Lower-Extremity Overuse Injuries: Primer on Causes and Corrections

By Mark Charrette, DC

From ankle sprains to stress fractures, shin splints to plantar fasciitis, the research is clear: These common overuse injuries of the lower extremities – among dozens of others – may be related to abnormal foot function in your patients.

The average person will walk thousands of miles over their lifetime. An average of 5,117 steps a day (much more if they’re active) reinforces foot and body problems every time the foot hits the ground.

The legs, from the feet to the hips, are frequently the source of pain and discomfort. Identifying the tissue(s) most affected provides us with a specific diagnosis. Treatment, however, must uncover and address the extrinsic and then the intrinsic causative factors.

Tissues Affected by Overuse

One of the most useful ways to categorize overuse injuries is to look at the specific tissue affected. Table 1 is a compendium, based on the major affected tissue, of symptoms, named conditions and diagnostic entities that encompass the large domain of overload injuries.

Muscles: Under repetitive strain, muscular tissues can either strengthen or break down. Chronic strain injuries, tight muscles and even sudden "pulls" develop from overwork of certain groups.

Tendons: The tendons, being connective tissues attached to muscles and exposed to frequent movement, are extremely susceptible to overload. They can develop an inflammatory response (tendinitis) or more accurately, a "tendinosis" condition.¹

Ligaments / fascia: The collagen of ligaments and fascia becomes tighter and stiffer in response to frequent overloading and eventually fails.

Bones: Normally, bones become stronger and denser in responses to repetitive, weight-bearing stimuli. If the stress is excessive, however, the bone is unable to repair and strengthen itself fast enough. A stress reaction and eventually, a stress fracture, can result. This process can occur quite rapidly; early signs of stress fractures have been found in the upper leg and hip after only two weeks of altered foot
biomechanics.²

Joints: Repetitive loading can have a detrimental effect on joints, especially when shock absorption is poor. Overuse can affect the weight-bearing joints,³ as well as those that sustain frequent movement, such as the patellofemoral joint.⁴

Nerves: Whenever nerve tissue is exposed to repetitive irritation, interruption or interference in normal signal transmission can occur. The normal body response in some of these cases is to develop an overgrowth of protective connective tissue.

| TABLE 1. OVERUSE INJURIES IN THE LOWER EXTREMITY |
|-----------------------------------------------|--------------------------------------------------|
| Tissues / Joints                             | Conditions                                        |
| Muscles                                      | Shin splints, groin strains, piriformis strains, pulled hamstrings, fascia lata tightness, compartment syndrome, plantar fasciitis, Achilles tendinitis, peroneal tendinitis, patellar tendinitis (“jumper’s knee”) |
| Tendons                                      | Plantar fasciitis, spring ligament sprains, hip joint capsulitis, compartment syndrome |
| Ligaments / Fascia                          | Plantar fasciitis, spring ligament sprains, hip joint capsulitis, compartment syndrome |
| Joints                                       | Chondromalacia patellae, degenerative joint disease of the ankle, knee and hip, osteoarthritis |
| Bones                                        | Stress reaction, bone marrow edema; stress fractures of the calcaneus, metatarsals, tarsals, tibia, and femur; sesamoiditis, tibial periostitis, calcaneal periostitis (heel spurs) |
| Nerves                                       | Morton’s (interdigital) neuromas, tarsal tunnel syndrome, nerve entrapment |

Overuse / Microtrauma

The non-trauma conditions listed in Table 1 are all due to excessive and/or repetitive motion. The end result is a "microtrauma" injury – the body is unable to keep up with the repair and re-strengthening needs, so the tissue begins to fail and becomes symptomatic. If it is not extremely painful (or if the pain is eliminated by pain-killing drugs), the excessive activity will be continued, eventually resulting in complete failure, such as a stress fracture or ligament tear. The various causes of overuse injuries are best categorized into intrinsic and extrinsic sources (Table 2).⁵

| TABLE 2. CAUSES OF OVERUSE INJURIES |
|--------------------------------------|-------------------------------------|
| Extrinsic Factors                    | Intrinsic Factors                   |
| Exercise program (intensity)         | Muscle imbalance                    |
| Exercise / work environment (surfaces)| Structural misalignment             |
| Equipment (shoes)                    | Joint dysfunction                   |
Sometimes a little detective work is needed to identify all the outside contributing factors. An example of an extrinsic source of lower-extremity overuse that is often overlooked is the forced pronation and "environmental" leg-length discrepancy due to repetitive running or walking on a banked surface, such as along the sides of roads with a pronounced slant for water runoff.⁶

**Impact Stress**

An experiment using human volunteers found that normal walking produces around 5 Gs of force on the foot and ankle, and then a shock wave (a "transient") travels rapidly up the spine. Within 10 milliseconds of heel strike (faster than we can consciously respond), the scientists recorded a .5 G impact at the skull.⁷ This is the equivalent of a 160-pound man being hit in the head by 80 pounds with each step.

