International Emergency Nursing xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

International Emergency Nursing

journal homepage: www.elsevier.com/locate/aaen

Female athlete triad: At breaking point

Martin Duignan [a,*], Niall O'Connor [a,b]

[a] Our Lady's Hospital, Navan, Ireland
[b] Our Lady of Lourdes Hospital, Drogheda, Ireland

ARTICLE INFO

Article history:
Received 11 November 2016
Accepted 26 March 2017
Available online xxxx

Keywords:

Female triad
Stress fracture
Advanced practice

1. Initial case presentation

A 29 year old female (Ms. Jones) presented to the Emergency Department (ED) with left lower leg pain which developed while she was out running the previous day. The triage nurse streamed the patient to the Registered Advanced Nurse Practitioner (RANP) (Appendix 1) in the ambulatory care area (ACA) for assessment. The patient was mobilising independently with a fluid gait.

2. Relevant history

Ms. Jones reported that she had been seen in another ED three months previously with a similar pain in the same lower leg. On that occasion, she was diagnosed with 'shin splints', and she reported that the pain had resolved over a number of weeks. Significantly, she also reported a stress fracture in her left femur two years earlier. Against this background, it was important to ask this lady regarding her exercise history. She reported running in excess of 70 km/week, and conceded she rarely took rest days. She admitted that the pain had been ongoing, initially occurring towards the end of her run, but was now occurring throughout her run session. During questioning she became tearful and said that stopping running was 'not an option' for her as she felt that running was intrinsically linked to her mental health.

3. Initial diagnostic thinking and physical examination findings

The RANP immediately felt that Ms. Jones may be a compulsive over-exerciser, and this sense combined with the risk factors of distance running [1], female sex [1] previous stress fracture [2] and lean body type heighted the suspicion of female athlete triad and specifically a stress fracture. She denied a history of disordered eating but admitted she did not drink milk or eat dairy products. She reported normal menses and reported normal bone health from a bone densitometry scan which was performed following her femoral stress fracture. The look, feel, move, special tests approach was used to frame Ms. Jones assessment in the ED with the affected leg being compared to the contralateral side [3]. This lady was observed to mobilise with a mild limp while transferring from the triage room to the ACA. She did not appear to have either a postural or structural lower limb abnormality. She was asked but was unable to perform a single leg squat as a functional test on the left leg due to pain, suggesting a compromised ability to attenuate loads [4] Swelling, erythema and increased heat was observed over the anterior lower leg at the junction of the middle and distal 1/3 of the tibia. Maximal bony tenderness was over the left tibial spine. Neurovascular assessment included assessment of motor and sensory nerves, pulses above and below the areas of tenderness and capillary refill. Full normal active and passive range of movements were preserved at the knees above and the ankle and feet below.

Although a vibrating tuning fork applied to the area of tenderness to aid the clinical diagnosis has been proposed as a specialist diagnostic test this modality is not supported and was therefore not utilised in this case [5].

* Corresponding author at: Emergency Department, Our Lady's Hospital, Navan, Co. Meath, Ireland.
E-mail address: martin.duignan@hse.ie (M. Duignan).

http://dx.doi.org/10.1016/j.ienj.2017.03.005

As part of her clinical assessment, her height and weight were recorded due to her underweight appearance. Her height was 180 cm and her weight was 54.5 kg giving a body mass index of 16.8 (underweight).

4. Overview of female athlete triad and bone stress injuries

The female athlete triad (Box 1) is a serious health concern for the young female athletic population [6–8]. As the name suggests it is made up of three components and the presence of the triad or any of its components increases the risk for bone stress fractures in the female athletic population [9].

Box 1 Female Athlete Triad.
Female Athlete Triad

1. Low bone mineral density or disordered eating
2. Low body mass index
3. Menstrual irregularity or prolonged absence of menses

Bone stress injuries exist on a continuum from stress reactions to stress fractures [4], with the incidence of stress fractures in female athletes reported in the literature being in the range of 1.86–18.7% [10]. Although the incidence of tibial bone stress injury in runners has not been elucidated [11], they are the most common stress fractures seen in active populations [12]. Bone stress injuries can be divided into those that are at high risk and those that are of low risk of malunion (Table 1) [5,10,13–16].

