presentation in our clinic, he was formally diagnosed with an ischial stress fracture. While stress fractures are a relatively common diagnosis, ischial stress fracture is extremely rare, with only a few reported cases in the literature [16–18, 32]. Previously, ischial stress fractures have been described after acetabular realignment osteotomy, due to narrowing of the posterior column and ischial cut [2, 20].

Stress fractures have numerous causes and can occur nearly anywhere, but most commonly occur in the lower extremities, especially in the foot or lower leg. In a survey by Matheson *et al.* of 320 athletes, tibia fractures were most common (49.1%) followed by tarsals and metatarsals (34.1%) [5]. A more recent review of high school athletes by Changstrom *et al.* showed stress fractures occurred in 389 injuries out of 51 773 (0.8%). Of these, 40.3% were in the tibia [8].In the military recruit population, metatarsal stress fractures are more common [6]. Stress fractures have been described in the patellae, ribs, elbow, humerus, sacrum or iatrogenically after bone graft harvest [10, 22, 26, 33–45]. In the hip region, stress fractures can occur in the femoral neck, pelvis or sacrum. Clinical suspicion should be high in high-level athletes, military recruits, and females who exhibit the female athlete triad. A sudden activity increase resulting in repetitive, cyclical loading on

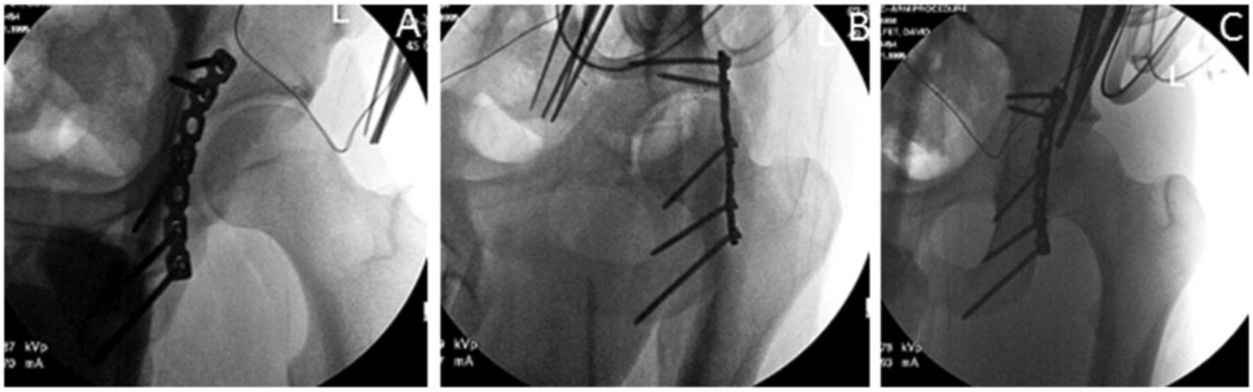

Fig. 2. Intraoperative (**A**) iliac oblique, (**B**) obdurator oblique and (**C**) AP fluoroscopy images left hip and ischium of the tension plate construct. The fracture non-union site was cleared of granulation tissue and demineralized bone matrix was placed around the fracture site.

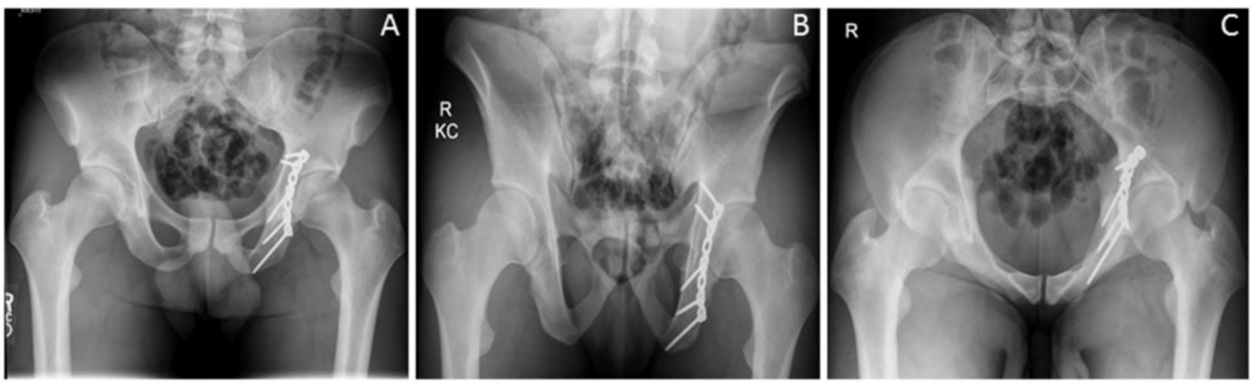

Fig. 3. (**A**) AP, (**B**) outlet and (**C**) inlet radiographs from 10 weeks post-operative follow-up demonstrating intact hardware. At the patient's last follow-up, he was pain free and cleared to resume summer football activities.

normal bone leads to local cortical disruption and microfracture [5–10]. Female athletes exhibiting the female athlete triad are particularly susceptible to this stress reaction [3, 5–9, 13–15].

