CASE REPORT

Proximal base stress fracture of the second metatarsal in a Highland dancer

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SUMMARY

A 15-year-old female Highland dancer presented to the accident and emergency department with an ankle inversion injury on a background of several weeks of pain in the right foot. A radiograph of the right foot demonstrated a stress fracture at the base of the second metatarsal. She was treated conservatively with a below knee removable supportive walking boot with a rocker bottom sole. She re-presented to the accident and emergency department 3 weeks later with pins and needles in the right foot; she was given crutches to use along side the supportive walking boot. Radiographs 12 weeks after the first presentation showed healing of the stress fracture. The patient was now asymptomatic of the injury. She was unable to fully train for 12 weeks due to the injury. Conservative management was successful in this patient.

BACKGROUND

Proximal stress fractures of the second metatarsals have been documented in the literature with respect to ballet dancers, athletes and military personnel. Compared to non-proximal stress fractures, proximal stress fractures of the second metatarsal are particularly uncommon. To the best of our knowledge, we report the first documented case of a stress fracture at the proximal base of the second metatarsal in a Highland dancer. Highland dancing is a traditional form of competitive solo dancing originating from the Highlands of Scotland. Stress fractures are the result of a repeated force that partially or completely damage the bone with a force lower than that needed to fracture the bone; they are not related to acute trauma. There have been various treatment methods attempted, including conservative management with rest and orthotics, open reduction and internal fixation with bone grafting and external shockwave therapy.

CASE PRESENTATION

A 15-year-old Caucasian woman presented to the accident and emergency (A&E) department with right foot pain thought to be secondary to an ankle inversion injury incurred during training. However, she had been experiencing pain in the right foot for several weeks prior to presentation, likely due to the insidious presentation of the stress fracture. She began highland dancing at the age of 5 years and now trains to an international level. A radiograph confirmed a right-sided stress fracture to the base of the second metatarsal. She re-presented to the accident and emergency department 3 weeks later with pins and needles in the right foot; she was given

crutches to use along side the supportive walking boot. The altered sensation was thought to be due to a change in gait and weight distribution secondary to the use of a supportive walking boot. She was born at 37 weeks gestation by spontaneous vaginal delivery. She takes no regular medications and is allergic to penicillin. Menarche began at the age of 15 and she continues to have regular menstrual cycles. There were no neonatal or early developmental problems. Her medical history consists of an innocent heart murmur. She has no surgical history. No relevant family history. Previously, she had been assessed for other Highland dancing-related injuries: multiple right ankle inversion injuries and a right ankle avulsion fracture at the tip of the fibula at age 6. She was treated conservatively on all occasions. At age 14, she was diagnosed with ankle ligament laxity leading to ankle instability. Training and competitions are mostly held on wooden floors with the occasional carpet surface.

INVESTIGATIONS

Initial radiographs of the right foot confirmed a stress fracture at the base of the second metatarsal (figure 1A) with a magnified view (figure 1B) of the right foot metatarsals.

TREATMENT

The patient was treated conservatively with a supportive walking boot with a rocker bottom sole and crutches. The advice given was complete rest for 6 weeks, with partial weight bearing after this period, with no high impact activities for 12 weeks; this included Highland dancing.

OUTCOME AND FOLLOW-UP

Repeat radiographs at 12 weeks confirmed the healing of the stress fracture and importantly the patient was asymptomatic of the injury. Conservative management with a supportive walking boot, crutches and rest enabled the patient to return to Highland dancing 12 weeks after the initial injury.

Follow-up radiographs of the right foot (figure 2A) with a magnified view (figure 2B) of the right foot metatarsals, demonstrating the healing of the stress fracture at the base of the second metatarsal, at 12 weeks postinjury.

DISCUSSION

Stress fractures are common injuries in dancers,^{1–8} athletes^{8–14} and military personnel,¹⁵ especially to the lower extremities. Stress fractures are a manifestation of repeated bone stress in occurrence with

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Figure 1 (A) Radiograph demonstrating a right-sided stress fracture to the base of the second metatarsal. (B) Radiograph with a magnified view of the stress fracture.

defined risk factors. They are caused by repetitive stress to the bone that is not enough to fracture the bone with a singular episode. Common anatomical sites include the metatarsals, tibia, fibula and the tarsal navicular.^{9 16} They are largely thought to be over use injuries.⁹ In the general population, the shaft of the second metatarsal is the site most at risk of developing a stress fracture.^{17 18} However, it has been shown in ballet dancers that the base of the second metatarsal is the most common location for a stress fracture,^{17 18} with this site being a high-risk location.¹⁹ Our case demonstrates that the same may be true in Highland dancers.