Low-risk stress fractures generally heal without complication and the corner-stone of management is a two-phase process. The initial stage involves activity modification followed by a graduated and step-wise second phase which involves a return to activity [4]. Pain intensity is used as a guide to increase loading.

High-risk stress fractures are a management challenge as they are at risk of non-union and progression to complete fracture. Additionally, more aggressive treatment is required and a return to full activity requires a longer period of time to minimise the risk of injury progression. In tibial stress fractures non-operative management usually takes longer than 6 months [17]. In addition to treating the stress injury, it is also important to address the underlying reasons which predisposed the patient to the fracture. For example menstrual abnormality may occur in as many as 51% of endurance runners [18]

5. Diagnostic tests

Plain X-rays are the first choice of imaging for suspected bone stress injuries due to their availability and low costs. However, they have low sensitivity of between 10 and 50% for detecting these injuries, particularly early in the clinical course [19]. Ms. Jones was cautioned that her normal initial plain X-rays (Fig. 1) did not exclude a bone stress injury as symptoms often precede radiographic changes [20]. Diagnostic musculoskeletal ultrasound has limited utility [5,21] and was not utilised.

Fig. 1. Initial X-ray.

Laboratory tests were requested to determine nutritional or hormonal abnormalities. These included full blood count, inflammatory markers and bone profile which returned with all results within normal parameters.

6. Initial discharge

RANPs interact and care for patients in a manner which extends beyond the medical management of their injury and which results in a clinical encounter sensitive to the patients perspective [22]. In this care episode, it was necessary to modify Ms. Jones activity (i.e. to ensure she did not continue to run due to the possibility of propagating the injury) while recognising the importance of exercise to her. It was emphasized to the patient that a stress fracture was suspected and that high-intensity or prolonged-duration activities such as running would result in repetitive microtrauma that would further weaken the architecture of the bone [23] and exacerbate her symptoms.

Table 1
Low-high risk stress fractures.

Low risk of non-union	High risk of non-union
Fractures of the pubic ramus	Femoral neck fractures (involving the Superior cortex)
Femoral neck fractures (involving the medial cortex)	Tibial shaft fractures (involving the anterior cortex)
Femoral shaft fractures	Fractures of the medial malleolus
Tibial shaft fractures (involving the posteromedial cortex)	Fractures of the talus neck
Fractures of the fibula	Navicular fractures
Calcaneal Fractures	Proximal fractures of the 2nd metatarsal
Cuboid Fractures	5th metatarsal (proximal diaphysis)
Cuneiform fractures	Great metatarsal sesamoids
Lateral malleolus Fractures of the distal 2nd to 4th metatarsals	Patella

Please cite this article in press as: Duignan M, O'Connor N. Female athlete triad: At breaking point. Int. Emerg. Nurs. (2017), http://dx.doi.org/10.1016/j.ienj.2017.03.005

An exercise prescription, prescribing aerobic exercise which minimised impact and load, such as cycling, swimming and using an elliptical cross-trainer, was provided to the patient to maintain cardiovascular fitness. Weight bearing was initially allowed as the patient was able to ambulate without pain [15]. A multi-modal pain management regime of analgesics, activity modification as described and appropriate loading was prescribed. Due to the potential for adverse effects on bone healing, non-steroidal anti-inflammatory medications (NSAIDs) did not form part of the pain management plan [24]. Additionally, 800iu Vitamin D and 1500 mg calcium supplementation was prescribed daily due to its prophylatic role in preventing fractures [10,25–27].

7. Review clinic

Ms. Jones was followed up at the consultant led review clinic two weeks post initial presentation. The review clinic provides senior clinician review for patients whom the emergency medicine doctors and RANPs feel require such follow up, but who do not meet the requirement for referral to a tertiary clinic (e.g. fracture clinic).

