



STRESS FRACTURES

ACK! WHAT IS A STRESS FRACTURE?

A **stress fracture** usually starts as a crack or a partial or total break in the bone due to repeated force on the bone (instead of a single incident causing the break). They most commonly occur in the bones of the lower leg and foot due to the repetitive stress placed on the legs during activity. Stress fractures can occur in the pelvis and vertebrae of the back as well. A healthy bone would find the 'stress' of exercise a stimulant to build stronger bones but, if you are in a state of low energy availability, exercise becomes a negative stressor instead of a positive stimulant.

WHAT CAN CAUSE A STRESS FRACTURE?

A stress fracture is a type of an overuse injury. Stress fractures can occur for reasons other than low energy availability including ramping up activity too quickly, poor footwear, poor mechanics or technique, or changes in surfaces without adaptation, but are often due to an underlying energy or nutrient deficit which weakens bones and makes them more susceptible to mechanical stress. Inadequate calories, protein, calcium, or vitamin D intake impair bone strength and the ability to withstand the demands of athletic activity.

RISK FACTORS FOR STRESS FRACTURES INCLUDE:

- * Female athletes
- * Under-fueling (inadequate calorie intake)
- * Low intake of calcium, vitamin D, or protein
- * Drive for thinness
- * Endurance (cross-country running, cycling) and aesthetic-concerned sports (gymnastics, dance, diving, skating)
- * Weight loss, especially when rapid
- * Amenorrhea (not getting your period)
- * Avoidance or elimination of food groups
- * Imbalance of training demands with food intake

A stress fracture is a common manifestation of the Triad, resulting from the interplay between poor bone health, low energy availability and hormonal imbalances.

WHAT DOES A STRESS FRACTURE LOOK LIKE? A CLOSER LOOK INTO BONE REMODELING:

A stress fracture starts with a crack, which signals the bone to "clean up" around it. This hole then signals osteoclasts (cells responsible for bone resorption and breakdown) to come in. The process of rebuilding and remineralization to create strengthened bone can take 6-8 weeks.

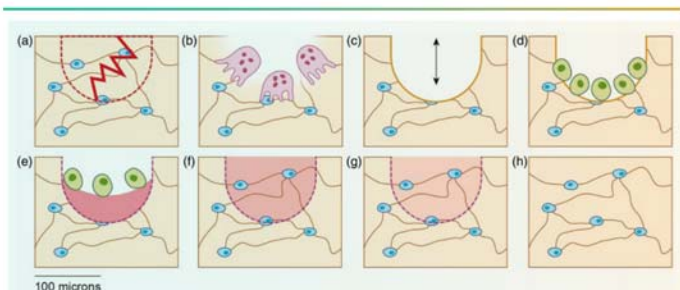


Figure 1 Schematic of bone remodeling following fatigue damage in trabecular bone. (a) Linear microcrack disrupting the osteocyte lacunocanalicular system, leading to osteocyte apoptosis in the affected area (dotted region). (b) Osteoclastic resorption of microdamaged bone. (c) Temporary negative bone space due to osteoclastic resorption. (d) Osteoblast recruitment to the remodeling space. (e) Osteoblastic deposition of unmineralized bone matrix (osteoid). (f) Primary mineralization of newly deposited matrix. (g) Secondary mineralization of bone matrix. (h) Completed remodeling cycle. (A color version of this figure is available in the online journal.)

Attributed to Hughes et al (2017)

HOW DO STRESS FRACTURES HEAL?

Stress fractures need time to heal. If under-fueling is at the root of the cause, healing will be hindered until caloric intake is corrected for. Athletes may fear eating more due to their inactivity, yet when the body is repairing bone, calories are necessary! A varied diet with adequate fats, proteins, and carbohydrates, including all the food groups to ensure calcium, magnesium, vitamin D and a host of other nutrients are provided, is necessary for proper healing.

Breakdown of bone and rebuilding of bone is an ongoing process. When there is a lessened hormonal status, which naturally occurs post-menopause, bone rebuilding is hindered. Poor energy intake hurts bone building even more than reduced hormones. When poor estrogen status (suppressed hormones) is coupled with poor energy status, as in the Triad, bone remodeling is compromised the most.

HOW ARE UNDER-FUELING AND POOR ESTROGEN STATUS RELATED TO BONE HEALTH?

Without adequate energy, exercise, the most immediate demand, is fueled. This leaves a deficit for other body systems to do their job appropriately and fully. The body

shunts energy away from some functions, such as those involved in reproduction and growth. In both females and males, the sex hormones estrogen and testosterone, respectively, are suppressed. In females, hormone levels can be decreased without loss of monthly periods (amenorrhea). It is important for female athletes to pay attention to changes in their cycle that may be indicative of low estrogen and progesterone levels, such as longer duration between periods, or shorter duration/lightening of period. Your physician might test your hormones to get better insight. Losing your menstrual cycle is a definitive sign something is amiss. Yet recognize that even if you have your period every month, you may still be in an energy deficit that can hurt your bone health. Read more about the menstrual cycle and the hormones affecting it in the handout Reproductive Hormones.

In addition, other hormonal systems are affected, such as suppressed thyroid hormones (T3) or growth hormones (IGF-1) and elevated cortisol, all of which work to suppress bone formation and increase bone resorption. Only with sufficient energy can the body “spend” calories on these systems that help to improve bone strength. It only takes 5 days at a low energy availability to affect your hormones!

Normal Bone Remodeling

Formation=Resorption

Poor Estrogen Status

Increased bone breakdown (resorption)

Poor Energy Status

Decreased IGF-1 and
Decreased bone formation

Poor Estrogen and Energy Status

Increased bone breakdown (resorption)
Decreased bone formation

Adapted from Parfitt, 1988 and Sanborn, 2005

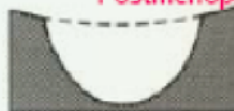
Attributed to Dr. DeSouza (FNCE 2019)

Resorption

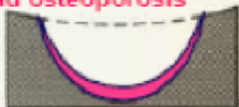
Formation



Postmenopausal osteoporosis



Female Athlete Triad osteoporosis



BOTTOM LINE:

Athletes must eat adequate calories to regain their menstrual cycle and allow for a stress fracture to heal!