CASE REPORT

A tale of two pelvises

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SUMMARY

Two female doctors who were undergoing officer training at the Royal Military Academy Sandhurst sustained pubic ramus stress fractures. This report looks at the reasons why these medical officers may have sustained these fractures and how they may be prevented in future.

BACKGROUND

The risk of stress fractures in military recruits is well described in the literature with a reported incidence of 4–32%.^{1–2} The diagnosis of stress fracture is difficult to make and is often delayed.³ A large (n=2962) study⁴ of female United States Marine Corps recruits showed that predictors of stress factors in female recruits were:

- ▶ lower aerobic fitness
- ▶ history of amenorrhoea >1 year.

This study also revealed an overall incidence of stress fractures of 5.1%, with pubic rami making up 21.6% of these. Pubic ramus stress fracture was found to make up just 8% of stress fractures in an Israeli study.⁵

Female sex is a risk factor for exercise-induced injury in general⁶ and stress fractures⁷ in particular. However, some researchers have attributed the increased risk among female recruits to decreased aerobic fitness alone.⁸

Whether age is a risk factor or not remains controversial. An Israeli study⁹ suggests that risk increases by 28% for every year of age above 17, whereas there was no significant difference in age between affected and control groups in an American study.⁴

Mixed-sex marching squads increase the likelihood of female pubic ramus fracture, due to excessive stride length.¹⁰

CASE PRESENTATION**Case 1**

- ▶ Age at injury 27
- ▶ Activity at the time of onset of symptoms: loaded march
- ▶ When: week 7 of the course
- ▶ Diagnostic pathway: Initially thought to be groin strain, this patient was seen twice by a primary care nurse and once by a general practitioner. She was put on light duties. Seven days after injury, she was seen by a physiotherapist who raised the possibility of a pelvic fracture. She was seen three more times by doctors and put on crutches: non-weight-bearing initially. An MRI was performed 3 weeks postinjury showing a stress fracture of the inferior pubic ramus
- ▶ Bloods: normal.

Case 2

- ▶ Age at injury 31
- ▶ Activity at the time of onset of symptoms: marching at night carrying weight
- ▶ When: week 5 of the course
- ▶ Diagnostic pathway: This patient attended the doctor 5 days post onset of symptoms. She saw the doctors again twice and then the physiotherapist once before a presumptive diagnosis of stress fracture was made. Her MRI 5 weeks postinjury confirmed inferior pubic ramus fracture
- ▶ Bloods: normal.

Neither patient had the classic risk factors of amenorrhoea or poor aerobic fitness.

INVESTIGATIONS

Definitive diagnosis in both of these cases was made only on MRI scans of the pelvis. Calcium and bone profiles in each case had been tested and found to be normal.

Radiographic investigations to be considered when attempting to diagnose any stress fractures:

- ▶ Plain radiographs
- ▶ CT/MRI
- ▶ ⁹⁹Tc^m isotope bone scans
- ▶ Dual energy x-ray absorptiometry scans

Blood tests to consider:

- ▶ Bone/renal profile: including Ca²⁺ and PO₄
- ▶ Thyroid function tests
- ▶ Rheumatoid factor

White cell count/erythrocyte sedimentation rate/C reactive protein

In some cases, biopsy of the affected area may be necessary.

DIFFERENTIAL DIAGNOSIS

- ▶ Adductor tendonitis
- ▶ Osteitis pubis
- ▶ L2/L3 radiculopathy
- ▶ Simple 'groin sprain'
- ▶ Meralgia paraesthetica
- ▶ Athletic pubalgia
- ▶ Inguinal/femoral hernia

TREATMENT

Both of these patients were treated by protected weight-bearing on crutches for 8 weeks, physiotherapy and a graded return to full physical activity.

OUTCOME AND FOLLOW-UP

Both patients made full recoveries and went on to serve as general duties medical officers in the Royal Army Medical Corps.

To cite: Eisenstein NM. *BMJ Case Reports* Published online: [please include Day Month Year] doi:10.1136/bcr-2012-007662

DISCUSSION

The key question here is: Why did two female medical officer cadets suffer inferior pubic rami fractures when neither had specific risk factors? Neither were amenorrhoeic and nor did they have poor cardiovascular fitness, major risk factors proposed in the literature. Their female sex and age >17 were not convincing independent risk factors either. To understand these cases better, one needs to understand the root cause of stress fractures.

Aetiology

The prevailing theory as to the aetiology of stress fractures is that the bone fails to remodel sufficiently with the application of repetitive subthreshold stress.¹¹ Running and loaded marching are activities that are undertaken at high intensity and for prolonged periods during military training and provide exactly this insult to the bone. Wolff's law dictates the cellular and biochemical responses to mechanical stress, a response that is affected by the number of loading cycles, cycle frequency, strain magnitude, strain rate and strain duration per cycle.¹² Accumulated microtrauma from repetitive load leads to crack initiation and, with insufficient repair, further loading leads to crack propagation and completion. Thus, it is clear that the risk of stress fracture will increase if loading is increased and/or if the capacity to remodel and heal is impaired.

Prevention

Once the underlying mechanism leading to the development of stress fracture has been elucidated, prevention strategies become obvious. Some factors such as bone geometry, sex and age are non-modifiable. However, key modifiable factors relating directly to bone healing include low calorific intake and calcium and vitamin D intake. These well-known pitfalls have long been recognised during military training at Sandhurst, and the diet fed to recruits has been developed to be highly calorific and supplemented with calcium-containing foodstuffs. Another modifiable factor is the exposure to bone loading. Military boots are designed to absorb shock and therefore minimise strain magnitude and rate transmitted to the bone. Hill *et al*¹⁰ recognised excessive stride length as a key factor leading to excessive strain on the pubic rami in particular. When female and male recruits march together, the females are forced to increase their stride length to match the males. When mixed-sex marching was stopped, cases of pubic ramus stress fracture plummeted.

Looking at all of the relevant factors in these two cases, I think that it is the last one that is the most pertinent. Previous training courses for medical officers were shorter and less physically intense. Thus, despite mixed-sex marching in the past, pubic ramus fractures did not occur as the accumulated strain was insufficient to lead to propagation of any microfractures.

The combination of excessive female stride length in mixed-sex marching and the greater duration of training meant that in these two cases the damage accumulated beyond the ability of the bone to remodel. This lesson had already been identified,¹⁰ and it is sadly ironic that it has been forgotten by the medical officer cadets with unfortunate consequences.

Learning points

- ▶ Military cadets are at risk of stress fractures, even if they are also doctors!
- ▶ The diagnosis of pubic ramus fracture is often delayed as self-limiting hip and groin pain is common among recruits. Therefore, the diagnosis of stress fracture must be considered in all such patients.
- ▶ Diagnosis is difficult and is often confirmed only on MRI.
- ▶ Mixed-sex marching leading to excessive stride length in females may have been the key risk factor in these cases.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

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