The Effect of Insole Height on Foot Pressure of Adult Males in Twenties

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Abstract.

[Purpose] The purpose of this study was to investigate how the foot plantar pressure varied as males wore shoes with insole heights of 0 cm, 2.5 cm and 5 cm. [Subjects] The subjects of this study were 20 young adult males who voluntarily consented to participate in the study and had no disease history or any problem with walking. Then, the foot plantar pressure was measured three times. The mean value was calculated for the analysis. The subjects rested for 30 minutes again and carried out the same experiment in the same manner, wearing height-increasing insoles of 2.5 cm and 5 cm. Gait Analyzer was used to measure the foot plantar pressure of the individual subjects. [Results] In the F4, F5, F6, R3 and R4 regions, the plantar pressure was significantly increased, but there was no significant difference in foot regions. [Conclusion] In conclusion, the height-increasing insoles used by young adult males, who consider their outer appearance important, possibly cause anomalies of the feet, the foot plantar pressure was changed by the insole height.

Key words: Insole height, Foot pressure, Gait analyzer

INTRODUCTION

Walking on feet or moving by walking is an indispensable and basic motion in daily living for humans. Gait coordinates alternative movements to move the body in a certain direction while maintaining speed in a certain direction through mutual cooperation of many skeletal muscles and joints of the upper and lower limbs1). During gait, shoes protect the feet and interact with various functional activities. Shoes can cause disorders caused by inappropriate gait habits or deformities of the feet. The functional aspects of shoes were initially emphasized, but the aesthetic aspects have recently become important. In particular, many women prefer high heels2). Recently, an increasing number of men want to make themselves look taller by wearing insole or heel inserts, as men are also interested in their outer appearance. The reason for this is that men also want to resolve dissatisfaction with their own physical body and to gain personal confidence from wearing heel inserts, just as women wear high heels3). Insole inserts alter the gravitational center-line of the body and they make it difficult to keep an ideal gait in the lower limbs as well as changing the location of the spine relative to the lower limb joints4). The internal arcuate position of the sole is elevated5) and more body weight is distributed on the forefoot during gait6). Due to the high heels, stability is lost and compensation takes place at the knee or hip joint7). Moreover, problems in the musculoskeletal system including weakened muscle strength, damaged ligament, joint adhesion and inappropriate body alignment are caused at the ankles8). Therefore, in this study, we investigated how foot plantar pressure varied when males wore shoes with insole heights of 0 cm, 2.5 cm and 5 cm height.

SUBJECTS AND METHODS

The subjects of this study were 20 young adult males who voluntarily consented to participate in the study and had no disease history or any problem with walking. Each of the subjects wore shoes with insole heights of 0 cm, 2.5 cm, 5 cm height and walked on flat ground for 30 minutes in each trial. Their average age was 22.27 ± 0.4 years, average height was 177.25 ± 3.78 cm, average weight was 72.25 ± 8.6 kg and average foot size was 265.56 ± 1.89 mm.

The subjects rested for 20 minutes in the laboratory before walking on flat ground for 30 minutes. Then, the foot plantar pressure was measured three times. The mean values were calculated for the analysis. The subjects rested for 30 minutes again and carried out the same experiment in the same manner, wearing shoes with insole heights of 2.5 cm or 5 cm.

Gait Analyzer™ (Tech Storm Inc. Korea) was used to measure the foot plantar pressure of the individual subjects. The gait analyzer system can analyze foot pressures by region while subjects are walking on the 384×1152 mm size plate. The sensor is a film-type pressure sensor consisting of a 2304-cell matrix array. The plantar area is divided into...
10 regions (Fig. 1). Data of pressure distribution during walking were analyzed using Gait Analyzer application software ver. 3.1. The pressure data by region were collected from three measurements for each insole height and the mean values were used. One-way ANOVA was used to compare the pressure data of each region among the different insole heights. LSD was used for a post hoc test and values of p<0.05 were considered statistically significant. A commercial statistical program, SPSS 12.0, was used for the statistical processing of data.

Table 1 shows the pressure data of each region of the dominant foot.

In the F1 region, which is the domain of the fourth and fifth toes, the pressure increased from 1.99 ± 1.57 N/cm² to 2.02 ± 1.46 N/cm² and 2.07 ± 1.44 N/cm², and in the F2 region, which is the domain of the third and second toes, the pressure increased from 17.59 ± 6.41 N/cm² to 19.62 ± 7.40 N/cm² and 19.98 ± 6.24 N/cm², and in the F3 region, which is the domain of the first toe, the pressure increased from 24.87 ± 7.08 N/cm² to 25.75 ± 4.94 N/cm² and 26.29 ± 7.74 N/cm² the height of the insole was increased from 0 cm to 2.5 cm and 5 cm, respectively, but the increases were not significant (p>0.05).

In the F4 region, which is the outer domain of the forefoot region, the pressure increased from 32.82 ± 4.55 N/cm² to 35.97 ± 5.07 N/cm² and 37.53 ± 8.17 N/cm², and in the F5 region, which is the middle domain of the forefoot region, the pressure increased from 89.33 ± 9.36 N/cm² to 95.69 ± 12.29 N/cm² and 102.44 ± 11.07 N/cm² when the height of the insole was increased from 0 cm to 2.5 cm and 5 cm, respectively, and the increases were significant (p<0.05).

