Development and testing of a new type of „barefoot running shoe“: The freeheel runningpad

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Common barefoot running shoes or minimal footwear have one or several of the following properties/deficiencies, depending on the type and brand and personal taste: - Coverage of a considerable fraction of the foot's surface with textile/plastic leading to sub-optimal foot climate - Considerable weight for a true "barefoot shoe" - Toe pockets that do not fit with non-standard feet - Considerable size and thickness, in particular in the heel section of the protective sole for a true "barefoot shoe" - Positive drop and therefore a change in the biomechanics compared to barefoot running. We wanted to design a new type of shoe that would be as close as possible to "real" barefoot running" and thereby overcome one or several of these perceived deficiencies. Whether this would lead to a reduction or increase in running related injuries and how to best train with the new shoes is not within the scope of this article.

Development and testing of a new type of „barefoot running shoe“: The freeheel runningpad

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Background

Common barefoot running shoes or minimal footwear have one or several of the following properties/deficiencies, depending on the type and brand and personal taste:
- Coverage of a considerable fraction of the foot's surface with textile/plastic leading to sub-optimal foot climate
- Considerable weight for a true "barefoot shoe"
- Toe pockets that do not fit with non-standard feet
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- Positive drop and therefore a change in the biomechanics compared to barefoot running

We wanted to design a new type of shoe that would be as close as possible to "real" barefoot running" and thereby overcome one or several of these perceived deficiencies. Whether this would lead to a reduction or increase in running related injuries and how to best train with the new shoes is not within the scope of this article.

Methods

Being a recreational runner for several years in normal running shoes the author performed a self-experiment by changing to run in Vibram five finger shoes. MD gained experience over a time period of 18 months, including a half-marathon, a marathon and an ultra-marathon in the mountains (>50km, >2000m)). During these runs an accelerometer recorded the accelerations at the COM (actibelt) and the subsequent analysis revealed changes in the step patterns. MD was stimulated by the work of Daniel Lieberman, by the work of Bernd Heinrich "Why we run" and by Christopher McDougall's "Born to run". The above mentioned properties/deficiencies were perceived in hundreds of hours running with conventional barefoot shoes. Based on the concept from evolutionary biology of being designed for running long distances with a forefoot strike, barefoot at high temperatures the idea emerged to develop a shoe that would only protect the forefoot, with minimal coverage of the rest of the foot and with a sole that would act like a "second skin" with minimal changes to the biomechanical properties of the otherwise unprotected foot. The following figure shows the different types of shoes used for the experiment.

Figure 1: Different types of shoes used for the experiment. (left-normal running shoes, middle – vibram five finger shoes, right – conventional runningpad) [1]

Figure 2: Vibram five finger shoes

Results

We developed the "freeheel runningpad" (http://www.runningpad.de/" \t "_top), a "shoe" that could be seen as the front part of huaraches, with a leather sole and an elastic strip or leather strip that attaches the sole to the foot. It has roughly, and by definition, 50% less sole area than usual (minimal) shoes. Because of this and the missing upper it is of very low weight. Sweating is not much different from being barefoot, but the front part protects both from cold and sharp surfaces. The shoe has a negative drop, because of the thinness of the sole being very close to a neural zero drop. MD could run marathons and an ultra-marathon without being severely injured (minor cuts in the sole during the ultra-marathon in the mountains). An early prototype of the shoe and the concept received the first price within the ISPO award 2012 in the category "performance footwear".

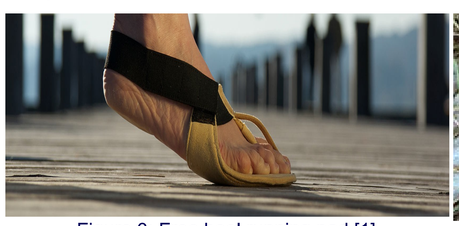

Figure 3: Free heel running pad [1]

Figure 4: Free heel running pad in use [1]

Figure 5: Free heel running pad [1]