Studies have shown a higher rate of stress fractures among female athletes, compared to male athletes.²⁰ One theory that has been discussed repeatedly is that of the 'female triad' of: an eating disorder (anorexia or bulimia nervosa), amenorrhoea or menstrual disturbances and low bone density.^{21 22} Our case study does not seem to fit the stereotype of the female triad.

Delayed diagnosis is relatively common given that the symptoms of stress fractures are fairly non-specific and do not lead to definitive disability.⁷ Importantly, stress fractures occur in a cohort that is mostly reluctant to take time out of training until an injury becomes more actively disabling. One study showed

Figure 2 (A) Follow-up radiographs demonstrating healing of the right-sided stress fracture to the base of the second metatarsal, at 12 weeks postinjury. (B) Follow-up radiographs with a magnified view of the healing stress fracture, at 12 weeks post-injury.

that patients took an average of 3.30 weeks to present after the onset of symptoms of the stress fracture.¹¹ Our case study reinforces this finding, in that the patient took several weeks to present and even then only because a more active injury had been sustained.

Risk factors can be divided into intrinsic and extrinsic qualities^{1 23} that are imposed on the athlete. Intrinsic factors include both mechanical and physiological risk factors. These relate to bone density and include delayed menarche, amenorrhoea, anorexia nervosa and poor nutrition.^{7 16 23–25} Naturally, age, sex and ethnicity are likely contributory factors. Extrinsic factors relate to repetitive activity, overtraining, poor technique, unsuitable equipment, training surface and orthotics.^{16 23 24}

Our case was diagnosed by history, examination and radiographic findings. A previous study has shown that one-third of stress fractures may be missed on initial radiographs.⁷ Radiographs may be normal for the first 2–3 weeks after stress fracture development.¹ MRI had been suggested necessary to differentiate a stress fracture from synovitis of the Lisfranc joint⁶; however, they both require the same conservative management. Currently, MRI is not considered essential in the diagnosis of a metatarsal stress fracture. CT may also play a part when identifying the exact location of the stress fracture¹ and for assessment of healing and diagnosing non-union.⁶

Conservative treatment is the accepted management for these patients with the use of orthotics being paramount. Historically, patients are limited in their activities for up to 12 weeks. Recent studies have shown that with the use of orthotics, bracing and modified training shoes, the athletes may be able to train while the stress fracture is healing without delaying healing and fracture union.⁸ The patient presented in this case was limited to upper arm exercises only during the first 12 weeks.

It is largely considered that the disappearance of tenderness in the area of the second metatarsal is the best indicator for when return to activity is most appropriate. However, it is still important that dancers return to full training gradually.¹ Furthermore, resolution of pain is not necessarily correlated with the union of stress fracture, and repeat radiographs should still be sought.²⁰

Residual symptoms following a stress fracture are common and a refracture is a possibility.⁷

In conclusion, early conservative management with supportive walking boot and crutches was successful for this patient, leading to a return to training within 12 weeks of the initial injury. Stress fractures at the base of the second metatarsal require a high index of suspicion for diagnosis and Highland dancing may be included in this category.

Learning points

- ▶ Early diagnosis is beneficial.
- ▶ Delayed presentation is common.
- ▶ A high index of suspicion is required.
- ▶ Conservative management is appropriate for most patients.
- ▶ Significant time out of training is an issue.

Contributors All authors contributed to the writing and editing of the case report.

Competing interests None.

Patient consent Obtained.

