Dynamic Postural Balance in Subjects with and without Flat Foot

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ABSTRACT

Background: *About 10% to 25% of population exhibits a flatfoot to varying degrees. In clinical practice, some subjects become symptomatic with foot pain or lower extremity soreness and limitation in their functional activities such as limitation of long distance walking or running and high-impact sports.* ***Objective:*** *In this study, our objective was to investigate whether patients with flatfoot have a poorer dynamic balance than normal subjects or not.* ***Methods:*** *Ten male patients with flexible flatfoot (group A) with mean age of 20.25 (±0.86) years, mean weight of 84.08 (±17.33) kg and mean height of 172.58 (±5.76) cm, and ten normal subjects (group B) with mean age of 20.30 (±0.94) years, mean weight of 84.8 (±16.91) kg, and mean height of 174 (±3.88) cm as a control group were tested by using the Biodex Stability System (Biodex Medical Systems, Shirley, NY, USA). Anteroposterior (AP), mediolateral (ML) and overall (OA) stability indices were calculated for athletes' single leg test at platform stability level 4 and overall stability index was calculated for fall risk test at platform stability from level 6 to 1. Subjects were tested 'eyes open' at all times.* ***Results:*** *The findings revealed that there were significant differences (P < 0.05) between groups in favor to group (B) (control group) where overall stability index (t = 3.25, P = 0.004), anterior-posterior stability index (t = 2.95, P = 0.007) and medial-lateral stability index (t = 2.81, P = 0.010) of athletes' single leg test and overall stability index of fall risk test (t = 3.59, P = 0.001).* ***Conclusion:*** *There was a poorer dynamic balance in the flexible flatfoot group (A) than the normal arch control group (B) in this study. It is therefore recommended to add a dynamic balance training exercise to traditional physical therapy program in cases of flatfoot patients.*

Key words: *Flatfoot, dynamic balance, biodex stability system.*

INTRODUCTION

Flexible flatfoot is defined as the postural appearance of the foot, with depressed medial longitudinal arch, pronated subtalar joint and the calcaneus assuming a valgus position under weight bearing conditions[9]. About 10% to 25% of population exhibit a flatfoot to varying degrees[2]. The most common cause of an acquired flatfoot deformity in an otherwise healthy adult is dysfunction of the tibialis posterior tendon[4]. Some subjects, in clinical practice, become symptomatic with foot pain or lower limb soreness and limitation in their functional activities such as limitation of long distance walking or running and high-impact sports[14].

Balance is defined as the process that maintains the center of gravity within the body's support base. Balance needs constant adjustments with joint positioning and muscular activity. Many musculoskeletal and nervous system diseases can alter balance control[3]. The literatures reveal controversy about the relation of flat-footedness and disability. Khodadadeh and Welton (1992)[7] and Lin et al. (2001)[10] stated that flat-footedness was related to some kind of disability but Tudor et al. (2009)[13] confirmed that children with flatfeet and children with normal feet were equally successful at accomplishing all motor tests.

It is very hard to decide whether flat foot is a physiologic adaptation or a pathologic condition. Therefore, it is believed that the decision to treat flexible flatfoot is often difficult, because there is a lack of objective criteria to assess possible functional abnormalities of the lower leg/foot/ankle complex and the controversy about the relation of foot morphology and foot function[13]. Therefore the purpose of the present study was to investigate whether patients with flatfoot have a poorer dynamic balance than normal subjects or not and to compare the balance indices between normal and flat foot patients.

METHODS

Subjects

Ten male patients with flexible flatfoot (group A) and ten normal subjects (group B) matched for age, weight, and height as a control group were tested by using the Biodex balance stability system (Biodex Medical Systems, Shirley, NY, USA).

All patients who participated in this study met the selection criteria: flexible flat foot and between 20 and 40 years of age. Subjects with foot surgeries, previous foot fractures, leg length discrepancy, systemic diseases, arthritis, or any other pathology that affect feet, knees, hips or spine were excluded.

Instruments

The Biodex balance stability system (Biodex Medical Systems, Shirley, NY, USA) was used for balance assessment by calculating anteroposterior (AP), mediolateral (ML) and overall (OA) indices. The indices were calculated for athletes' single leg test at platform stability level 4 and for fall risk test at platform stability from level 6 to 1. Subjects were tested with 'eyes open' all times. Karimi et al. (2008)[5] found the Biodex balance system reliable for postural balance assessment (fig 1).

Fig. (1): The Biodex balance stability system.

Procedures

Participants stood on the Biodex balance locked platform, to assess the foot position coordinates and establish the ideal foot positioning for testing. The platform was unlocked to allow movement. Subjects were instructed to adjust the foot position unit they found a position at which they could maintain platform in ideal position. The platform was locked and the foot position coordinates were recorded; the foot position was constant throughout the test. When the test began, the platform was released for 20 seconds and subjects were asked to maintain an upright position standing on the right lower limb for calculating anteroposterior (AP), mediolateral (ML) and overall (OA) indices of athletes' single leg test at platform stability of level 4 and on both lower limbs for calculating of overall stability index of fall risk test at platform stability from level 6 to 1. Subjects were tested 'eyes open' at all times.