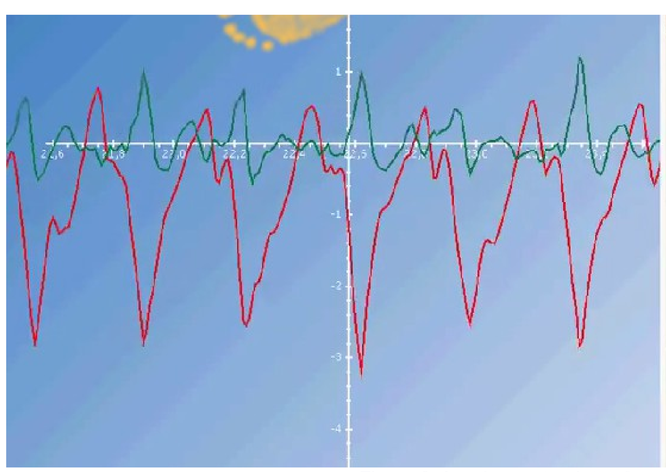

Figure 6: Accelerometry data of a run with runningpads [1]

A short overview about the history of shoes

The following figures show different types of shoes and some background information.

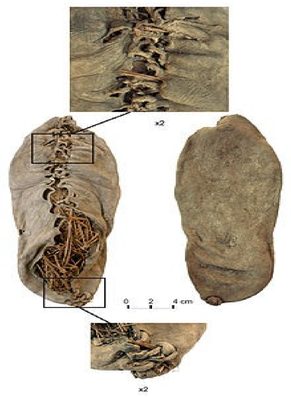

Figure 7: The oldest known leather shoe was found in Armenia (3500 B.C., Armeni-1 cave complex) [3]

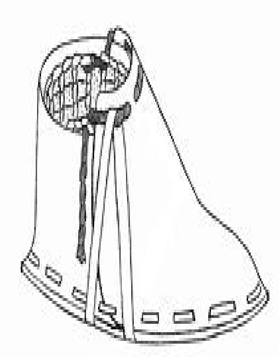

Figure 8: Right Shoe of Ötzi (Reconstruction painting (Europe, 3300 B.C.) [2]

Figure 9: Shoe of Ötzi (Europe, 3300 B.C.) [8]

Figure 10: Wooden sandals found in egypt (2500 B.C.) [9]

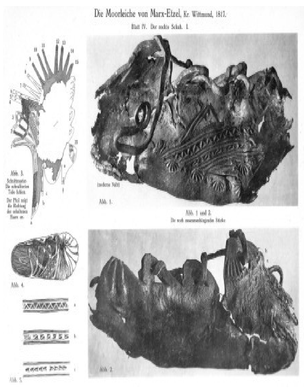

Figure 11: Leather shoes bog mummy of Marx-Etzel nord west europe (700 B.C.) [5]

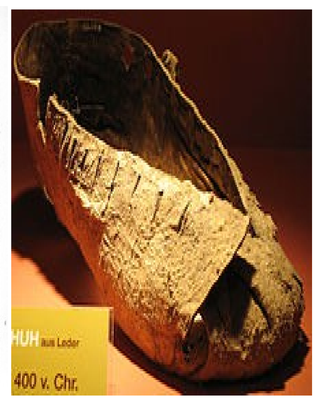

Figure 12: Drawstring shoes (400 B.C.) [2]

Figure 13: Roman Sandals [2]

Figure 14: Drawstring shoes of the bog mummy of Damendorf (2nd to 4th century, europe) [6]

Figure 15: The first article about high heels was found in 1533 [4]

Figure 16: King Ludwig XIV with high heels (17th century) [4]

Figure 17: Ashinakas were worn in japan by all classes of the population (11th century, Japan) [1]

Figure 18: Moccasins of native Americans (early 20th century) [7]

Conclusions

The concept of the shoe is actually not entirely new. It turned out that "ashinakas" (Figure ...) were worn in Japan a long time ago by a larger fraction of the population as standard footwear (fishermen, rice farmers, samurai etc). The advantages of these shoes listed in the old Japanese texts are very similar to the marketing claims of the freeheel runningpad. There is some historical evidence that such "shoes" can be worn without increasing the risk of injuries when done in the right way. The question of who should change footwear and/or running style in order to decrease the risk of injury is more relevant than ever and it seems that in particular the transition phase comes with a much increased risk of injury (https://peerj.com/preprints/250/). It will be interesting to see if the shoe can be integrated in the context of natural walking/exercise walking in a rehabilitation setting. Independent and knowledgeable research in the biomechanical properties of barefoot shoes and the relationship with running injuries is warranted.

REFERENCES

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