Running multiplies the impact of heel strike on the body about three times (the Rule of Three).⁸ If the foot goes too far into pronation or stays too supinated, the effects are amplified. "A high-arched (cavus) foot with limited range of motion attenuates shock poorly; a hypermobile flat foot also does poorly on shock attenuation because of its function near the end of the range of motion."⁹

This is an excellent example of the interplay between extrinsic factors (whether the biomechanics can handle the forces). Several studies have found the use of a viscoelastic polymer heel cup to reduce heel strike shock will significantly decrease both foot and back symptoms, and prevent lower-extremity overuse conditions.¹⁰-¹¹ Virtually all of the conditions listed in Table 1 have been directly correlated with abnormal foot biomechanics.¹²

**Factors at Play**

*Extrinsic factors.* Causes of microtrauma injuries that originate from the outside are often the easiest to modify; they should be addressed immediately in treatment. Extrinsic factors include:

- The patient’s exercise program (such as running mileage per week, intensity of workouts, recent increases in exercising, and amount of rest time)
- Repetitive physical demands at the workplace, exercise or work surfaces (such as asphalt, concrete or rigid flooring)
- Footwear (design and materials of athletic and work shoes)
Modifications in repetitive physical activities (such as less mileage, more rest days, or work limitations) and new, more supportive shoes or custom-made orthotics should be recommended immediately.

Intrinsic factors. The individual variables associated with overuse injuries are either muscle imbalances or structural alignment problems. These factors are more difficult to modify, but must be addressed for long-term correction. In fact, this is actually the most difficult part – recognizing the intrinsic source of the overuse symptoms.

A well-designed examination is necessary to investigate the structural, biomechanical and dynamic aspects, including a search for muscle imbalances, structural misalignments and joint dysfunctions. Several intrinsic factors often combine to interfere with musculoskeletal efficiency and lead to a breakdown in a previously functioning physical system, which then becomes symptomatic.

However, a categorization such as this is somewhat simplistic. The intrinsic and extrinsic factors are closely intertwined, and both are significant contributors to most lower-extremity overuse injuries. A good example of this is the effect of impact stress during running and how well (poorly) a person absorbs the shock of each heel strike.

Foot Function and Overuse

A retrospective study looked at the characteristics of athletes who reported recent foot and leg overuse problems, and compared them with a control group. The researchers were interested in learning whether excessive pronation while standing or running was correlated with a higher possibility of developing various types of "overload" sports injuries. Sixty-six injured athletes (the study group) were compared to a control group of 216 athletes with no overuse injury symptoms. The amount of pronation during standing and while running at "regular speed" was determined by measuring the angles of their footprints (plantar prints).

The investigators found a significant correlation: Athletes with more pronation had a much greater likelihood of having sustained an overuse athletic injury. While both the standing (static) and running (dynamic) prints showed some correlation, the amount of pronation seen in the static weight-bearing footprint was the most predictive of developing an overuse injury. This study reminds us of the value of checking the alignment of the feet of patients with overuse injuries in the standing position.
Supplementing Adjustments and Exercise With Orthotics

When the feet have biomechanical problems, adjustments and exercises are helpful, but orthotics are often necessary for long-term support. A properly designed and custom-fitted orthotic will provide the following corrections throughout the day:

- Shock absorption from viscoelastic materials eases the impact at heel strike and reduces the forces on all weight-bearing joints.
- Decreasing the extent and speed of pronation reduces the medial rotation force transmitted into the knees and spine.
- Improved alignment and mobility of the arches, with less muscle and connective-tissue stretch, provides more accurate proprioception for better balance and alignment.
- Reducing calcaneal eversion with a "pronation wedge" and supporting the medial arch improves the biomechanics of the foot during gait, and provides greater efficiency during locomotion.

Daily activities and athletic endeavors expose the joints, muscles and connective tissues to high levels of repetitive stress. When treating overuse conditions in the lower extremities, we must be alert for evidence of abnormal biomechanics in the feet and altered gait. If the foot and ankle complex is not functioning correctly during the stance phase of gait, this stress is transmitted to all of the various tissues in the leg, and into the pelvis and spine. Patients who have a tendency to develop overuse injuries must have dispersion of the ground reaction forces (additional shock absorption) as an important part of their treatment and rehabilitation.

Whether a foot tends toward hyperpronation or excessive supination, undue forces are easily transmitted along the kinetic chain of the lower extremity. For long-term support and to help decrease the higher forces on the feet with strenuous activities, custom-fitted orthotics are usually necessary. By providing proper support for each phase of the gait cycle, we can ensure balanced function throughout the musculoskeletal system – from heel strike, through foot flat, to toe-off.

References


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