RESULTS

According to demographic data of both groups, there was no significant difference between group (A) with mean age of 20.25 (±0.86) years, mean height of 172.58 (±5.76) cm and mean weight of 84.08 (±17.33) kg and group (B) with mean age of 20.30 (±0.94) years, mean height of 174 (±3.88) cm, and mean weight of 84.8 (±16.91) kg (Table 1).

Table (1): Demographic data of both groups.

	Group A	Group B	t-value	P value
Age (yrs.)	20.25(±0.86)	20.30(±0.94)	0.12	0.89 (NS)
Weight (kg)	84.08(±17.33)	84.8(±16.91)	0 .09	0.92 (NS)
Height (cm)	172.58(±5.76)	174(±3.88)	0.66	0.51 (NS)

Data are expressed as mean (± SD). NS= Not significant.

Comparison between groups

Unpaired t-test revealed that there were significant differences ($P < 0.05$) between groups in favour of group (B) (control group) with overall stability index of fall risk test ($t = 3.59$, $P = 0.001$) and overall stability index ($t = 3.25$, $P = 0.004$), mediolateral stability index ($t = 2.81$, $P = 0.010$) and anteroposterior stability index ($t = 2.95$, $P = 0.007$) of athletes' single leg test. (Table 2 and figures 2 and 3).

Table (2): Comparison between groups.

	Group A	Group B	t-value	P value
OA stability index of Fall risk test	5.24(±3.06)	1.70(±0.52)	3.59	0.001
OA stability index of athletes' single leg test	4.80(±2.50)	2.10(±0.83)	3.25	0.004
ML stability index of athletes' single leg test	2.68(±1.33)	1.42(±0.52)	2.81	1.010
AP stability index of athletes' single leg test	3.42(±1.93)	1.56(±0.49)	2.95	0.007

Data are expressed as means (± SD).

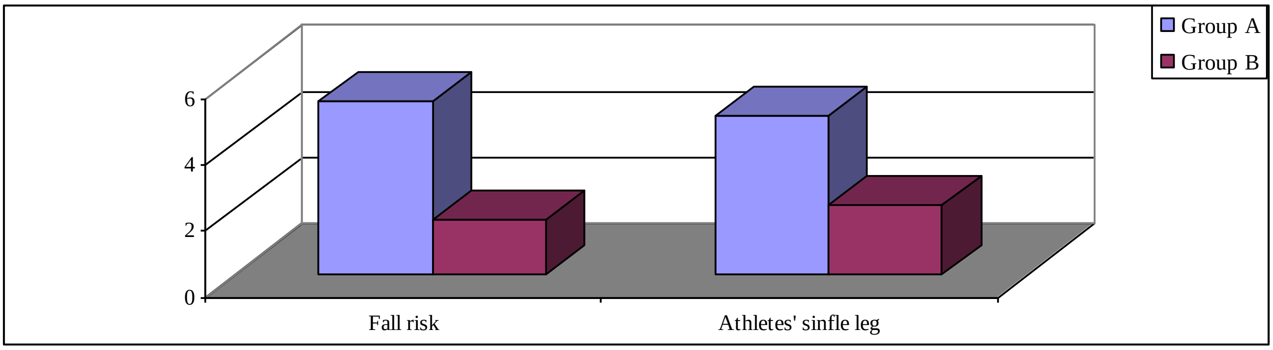

Fig. (2): The mean values of overall stability indices of fall risk and athletes' single leg test of both groups.

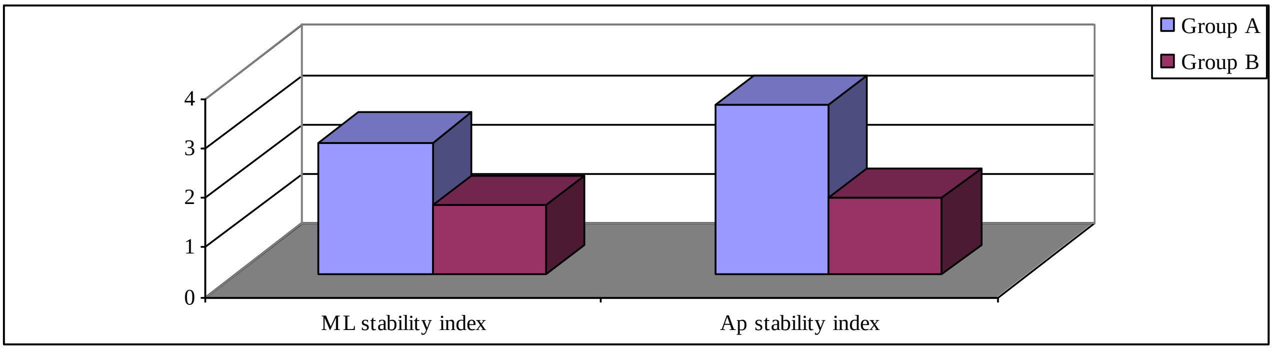

Fig. (3): The mean values of mediolateral and anteroposterior stability indices of athletes' single leg test of both groups.

