Abstract

Title
Atypical Pronation of the Sub-Talar Joint: Its Implications on the Lower Limb

Background
Atypical pronation of the sub-talar joint, or overpronation of the foot, as it is more commonly known, is a current subtopic in foot and lower limb-related biomechanical issues. Typical pronation is a tri-planar movement that involves eversion of the hindfoot, combined with abduction and dorsiflexion of the forefoot. Atypical pronation is recognized when this motion is excessive, and may be determined by the extent and duration to which this occurs according to the rhythmic timing during the gait pattern. It is a mechanical problem of the foot that primarily results from a subluxation or shift of the sub-talar joint and bones of the mid- and hind-foot. As a common finding in the general population, especially in those with flexible flat feet, atypical pronation may result chronically in a displacement of the bones and joints of the lower limb. Research has stated that excessive pronation of the ankle-foot complex may cause change in position of certain bones in the lower limb. This is believed to occur through an interaction between foot and pelvis through a kinetic chain mechanism. Furthermore, it has been stated that atypical pronation may affect weight transfer of the lower limb during gait that may lead to functional changes, overuse injuries and other problems further up along the chain of movement, even as far as the pelvis and low back. Some evidence exists to connect secondary associated conditions with atypical pronation. These symptoms are quite broad, and have been shown to vary from localized ankle pain to low back pain. Additional studies related atypical pronation to overuse injuries of the lower limb involving ligaments, muscles, tendons and other soft tissues, such as the plantar fascia. Little is known or understood about the specifics of this condition and its implications on the lower limb.

Objectives
This thesis will explore if atypical pronation of the sub-talar joint holds any implications to the lower limb and attempt to describe what those implications are. It will review the epidemiology, development, and mechanics behind atypical pronation. It will explore the evidence on atypical pronation-related injuries. My questions for investigation are the following:
1. What are the implications of atypical pronation on the lower limb with respect to gait function and biomechanics?
2. What is the evidence on atypical pronation-related injury to the lower limb?
3. What does the evidence say from treatment results and effects?
4. How is it atypical pronation diagnosed effectively?

**Methods**

This thesis is a literary review. The information found in this thesis has been collected from a variety of sources. These sources include online journals and scientific articles collected from online databases such as: EBSCO host, MEDLINE, PubMed, Science Direct as well as information taken from books. The information that was gathered to answer the research questions included scientific studies and articles from online journals that dated between the periods of 1967-2017. The section in Chapter One about the review of anatomy and biomechanics was taken from sources that were mostly books and some online articles; the earliest of which dated from 1918.

Inclusive Criteria – inclusive studies were based on all cases of atypical or excessive pronation, whether in athletes or non-athletes, in all ages, including subjects involving pes planus and other foot posture deformities. Included studies were concerning problems or conditions that may create the effect of hindfoot pronation, including problems to the midfoot and forefoot. The following foot posture types that were included in the research were: rearfoot varus, forefoot varus, equinus, and forefoot valgus. Studies involving both static and dynamic pronation were included.

Exclusive Criteria – studies and articles that dated from 1967 and earlier – these studies were excluded. Studies involving supination of the sub-talar joint were excluded.

**Findings**

Several studies show a correlation between sub-talar pronation and identify mechanical and physiological factors altering the bone and joint position of the lower limb and pelvis. But there is not enough evidence to support that these physiological changes in position are guaranteed to result in painful symptoms, conditions and specific overuse injuries to the lower limb itself. More studies are required with relevance to sample sizes, collection and analysis of data, and better-established methods for classifying the severity of injury, when determining risk factors.
for the lower limb. In addition, more research studies should be conducted on the effectiveness of non-orthotic treatment for atypical pronation, such as the effect of muscle strengthening techniques or muscle stretching techniques applied to the foot and lower limb.

**Conclusion**

Enough evidence exists to say that biomechanical changes do occur in the lower limb due to atypical pronation of the sub-talar joint. However, there is still not enough evidence to say that atypical pronation will cause acute or chronic injury to the joints, bones, soft tissues. Increase in knowledge of the intrinsic and extrinsic factors of atypical pronation and its influencing factors on the lower limb leads to insight on the probability of developing overuse injury and chronic painful symptoms and prevention of them.

**Keywords**

excessive pronation, pronation, hyperpronation, overpronation, foot pronation, foot, subtalar joint, subtalar joint instability, talotarsal joint dislocation, coxa pedis, talo-calcaneo-navicular joint, foot posture, foot mechanics, foot biomechanics, flat foot, pes planus, ankle eversion, ankle valgosity, hindfoot, hindfoot eversion, forefoot varus, hindfoot varus