High Heel Design Puts Less Pressure On Forefoot

The Choice Of Higher Heeled Shoes For Women Has Been Questioned Over The Years As A Foot Health Hazard.

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The choice of higher heeled shoes for women has been questioned over the years as a foot health hazard. Recent studies have shown problems related to their use in not only the feet but in the more proximal joints as well. News reports, which convey this message, have been widespread. Despite all the adverse findings and publicity, women continue to purchase and wear higher heeled footwear. Data collected from the US foot industry demonstrates a staggering 300,000,000 pair of heeled shoes sold annually. It would seem clear that despite the warnings and for a variety of reasons, women continue to have a desire for an elevated heel in their shoes of choice. Considering the strong demand in spite of the inherent problems associated with their use, it would seem prudent that the shoe industry take a careful look at the high heeled product design and create safer yet stylish product.

A new product, the Insolia Invisible Comfort System,\(^1,2\) has been developed after years of study. This is a fundamental change in the intrinsic construction of high-heeled footwear, which addresses the nature of stress the high heel places on the foot and uses sound biomechanical principles to create a more optimal environment in which the plantarflexed foot can function. This paper presents a prospective study that measures changes in force load on the forefoot when the Insolia System is compared to standard design footwear. It also details a before/after comfort and perception survey of 130 women who wore shoes with the Insolia Invisible Comfort System but who were not told of the technological changes or how it would affect them.
Foot pathomechanics in high-heeled shoes:

In a previous study, women's complaints of foot pain regarding high-heeled shoes have been detailed. This includes pain in the digits, balls of the foot, ankle instability, pain in the muscles of the legs and lower back pain. Almost 85% of women list one or more of the above problems as a regular occurrence with the use of high-heeled shoes. The reason for this can be explained as follows. Standard high-heeled shoe construction creates an angle of the heel seat to the ground surface (known as the "wedge angle"). In essence, this creates a ramp effect, with the foot sliding forward into the toe box. The generally narrow toe box, aside from its fashionable attributes, acts to prevent the foot from this forward motion, and thus creates a continuous pressure on the digits. In other words, the proverbial "caught between a rock and a hard place" slogan is brought to life. Excessive loading of the metatarsal heads, particularly the longest 2nd metatarsal, also is exacerbated by this same ramp effect. Previous studies have shown that women who go from flat athletic type shoe gear to 2" heels have nearly a 64% increase in pressure to the forefoot. Subjective descriptions of women confirm this finding.

Instability, particularly around the ankle, is also a problem for women wearing this type shoe. When the ankle plantar flexes to accommodate the heel height, the talus moves its narrower, posterior trochlear surface into the ankle mortise, thus creating an intrinsically unstable alignment for the ankle. Knee flexion must accommodate this positional alteration, and thus a distinctive but hazardous gait develops. Complaints of lower back pain have also been suggested as due to an increased lordosis. This is in addition to the forward lean of the torso occurs which is a necessary accommodation to the induced forward pitch imparted by the shoe. Gluteal overuse then results as these muscles attempt to maintain an extended position of the torso on the waist.
The Insolia Invisible Comfort System:
While high heeled shoe gear will never be a perfect environment for a woman's foot, the concept of The Insolia System is to optimize the position so that it functions in as suitable environment as possible. The essence of the system is to reverse the talar declination that occurs with foot plantarflexion. With talar positional change, the wider portion of the talus is placed into the ankle mortise thus creating an intrinsically stable foot. Additionally, with this change in ankle plantarflexion, there is a concurrent weight shift from the ball to the heel. With the increased heel weight bearing, less stress is applied to the forefoot. Other accommodations are made as well to encourage a more broad weight bearing of the forefoot rather than a concentration on the longer 2nd and 3rd rays. Illusions as to toe box shape and other aspects lead to a product that appears high styled yet functions as a comfortable alternative to standard heeled footwear.

