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Comparison of hallux valgus deformed ballerinas and sedentary individuals in terms of balance parameters

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Abstract

Background: We aimed to compare static and dynamic balance parameters and health quality parameters in ballerina and non-ballerina adolescents with hallux valgus deformity.

Methods: Forty five volunteer female adolescent ballet students between the ages of 7 and 17, with hallux valgus were recruited. Group 1 = in the control group, 31 sedentary adolescents with hallux valgus were included. Group 2 = Romberg test and Flamingo test were used for static balance. The SEBT (Star Excursion Balance Test) was used to measure dynamic balance.

Results: Age, sex, and body mass index (BMI) characteristics were similar between ballerina and control groups ($P < .05$). The Romberg test stands upright with closed eyes, with a significant difference 47.22 in group 1 and 38.13 in group 2. In contrast there was a significant difference between the two groups in the Romberg test single limb with eyes open and closed. For open eyes single limb test mean score was 55.06 in ballerinas and 44.2 in sedentary group, similarly single limb test with closed eyes mean score was 25.68 in group 1 and 18.67 in group 2.

Conclusion: In conclusion, the results of this study show that ballerinas have better single-limb and closed-eye balance than sedentary individuals with HV deformities.

Abbreviations: BMI = body mass index, HV = hallux valgus, SEBT = Star Excursion Balance Test.

Keywords: balance, ballerina, dancer, dynamic, hallux valgus, static

1. Introduction

Hallux valgus is a malalignment of the first intermetatarsal and metatarsophalangeal joints that causes progressive and long-term foot deformities.[1] Hallux valgus is a common condition, and it has been demonstrated that 89% of professional ballet dancers have hallux valgus deformities.[2] Hypermobility, inappropriate footwear, genetic factors and malalignment of the first proximal joint are the main factors that cause a hallux valgus deformity. It has been determined that in dance styles based on classical ballet, morbidity based on hallux valgus is higher than that of other dance styles. An increasing HV angle has negative effects on the plantar pressure distribution. Plantar foot loading is shifted medially and especially to the second and third metatarsal heads in a foot with pathological hallux valgus.[3] Muscle imbalance in adductor and abductor muscles around the hallux has also been reported in studies.[4] These situations can affect postural stability and balance. Single-limb postural stability and proprioception are key components of the functional status of the lower extremities.[5] Impaired postural stability is a risk factor for ankle and knee injuries. Additionally, a pathological HV angle may affect postural stability even if the patient does not experience pain. Studies focusing on the effect of hallux valgus on functional performance have generally dealt with older people.[6–8] However, we know that in adolescent ballerinas, hallux valgus deformities are observed to a considerable extent. These deformities can affect dynamic or static balance, which is important for the continuity of the dance discipline. It is important to understand the compensation mechanisms of dancers for possible disadvantages of hallux valgus deformities.

We aimed to compare static and dynamic balance parameters and health quality parameters in ballerina and nonballerina adolescent groups with hallux valgus deformities. This study is the first to clarify whether deformities worsen or have no potency in the postural stability of adolescent dancers.

2. Materials and Methods

2.1. Participants

Forty five volunteer female adolescent ballet students between the ages of 7 and 17 years old who had been actively attending private ballet school for at least 1 year with a hallux valgus angle of 15 degrees or more were included in group 1 and 31 sedentary

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All data generated or analyzed during this study are included in this published article.

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adolescents between the ages of 7 and 17 years old who were not ballet students with a hallux valgus angle of 15 degrees or more were included in group 2. Participants who had severe neurological, orthopedic and rheumatological problems and a surgical history that could hinder the application of evaluation parameters were not included in the study. The research was completed with a total of 76 volunteers. Ethical board permission was given by Istinye University (20/762). The participants read and signed a consent form before data collection began. The study was carried out in line with the 2008 Helsinki Declaration principles.

2.2. Measurements

The age, body weight (kg) and height (centimeter) of each individual included in the study were recorded. The assessment form, which included demographic information such as ballet duration, frequency and continuity, was recorded.

The HV angle was evaluated with a goniometer by an experienced physiotherapist. With the patient in the standing position, the fixed arm of the toe goniometer was placed on the longitudinal line of the first metatarsal bone, and the movable arm was placed on the longitudinal line of the great toe. The value of the hallux angle between these 2 lines was recorded. The pathological hallux valgus angle was defined as an angle greater than 15° between the longitudinal line of the great toe and longitudinal line of the first metatarsal bone.[3]

Static balance was assessed during the double- and single-support conditions. During double support, participants were required to stand upright with their arms crossed around their shoulders and their feet together. Balance was examined during the eyes-open and eyes-closed conditions (Romberg test) for at least 30 seconds. Single-leg support was performed with the eyes open and closed for 10 seconds.[9]

The Flamingo balance test was used to indicate static balance. The advantages of this test are its simplicity and low cost, and it is capable of use in mass investigations. In this test, the participant stood on their preferred foot, bent their free leg backwards and gripped the back of the foot with the hand on the same side, standing like a flamingo. The measurement time was kept for one minute. The electronic chronometer was stopped as soon as the participant lost their balance or touched the ground. Their balance was restored, and the electronic chronometer was continued until one minute had passed. The score was recorded as the number of attempts to maintain balance within one minute.