In the R3 region, which is the outer domain of the midfoot region, the pressure increased from 59.43 ± 13.84 N/cm² to 64.09 ± 18.32 N/cm² and 76.07 ± 20.07 N/cm², and in the R4 region, which is the inner domain of the midfoot region, the pressure increased from 10.26 ± 5.34 N/cm² to 14.59 ± 14.46 N/cm² and 19.79 ± 12.59 N/cm² when the height of the insole was increased from 0 cm to 2.5 cm and 5 cm, respectively, and the increases were significant (p<0.05).

In the R1 region, which is the outer domain of the heel region, the pressure increased from 50.24 ± 30.88 N/cm² to 52.55 ± 32.18 N/cm² and decreased to 48.06 ± 29.49 N/cm², and in the R2 region, which is the inner domain of the heel region, the pressure increased from 139.41 ± 39.59 N/cm² to 141.19 ± 47.74 N/cm² and 144.41 ± 28.79 N/cm² when the height of the insole was increased from 0 cm to 2.5 cm and 5 cm, respectively, but these changes were not significant (p>0.05).

DISCUSSION

The preference for wearing high heels was first observed among women. In recent times, however, more men are showing a preference for height-raising shoes, and many men are now wearing with height increasing insole inserts that can be inserted into shoes. It was reported that high-heel shoes increase the vertical impulse during the gait, thus causing variation in the soft tissue around the feet. This variation can lead to various changes to the musculoskeletal, system weakening muscles damaging ligaments and joint adhesion and encouraging inappropriate body alignment8). Wearing high-heel shoes increases ankle joint flexion and changes the relative positions of the bones and the origins of the muscles9). Since there has been insufficient study of the effect of height increasing insoles on men’s feet, we investigated the effect of them on foot plantar pressure.

Our results show that there was no significant difference in the foot plantar pressure dependent on the height of insole inserts, which ranged from 0 cm to 5 cm, between the toe region and the heel region. However, we found that the pressure in the forefoot region and the midfoot region gradually increased as the height of the insole was increased. The reason for this is that an elevated heel causes excessive plantar flexion and increases the vertical load on

Table 1. Comparison of foot pressure distributions among different insole heights.

<table>
<thead>
<tr>
<th>Region</th>
<th>0 cm</th>
<th>2.5 cm</th>
<th>5 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>1.99 ± 1.57</td>
<td>2.02 ± 1.46</td>
<td>2.07 ± 1.44</td>
</tr>
<tr>
<td>F3</td>
<td>24.87 ± 7.08</td>
<td>25.75 ± 4.94</td>
<td>26.29 ± 7.74</td>
</tr>
<tr>
<td>F4</td>
<td>32.82 ± 4.55</td>
<td>35.97 ± 5.07</td>
<td>37.53 ± 8.17*</td>
</tr>
<tr>
<td>F5</td>
<td>89.33 ± 9.36</td>
<td>95.69 ± 12.29</td>
<td>102.44 ± 11.07*</td>
</tr>
<tr>
<td>F6</td>
<td>71.28 ± 10.07</td>
<td>75.85 ± 13.56</td>
<td>83.43 ± 11.95*</td>
</tr>
<tr>
<td>R3</td>
<td>59.43 ± 13.84</td>
<td>64.09 ± 18.32</td>
<td>76.07 ± 20.07*</td>
</tr>
<tr>
<td>R4</td>
<td>10.26 ± 5.34</td>
<td>14.59 ± 14.46</td>
<td>19.79 ± 12.59*</td>
</tr>
<tr>
<td>R1</td>
<td>50.24 ± 30.88</td>
<td>52.55 ± 32.18</td>
<td>48.06 ± 29.49</td>
</tr>
<tr>
<td>R2</td>
<td>139.41 ± 39.59</td>
<td>141.19 ± 47.74</td>
<td>144.41 ± 28.79</td>
</tr>
</tbody>
</table>

unit : kg, %MVIC, *: p<0.05.
the forefoot switching the centerline of the body to the forefoot. Hence, the result showed that the pressure on the forefoot was increased. In the case of the toe region, the mean pressure increased. Even though the increase was not significant, it could lead to hallux valgus at the toes, and a clavus being generated the forefoot. As the heel was elevated, the pressure on the midfoot region increased, although the difference was not very large. The midfoot reduces the pressure of the body weight through the foot arch. The increased pressure in this region was consistent with the result of Garn and Newton (1988) that the foot structure may be altered by continuous wearing of an insole insert.

All the results in this study showed differences between insole heights of 0 cm and 5 cm. Small differences were also found for the 2.5 cm insole height, but that height may not have had a significant effect because it is similar to that of ordinary shoes. Moreover, subjects stated that they felt that the height was higher and they showed more anxiety when they were wearing the insole of 5 cm height, indicating that they were using more muscles.

The height-increasing insoles used by young adult males who consider their outer appearance important, many cause anomalies of the feet. Based on the result of this study that foot plantar pressure is changed by insole height, a more detailed study needs to be carried out focusing on the biomechanics.

REFERENCES

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