PLANTAR MECHANICS INFLUENCE OF DIFFERENT AND EXTRINSIC BIOMECHANICS INSTRUMENTALITIES IN STANDING VERTICAL JUMP

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The research has studied and compared with the areal characters of plantar pressure distribution in standing vertical jump, MMP (mean maximum pressure), MVP (mean value pressure) and the plantar force changes. The research has studied the formation of the shockproof mechanism in different designed shockproof systems, the aim is to guide to design shockproof shoes and to strengthen people's understanding to sports shockproof shoes.

KEY WORDS: shockproof, barefoot, MMP, MVP, force, pressure

INTRODUCTION: Most plantar shockproof instrumentalities in human movements are related to biomechanics properties, including intrinsic and extrinsic biomechanics instrumentalities. Intrinsic biomechanics instrumentalites are mainly of optimizing mechanics structure of body, as the flexible arch of pedis, flexible ankle joint and so on. Extrinsic biomechanics instrumentalities mean certain techniques and conditions that can prevent from or lessen the injury of feet, except for body structures. The function of extrinsic biomechanics instrumentalities is: Reduce the influence of mechanics factors upon the health of foot, such as the sports shockproof shoes, the material of the exercise ground etc. This research mainly starts with the experimental research on the shockproof function characteristic of the sports shockproof shoes. The qualitative analysis and quantitative analysis were carried out on the distributing plantar pressures, taking bare foot appearance as to according to, to show the functions of different designed shockproof shoes.

METHODS:

Subject: This research was a case study and the following test procedures were carried out on a highly trained in track and field, 22-year-old, 178 cm height, 65 kg weight male athlete of Zhejiang University. His standing CG height was 100.57 cm and foot size is 25.5 cm. He was passed by a enquiry of foot injury history and physical examination who had well foot health with no pigeon-toed and other foot diseases or injuries. Foot anatomy structure, function and his health were all normal.

Equipments: Novel Pedar plantar pressure testing system (Made in Germany), a certain height fixed touchable mark, Testing shoes No.a (normal gumshoes) and testing shoes No.b (whole sole air shockproof shoes), as well as a pair of thin socks.

Data processing: Novel Pedar syetem, which was linked to the computer, transferred plantar pressures and forces data tested by the sensors from the pair of insoles to the computer memory, each area's transferring frequency was 50 times/second, each insole contains of 99 areas. This research has taken the data of left foot as a random sample to statistical study. The statistical analysis and charts were analyzed in Microsoft Excel.

Design: Step I: The testee weared the thin socks and should lay down the insoles between the plantar and the socks. Then testee touched the certain height mark 20 times by standing vertical jumpings. Every time the testee must be do his best to jump. At last, he can have 10 minutes left rest enough. Then he should take the step II.

Step II: The testee should redo the same actions as Step Ⅰ, but wearing No.a normal gumshoes and the insoles should be laid down between plantar and inside shoes.

Step III: The testee should redo the same actions as Step Ⅰ, but wearing No.b whole sole air shockproof shoes and the insoles should be laid down between plantar and inside shoes.

Testing control: Make sure that every jump and buffer action should be integrated, effective, uniform and natural. Sensors of insoles should perfectly memorize and tansfer the data.

RESULTS AND DISCUSSION:

MMP: MMP numerical values when he in barefoot, wearing No.a normal gumshoes and wearing No.b whole sole air shockproof shoes are respectively showed in Figure 1.

From Figure 1,we can see that bare foot MMP value is 0.483 N/cm^2 higher than wearing No.a shoes and is 1.174 N/cm^2 higher than wearing No.b shoes.And wearing No.a shoes MMP value is 0.691 N/cm^2 higher than No.b shoes. It seemed that the MMP value when he was wearing shoes was lower than barefoot, so the material of these two shoes can reduce the maximal pressure engendered in body movement effectively, and also can alleviate the influence of strike and impact produced by the counter force. Moreover, there is difference between different kind of shoes. No.b shoes can reduce the MMP better than No.a shoes. Compared with these two kinds of shoes, the whole sole air shockproof design of No.b shoes can better decrease foot injuries appeared in sports than design of No.a shoes, can bring our feet security and trustiness in exercises.

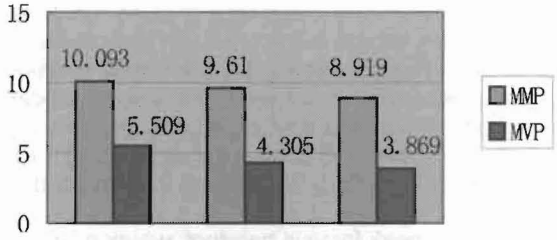


Figure 1 MMP, MVP values ($p < 0.01$).
(N/cm^2) Barefoot Wearing No.a Wearing No.b

MVP: As we seen in Figure 1,when he in barefoot, in No.a shoes and in No.b shoes, the MVP values characters of barefoot is 1.204 N/cm^2 higher than wearing No.a and 1.64 N/cm^2 higher than wearing No.b. The MVP value wearing No.a is 0.463 N/cm^2 higher than wearing No.b.