DISCUSSION

Sensory detection of body's motion, an appropriate motor response and integration of sensory motor information into the central nervous system are essentials for maintaining postural balance. The position of the body in relation to space is determined by somatic, sensitive, vestibular and visual functions[3].

Postural stabilization of upright stance is usually modelled as a single-segment, linear feedback control system that predicts ankle joint torques based on changes in ankle joint kinematics[11]. A high gain of ankle angle feedback suggests that the nervous system increases the relative weight of ankle joint feedback for generating compensatory ankle joint torques[8]. Many musculoskeletal and nervous system diseases can alter balance control which needs constant adjustments with muscular activity and joint positioning[3]. Because the controversy about the relation of foot morphology and foot function is still present[13], therefore the purpose of the present study was to investigate whether patients with flatfoot have a poorer dynamic balance than normal subjects or not and to compare the balance indices between normal and flatfoot patients.

The results of the present study revealed that there were significant differences between both groups in all measured variables (Athletes' single leg test and fall risk test). This could be due to low muscular mass which can generate biomechanical failure of muscular responses and loss of stability mechanisms[6] or dysfunction of the tibialis posterior tendon[4] or musculoskeletal disorders which can alter balance control[3]. These results agreed with Lin et al. (2001)[10] who showed poorer performance in children with flexible flat foot and with Khodadadeh and Welton (1992)[7] who stated that for some reason, traditionally, flat-footedness is related to some kind of disability: "Children who have flexible flat foot are often noted to be slow in running or in performing athletic skills" or "people with low-arch feet were often assumed to be inefficient in foot skills and to be predisposed to injuries of the lower limbs. Akbari et al. (2006)[1] also showed that balance ability in patients with acute lateral ankle sprain was significantly weaker under closed- versus open-eye conditions and Rahnama et al. (2010)[12] concluded that subjects with foot ankle instability demonstrated poorer postural stability when tested at level 5 on the Biodex stability system, but not at level 7.

In contrast to the findings of this study Tudor et al. (2009)[13] confirmed that there were no disadvantages in sport performance originating from flat-footedness. Children with "flat" and children with "normal" feet were equally successful at accomplishing all motor tests; thus, they suggested that there was no need for treatment of flexible flat feet with the sole purpose of improving athletic performance, as traditionally advised by many. Although it is not easy to solve the controversy about flat-footedness by only one study. Their findings are just a contribution to the overall understanding of the functionality of flat feet and possibly related problems.

Conclusion

There was a poorer dynamic balance in the flexible flatfoot group (A) than the normal arch control group (B) in this study. Therefore it is recommended to add dynamic balance training exercises to traditional physical therapy program in cases of flatfoot patients. In addition to this, further studies using larger samples are recommended.

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الملخص العربي

الاتزان القوامى الحركي في الأشخاص ذو الأقدام المسطّحة و الأصحاء

هناك ما يقرب من عشره إلى خمسة وعشرون في المائة من الناس معرضون للإصابة بالأقدام المسطحة . **الغرض من هذه الدراسة :** هو معرفة هل هناك خلل في الاتزان القوامى الحركي عند مرضى القدم المسطّحه المرنه بالمقارنة بالأصحاء أم لا ؟ **العينة وطرق البحث :** شارك في هذه الدراسة عشر ة من المرضى المصابين بالقدم المسطّحه المرنه (مجموعه أ) و عشرة أشخاص أصحاء كمجموعه ضابطه (مجموعه ب) وقد تم تقييمهم باستخدام جهاز الاتزان البيودكس وتم حساب معامل الاتزان الامامى- الخلفي والجانبي وكذلك معامل الاتزان الكلى لاختبار القدم الواحده للرياضيين و كذلك معامل الاتزان الكلى لاختبار خطر السقوط . **النتائج :** أظهرت نتائج الدراسة وجود فروق ملحوظة ذو دلاله إحصائية بين المجموعتين فيما يخص معامل الاتزان الامامى- الخلفي والجانبي و معامل الاتزان الكلى لاختبار القدم الواحده للرياضيين و كذلك معامل الاتزان الكلى لاختبار خطر السقوط . **الاستنتاجات :** بناء على البيانات والنتائج الحالية للدراسة تبين أن هناك خلل في الاتزان القوامى الحركي عند المرضى المصابين بالقدم المسطّحه المرنه ولذا نوصى بإضافة تمرينات الاتزان لبرنامج العلاج الطبيعي التقليدي الذي سيحسن بشكل ملحوظ الاتزان القوامى الحركي .

الكلمات الدالة : المصابين بالقدم المسطّحة المرنه ، الاتزان القوامى الحركي ، جهاز الاتزان البيودكس .