WHAT, EXACTLY, IS AN EXCESSIVELY PRONATED FOOT?
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When you tell your patients (or customers) they have "excessively pronated feet," what exactly do you mean? It's a phrase used by almost everyone in the foot health care industry—from podiatrists, physiotherapists, chiropractors, and research biomechanists, to the sales assistants in the running shoe stores. However, when one considers the multitude of different presentations of a pronated foot seen in clinical practice, it's clear a single descriptor such as "excessively pronated foot" is inadequate to describe all weight-bearing feet under the influence of excessive pronation forces.

Open versus closed-chain foot pronation

Open chain (non-weight-bearing) foot pronation has been described as motion around a single axis, which includes eversion in the frontal plane, abduction in the transverse plane, and dorsiflexion in the sagittal plane (Fig. 1.). Confusion—even in medical and para-medical circles—often occurs when motion of the subtalar joint (rather than the whole foot) is described during closed-chain (weight-bearing) foot pronation, where the talus plantarflexes and adducts, and the calcaneus everts to varying degrees: plantarflexion, adduction and eversion. In addition, when one considers the kinematic compensations taking place within the joints of the lesser-tarsus and metatarsus (i.e., the forefoot), an accurate description of the resting position of the foot becomes an even more daunting task.
Foot Pronation and Supination: An Historical Perspective

The terms pronation and supination were first used in comparative anatomy to describe the unique rotation motion of the radius around the ulna at the elbow; where supination rotates the palm of the hand into an upwards position, and pronation rotates the palm towards the ground² (Fig. 2.). This motion occurs only at the radioulnar joint, and most anatomists will argue that pronation and supination do not occur in the human foot. It is unclear when the terms pronation and supination were first applied to movement of the human rearfoot; where the rotation of the fibular around the tibia at the subtalar joint is similar, but not exactly the same, as the motion that occurs at the elbow.

Fig. 2.

Morton (1922) and Weidenreich (1923) used the term pronation in papers on primate foot evolution². In 1930, Morton wrote that the foot rolled inwards into a “pronated posture,” and that the associated lowering of the medial longitudinal arch height was a “pronated deformity”². Further confusion has been caused by the interchanging of the terms inversion and supination, and eversion and pronation. Keith (1923 and 1929) used the terms inversion and eversion in papers on foot evolution. Elftman and Manter (1935) used the same terms, and described the position of a chimpanzee foot when flat to the ground as being “pronated.”² At some point in time, the terms everted foot, pronated foot, and flat foot became inappropriately synonymous. In 1952, Knowles described the problems of defining the term pronation as follows: “Unfortunately, the word is sometimes used rather loosely, even among the medical professions. The main difficulty is that there are a number of symptoms of ‘pronation’ which may not occur together, each of which has been used as the basis of a different definition of the term. Because of this, the term ‘pronation’ in the foot should be avoided.”³
Excessive Foot Pronation and Planal Dominance

Clinically, a weight-bearing pronated foot may include a combination (more than one or two, but not usually all) of the following motions at the joints of the ankle, tarsus, lesser tarsus, and metatarsus:

- Plantarflexion at the ankle joint.
- Eversion of the calcaneus at the talo-calcaneal (subtalar) joint.
- Adduction and plantarflexion of the talus at the subtalar joint.
- Dorsiflexion and inversion of the navicular at the talo-navicular joint.
- Dorsiflexion of the lesser metatarsals at the metatarsal-cuneiform joints.
- Dorsiflexion of the first metatarsal at the metatarso-cuneiform joint.
- Abduction and dorsiflexion of the cuboid at the calcaneo-cuboid joint.

Green and Carol (1984) elegantly described how, due to variations in the shape of the articular facets, the subtalar and midtarsal joints of individual patients demonstrate differences in what they called planal dominance (i.e., more or less motion in one cardinal body plane than another) during both "normal" and abnormal function. Therefore, if an accurate description of a “hyperpronated” foot is clinically important, it is important to describe the position of the foot in terms of how it has compensated according to the individual planal dominance of the joints. Horwood (2004) proposed the following classification system to describe the most common presentations of a foot exposed to excessive pronation forces:

1. Hyperpronated: Transverse Plane Dominant
   A foot demonstrating minimal navicular (arch) drop, little frontal plane calcaneal eversion, but a large degree of forefoot abduction (Fig. 3).
2. **Hyperpronated: Sagittal Plane Dominant**
   A foot demonstrating marked navicular (arch) drop, without significant forefoot abduction, and calcaneal eversion. Dorsiflexion of the forefoot on the rearfoot is the primary compensation (Fig. 4.).

3. **Hyperpronated: Frontal and Sagittal Plane Dominant**
   A foot demonstrating marked navicular (arch) drop, marked calcaneal eversion, but forefoot abduction is minimal or absent (Fig. 5.).
4. **Hyperpronated: Without Planal Dominance**

A foot demonstrating abnormal compensation in all three cardinal body planes: frontal, sagittal, and transverse (Fig. 6.).

![Fig. 6.](image)

Horwood admits his planal dominance classification system is incomplete: “*There are a large number of patients whose feet would not seem to follow all the classic signs of ‘overpronation’ and would give normal scores on the FPI (The Foot Posture Index).* Despite this, they clearly show signs of some postural abnormality and have attended the clinic with symptoms varying from arch strain and cuboid dysfunction, to recurrent lateral instability; the most common type is the anatomical flat foot with minimal if any forefoot abduction, an *inverted* calcaneus . . . with medial fat pad displacement.”

**Summary**

“Oh there is no greater impediment to the advancement of knowledge than the ambiguity of words.”

—Thomas Reid (1710-1796)

Pronated foot is overtly generic term, which by itself is unable to accurately describe the variety of complex “flat foot” deformities seen in clinical practice. Pronated foot, excessively pronated foot, hyper-pronated foot, over-pronation, and hyper-pronation are essentially useless descriptors if the intention is to accurately describe the compensations taking place within the joints of a weight-bearing foot under the influence of high magnitudes of pronation forces, especially in the clinical and research areas.
Symptoms are often directly related to excessive motion (and forces that may not necessarily create motion) taking place in the dominant plane. Orthotic devices should never be dispensed to treat "a pronated foot"; rather they should be prescribed in an attempt to reduce pathological forces (in the dominant plane) that may be contributing to abnormal tissue stress, e.g., excessive forefoot abduction (transverse plane) as the cause of an heloma of the fifth digit; excessive plantarflexion of the talus and associated dorsiflexion of the navicular (sagittal plane) as the cause of spring ligament strain; excessive adduction of the talus (and therefore internal rotation of the lower-limb) as a contributing factor to various knee and hip joint pathologies, and excessive calcaneal eversion to end range as a possible aetiology of sinus tarsi syndrome. An understanding of the concepts of planal dominance makes the term "excessively pronated foot" terminologically inadequate in the clinical application of mechanical principles to the human foot.

References