Bone Stress Injuries in Runners

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KEYWORDS

• Stress fractures • Runners • Female athlete triad • Track and field • Cross-country

KEY POINTS

- Bone stress injuries (BSIs) are a common form of injury in runners of both sexes.
- Both biological and biomechanical risk factors may contribute to BSI.
- History and physical examination are helpful to diagnose BSI, and MRI may be useful for radiographic confirmation and grading BSI.
- Prevention strategies include screening for risk factors during preparticipation evaluation, promoting optimal nutrition, and encouraging appropriate bone loading activities, including ball sports.

INTRODUCTION

Bone stress injuries (BSIs) in runners result from the failure of skeleton to withstand repetitive, submaximal forces from running. BSI can range in severity, with early injuries showing radiographic findings of periosteal edema with varying degrees of marrow edema and more advanced stress fractures showing evidence of a fracture line. Stress fractures account for up to 20% of injuries seen in sports medicine clinic.[1]

Studies suggest the annual incidence of BSI may be greater than 20% in runners and that BSI is a common cause of injury in track and field athletes.[2,3] Early identification of a BSI is important in management, because delay in diagnosis or continued running may result in a higher-grade BSI that requires longer healing time.[4,5] This article discusses the incidence and distribution of BSI in runners. It reviews biological and biomechanical risk factors for BSI, with a focus on risk factors that can be

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efficiently evaluated in the clinic setting. It discusses evaluation and management of BSI by anatomic location and grade of injury by MRI. In addition, it reviews evidence for prevention of BSI in runners.

SUMMARY/DISCUSSION

Incidence and Distribution

The incidence of BSI varies by age and sex. In a study comparing high school sports, female and male athletes participating in cross-country had the first and third highest incidences of injuries at 10.62 and 5.42 per 100,000 athletic exposures, respectively.[6] In a separate investigation, adolescent runners of both sexes sustained stress fractures at a similar rate of approximately 4% to 5% annually.[7] Elite collegiate runners may sustain BSIs at a rate exceeding 20% per year.[2] Common sites for BSI include the tibia, fibula, metatarsals, tarsals, calcaneus, and femur.

RISK FACTORS

Risk factors for BSI can be divided into biological and biomechanical risk factors (**Table 1**). Genetics are reported to modulate fracture risk.[8] Medications, including steroids, anticonvulsants, antidepressants, and antacids, may impair bone health. Nutritional deficiencies in calcium and vitamin D increase risk for BSI.[9–11] Female athletes seem to be at greater risk for BSI than male athletes.[12] Sex-specific differences include the female athlete triad (hereafter referred to as the triad), defined as the interrelationship of energy availability, menstrual function, and bone mineral density (BMD).[13] Each aspect occurs on a continuum of health with the most severe form of the triad represented by low energy availability with an eating disorder, functional hypothalamic amenorrhea, and osteoporosis.[13] A female runner may have 1 or more components of the triad, and greater number of triad risk factors has been associated with increased risk for BSI in female athletes.[14]

In both sexes, prior fracture has been found to be a risk factor for development of BSI in runners.[7,9,15] Lower whole body bone mineral content values increase risk for BSI in female runners aged 18 to 26 years.[9] In adolescent female runners, the combination of menstrual irregularities with fracture history was associated with low bone density.[16] The largest study to date in male runners identified lower BMD as an independent risk factor for increased time for healing from a BSI.[4] In addition, athletes with

Table 1
Risk factors for BSI

Biological Factors	Biomechanical Factors
Female sex	Training patterns, including volume or changes in intensity
Genetics	Bone characteristics (thinner cortex, lower bone mineral density)
Medications (including anticonvulsants, steroids, antidepressants, antacids)	Anatomic considerations (leg length discrepancy, lean mass, foot type, smaller calf cross-sectional area)
Female athlete triad (low energy availability, menstrual dysfunction, and low bone mineral density)	
Other dietary contributors (insufficient calcium and vitamin D)	—