A STUDY TO COMPARE DYNAMIC BALANCE BETWEEN INDIVIDUALS WITH FLAT FEET AND INDIVIDUALS WITH NORMAL ARCHED FEET USING Y- BALANCE TEST – AN OBSERVASTIONAL STUDY

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ABSTRACT

Background: The foot is the most distal segment in the lower extremity chain and represents a relatively small base of support on which the body maintains balance. Although it seems reasonable that even minor biomechanical alterations in the support surface may influence postural-control strategies. 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 underweight bearing conditions. The term "flexible" means that while the foot is flat when standing (weight-bearing), the arch returns when not standing. Dynamic balance is the ability of an object to balance while in motion. Y balance test is useful tool to measure dynamic balance which measures dynamic balance in three different directions, anterior, posteromedial and posterolateral direction.

Method: 10 subjects with bilateral flexible flat feet as assessed by sit to stand navicular drop test and 10 subjects with normal arched feet both in the age group 18-25 years were chosen for the study. The sample size therefore was 40 feet (20 flat feet and 20 normal arched feet). Group A (n= 10) subjects was individuals with flatfeet and group B (n= 10) subjects was individuals with normal arched feet. All the subjects were asked to perform Y – Balance test. Subjects were asked to keep their non-testing leg on the center of the grid. Subjects was asked to reach in all three directions (anterior, posteromedial and posterolateral) by great toe of testing leg as much as he can. Distance covered by the subjects in all three direction was recorded. Then same procedure was repeated for another leg. Data analysis was done by the Unpaired -'t' test using SPSS software version 20.

Result: There was no significant difference found between flatfeet and normal arched feet.

Conclusion: Dynamic balance is not affected in flat feet individuals.

KEYWORDS: Dynamic balance; Flat feet; Sit to stand navicular drop test; Y- balance test.

INTRODUCTION

The foot is the most distal segment in the lower extremity chain and represents a relatively small base of support on which the body maintains balance. Although it seems reasonable that even minor biomechanical alterations in the support surface may influence postural-control strategies[1]. Foot performance significantly depends on its shape. Biomechanical foot changes affect its dynamic stability. Foot is the last part of lowest extremity, and this small supporting surface provides balance of the entire body. It seems that any biomechanical changes in this supporting surface may affect body posture[2].

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 underweight bearing conditions[3]. The term "flexible" means that while the foot is flat when standing (weight-bearing), the arch returns when not standing. Flexible flatfoot is one of the most common types of flatfoot. It typically begins in childhood or adolescence and continues into adulthood. It usually occurs in both feet and progresses in severity throughout the adult years. About 20-30% of the population generally has flat feet[4]. Functional Foot Stability is defined as 'the ability of the foot to continually adjust its position to maintain the body in an upright, balanced position'[5].

Balance is defined as the process that maintains the center of gravity within the body's support base[3]. Balance needs constant adjustments with joint positioning and muscular activity[3]. Balance is one of the basic needs for daily activities and static and dynamic activities[6]. Balance is a physiological and mechanical situation and the desire of moving body within the optimal level of support[6]. Factors that influence balance include sensory information obtained from the somatosensory, visual, and vestibular systems and motor responses that affect coordination, joint range of motion (ROM), and strength[7].

Dynamic balance is the ability of an object to balance while in motion. Ability to maintain postural stability under dynamic conditions is an important underlying component of physical activity performance[5]. Structural deviations in the ankle and foot complex predispose the individual to changes in weight bearing, muscle imbalance static as well as dynamic balance in ambulation resulting in compensatory strategies which often predispose the individual to overuse injuries[5].

The human foot serves to balance the individual directly or indirectly during a variety of static and dynamic activities such as standing, walking, running, swimming, and diving. During a static or dynamic stance, the foot is a "mobile adaptor" which provides optimal function with minimal risk of injury. The foot is the only direct source of contact with a supporting surface and therefore it plays an important role in all weight bearing tasks. When the components of foot effectively work together, it provides a balanced foundation for the body. Changes to foot structure, therefore, have the potential to alter the load distribution functions of the foot[8].

The architecture of the foot ankle complex is inclusive of bone, muscle and ligaments which support the medial longitudinal arch giving it its shape, strength and stability[9]. Variations to the arch structure lead to the high and flat arches as described. Deviation from the normal arch can be due to an ordinary variant, hereditary and/or neurological problem[9].

