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Effect of Shoe Design and Gender on Valgus Angle

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Abstract

The purpose of this study was to determine the difference between genders in body position during jumping movements while wearing shoes with varying midsoles. Twenty-two apparently healthy female and seven males voluntarily participated in this study. Subjects were current or recently graduated NCAA division III athletes of weight bearing sports and familiar with plyometric jumping. Subjects performed plyometric jumps from three box heights (46 cm, 30.5 cm and 21.6 cm) while being filmed from both the front and side view. Each jump was completed wearing four different pairs of shoes. The subject was represented as digitized points designed to capture pertinent angles and velocities of the body. Females showed a greater valgus angle than males in all shoe. The Medial Post shoe resulted in subjects having the smallest degree of valgus.

Background

There is evidence that females are more prone to knee injuries, specifically of the anterior cruciate ligament (ACL) than males (Haycock & Gillette, 1976). Females have gender-specific factors including looseness of the joints, hormonal influences and structural alignment that play a major role in the prevalence of injury (Harmon & Ireland, 2000). Valgus and varus are two structural alignments responsible for gender differences in conjunction with injury rate of the ACL (Figure 1). These terms refer to the position of the knee in relation to the tibia which can result in either a knock kneed or bowlegged position. During specific landing and jumping tasks, females have greater valgus angles whereas males have greater varus angles (Chappell, Yu, Kirkendall & Garrett, 2000). This can be attributed to the ability of men to absorb the impact of a jump better than females (Chappell et. al, 2000). Limited research has suggested the use of orthotics or specialized shoes in order to reduce the effects of the natural tendencies of the body during jumping tasks (Luiethi, Frederick & Niggs, 1986; Orenduff, Rohr, Segal, Medley, Green & Kadel, 2008). The aim of this study was to determine a more favorable shoe fit for women to reduce valgus movement.

Purpose

The purpose of this study was to determine the difference between genders in body position and during jumping movements while wearing shoes with varying midsoles.

Method

Twenty two apparently healthy females with a mean body mass of (73.8±8.4 kg) and a mean height of (1.74±.06 m) and seven apparently healthy males with a mean body mass of (73.5±5.3 kg) and a mean height of (1.68±.02 m) signed written consent forms from the University of Puget Sound internal review board before participating in this study. Subjects were current or recently graduated NCAA division III athletes familiar with plyometric jumping. Subjects completed all testing within one visit lasting approximately one hour.

Before testing, subjects were asked to warm up for five minutes at a self selected pace on a stationary bike. Subjects performed plyometric jumps from three box heights (46 cm, 30.5 cm and 21.6 cm) while being filmed from both the front and side view. While being filmed from the front, subjects stepped off the designated box, landed with both feet then immediately returned to a height of 46 cm. Subjects performed the jump from each box height one time for each pair of shoes. From the side view, each subject stepped off the designated box, landed with both feet then immediately returned to a height of 46 cm. All jumps were completed as a single motion without hesitation.

Digital video files were recorded on the hard drive of the computer using SIMI on MOTION (v6.2) with a JVC camera collecting at 60Hz. The subject was represented as points designed to capture pertinent angles and velocities of the body. From the side view, the left elbow, shoulder, hip, knee, ankle, heel and toe were digitized (Figure 4). From this, ankle, hip and shoulder angles were calculated as relative angles. The trunk angle was calculated as an absolute angle to the y-axis (Figure 4). The view of the subject from the front yielded valgus angles (Figure 5). The valgus angle is the relative angle from the hip to knee to ankle (Figure 5). Important parameters that were collected include: maximal valgus, maximal hip, knee, trunk and ankle angles.