The Star Excursion Balance Test (SEBT) is a screening tool that is commonly used to evaluate lower extremity dynamic stability, neuromuscular control, and injury risk in athletes. It is also used to monitor rehabilitation progress after injury. The SEBT was performed by having the participant stand on one leg and extend the other leg away from their body in eight different directions[10] (Fig. 1).

The American Orthopaedic Foot and Ankle Society (AOFAS) and Manchester score systems were used to evaluate the functional status of the participants. The AOFAS ankle-hindfoot rating system is a standardized evaluation of the clinical status of the ankle-hindfoot. The patients reported their pain, and the physicians assessed their alignment. The patient and physician worked together to complete the functional portion. The scores ranged from 0 to 100, with patients with healthy ankles receiving 100 points. The 36-item Short Form Health Survey (SF36) is a well-documented scoring system that has been widely used and validated as a quality-of-life assessment tool for the general population. Multi-item scales have been developed to represent aspects of the following eight physical and mental health domains: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE), and mental health (MH). It's most obvious superiority is in measuring physical function and related abilities. The subscales evaluated health between 0 and 100, where 0 indicated "bad health" and 100 indicated "good health".

2.3. Data analysis

Our results were analyzed with IBM SPSS Statistics 26. We used nonparametric statistical methods because the variables obtained from the data analysis were consecutive or categorized and constant variables did not show a normal distribution. We used the Mann–Whitney *U* test for comparing the 2 groups. Spearman's rho test was used when assessing the relationship between variables. For all analyses, the level of significance was set at $P < .05$.

3. Results

Age, sex, and BMI characteristics were similar for the ballerina group and control group. The mean age was 11.91 years (range 7-17) in group 1 and 11.23 years (range 7-17) in group 2. The mean BMI was 18.3 (±2.58) in group 1 and 19.47 (±2.42) in group 2. All participants included in the study were female. All demographic data is shown in Table 1. The mean degree of hallux valgus was 18.35 (±2.67) in group 1 and 17.84 (±2.63) in group 2.

For the AOFAS and Manchester's test, no statistically significant differences were found between the groups ($P > .05$), and the SF scores for general health, pain and physical activity were not significantly different between the groups ($P > .05$) (Table 2).

The mean Romberg test time standing upright with open eyes was 58.63 (±3.68) in the ballerina group and 55.096 (±3.49) in the sedentary group. There was no significant difference between the groups, but the mean Romberg test time standing upright with closed eyes, had a significant difference of 47.22 (±12.13) in group 1 and 38.13 (±12.18) in group 2. In contrast, there was a statistically significant difference between the two groups for the single limb Romberg test with open and closed eyes. For the single limb test with open eyes, the mean score was 55.06 (±4.49) in the ballerina group and 44.2 (±4.02) in the sedentary group; similarly, for the single limb test with closed eyes, the mean score was 25.68 (±1.26) in group 1 and 18.67 (±1.22) in group 2. However, there was no significant difference between the two groups in the Flamingo test and SEBT dynamic balance test (Table 3).

4. Discussion

Hallux valgus, which is a specific deformity of the foot, can affect balance and performance in foot-related sport

Figure 1. Template for SEBT (Star Excursion Balance Test).

Table 1

Demographic data of patients.

	Group 1 (adolescent ballet students with hallux)	Group 2 (sedentary adolescents with hallux)	*P* values
Age	11.91 (7-17)	11.23 (7-17)	*P* = .23
BMI	18.3 (±2.58)	19.47 (±2.42)	*P* = .18
HV degree	18.35 (±2.67)	17.84 (±2.63)	*P* = .24

BMI = body mass index, HV = hallux valgus.

Table 2

Health quality scores for patients.

	Group 1 (adolescent ballet students with hallux)	Group 2 (sedentary adolescents with hallux)	*P* values
AOFAS	86.80 (±7.54)	87.2 (±7.42)	*P* = .081
Manchester	1.96 (±0.45)	2.13 (±0.49)	*P* = .11
SF general	64.11 (±5.56)	72.34 (±6.01)	*P* = .065
SF pain	80.48 (±7.22)	86 (±6.98)	*P* = .078
SF physical activity	85.38 (±8.23)	89.97 (±8.31)	*P* = .082

AOFAS = American Orthopaedic Foot and Ankle Society, SF = Short Form Health Survey.