(2.1) Barefoot (2.2) Wearing No.a shoes (2.3) Wearing No.a shoes

Figure 2 3D-MVP figures.

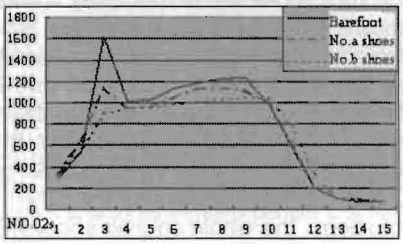
Figure 2.1 shows that pressures around all metatarsuses and halluces, especially for the first and second metatarsuses as well as halluces, are obviously higher than other parts of the foot. The highest pressure position is halluces. The pressures of every position is far different from each other, it coincides with the natural biomechanics regulation that plantar pressures are high around these positions in landing moment of a standing vertical jump.

What Figure 2.2 shows is similar with Figure 2.1, but every plantar podition is not so high. The highest pressure position is also halluces, but MVP value is lower than Figure 2.1.

What showed in Figure 2.3 is similar with Figure 2.2, but there are larger MVP distributing area around arch of pedis and calcaneus and the MVP value is not so differ from other poditions.

As a result, the MVP value of wearing these two kinds of sports shoes is obviously lower than barefoot, sports shoes can do certain buffer action in human movement. And sports shoes can lessen the disadvantageous and cumulate influence of counter force that up to plantar. Otherwise, different design kinds of sports shoes have different buffer actions such as No.b shoes has better buffer than No.a shoes. The design of No.b shoes is advanced and also can eliminate the fatigue of long time mechanics effect.

The plantar mutative force: After data processing, three curves related to force and time showed in Figure 3 reveal the plantar force in 3 different conditions.



(p<0.05)

Figure 3 Plantar mutative force.

Three curves show that Y-axis appears peak forces between 0 and 3(0.06) of X-axis fore-and-aft. It was buffer moment of landing, the slopes of three curves are highest and the force raised immediately. As besides intrinsic biomechanics instrumentalities-knee joint and ankle joint absorb a part of kinetic energy, extrinsic biomechanics instrumentalities-sports shoes' shockproof system changed kinetic energy to potential energy. Because of different material and structures of shockproof design, the time peak force appears asynchronous in different design kinds of shoes. In this figure, the peak force appears at 3 (0.02 s) by reason of 50-times/second-testing frequency and 0.02s-tesing can not reveal difference of each kind of shoes.

Figure 3 shows that the highest peak force is barefoot, wearing No.a shoes after and wearing No.b shoes is lowest. As the counter force to plantar when in barefoot is the most harmfull, wearing No.a second and wearing No.b shoes is safer.

The smoothness of wearing No.b shoes is flat, barefoot is the most accidented. So it seemed that No.b shoes' buffer ability and stability are better than No.a shoes.

It seemed that shoes having better buffer ability are finer, but at the meantime, considering with the agile ability, the better buffer must cost more time to absorb energy and to distort. It can't meet the need of agile and turning ability. So buffer and agile are contradictory. The design of sports shoes' shockproof should balance these two factors.

The pressure inducted area size in buffer:

4.1 Barefoot 4.2 Wearing No.a shoes 4.3 Wearing No.b shoes

Figure 4 The pressure inducted area in buffer.

Table1 The pressure inducted area in buffer (p<0.01).

Conditions of feet	Barefoot	No.a shoes	No.b shoes
The percent of pressure inducted area	65.11%	83.98%	95.78%

Each sole is composed of 99 small areas, counter for the number of small inducted areas. By data analysis, the results are as shown in Figure 4 and Table 1. The largest pressure inducted area appears in No.b shoes, the smallest is barefoot. It explains that shoes with larger inducted area have better buffer to disperse counter force. So No.b shoes is better than No.a shoes and barefoot.

CONCLUSION: One of extrinsic biomechanics instrumentalities-shockproof shoes can effectively reduce the value of MMP, MVP and can enlarge pressure inducted area to

disperse counter force so as to be propitious to foot health. Shockproof system can reduce the counter force to plantar muscles, tendons, nerves and veins etc. It can enhance safeguard and reduce foot injurie shoes. And different design kings of sports shockproof shoes' efficacies are different.

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