Case report

Symptomatic stress reaction of the humerus in a professional cricketer

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SUMMARY

A symptomatic bone stress reaction is an early pathological feature, which can lead to stress fractures. It typically affects bones of the lower limbs in response to unaccustomed disproportional compressive loading. Professional sportspeople are susceptible to both bone stress reaction and stress fractures, where training regimes and competition predispose to overuse injuries. We discuss a unique case of a professional cricketer developing pain in the throwing arm due to bone stress reaction in the distal humerus, as confirmed on MRI. Modification of the patient's training regime, presented in this case, facilitated complete recovery within 6 weeks. The positive response to modified training suggests a biomechanical origin of the pain. This case illustrates that tensile stress associated with throwing activities can result in a symptomatic bone stress reaction of the humerus in elite cricketers.

BACKGROUND

Bone is a dynamic and adaptive connective tissue, capable of remodelling in response to the mechanical stresses exerted on it via mechanotransduction.¹ This physiological adaptation contributes to the immense strength of bone and has been described in the 19th century by Julius Wolff.² However, when the forces exerted on bone exceed its capacity to remodel within the given time appropriately, microfractures can occur leading to inflammation and pain.³ This is a process through which overuse injury can be sustained by bone, resulting from repeatedly performing actions leading to 'cumulative trauma' and tissue damage.

Sportspeople are at an increased risk of developing repetitive overuse injuries. The incidence of upper limb repetitive overuse injuries is unclear however in the lower limb the incidence is estimated at approximately 200 per 100 000 person-years.⁴ Each sport has specific injury risks associated with performed actions.⁵ Among elite cricket players, specifically fast bowlers, there is an increased risk of developing bone stress reaction in the pars interarticularis of the spine due to high loading compressive forces.^{6,7} A bone stress reaction is a precursor to stress fractures that manifests clinically with pain and oedematous change within the bone marrow. It is commonly identified in distance runners where the tibiae and fibulae are affected.⁸ Most cases of bone stress reaction are either associated with trauma or excessive compressive forces. Stress injuries in the femoral neck are far more at risk of

progressing to completed fracture if they affect the tension side of the superior aspect of the femoral neck.⁹ However, cricketers and other throwing sportspeople can develop problems associated with repetitive tensile forces. The development of bone stress reaction in the upper limbs is uncommon due to the relatively lower forces exerted through the arms, although there are some reports in the literature where this has occurred in tennis players and baseball pitchers.^{10,11} In these sports, tensile forces are also exerted on the upper limb. There are currently no reports of bone stress reaction developing in the upper limb of a cricket player.

The injury rate among women partaking in bat-or-stick sports is high relative to other sportswomen, but often too little is known of the pathological mechanisms to direct evidence-based interventions. Furthermore, cricketers have higher rates of total joint replacements and osteoarthritis relative to the general population, but again, the causative factors underpinning this are currently unclear.^{12,13}

An inability to recognise bone stress can delay intervention and result in progression to stress fractures.^{10,14} Furthermore, though pain control is often achieved by complete rest and non-steroidal anti-inflammatory drugs (NSAIDs), these may exert important negative effects on bone and muscle strength and increase the risk of future injuries.¹⁵ We report a diagnosis of bone stress reaction secondary to tensile forces in the throwing upper limb of a cricket player and highlight how modifications to the way this presentation is managed can lead to improved outcomes.

CASE PRESENTATION

A 24-year-old female international cricket player presented with a 2-week history of non-specific, insidious-onset pain in her right elbow and upper arm that was exacerbated by throwing and relieved by rest. She had not experienced any recent trauma or modifications to her throwing regimen. Her training history was monitored and included a high throwing volume (during matches and fielding drills), though this is common for a professional cricketer. The patient's performance and participation in training were limited by the pain.