Re-examination revealed an increasingly antalgic gait with bilateral tibial bony tenderness and a small area of anterior bruising over the right tibial spine. The patient admitted that she had not been compliant with her discharge advice or exercise prescription and had continued running daily. She reported increasing right lower leg pain following her runs over the previous ten days.

At this review, the patient was re-questioned regarding her history. She admitted a history of anorexia nervosa during her adolescent years which required extended periods of hospitalisation and also secondary amenorrhea during her mid-teenage years. This new information was relevant to her current presentation as research suggests that approximately 50% of peak bone mass is accrued during adolescence and this is a 'bone-bank' on which adults draw for their entire lives [28]. She reported that she was now recovered and ate a 'normal' diet (albeit although she did not drink milk or eat dairy products). When Ms. Jones was advised that she would need a dual-energy X-ray absorptiometry (DEXA) scan she admitted to oligomenorrhea (i.e. menstrual cycles occurring greater than 35 days apart [29] with fewer than 5 menses per year. This was particularly relevant as 49% of female collegiate athletes who had less than 5 menses per year were found to have a stress fracture in a study by Barrow [30] with an incidence of 29% found in those who had 10–13 menses a year.

Fig. 2. Follow-up X-ray (8 weeks following initial X-ray).

Bilateral magnetic resonance imaging (MRI) scans of both lower legs were requested. MRI is both sensitive and specific for stress fracture [9], and also provides information which assists in excluding other potential causes of the patients symptoms [31]. The MRI of the left lower leg revealed a stress fracture of the anteromedial distal tibial diametaphysis with adjacent cortical thickening, periosteal reaction and soft tissue oedema. MRI of the right lower leg excluded a stress fracture but revealed bone marrow oedema with mild cortical thickening and soft tissue oedema suggestive of a bone stress reaction. The left lower leg stress fracture was thought to be high risk for malunion. Despite this, the left leg was not immobilised in cast, as it was felt that this would increase the loading through the contralateral right leg and may propagate the existing bone stress reaction.

A dual-energy X-ray absorptiometry (DEXA) scan was delayed due to this lady's irregular menses and was only performed post her referral to Orthopaedics. This was four months following her ED presentation and demonstrated normal bone density which excluded osteopenia or osteoporosis. Referrals and Follow-Up.

Ms. Jones was referred to our Orthopaedic trauma clinic. Her left leg was immobilised in an pneumatic walking brace at the fracture clinic to achieve some off-loading. The possibility of surgical intervention was discussed with the patient due to the risk of poor outcomes including fracture progression, delayed healing, non-union and chronic pain [32]. Radiographs were repeated at clinic eight weeks after the initial radiographs and these confirmed the presence of healing stress fractures (Fig. 2). She was also referred to the nutrition and dietetics department. She completed the self-report Eating Disorders Examination-Questionnaire (EDE-Q) which suggested disordered eating behaviour, and was subsequently followed up by the clinical psychology services. Physical activity was advanced slowly over the following 6 months using pain as a clinical guide and by alternating and moderating activities. Good bone consolidation was achieved five months post referral with resolution of her clinical symptoms. She was provided with a return to sport strategy by the department of rehabilitation following four weeks of pain free ambulation. This strategy focused on training periodisation as a method of allowing adequate adaptation to the stress imposed by distance running.

8. Learning points

- Eliciting a comprehensive health and clinical history may not be possible during the initial ED clinical encounter as patients may decline or not be comfortable in providing information they do not see as relevant to the current presentation; however persistence with important history questions may illicit more details during subsequent follow-up visits.
- The female athlete triad is characterised by low energy availability, menstrual dysfunction and bone loss.
- Bone stress injuries exist on a continuum from stress reactions to stress fracture.
- Anatomical location determines whether the fracture is high or low risk for malunion.
- Although bilateral stress injuries are rare, clinicians should maintain a high index of suspicion in the young female athletic population.