Table 3

Static and dynamic balance tests.

	Group 1 (adolescent ballet students with hallux)	Group 2 (sedentary adolescents with hallux)	*P* values
Romberg stand up open eyes	58.63 (±3.68)	55.096 (±3.49)	.12
Romberg stand up close eyes	47.22 (±12.13)	38.13 (±12.18)	.021*
Romberg single limb open eyes	55.06 (±4.49)	44.2 (±4.02)	.054
Romberg single limb close eyes	25.68 (±1.26)	18.67 (±1.22)	.025*
Flamingo static test	0.94 (±1.1)	0.96 (±1.02)	.14
SEBT	92.5 (±18.16)	90.21 (±21.3)	.092

SEBT = Star Excursion Balance Test.
* $P < .05$.

disciplines such as dancing or running. However, in the literature, only a few studies have focused on the relationship between hallux valgus deformities and dancer performance and balance.

In our study, we chose adolescent ballerinas as the working set and nondancer volunteers who were in the same age range and had similar demographic characteristics. It is crucial to assess hallux deformities in adolescent groups because professional sport activities such as dance, ballet or gymnastics usually begin at early ages, and developmental deformities can interact with training. In contrast, other studies have typically focused on adult patients with hallux valgus deformities or did not compare parameters with a control group.[11]

Balance can be related to many factors, but a proprioceptive mechanism is necessary to ensure postural control. A foot abnormality may alter sensory input from the plantar surface and joints. It is known that the type of foot deformity affects postural stability.[12] Menz et al found that a moderate HV angle affects the maximum balance range, and Nix et al found that HV angles affect mediolateral postural sway in bilateral standing adults.[13,14] There may be two possible reasons for this: first, a decrease in the duration of forefoot loading, decreased loading of the hallux and increased loading of the second and third rays affect frontal plane dynamics.[15,16] These pathological loading strategies negatively affect foot balance in the mediolateral direction.[17] Additionally, pronation of the first metatarsal and imbalance of intrinsic muscles with HV deformities can also affect segmental stability.[18] In our study, we found no difference in static balance with the eyes open test between the two groups (ballerinas and sedentary adolescents) when standing upright. However, ballerinas were statistically superior standing upright with closed eyes according to Romberg test. Additionally, the ballerinas' scores were higher with the single limb balance test with both open and closed eyes. Medeni et al found that increasing the HV angle affects single limb balance.[3] In our study, single limb balance was better in the ballerina group than in the sedentary group with the same HV angle. This may be explained by young dancers developing compensation mechanisms; for example, strengthening their extensor muscles to prevent balance impairments. On the other hand, visual restriction is another important parameter to provide balance, and many studies show that visual restriction affects the durability of standing single limbs.[19,20] However, young ballerinas tolerate more than other individuals because of better proprioception and plantar sensitivity.[21] However, we did not find a difference in dynamic balance between the groups, and we can interpret that young ballerinas develop better compensation to provide balance.

Hallux valgus deformities badly affect life quality parameters. Many studies have shown that foot deformities, especially hallux valgus deformities, decrease health quality scores, causing more pain and movement restrictions.[19,22–24] In our study, there was no significant difference in the AOFAS and SF scores for pain and physical activity between the two groups. However, both the sedentary individuals and dancers had HV deformities to the same degree. Perhaps it is more reasonable to compare ballerinas' health quality with individuals with no deformities. However, in the literature, there is no study that evaluates HV deformities and life quality scores in dancers. We expected particularly better SF physical activity scores in ballerinas but could not find any differences between the groups.

We had several limitations in our study. For example, our sample cluster number is not too large. However, it is valuable to study adolescent individuals; on the other hand, it is difficult to find young dancers. The other limitation is that we did not measure HV deformities with X-rays, because we did not want to expose healthy adolescents to radiation. The measurement scales could have been more detailed, but we thought it was more important to look at specific parameters in a more homogeneous population.

In conclusion, the results of this study show that ballerinas have better single limb and closed eye balance than sedentary groups with HV deformities. It is related to better balance compensation, and clinically, provides direction for the improvement of balance mechanisms and training models for adolescent dancers with HV deformities.

Authors contributions

Data curation: Okan Ozkunt and İrem Kurut.
Formal analysis: Okan Ozkunt
Writing – original draft: Okan Ozkunt.
Software: Ozcan Kaya.
Visualization: İrem Kurut.
Writing – review & editing: Ozcan Kaya and İrem Kurut.

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