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Femoral Neck Stress Fracture and Medial Tibial Stress Syndrome Following High Intensity Interval Training (HIIT) : A Case Report

Tan DS *et al.* Stress injury after HIIT

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Abstract

BACKGROUND

Femoral and tibial stress injuries are commonly found in long distance running athletes. Stress fractures have rarely been reported in athletes performing high intensity interval training (HIIT) exercise. The objective of this study was to report a case of a patient who presented with medial tibial stress syndrome and femoral neck stress fracture after performing HIIT exercises.

CASE SUMMARY

A 26 year old female presented with bilateral medial tibial pain. She had been performing HIIT exercise for 45 minutes, five times weekly, for a seven month period. Her tibial pain was gradual in onset, and was now severe and worse on exercise, despite six weeks of rest. Magnetic resonance imaging (MRI) revealed bilateral medial tibial stress syndrome. As she was taking norethisterone for birth control, a dual energy X-ray absorbitometry (DEXA) scan was performed which demonstrated normal bone mineral density of her lumbar spine and femoral neck.

She was managed conservatively with analgesia and physiotherapy, but continued to exercise against medical advice. She presented again six months later with severe right hip pain. MRI of her right hip demonstrated an incomplete stress fracture of her subtrochanteric region. Her symptoms resolved with strict rest and physiotherapy.

CONCLUSION

High intensity interval training (HIIT) may cause stress injury of the tibia and femur in young individuals.

Key Words: High intensity interval training; medial tibial stress syndrome; femoral neck stress fracture; exercise; fracture; case report

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Core Tip: Stress injuries of the femur and tibia commonly occur in long distance runners, but have rarely been reported in individuals performing high intensity interval training (HIIT). An index of suspicion for stress injury, and proper investigation is required for patients presenting with hip or tibial pain following HIIT.

INTRODUCTION

³ High Intensity Interval Training (HIIT) has become increasingly popular as a method of exercise. HIIT involves alternating periods of relatively intense work and recovery. HIIT exercises may be subdivided into aerobic exercises *e.g.* running and cycling, and body weight/resistance exercises. HIIT programs can vary greatly and combine both types of exercise [1]. The incidence and type adverse events related to HIIT exercise are not well known, with isolated case reports described in the literature. However, injury rates may be under-reported and higher than previously realised [2].

Medial tibial stress syndrome (MTSS), also known to the layman as ‘shin-splints’, is exercise-induced pain over the anterior tibia which may lead to stress fracture. MTSS is common in long distance runners and military personnel [3]. Femoral neck stress fractures (FNSF) are an uncommon but potentially disabling cause of athletes presenting with exercise-related hip and groin pain. The commonest causative sports are marathon and long-distance running. Outcomes are considerably worse for fractures with a delay in diagnosis, and displacement [4].

This study reports a case of bilateral medial tibial stress syndrome, and subsequent femoral neck stress fracture, following prolonged high intensity interval training in a young female adult. Such a ² case has not previously been reported.

CASE PRESENTATION

Chief complaints

A 26 year old female presented in the outpatient clinic with bilateral tibial pain following HIIT. Continuation of exercise resulted in severe right groin pain six months later.

History of present illness

A 26 year old female presented with bilateral medial tibial pain. She had been performing HIIT exercise for 45 minutes, five times weekly, for a seven month period. Her tibial pain was gradual in onset, and was now severe and worse on exercise, despite six weeks of rest. The patient was unwilling to cease HIIT and continued to exercise against medical advice. She presented with severe right groin pain six months later.

2 History of past illness

There was no specific underlying disease.

Personal and family history

The patient was taking norethisterone for birth control. She had previously had an open reduction and internal fixation of a right ankle fracture seven years previously and had made a full recovery.

Physical examination

On initial presentation the patient complained of pain in the anteromedial aspect of the middle third of both tibiae. There was tenderness bilaterally in these regions. Gait was normal and the patient was able to squat and tiptoe easily. Spine and bilateral hip, knee and ankle examination was within normal limits. There were no clinical features of rhabdomyolysis such as myalgia, muscle weakness or dark urine.

She presented six months later with right groin pain. Range of motion in both hips was 135/135, adduction 35/35, abduction 45/45, internal rotation 10/15 (painful and reduced motion on the right).

Laboratory examinations

Blood tests did not show any abnormality. Vitamin D level was within normal limits.

Imaging examinations

Radiographs did not show any tibial fracture. An old healed right ankle fracture fixation was seen (FIGURE 1a,b). MRI scans of both tibiae demonstrated periosteal oedema and fluid overlying the antero-medial cortices of the tibial diaphyses, but no fracture, consistent with bilateral medial tibial stress syndrome (FIGURE 2).

MRI scan of the right hip demonstrated an incomplete, undisplaced stress fracture at the medial subtrochanteric level of the right femur. (FIGURE 3)

DEXA scan demonstrated a normal BMD of the lumbar (L1-L4) vertebrae with a T-score of +0.6 and normal BMD of the left femoral neck, T-score +1.8.

