The effect of the medial longitudinal arch height of the foot on static and dynamic balance of female college athletes

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Abstract

Balance is considered as one of the main components in the motor fitness and as one of fundamental factors in the maintenance of physical posture and daily activities; therefore, the aim of this survey is to investigate the impact of the height of the medial longitudinal arch on the static and dynamic balances among the academic female athletes.

There have been selected 45 subjects purposely among the statistical population and have been divided into three groups, each 15 subjects including the increased pronation group with the average age 23.92±0.99 years, the weight 57.67±6.9 Kg and the length 163.14±6.37 cm; the increased supination group with the average age 24.2±1.2 years, the weight 55.52±9.26 Kg and the length163.43±5.69 cm and the normal foot group with the average age 24.1±1.09 years, the weight 58.6±5.74 Kg and the length 165.07±7.54cm. There has been used Navicular drop test (NDT) using the descriptive method Brody in order to classify the persons into three groups. Also, there has been performed the statistic balance of the persons by standing balance test on one leg with the open eyes and the dynamic balance of the persons by the Star Excursion Balance Test (SEBT). Finally, data were analyzed in the statistical descriptive and inferential parts by SPSS Software, version 19.

The results showed that there has been the significant difference between the static balance (P=0.001, F=87.29, df=42,2)and the dynamic balance (P=0.001, F=63.55, df=42,2). Also, the results of Tukey test showed that there has been the significant difference between the average of the static balance and the dynamic balance among the supination athletes (P=0.01, P=0.002) and the increased pronation (P=0.02, P=0.001) with the normal foot athletes. As a whole, it can be concluded that changing the height of the medial longitudinal arch on the static and dynamic balances among the increased pronation and supination subjects has the negative effect.

Key words: dynamic balance; medial longitudinal arch height; static balance; Star Excursion Balance Test; types of foot.

Introduction

Balance is one of the inseparable components in all daily activities and the maintenance of the stature control is important in doing all activities. Also, the balance is considered as one of the main components in the motor fitness and as one of fundamental factors in the maintenance of physical posture and daily activities. The results of studies have shown that those who have less balance are more at risk of injury (Giansanti et al., 2009; Maki et al., 1999).

In recent decades, there has been performed the extensive studies and investigations on the postural control and balance with various definitions. In some studies, balance has been defined as the maintenance process of the body gravity center at the dependence level but Shumway and et al (2000), in a more complete definition,
have considered the balance as the control of the body position in space to indicate the sustainability and the
direction(Woollacott, 2000; Ghasemi, 2009).
In general, the balance has been classified into two types: static balance and dynamic balance so that the
central and the peripheral components of the nervous system interact continuously in order to maintain the
effective body standing and the gravity center with each other (Hertelet al., 2002). The static balance is the
ability to maintain the body gravity center at the dependence level while standing and the dynamic balance is the
ability to maintain the constant dependence level while doing a movement (Cote et al., 2005).
The most common types of foot are persons with the normal foot, persons with pronated foot and persons
with the supinated foot (Kelikian and Sarrafian, 2011). The pronated foot is a kind of abnormality accompanied
to the absence or the sever reduction of the medial longitudinal arch with the high irritability in the midfoot and
the supinated foot is a kind of abnormality accompanied to the high arch and low movement in the midfoot
(Brody, 1982).
Since the balance is maintained in a closed motor chain and relied on the integrated feedback of the
movements of the hip joints, knees and ankles, the disorder in the sensory information or the performance of the
muscles surrounding each joint can disrupt the mechanical strength of other joints and also the beneath organs
and subsequently the balance of the body (Guskiewicz, 1996). With regard to this matter that the foot is the
lowest part of the body, it seems that every change in the dependence level or the foot morphological
characteristics may affect the control of the balance. In this regard, there have been performed various studies
but the results are inconsistent on the impact of the changes of medial longitudinal arch on the balance level and
there are limited studies on the female athletes.
In 2008, Mousavi and et al investigated the relationship between the amount of the medial longitudinal arch
and the static and dynamic balance among 90 male students at age 12-14. They used Staheli index in order to
diagnose the type of the foot and used the balance test of standing on one leg and star excursion balance test
(SEBT) to assess the static and dynamic balance, respectively.
The results showed that there has not been any significant relationship between the arch foot level and the
static balance but there has been observed a significant relationship between the arch foot level and the dynamic
balance since by increasing Staheli index, the dynamic balance among the male athletes increases and by
decreasing Staheli index among them, the dynamic balance decreases. They concluded that the amount of the
medial longitudinal arch has some significant relationship with the dynamic performance of the persons and the
type of the foot, except sensory- deep receptors, has some effect on the control of the dynamic balance (Mousavi
et al., 2011).
While in 2014, Kordi investigated the relationship between the amounts of the medial longitudinal arch and
the dynamic and static balance among 90 academic male athletes in three groups including the pronated foot
group, the supinated foot group and the normal foot. The results showed that there is the significant difference
between the posture average changes of the persons statically but there is no significant difference between the
dynamic balances among these groups (Kordi Ashkezari, 2014).
In another research, Tsai and et al (2006) investigated the impact of different structures of the foot on the
static postural control in 7 males and 7 females of the subjects in three groups including the pronated foot group,
the supinated foot group and the normal foot group. The results showed that the persons in the pronated foot
group and the supinated foot group were weaker in the postural control than the normal foot group (Tsai et al.,
2006).
Therefore, due to the lack of transparency in the background of the research about the impact of the medial
longitudinal arch height on the static and static balances, especially in female athletes, there is discussed this
question that whether the height of the medial longitudinal arch has an effect on the static and dynamic balances
in the female athletes or not?