Please cite this article in press as: Duignan M, O'Connor N. Female athlete triad: At breaking point. Int. Emerg. Nurs. (2017), http://dx.doi.org/10.1016/j.ienj.2017.03.005

9. Conclusion

As senior decision makers, ED RANP's negotiate not only the evidence but also the individual patient contextual factors to inform their clinical care. RANP's are uniquely positioned to recognise and inquire about the female athlete triad in the young female exercising population presenting following injury. RANP's need to be particularly cognisant of the relationship between the female athlete triad and injury risk. In this case, the patient had all three components of the triad i.e. menstrual dysfunction, disordered eating and low body mass index. Additionally, she sought to minimise each of these components during her initial presentation, which illustrates the necessity for a broader awareness of factors complicating seemingly simple injuries. Appropriate recognition and management of these injuries mitigates against the risk of a complicated recovery and allows appropriate referral and involvement of the multidisciplinary team as demonstrated in this case.

Appendix 1: Author and Section Editor's note

Registered Advanced Nurse Practitioner (RANP)

Is a protected title for a nurse who is on the Nursing and Midwifery Board of Ireland (NMBI) register of Advanced Nurse Practitioners. She/he must have fulfilled the criteria and standards for the specific advanced practice role. These include

- Be educated to master's degree level (or higher)
- Have a minimum of seven years post-registration experience
- Five years experience in the chosen area of specialist practice
- Demonstrate competencies relevant to context of practice
- Provide evidence of continuing professional development

In addition to the registration criteria, the clinical role rests on the four core concepts of autonomy in clinical practice, expert practice, professional and clinical leadership and research.