MULTIDISCIPLINARY EXPERT CONSULTATION

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FINAL DIAGNOSIS

Bilateral medial tibial stress syndrome

Femoral neck stress fracture

TREATMENT

The patient was managed conservatively with analgesia and physiotherapy, but continued to exercise against medical advice. She presented again six months later with severe right hip pain.

OUTCOME AND FOLLOW-UP

The patient was warned of the risk of hip fracture requiring surgery. Her symptoms resolved with strict rest and physiotherapy.

DISCUSSION

The main objective of this study was to highlight the risk of stress injury to the tibia and femur in a young population performing HIIT. A sequential combination of these injuries is unusual and has not been reported before following HIIT.

³ High Intensity Interval Training (HIIT) has become increasingly popular as a method of exercise. HIIT involves alternating periods of relatively intense work and recovery. HIIT exercises may be subdivided into aerobic exercises *e.g.* running and cycling, and body weight/resistance exercises ^[1]. Disciplines such as Crossfit, Tabata training, F45, and 'Bootcamps' are examples of HIIT ^[5-8]. HIIT programs can vary greatly, and may combine aerobic and weight/resistance exercises.

⁴ The principle of HIIT is that a greater volume of higher intensity exercise is accumulated during a single HIIT exercise session, compared to traditional moderate-intensity continuous exercise (MICE) training ^[9,10]. It has been postulated that HIIT improves cardiovascular health, metabolic capacity, and aerobic performance, at a similar or superior rate to MICE ^[11]. HIIT may be beneficial in individuals with chronic disease ^[12-19], and in adolescents and the elderly ^[20-23]. The incidence and type adverse events related to HIIT exercise are not well known, with isolated case reports described in the literature ^[24-26]. However, injury rates may be under-reported and higher than previously realised ^[2, 27].

Medial tibial stress syndrome (MTSS), known to the layperson as 'shin-splints', is exercise-induced pain over the anterior tibia, and may lead to tibial stress fractures ^[1]. MTSS has an incidence of approximately 13 to 20% in runners, and up to 35% in military recruits ^[28]. Predisposing factors include increasing load and volume of high impact exercise, female gender, previous history of MTSS, high BMI ^[29-33], as well as Vitamin D deficiency ^[34,35].

MTSS results from accumulated cortical microdamage which exceeds the ability of the bone to repair itself [36]. Periostitis usually occurs at the site of bony injury, which is at the site of attachment of the ¹the tendinous attachments of the soleus, flexor digitorum longus, and posterior tibialis muscles.

MTSS is primarily a clinical diagnosis [37]. Imaging may be performed to exclude a more significant tibial injury such as a stress fracture. Whereas radiographs alone may detect a stress fracture, MRI is the gold standard investigation for identifying MTSS and stress fractures. MRI findings include periosteal oedema and bone marrow oedema. Isotope bone scans are less specific and sensitive than MRI. High-resolution CT is an option but has lower sensitivity than MRI or isotope bone scan. Excluding Vitamin D deficiency is also helpful [31,38].

MTSS is typically managed conservatively, with rest and lifestyle/activity modification to reduce load and stress. An ideal duration of rest and activity has not been defined. There is low-quality evidence to suggest that adjunct therapies such as ice massage, ultrasound therapy, and extracorporeal shockwave therapy, and orthotics may be of benefit. ¹Not every patient that experiences MTSS develops a tibial stress fracture. Severe tibial stress fractures may require surgical intervention [39-41].

Femoral neck stress fractures (FNSF) are an uncommon but ¹potentially disabling cause of athletes presenting with exercise-related hip and groin pain. FNSFs account for 5% of all stress fractures and 3% of all sports-related stress fractures. The commonest causative sports are marathon and long-distance running. Outcomes are considerably worse for fractures with a delay in diagnosis and displacement. ¹Risk factors for FNSFs include female gender, poor baseline physical fitness, eating disorders, amenorrhea, and decreased bone mineral density. A combination of repetitive mechanical load to the femoral neck, and bone absorption exceeding metabolic repair during remodelling, may result in FNSF. Radiographs are initially used for diagnosis but have low sensitivity. MRI scan has 100% sensitivity and is the gold standard investigation to detect FNSF. An early diagnosis is important to prevent fracture displacement and reduce risk of avascular necrosis. Management consists of surgical and non-surgical treatments,

depending upon symptoms, and fracture characteristics such as location and displacement ^[42-47].

In this case report, the patient was a female who had subjected herself to a large volume of high intensity training. MRI scanning, which is the gold standard to detect bony stress injury, was utilised to confirm the diagnosis ^[48]. Vitamin D deficiency and osteoporosis were excluded. Stress injury was detected, and treated with rest and physical therapy. Surgery was not required. A sequential combination of tibial and femoral stress injury following HIIT exercise has not been reported before. More research needs to be performed to determine a safe duration, type and intensity of exercise performed during HIIT to reduce risk of stress injury.

CONCLUSION

HIIT can lead to stress injury of the tibia and femur in a young population.

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