Her medical history included osteochondral defect (OCD) of the capitulum of the right elbow which was treated conservatively. Three years previously, the patient developed an L5 pars interarticularis stress fracture which resolved with conservative management. The patient had not experienced previous episodes of a similar pain

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Figure 1 (A–D) Serial coronal MRI images of the right distal humerus. (E) Sagittal MRI image of the right humerus. (F) Axial MRI image of the distal humerus. *Denotes significant bone marrow oedema.

in the upper arm. There was no history of disordered eating patterns, weight loss or amenorrhoea.

Musculoskeletal examination of the upper limb revealed tenderness in the distal humerus with no specific tenderness in the overlying structures. Functional tests stressing the musculature of the upper limbs did not elicit pain, except for pushups, which elicited the same pain in the distal humerus that she had experienced while throwing.

Investigations

MRI was conducted and identified a large area of bone marrow oedema of the distal humerus, no abnormalities of the medial elbow structures and no excessive fluid in the elbow joint (figure 1). Blood tests for a bone health screen (including full blood count, renal and liver function, bone profile, vitamin D, thyroid function, coeliac antibodies, C reactive protein, erythrocyte sedimentation rate and serum immunoglobulins) were conducted in which no abnormality was detected. Similarly, a dual-energy X-ray absorptiometry scan showed a bone mineral density that was within the normal range. CT scanning was performed to exclude the presence of a stress line fracture in the affected area, but no abnormality was detected.

Differential diagnosis

This case concerns a patient complaining of non-specific tenderness in the upper arm and elbow, for which there are several potential causes. Given the clinical history of the patient, it was suspected that a recurrence of OCD could be the cause of her symptoms. As she is effectively a throwing athlete, the patient is also at risk of developing overuse injuries, including chronic overuse injuries of medial elbow structures.

Treatment

The patient's training regime was modified to avoid exacerbation of her symptoms although at no point did she cease training altogether. For the first 2 weeks, she refrained from throwing while continuing to bowl, bat and partake in other fielding drills. These activities did not elicit any pain. She avoided diving onto that side during fielding drills. She continued with lower body gym programme but did not do any heavy lifting in the gym involving the upper limbs. Scapula control exercises were undertaken to reduce the amount of stress exerted on the bone during the throwing motion.

In the third week of the modified training programme, the patient resumed a limited number of throwing exercises. The

patient reported that she no longer experienced pain when throwing. From the fourth week, the patient continued to increase her throwing volume. By 6 weeks postinjury, she was back to a full throwing programme and participated in all her regular training regime and did not experience any symptoms thereafter.

OUTCOME AND FOLLOW-UP

Since the temporary adjustment to her training, the patient has remained asymptomatic and has continued to train and compete as she had been before the onset of pain.

Follow-up MRI at 6 weeks showed a minor reduction in bone marrow oedema. At 4 months, repeat MRI scans still showed some remnant bone marrow oedema, despite the patient remaining asymptomatic for almost 3 months.

DISCUSSION

Bones are dynamic structures that adapt to the external forces placed on them. Bone stiffness is dependent on both the loading direction and the previous adaptation of that bone.¹⁶ Tensile and compressive loading might have different effects on bone strength and adaptation.^{17 18} When the bone response is not sufficient to increase or novel demands, this can result in fatigue bone injuries including stress fractures. These injuries are fairly common in active members of the general population but are particularly prevalent in professional sportspeople. It is frequently the result of increases in training intensity or frequency.¹⁹ Stress reactions and fractures are much more common in the lower limb than the upper limb.²⁰ It is unusual to see stress fractures of the upper limb and stress injuries are not widely recognised as a cricketing injury. In female cricket players, there are currently no cases of stress fractures or reactions of the humerus reported in the literature.

Although cricketers are primarily grouped into batsmen and bowlers, it is in fact fielding, and in particular, throwing during fielding, that causes the upper limb to overuse injuries.²¹ For this reason, professional cricketers' throwing volumes are closely monitored by medical staff in order to prevent injury. This case highlights an unusual overuse upper limb injury in a cricketer. In other throwing sports, such as baseball, tensile forces are exerted on the humerus and similarly there have been reported cases of bone stress reaction of the humerus.¹¹ Hence, it is important to consider this injury when assessing a throwing athlete with elbow and upper arm pains.

