Our feet are the foundation for our bodies, including the pelvis and spine: they provide balance, propel us, safely absorb heel-strike shock and adapt to walking stresses. The feet provide the necessary stability to perform daily activities and are reliant upon an arched structure comprised of 3 bony arches (Fig. 1): the medial longitudinal arch (A–C), the lateral longitudinal arch (B–C) and the anterior transverse (metatarsal) arch (A–B).

Each arch consists of several bones bound together by tough, yet somewhat elastic ligaments and tendons. The strong connective tissue ensures that the structure is flexible and movable, yet is able to tolerate both sustained stress and sudden, high forces. Together, these 3 arches form an extremely strong, supportive ‘plantar vault’ that distributes the weight of the entire body.

The structural design of a 3-arched plantar vault is very good at supporting weight and carrying high loads, while remaining flexible. During normal standing the load of the body is balanced over the center of the foot, anterior to the ankle (Fig. 2). This places the greatest amount of load at the apex of the 3 arches. This force is then distributed along the ‘buttresses’ of the arches to the heel (which bears 50% to 60% of body weight) and the metatarsal heads (which bear 40% to 50% of body weight).

Arch Collapse
If any one of these 3 arches is compromised, the entire plantar vault loses its structural integrity. In addition to losing the support of the compromised arch, biomechanical stresses distress the other arches and symptoms develop. A lack of development or loss of this configuration results in abnormal force concentrations, which eventually cause degenerative and symptomatic clinical conditions (Fig. 3). Because the feet are under continuous gravitational pressure when bearing the body’s weight, the collapse of one or more arches over time is a common experience for bipedal creatures.
Interestingly, the symptoms of a collapsed arch can be expressed anywhere in the musculoskeletal system, from the legs to the pelvis and even into the back and neck. Custom-made functional orthotics align and support the structures of the feet in a near-normal physiologic position to prevent dysfunction and to improve the function of movable body parts.

**Pes planus** (flat foot)
Numerous scientific studies over the years demonstrate that the arches are maintained almost completely by passive connective tissues. Passive connective tissues do not have the viscoelastic properties that allow the arch to naturally reform after stress due to overload. It is only in the propulsive ('toe-off') phase of walking and during running that the intrinsic and extrinsic muscles come into play. This is the reason that strengthening exercises have never been found to be successful in re-developing a poorly formed or collapsed arch. The good news, however, is that most flat feet are flexible and respond rapidly to orthotic support.

Studies also show that orthotics help with non-specific symptoms, such as fatigue associated with playing 9 holes of golf. A rigid flat foot is rarely encountered and is usually due to a bony anomaly. These unusual cases require specialized treatment and will possibly require surgery.

**Excessive pronation**
At heel strike and during the initial part of stance phase, the foot normally pronates. This absorbs some of the shock of heel strike and accommodates uneven terrain.

However, if the foot stays in pronation beyond heel strike, it is hyperpronating or going into prolonged pronation. This movement occurs primarily at the subtalar and talonavicular joints, with excessive loading affecting all of the arches, but the medial arch most acutely. Excessive pronation causes an obvious flattening of the medial longitudinal arch, with a medial and inferior movement of the navicular bone. This arch collapse destroys the structural support of the plantar vault, making the body at risk for subluxations as the musculoskeletal system attempts to adapt and compensate.

**How You Can Measure Arch Collapse**
You can perform a quick test that measures the change in position of the navicular prominence to quantify the presence of arch collapse during weight-bearing. The Navicular Drop Test is especially useful because it shows the change in arch height from non-weight bearing to weight-bearing, as well as any asymmetry between left and right arches. The test helps to verify poor spinal support from the arches and demonstrates the need for orthotics to the patient. Foot Levelers, Inc. has developed a student pair to give students a sample of what orthotics can do for the feet. All students need to do to get their pair is contact us at 800.553.4860 and provide us with their information.

**What Can Orthotics Do?**

**Static support**
During standing posture, the alignment of the arches in each foot has a significant impact on the position of the legs and
When the arches are low and/or pronating excessively, the lower extremities tend to rotate medially.

**Dynamic support**

During gait, the foot undergoes substantial changes. The arches and connective tissues must sustain the stress of heel strike, then adapt to the ground during stance phase and finally become a rigid lever to provide an efficient push-off. This must all occur in a coordinated manner, with no glitches or hang-ups. The foot must permit a smooth transfer of the body’s center of mass over the leg to conserve energy and keep the work expenditure at a minimum. The heavier a patient is, the greater the stresses on the feet and ankles. This requires an orthotic to be flexible, yet supportive. Orthotic designs consider weight and intensity of forces, in addition to encouraging proper movement and function of the foot, while supporting all 3 arches.

**Postural benefits**

Only orthotics are designed to provide support for all 3 arches of the feet. Because the entire body structure is balanced on one foot at a time when walking and running, improving foot alignment can improve knee, hip, pelvis and even spinal postural alignment. A low femur head seen on properly positioned postural films indicates a difference in leg length. While there are several causes (from injury to growth asymmetry to arch collapse), most patients will benefit from the additional support provided by a pair of orthotics. An added heel lift may also be necessary in some cases. Joint degeneration (of the hip, knee or spinal joints) with wearing of the cartilage requires the additional support and shock absorption provided by orthotics. A pelvic or spinal tilt or recurrent subluxations will often respond rapidly to orthotic support of the arches (Fig. 4A & 4B).

**All It Takes is a Quick Glance at the Feet**

It's not unusual to have musculoskeletal complaints in the legs, hips and spine from malfunctioning arches. A brief screening exam can help identify the commonly seen clues: look for lowered arches, heel eversion, uneven shoe wear, Achilles tendon bowing and leg length differences. Foot Levelers’ custom-made orthotics can provide much of the support that is lacking and improve locomotive efficiency by guiding the calcaneus and arches through the gait cycle.

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**Reference**


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