The treatment for stress fractures, when promptly diagnosed, is activity modification and limited weight bearing on the affected bone, with full healing expected in most cases [5, 6, 24]. However, chronic injuries often require surgical stabilization. Tension-type anterior tibial stress fractures have an increased propensity to develop chronic non-union due to the poor vascularity of the region and require consistent radiographic monitoring to follow progression of healing [46, 47]. To prevent this complication, surgical treatment with intramedullary reaming and statically locked nail has been advocated once radiographs show evidence of a 'dreaded black line' [48–51]. More recent literature has shown that open treatment with debridement and tension band plating results in successful tibial stress fracture healing [52–55]. In their series, Zbeda *et al.* treated 12 patients with 13 chronic anterior tibia stress fractures, with a 92% rate of return to preinjury function at an average of 11 weeks after surgery. Five of the 13 (38%) underwent removal of hardware due to plate prominence [55]. In Markolf *et al.*'s biomechanical analysis comparing anterior tension band plating to intramedullary nailing for anterior stress fractures, significantly less fracture gapping was noted with bending stress using an anteriorly positioned plate [56]. There is, however, no consensus on treatment of ischial stress fractures.

In our patient, conservative treatment and delayed diagnosis contributed to a chronic non-healing stress fracture of his ischium. We recommended surgical treatment, and the patient opted to proceed given the significant impact his ongoing pain had on his life. As the location of his stress fracture was similar to an ischial avulsion, a Kocher–Langenbeck approach was used, with visualization and debridement of the fracture line and placement of a tension band plate construct. [30]. While sciatic nerve monitoring has not definitively been shown to decrease rates of iatrogenic palsy, it is regularly utilized at our institution [57].

Newer research shows improved results for non-union of stress fracture with adjuvant treatments in addition to surgery. This includes addressing underlying nutritional and metabolic deficits, as well as altering the local fracture environment [13–15, 58]. Vitamin D levels correlate highly with quality of local bone micro-environment and reparative ability after repetitive stress. Numerous studies have evaluated the use of vitamin D supplementation in the military and in collegiate athletes. Patients with vitamin D insufficiency and deficiencies show delayed healing; however, vitamin D treatment alone without calcium does not appear to reduce stress fracture risk [59–64]. In our patient, vitamin D levels were drawn and were within normal limits.

Bisphosphonates have not yet been proven to provide a benefit in the treatment of these injuries. In a retrospective study, Simon *et al.* evaluated 25 professional athletes with bone stress reactions (not true fractures) treated with intravenous ibandronate. While those treated with ibandronate showed faster return to competition, the time to definitive diagnosis also played a crucial role in the rate of healing. Furthermore, there was no control group for comparison, and patients also received concurrent vitamin D supplementation [65]. Sloan *et al.* performed a study comparing parathyroid hormone (Forteo) with alendronate in adult rats with induced stress fractures. Rats receiving Forteo had significant increases in bone mineral density, content, bone formation and yield strength compared with those treated with bisphosphonates [66]. There has been an increased interest in using Forteo in the setting of high-risk stress fractures, principally those with tendency for non-union such as fifth metatarsal and femoral neck fractures, though definitive effectiveness has yet to be proven [67–70].

Based on a study by Hernigou and others, bone marrow aspirate concentrate (BMAC) has demonstrated success as an adjuvant in difficult tibial fracture non-unions [71, 72]. Currently, a double-blind randomized trial has been initiated to evaluate the effect of BMAC on time to union of fifth metatarsal stress fractures. This technique has been described previously, utilizing a cannulated screw as the delivery device for injecting the aspirate [73]. However, further research is required to prove the efficacy of BMAC in the setting of non-union.

Finally, low-intensity pulsed ultrasound has shown some evidence of improvement in healing rates with acute fractures but does not appear to play a significant role in reducing time to union in the setting of stress fracture [74–76].

CONCLUSIONS

Hip pain is common in the adolescent athlete, and while stress fractures may not be the most common etiology, the clinician should maintain a high clinical suspicion throughout examination and workup, especially in those with refractory or atypical pain presentations. Ischial stress fractures are rare but can closely mimic common causes of posterior hip pain and are thus difficult to diagnose. Most are successfully treated with conservative treatment when recognized early. Continued repetitive stress can lead to non-union. Failed conservative management may require open treatment, with debridement of the fracture site and compression plating, as described in our case presentation. Adjuvant treatments such as BMAC and/or BMP may have a role in chronic non-unions where the local bone environment has decreased propensity to heal.

CONFLICT OF INTEREST STATEMENT

None declared.

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