References

[1] Thein-Nissenbaum J. Long term consequences of the female athlete triad. Maturitas 2013;75(2):107–12.
[2] Tenforde AS, Sayres LC, McCurdy ML, Sainani KL, Fredericson M. Identifying sex-specific risk factors for stress fractures in adolescent runners. Med Sci Sports Exerc 2013;45(10):1843–51.
[3] Purcell D. Minor injuries: a clinical guide. Edinburgh; New York: Elsevier Churchill Livingstone; 2010.
[4] Warden SJ, Davis IS, Fredericson M. Management and prevention of bone stress injuries in long-distance runners. J Orthop Sports Phys Ther 2014;44(10):749–65.
[5] Schneiders AG, Sullivan SJ, Hendrick PA, Hones BDGM, McMaster AR, Sugden BA, et al. The ability of clinical tests to diagnose stress fractures: a systematic review and meta-analysis. J Orthop Sports Phys Ther 2012;42(9):760–71.
[6] Birch K. Female athlete triad. BMJ 2005;330(7485):244–6.
[7] Hasdemir PS, Oral O, Calik E, Ulusoy M, Varol R, Ozcakir HT. Evaluation of female athlete triad and gynecological complaints in young Turkish female athletes. Clin Exp Obstet Gynecol 2016;43(2):258–61.
[8] Marcason W. Female athlete triad or relative energy deficiency in sports (RED-S): is there a difference? J Acad Nutr Diet 2016;116(4):744.
[9] Pegrum J, Crisp T, Padhiar N. Diagnosis and management of bone stress injuries of the lower limb in athletes. BMJ 2012;344(apr24 3). e2511-e2511.
[10] Wentz L, Liu P-Y, Haymes E, Ilich JZ. Females have a greater incidence of stress fractures than males in both military and athletic populations: a systemic review. Mil Med 2011;176(4):420–30.
[11] Rajasekaran S, Finnoff JT. Exertional leg pain. Phys Med Rehabil Clin N Am 2016;27(1):91–119.
[12] Anderson RB, Cohen BE. Stress fractures of the foot and ankle. In: Mann's surgery of the foot and ankle. Philadelphia, PA: Saunders Elsevier; 2014. p. 1688–722.
[13] Boden BP, Osbahr DC, Jimenez C. Low-risk stress fractures. Am J Sports Me. 2001;29(1):100–11.
[14] Boden BP, Osbahr DC. High-risk stress fractures: evaluation and treatment. J Am Acad Orthop Surg 2000;8(6):344–53.
[15] Chen Y-T, Tenforde AS, Fredericson M. Update on stress fractures in female athletes: epidemiology, treatment, and prevention. Curr Rev Musculoskelet Med 2013;6(2):173–81.
[16] Kaeding CC, Yu JR, Wright R, Amendola A, Spindler KP. Management and return to play of stress fractures. Clin J Sport Med 2005;15(6):442–7.
[17] McInnis KC, Ramey LN. High-risk stress fractures: diagnosis and management. PM&R 2016;8(3):S113–24.
[18] De Souza MJ, Williams NI, Nattiv A, Joy E, Misra M, Loucks AB, et al. Misunderstanding the female athlete triad: refuting the IOC consensus statement on relative energy deficiency in sport (RED-S). Br J Sports Med 2014;48(20):1461–5.
[19] Swischuk LE, Jadhav SP. Tibial stress phenomena and fractures: imaging evaluation. Emerg Radiol 2014;21(2):173–7.
[20] Knobloch K, Schreibmueller L, Jagodzinski M, Zeichen J, Krettek C. Rapid rehabilitation programme following sacral stress fracture in a long-distance running female athlete. Arch Orthop Trauma Surg 2007;127(9):809–13.
[21] Moran DS, Evans RK, Hadad E. Imaging of lower extremity stress fracture injuries. Sports Med 2008;38(4):345–56.
[22] ter Maten-Speksnijder AJ, Dwarswaard J, Meurs PL, van Staa A. Rhetoric or reality? What nurse practitioners do to provide self-management support in outpatient clinics: an ethnographic study. J Clin Nurs 2016 [cited 2016 Aug 13]; Available from: http://doi.wiley.com/10.1111/jocn.13345.
[23] Diehl JJ, Best TM, Kaeding CC. Classification and return-to-play considerations for stress fractures. Clin Sports Med 2006;25(1):17–28.
[24] Ziltener J-L, Leal S, Fournier P-E. Non-steroidal anti-inflammatory drugs for athletes: an update. Ann Phys Rehabil Med 2010;53(4):278–88.
[25] McCabe MP, Smyth MP, Richardson DR. Current concept review: vitamin D and stress fractures. Foot Ankle Int 2012;33(6):526–33.
[26] Sonneville KR, Gordon CM, Kocher MS, Pierce LM, Ramappa A, Field AE. Vitamin D, calcium, and dairy intakes and stress fractures among female adolescents. Arch Pediatr Adolesc Med 2012;166(7) [cited 2016 Aug 29]; Available from: http://archpedi.jamanetwork.com/article.aspx?doi=10.1001/archpediatrics.2012.5.
[27] Tenforde AS, Sayres LC, Sainani KL, Fredericson M. Evaluating the relationship of calcium and vitamin D in the prevention of stress fracture injuries in the young athlete: a review of the literature. PM&R 2010;2(10):945–9.
[28] Loud KJ, Gordon CM. Adolescent bone health. Arch PediatrAdolesc Med 2006;160(10):1026.
[29] Greydanus DE, Omar H, Pratt HD. The adolescent female athlete: current concepts and conundrums. Pediatr Clin North Am 2010;57(3):697–718.
[30] Barrow GW, Saha S. Menstrual irregularity and stress fractures in collegiate female distance runners. Am J Sports Med 1988;16(3):209–16.
[31] Datir AP, Saini A, Connell D, Saifuddin A. Stress-related bone injuries with emphasis on MRI. Clin Radiol 2007;62(9):828–36.
[32] Menge TJ, Looney CG. Medial malleolar stress fracture in an adolescent athlete. J Foot Ankle Surg 2015;54(2):242–6.

Please cite this article in press as: Duignan M, O'Connor N. Female athlete triad: At breaking point. Int. Emerg. Nurs. (2017), http://dx.doi.org/10.1016/j.ienj.2017.03.005