Materials and Methods

This study is a descriptive research and the type of sampling is targeted. The current statistical population
includes academic female athletes at the age 20-25 years who exercise regularly at least three sessions a week.
There have been selected 45 subjects purposely among the statistical population and have been divided into
three groups, each 15 subjects including the pronated foot group with the average age 23.92±0.99 years, the
eight 57.67±6.9 Kg and the length 163.14±6.37 cm; the increased supination group with the average age
24.2±1.2 years, the weight 55.52±9.26 Kg and the length163.43±5.69 cm and the normal foot group with the
average age 24.1±1.09 years, the weight 58.6±5.74 Kg and the length 165.07±7.54cm.
After selecting purposely, due to the inclusion and exclusion criteria of the study on Navicular drop test
(NDT), the samples were divided into three groups including the supinated foot group (Navicular drop equal to
or less than 4 mm), the pronated group test (Navicular drop equal to or less than 10 mm) and the normal foot
group. The samples in three groups were ranged closely in terms of body mass index and the type of sport
(volleyball, basketball, and handball). Each subject completed the consent form after entering the lab. Then, the
background information of the subjects (age, height, weight) were measured and recorded. Afterward, Navicular drop test (NDT) of subjects were measured and finally the static balance of each subject was performed by standing balance test on one foot with open eyes and the dynamic balance was performed by Star Excursion Balance Test (SEBT). It should be noted that all evaluations in the subjects were performed on their dominant foot.

There was used the standing balance test on one foot in order to gain the static balance. The subjects were asked to stand barefoot on their foot comfortably. Then, every subject placed his hands on his waist and placed his fingers of one foot on the other knee. After notifying the examiner, the subject tried to hold himself with the foot on the ground and maintain his balance. Time was calculated since the subject was on his foot until he lost his balance. Every subject was tested twice by standing balance test on one foot and then the best records were selected and recorded for further calculations. If when running the test, the subject was committed an error, time was not calculated and if every subject had two errors, the score was considered zero (Mousavi et al., 2011).

There was used the star excursion balance test in order to assess the dynamic balance. This network test with 8 lines is in different directions at angle 4° specified by using of an adhesive tape, 8-mm tape and a belt on a non-polished surface. The subjects were asked to stand in the center of this network on one foot and move other foot on 8 directions as possible. One subject moved his foot in each direction six times that was three times higher in each direction. He returned after each attempt to the standing position on one foot statically. Before doing another attempt, he stayed, for 3 to 4 seconds after changing his direction for 10 to 15 seconds, at this position. The subjects with the non-fixed right foot did the test the counterclockwise and the subjects with the non-fixed left foot did the test the clockwise. Each movement was calculated from the center of the star in centimeter and the average of every direction and then was divided in the length of the leg (the leg length of every person is calculated from the lowest part of the upper anterior iliac to medial malleolus of foot) and the total score of the dynamic balance of every person was recorded by using of the general formula of star excursion balance test (Mousavi et al., 2011).

Finally, after collecting information, there has been investigated the data related to the characteristics of the subjects including age, height and weight as well as the research variables in two descriptive and inferential statistical parts by SPSS Software, version 19. Also, there has been used ANOVA test to compare the results in three groups. It has been considered the significant level, throughout the study, at level 95% with alpha<0.05 or alpha=0.05.

Results

In this study, information due to the age, height, weight and the amount of Navicular drop in three groups have been delivered in related tables in order to recognize the characteristics of the subjects and their comparisons with each other.

| Table 1: Age, weight, length research subjects (n = 15 per group) |
|-----------------|-----------------|-----------------|
| Group           | age             | weight          | Lenght          |
| Pronation       | 23.92±0.99      | 57.67±6.9       | 163.14±6.37     |
| Supination      | 24.2±1.2        | 55.24±9.26      | 164.43±5.69     |
| Normal          | 24.1±1.09       | 58.65±5.74      | 165.07±7.54     |

| Table 2: The subjects were divided into three groups based on the amount of Navicular drop (mm) |
|-----------------|-----------------|-----------------|
| Group           | Mean            | Standard Deviation |
| pronation       | 10.63           | ± 0.44          |
| Supination      | 3.14            | ± 0.53          |
| Normal          | 6.52            | ± 0.52          |
Table 3: Descriptive data measured variables

<table>
<thead>
<tr>
<th>Group</th>
<th>mean of static balance</th>
<th>mean of static balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>pronation</td>
<td>65.2±4.78</td>
<td>98.06±2.94</td>
</tr>
<tr>
<td>Supination</td>
<td>61.2±3.46</td>
<td>94.73±4.93</td>
</tr>
<tr>
<td>Normal</td>
<td>78.53±4.67</td>
<td>105.01±2.5</td>
</tr>
</tbody>
</table>

There has been used ANOVA test to compare the balance between three groups in order to clarify the impact of the height of the medial longitudinal arch on the static and dynamic balances among the academic athletes. The results are shown in tables 4 and 5.