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REFERENCES

- 1 Albisetti W, Perugia D, Bartolomeo OD, *et al.* Stress fractures of the base of the metatarsal bones in the young trainee ballet dancers. *Int Orthop* 2010;34:51–5.
- 2 Davidson G, Pizzari T, Mayes S. The influence of second toe and metatarsal length on stress fractures at the base of the second metatarsal in classical dancers. *Foot Ankle Int* 2007;28:1082–6.
- 3 Dobrindt O, Hoffmeyer B, Ruf J, *et al.* Estimation of return-to-sports-time for athletes with stress fracture—an approach combining risk level of fracture site with severity based on imaging. *BMC Musculoskelet Disord* 2012;13:139.
- 4 Kadel NJ. Foot and ankle injuries in dance. *Phys Med Rehabil Clin N Am* 2006;17:813–26.
- 5 Kennedy JG, Hodgkins CW, Guyette S. Foot and ankle injuries in dancers. *Int Sports Med J* 2007;8:141–65.
- 6 Muscolo L, Miguez A, Slullitel G, *et al.* Stress fracture nonunion at the base of the second metatarsal in a ballet dancer: a case report. *Am J Sports Med* 2004;32:1535–7.
- 7 O'Malley MJ, Hamilton WG, Munyak J, *et al.* Stress fractures at the base of the second metatarsal in ballet dancers. *Foot Ankle Int* 1996;17:89–94.
- 8 Queen RM, Crowder TT, Johnson H, *et al.* Treatment of metatarsal stress fractures: case reports. *Foot Ankle Int* 2007;28:506–10.
- 9 Ardnt A, Westblad P, Ekenman I, *et al.* A comparison of external plantar loading and in vivo local metatarsal deformation wearing two military boots. *Gait Posture* 2003;18:20–6.
- 10 Chuckpaiwong B, Cook C, Nunley J. Stress fractures of the second metatarsal base occur in non-dancers. *Clin Orthop Relat Res* 2007;461:197–202.
- 11 Heaslet MW, Kanda-Mehtani SL. Return-to-activity levels in 96 athletes with stress fractures of the foot, ankle, and leg: a retrospective analysis. *J Am Podiatr Med Assoc* 2007;97:81–4.
- 12 Korpelainen R, Orava S, Karpakka J, *et al.* Risk factors for recurrent stress fractures in athletes. *Am J Sports Med* 2001;29:304–10.
- 13 Queen RM, Abbey AN, Chuckpaiwong B, *et al.* Plantar loading comparisons between women with a history of second metatarsal stress fractures and normal controls. *Am J Sports Med* 2009;37:390–5.
- 14 Weist R, Eils E, Rosenbaum D. The influence of muscle fatigue on electromyogram and plantar pressure patterns as an explanation for the incidence of metatarsal stress fractures. *Am J Sports Med* 2004;32:1893–8.
- 15 Chuckpaiwong B, Cook C, Pietrobon R, *et al.* Second metatarsal stress fracture in sport: comparative risk factors between proximal and non-proximal lesions. *Br J Sports Med* 2007;41:510–14.
- 16 Pecina MM, Bojanic I. Stress fractures. In: Pecina MM, Bojanic I, eds. *Overuse injuries of the musculoskeletal system*. 2nd edn. Boca Raton, FL: CRC Press, 2004:315–37.
- 17 Harrington T, Crichton KJ, Anderson IF. Overuse ballet injury of the base of the second metatarsal. A diagnostic problem. *Am J Sports Med* 1993;21:591–8.
- 18 Micheli LJ, Sohn RS, Solomon R. Stress fractures of the second metatarsal involving Lisfranc's joint in ballet dancers. A new overuse injury of the foot. *J Bone Joint Surg Am* 1985;67:1372–5.
- 19 Boden BP, Osbahr DC, Jimenez C. Low-risk stress fractures. *Am J Sports Med* 2001;29:100–11.
- 20 Orava S. Stress fractures. *Br J Sports Med* 1980;14:40–4.
- 21 Monteleone GP Jr. Stress fractures in the athlete. *Orthop Clin North Am* 1995;26:423–32.
- 22 Gibbs JC, Williams NI, De Souza MJ. Prevalence of individual and combined components of the female athlete triad. *Med Sci Sports Exerc* 2013;45:985–96.
- 23 Bennell K, Matheson G, Meeuwisse W, *et al.* Risk factors for stress fractures. *Sports Med* 1999;28:91–122.
- 24 Bennell K, Malcom S, Thomas S. Risk factors for stress fractures in track and field athletes. A twelve-month prospective study. *Am J Sports Med* 1996;24:810–18.
- 25 Duckham RL, Peirce N, Meyer C, *et al.* Risk fractures for stress fracture in female endurance athletes: a cross-sectional study. *BMJ Open* 2012;2:e001920.

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