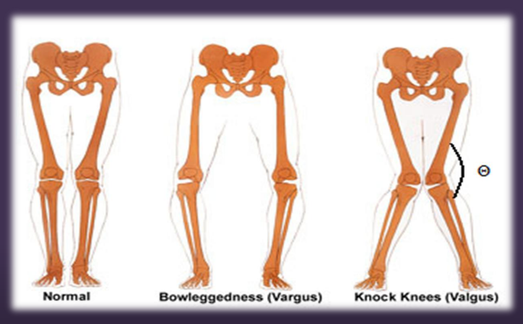

Figure 1: Illustration of varus and valgus

Results

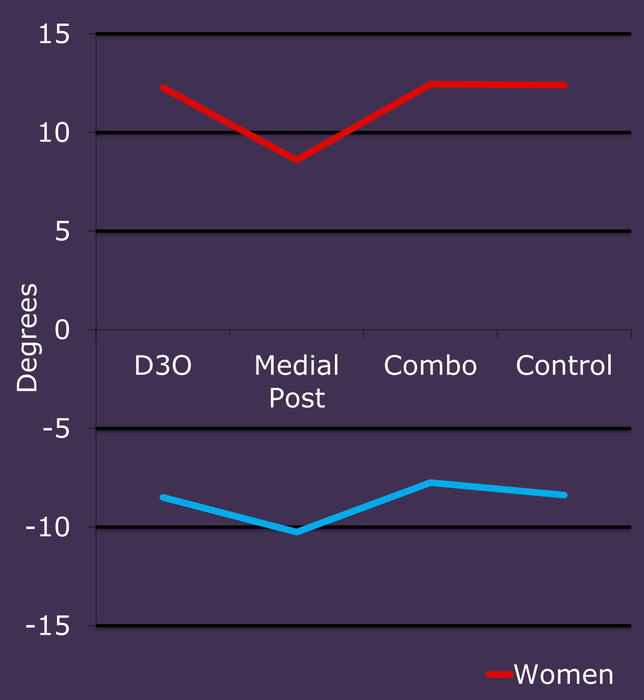

Figure 2: Left Valgus in Landing

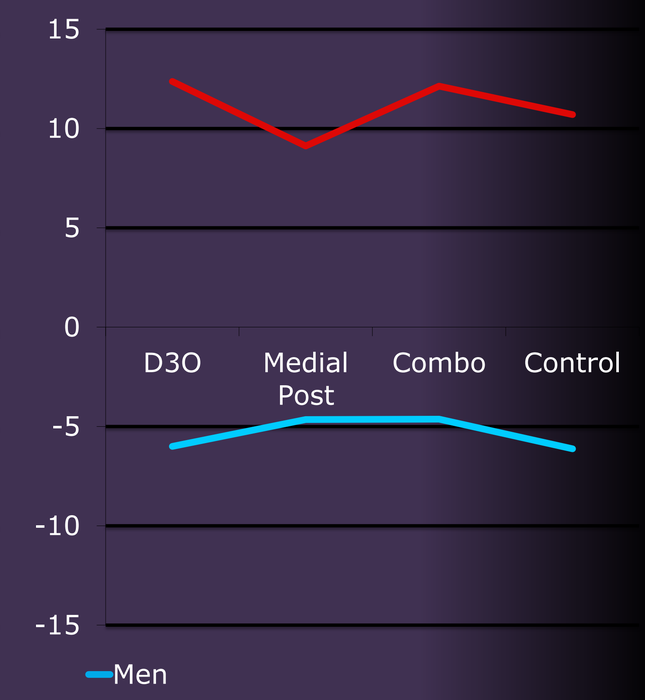

Figure 3: Right Valgus in Landing

Shoes:

The shoes were made in a women's ten (men's size 8.5). Prototype shoes are typically made in one size to reduce overhead before mass production of the shoe. Each subject performed all plyometric jumps in four different shoe designs:

- **Control**: a typical *Nfinity* volleyball shoe currently on the market
- **Medial Post**: a shoe with a constructed mid-sole to reduce valgus
- **D3O**: a shoe with a mid-sole contructed to increase jumping capabilities
- **Combo**: a shoe with a combination of both the Medial Post and D3O shoes

**Due to signing of non-disclosure agreement, specifications of shoes cannot be discussed*

Discussion

Previous studies have concluded that females show a greater amount of valgus than males when performing jumping tasks (Chappell et. al, 2002). Additionally, although there is suggestive research that shoe design can positively influence body position and movement during jumping motions, the appropriate shoe design has not been determined (Cornwall & McPoil, 1995). The aim of the current study was to determine an appropriate shoe design for women through differences in valgus between genders as well as the effect of shoe design on reducing valgus. This study found females to have a greater valgus angle than males for all shoes. Although valgus occurred while wearing all shoes, the Medial Post shoe showed the smallest degree of valgus.

Conclusion

Gender differences were concluded with females having a greater degree of valgus than males. For females the degree of valgus was reduced while wearing the Medial Post shoe.

Figure 4: Digitized points (side view)

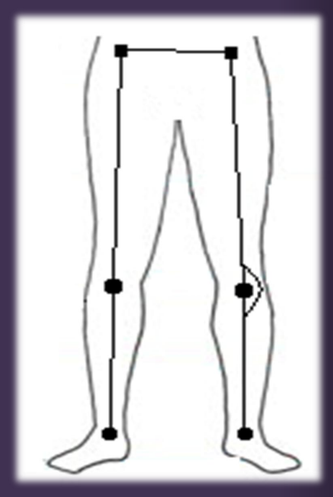

Figure 5: Digitized points (front view)

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