Materials and Methods:
Ten women with previous experience in wearing high-heeled shoes were recruited to be part of this study. They agreed to be tested with the F-scan in-shoe pressure analysis system in both a standard type athletic shoe and 2 1/8" high-heeled shoes designed and constructed with the Insolia Invisible Comfort System. Each underwent two test series in both the athletic shoes and the Insolia System shoes. Data was acquired in the standard methods recommended by the manufacturers of the F-scan including sensor calibration. All testing was performed for each subject over an approximately one-hour period. All testing was completed over an interval of two days.

F-max was the feature used to determine the changes in force loads on each subject. Creating an "object box area" which encompasses the five metatarsal heads performs this. The software can calculate the total force applied to this site and it can then be compared from one test to another in the same location. The highest load found in each test was used for the calculations.

Additional data was taken from a "before and after" research designed survey of 130 women consumers who have experienced the Insolia Invisible Comfort Sys-
tem. The survey was performed in a two-stage research process. The aspects of Stage 1 was as follows:
• Face-to-face group meetings 5 - 15 women
• Written survey covering demographics, buying habits & shoe issues
• Received shoes with Insolia System
• No technology information provided
• Commitment to wear test shoes over 2-3 weeks
• Commitment to a minimum of 3 all day wear tests
Stage 2 was as follows.
• Contacted 3 - 4 weeks later via telephone or email
• Written survey covering wear testing experiences

Research Results:
Figure 1 shows the data obtained from F-max measurements of load increase across the five metatarsal heads with shoes using the Insolia System vs. athletic shoes. The average increase was 22.1% from athletic shoes. This is compared to the 64% increase previously demonstrated for 2” high-heeled shoe gear. Some patients actually showed a decrease in load as compared to their athletic shoe use. While no morphological foot information was included, feet with forefoot equines type shape can be expected to do quite well with the Insolia System as it does create a very efficient platform about which they can walk.
The results of the survey research data are provided in Figure 2 and support the pressure study information reported above. Women clearly found the Insolia Invisible Comfort System to be a vastly superior product in terms of comfort, stability, posture and balance, as well as end of the day comfort. (End of the day comfort describes the difference between the immediate sensations of the shoe vs. the sensations that are felt after wearing them all day long.) What is interesting is that while the women surveyed found the Insolia System to be superior to the shoes they are currently wearing, the heel height of the shoes with the Insolia System was higher than the shoe they generally wore. This means that despite the raise in heel elevation, the Insolia Invisible Comfort System delivers significant improvement over standard higher heeled shoe design.
Discussion:
William Rossi, DPM has written extensively about the influence of fashion trends on shoe design. While seeming frivolous to those practicing foot medicine, the consumers of these products continue to purchase these shoes for a variety of reasons, some of which are clearly contrary to their foot and postural health. It therefore seems prudent that the manufacturers of these products need to provide a stylish product, which does not create significant deformity and undo stress upon the foot. The Insolia Invisible Comfort System appears to be the first product to perform this type of form/function convergence in a beneficial manner. The patents governing the design of this product are now filed in 53 countries worldwide. These cover a range of heel heights and can be used in virtually any.
style of shoe. The product will not be confined to any specific shoe company, but rather will be available via license agreement to many companies to use within their product line.

**Conclusion:**
The Insolia System represents a new manufacturing method that permits the fabrication of high-heeled shoes in both a fashionable yet biomechanically sound way. Women who have worn this product describe it as feeling more like "flats" than high-heeled shoes. It patented design reduces the forefoot load by 2/3rds over standard design high heeled shoes of comparable height. It provides increased ankle and postural stability by relieving the ramp effect of the elevated heel while utilizing the biomechanics of foot and ankle to optimize function.

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**References**
1 Insolia Invisible Comfort System is a registered trademark of HBN Shoe, LLC of Salem, New Hampshire
2 Insolia Invisible Comfort System has been issued US Patent 5,782,015 International Publication Number WO98/14083
4 Mandato, MG and Nester, E. "The Effects of Increasing Heel Height on Forefoot Peak Pressure" Journal of the American Podiatric Medical Association, February, 1999 89:2 p 75.