Table 4: ANOVA test results for comparison of static balance in the different groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>2471.11</td>
<td>2</td>
<td>1235.56</td>
<td>65.31</td>
<td>0.001</td>
</tr>
<tr>
<td>Within the group</td>
<td>794.53</td>
<td>42</td>
<td>18.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3265.64</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5: ANOVA test results for comparison of dynamic balance in the different groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>822.93</td>
<td>2</td>
<td>411.47</td>
<td>35.87</td>
<td>0.001</td>
</tr>
<tr>
<td>Within the group</td>
<td>481.86</td>
<td>42</td>
<td>11.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1304.80</td>
<td>44</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results of ANOVA test showed that the static balance level (P=0.001, F=87.29, df=42,2) and the dynamic balance level (P=0.001, F=63.55, df=42,2) among two groups have the significant difference; therefore, there was used Tukey test in order to compare pairs of groups. The results of this study are shown in tables 6 and 7.

Table 6: Tukey test results of the static balance in the different groups

<table>
<thead>
<tr>
<th>Group</th>
<th>P</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supination</td>
<td>0.01</td>
<td>Significant</td>
</tr>
<tr>
<td>Normal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pronation</td>
<td>0.02</td>
<td>Significant</td>
</tr>
<tr>
<td>Supination pronation</td>
<td>0.99</td>
<td>Not Significant</td>
</tr>
</tbody>
</table>
Table 7: Table6- Tukey test results of the static balance in the different groups

<table>
<thead>
<tr>
<th>Group</th>
<th>P</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supination</td>
<td>0.002</td>
<td>Significant</td>
</tr>
<tr>
<td>Pronation</td>
<td>0.001</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Supination pronation 0.95 Not Significant

The results of Tukey test showed there is some significant difference between the pronated foot group- normal foot group and between the supinated foot group and the normal foot group but no significant difference between the pronated foot group and supinated foot group. So, the static and dynamic balance levels in the athletes among these groups including pronated foot group (P=0.02, P=0.001) and supinated foot group (P=0.01, P=0.002) are significantly lower than athletes in normal foot group. It means that the athletes with the supinated foot and the athletes with the pronated foot have lower dynamic and static balances than the athletes with the normal foot.

Discussion and Conclusion

The aim of the current study was to investigate the impact of the height of the medial longitudinal arch on the static and dynamic balances among the academic female athletes. Due to the results of this study, there was the significant difference between the height of the medial longitudinal arch and the dynamic and static balances among two groups of athletes including the supinated foot group and the pronated foot group with the normal foot group.

In this regard, the results of this study is compatible with the studies of some researchers including Hertel et al. (2002), Setooti et al. (2011), Tsai (2006) and Cate et al. (2005). They reported that the persons with the arch and flat feet have lower balance than the persons with the normal feet. But, these studies are incompatible with the studies of some researchers including Raisi (2009), Abdoli et al. (2010) and Mousavi et al. (2011). In this regard, due to the no significant difference in the study of Raisi and being active the subjects of this study, it can be justified that the persons in this study were not consistent and all athletes from all sports (except gymnastics) could participate in this study because the athletes in different sports have different balances (Reisi, 2009.). Also, Abdoli and et al reported in their study there is no balance in the persons with the arch and flat feet. They stated that children with the arch feet have better balance than the persons with the normal and flat feet (Abdoli et al., 2010). In this regard, Mousavi and et al reported there is no significant relation between the foot arch level and the static balance. It can be stated to justify these two studies that the participants in these two studies were children but the participants in our study were the female athletes at the age 20-15 years. In explaining the obtained results in the current study, the change in foot joint position and subsequent changes in the medial longitudinal arch increased in the supinated foot group and the pronated foot group. Also, the change in the proximal segments has caused to form some changes in foot surface and the lower limbs. When a joint structure has been placed outside its line, the unnatural anddisarranged forces enter on the articular surfaces. It also causes to change the mechanical function of the muscles and the force coupling connections in all muscles passing through the joints. This leads to decrease the neuromuscular performance (Clark et al., 2010) and interfere with the balance of the persons. Thus, it is recommended to prescribe the balance training with more emphasis in their correction programs, rehabilitation and exercises.

Conflict of interest

The authors declare no conflict of interest

References