Our patient's clinical examination was largely normal apart from pain on doing a pushup. This is probably because during a pushup, the upper limb is loaded axially, with one's body weight. The radiological investigation eventually generated the diagnosis here. Hoy *et al* discuss the importance of MRI in the diagnosis of bone stress reaction due to its high sensitivity where other modalities may yield little-to-no indication of any disease processes occurring.²² Furthermore, specific MRI sequences, such as the volumetric interpolated breath-hold examination (VIBE) have proven to be particularly sensitive in the detection of bone marrow oedema, stress fractures and other sports-related osseous pathology. VIBE images permit high-quality imaging of bone tissue with superior spatial resolution.^{23 24} In our case, the use of MRI facilitated prompt diagnosis and enabled appropriate intervention, without which it is plausible that she would have progressed to develop a stress fracture. The resolution of bone marrow oedema on MRI lagged behind the resolution of symptoms.

In the management of stress injuries of the lower limb in elite athletes, temporary discontinuation of activity is advised before a graduated return to full activity.²⁵ However, this rest period is limited so as to avoid significant deconditioning, and negative effects on osteoblast activity. Furthermore, while NSAIDs may provide adequate analgesia, they might also impair bone healing and adaptability. This presents an unfavourable risk-benefit ratio, hence they are not advised in the management of these injuries.¹⁵ Conversely, although pulsed ultrasound and extracorporeal shockwave therapies have not yet been shown to significantly reduce healing time, these non-invasive methods are commonly used to promote bone healing.²⁶

There is a paucity of evidence directing how stress reactions in the humerus should be managed in professional sportspeople. In a group of tennis players with bone stress injuries of the humerus their symptoms remained, on average, for 7 weeks.²⁷ In comparison, our athlete lost minimal time to this injury and also managed to continue training in her other disciplines of batting and bowling. Lee *et al* propose that, with regard to professional tennis players, the extent of oedema correlates with the length of rehabilitation required before returning to full intensity training.²⁷ Although the bone marrow oedema in our athlete was quite significant, we decided to use the clinical marker of pain on throwing and during pushups to determine when to introduce and increase at-risk activity (ie, throwing).

Learning points

- ▶ Throwing athletes are at risk of developing overuse injuries, including bone stress injuries. When throwing athletes present with the elbow and upper arm pain, bone stress injuries should be considered in the differential diagnosis.
- ▶ Repetitive actions exerting tensile forces on the humerus (ie, throwing) can contribute to the development of bone stress reaction.
- ▶ Prompt diagnosis and treatment of bone stress reaction reduce the risk of progression to stress fractures, which would otherwise have a far greater impact on a sportsperson's training.
- ▶ Bone marrow oedema can persist for months after symptoms have resolved. It is unclear what the consequences are of persisting oedema.
- ▶ Using pain as a clinical marker of when to reintroduce risk activities may be an effective method of reducing the duration of recovery time.

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REFERENCES

- 1 Hadjidakis DJ, Androulakis II. Bone remodeling. *Ann N Y Acad Sci* 2006;1092:385–96.
- 2 Frost HM. Wolff's Law and bone's structural adaptations to mechanical usage: an overview for clinicians. *Angle Orthod* 1994;64:175–88.
- 3 Warden SJ, Burr DB, Brukner PD, *et al*. Stress fractures: pathophysiology, epidemiology, and risk factors. *Curr Osteoporos Rep* 2006;4:103–9.
- 4 Niva MH, Kiuru MJ, Haataja R, *et al*. Fatigue injuries of the femur. *J Bone Joint Surg Br* 2005;87-B:1385–90.
- 5 Fredericson M, Jennings F, Beaulieu C, *et al*. Stress fractures in athletes. *Top Magn Reson Imaging* 2006;17:309–25.
- 6 Gregory PL. Comparing spondylolysis in cricketers and soccer players. *Br J Sports Med* 2004;38:737–42.
- 7 Pantelidis P, Nagra NS, Edwards KL, *et al*. Athletic population with spondylolysis: review of outcomes following surgical repair or conservative management. *Global Spine J* 2016;6:615–25.
- 8 Fredericson M, Bergman AG, Hoffman KL, *et al*. Tibial stress reaction in runners. Correlation of clinical symptoms and scintigraphy with a new magnetic resonance imaging grading system. *Am J Sports Med* 1995;23:472–81.
- 9 Oh Y, Fujita K, Wakabayashi Y, *et al*. Location of atypical femoral fracture can be determined by tensile stress distribution influenced by femoral bowing and neck-shaft angle: a CT-based nonlinear finite element analysis model for the assessment of femoral shaft loading stress. *Injury* 2017;48:2736–43.
- 10 Silva RT, Hartmann LG, Laurino CF. Stress reaction of the humerus in tennis players. *Br J Sports Med* 2007;41:824–6.
- 11 Gonzalez-Zapata A, Familiari F, McFarland EG. Stress reaction of the humerus in a high school baseball player. *J Orthop Sports Phys Ther* 2014;44:998.
- 12 Panagodage Perera NK, Joseph C, Kemp JL, *et al*. Epidemiology of Injuries in Women Playing Competitive Team Bat-or-Stick Sports: A Systematic Review and a Meta-Analysis. *Sports Med* 2018;48:617–40.
- 13 Jones ME, Davies MAM, Leyland KM, *et al*. Osteoarthritis and other long-term health conditions in former elite cricketers. *J Sci Med Sport* 2018;21:558–63.
- 14 Schultz W, Stinus H, Schleicher W, *et al*. [Stress reactions--stress fracture of the upper femoral neck in endurance sports]. *Sportverletz Sportschaden* 1991;5:81–4.
- 15 Warden SJ, Davis IS, Fredericson M. Management and prevention of bone stress injuries in long-distance runners. *J Orthop Sports Phys Ther* 2014;44:749–65.
- 16 Brosh T, Rozitsky D, Geron S, *et al*. Tensile mechanical properties of swine cortical mandibular bone. *PLoS One* 2014;9:e113229.
- 17 Röhl L, Larsen E, Linde F, *et al*. Tensile and compressive properties of cancellous bone. *J Biomech* 1991;24:459.
- 18 Chung E, Rylander MN. Response of a preosteoblastic cell line to cyclic tensile stress conditioning and growth factors for bone tissue engineering. *Tissue Eng Part A* 2012;18(3-4):397–410.
- 19 Wesner ML. Nutrient effects on stress reaction to bone. *Can Fam Physician* 2012;58:1226–30.
- 20 Brukner P. Stress fractures of the upper limb. *Sports Med* 1998;26:415–24.
- 21 Saw R, Dennis RJ, Bentley D, *et al*. Throwing workload and injury risk in elite cricketers. *Br J Sports Med* 2011;45:805–8.
- 22 Hoy G, Wood T, Phillips N, *et al*. When physiology becomes pathology: the role of magnetic resonance imaging in evaluating bone marrow oedema in the humerus in elite tennis players with an upper limb pain syndrome. *Br J Sports Med* 2006;40:710–3.
- 23 Koh E, Walton ERJ, Watson P. VIBE MRI: an alternative to CT in the imaging of sports-related osseous pathology? *Br J Radiol* 2018;62:20170815.
- 24 Ang EC, Robertson AF, Malara FA, *et al*. Diagnostic accuracy of 3-T magnetic resonance imaging with 3D T1 VIBE versus computer tomography in pars stress fracture of the lumbar spine. *Skeletal Radiol* 2016;45:1533–40.
- 25 Warden SJ. Prophylactic use of NSAIDs by athletes: a risk/benefit assessment. *Phys Sportsmed* 2010;38:132–8.
- 26 Leal C, D'Agostino C, Gomez Garcia S, *et al*. Current concepts of shockwave therapy in stress fractures. *Int J Surg* 2015;24:195–200.
- 27 Lee JC, Malara FA, Wood T, *et al*. MRI of stress reaction of the distal humerus in elite tennis players. *AJR Am J Roentgenol* 2006;187:901–4.

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