The ankle and foot complex play a critical role in maintaining erect posture, as also in adaptation to supporting surfaces, in correcting postural sway in single limb stance, in shock absorption and in transition of ground reaction force (GRF) in order to aid the push off during normal gait. Functional variance and minimal biomechanical alterations in the ankle and foot complex in turn alters the contact with the surface area and the peripheral sensory input in weight bearing posture[10].

The presence of abnormalities in the foot structure may affect the function of the position of static, dynamic, movement and especially affected the displacement of the body. Flat foot deformities may disrupt the motion sensing receptors. So balance requires motion sensing receptor information processing to evaluate the body's position in space and the ability to control power generation system and it can involve posture in a complex interaction and also involves joint in entire range of motion for maximum balance[6][12]. Flat feet cause changes in foot mobility, foot posture, and load distribution under the foot which influences dynamic balance, that is essential in activities of daily living and for optimal performance in sports activity[11].

The navicular drop test (NDT) has been widely used as a clinical method to assess foot mobility. The NDT has also been associated with lower limb musculoskeletal injuries. Brody was one of the first to describe the NDT and he noted that it was helpful in evaluating the amount of foot mobility, specifically pronation, in runners[13]. Brody stated that the height of the navicular bone in subtalar joint neutral position is subtracted from the height of the navicular bone in relaxed standing posture. Brody further noted that a normal amount of navicular drop was approximately 10 mm. Since Brody's initial description of the NDT, several authors have attempted to determine the reliability of the measurement as well as establish normative values in a healthy population. Studies have reported NDT values ranging from 6 to 9mm[12].

The Y Balance Test is a modified version of the Star excursion balance test (SEBT) developed to improve the repeatability of measurement and standardize performance of the test. The test utilizes the anterior, posteromedial, and posterolateral components of the SEBT[13]. YBT are that it takes less time to complete and has a standard protocol and high interrater and intrarater reliability[14]. So, purpose of the study was to compare dynamic balance in individual with flatfeet and an individual with normal arched feet using Y balance test.

AIM OF THE STUDY

Aim of this study is to compare dynamic balance between individuals with flatfeet and individuals with normal arched feet using y-balance test.

OBJECTIVES OF THE STUDY

To check dynamic balance in individuals with flatfeet using Y balance test.

To check dynamic balance in individuals with normal arched feet using Y balance test.

To compare dynamic balance between individuals with flatfeet and individuals with normal arched feet using Y balance test.

HYPOTHESIS

Null Hypothesis: There is no significant difference in dynamic balance between individuals with flatfeet and individuals with normal arched feet using Y balance test.

Alternative Hypothesis: There is significant difference in dynamic balance between individuals with flatfeet and individuals with normal arched feet using Y balance test.

METHOD

A total number of 20 subjects were selected (10 subjects with flexible flatfeet and 10 subjects with normal arched feet). Purposive sampling method was used for data collection. It was an observational study. Subjects were selected for study by giving consideration to inclusion and exclusion criteria. Inclusion criteria was 1) Bilateral Flexible flatfeet 2) Age group 18-25 years 3) Both male and female subjects 4) Ability to follow commands 5) Co-operative patients. Exclusion criteria was 1) Structural flatfeet 2) Any neurological problem of lower limb and spine 3) Any pathological conditions of lower limb and spine, e.g. back pain, OA knee 4) Any past history of injury of lower limb and spine 5) Congenital abnormalities 6) Limb length discrepancy 7) Lower limb amputation 8) Pregnancy 9) Body mass index (BMI) > 30.

MATERIAL

- Record or data collection sheet
- Pen & paper
- Consent form
- Chair
- Measure tape
- Marker
- Weighing machine

PROCEDURE

A total number of 20 subjects were selected. (10 subjects with flexible flatfeet and 10 subjects with normal arched feet). Subjects were selected for study by giving consideration to inclusion and exclusion criteria. All the subjects were explained about the goal of the study the test procedures & written consent was obtained. All the subjects were divided into two group according to feet type. Group A (n= 10) subjects were individuals with flatfeet and group B (n= 10) subjects were individuals with normal arched feet. All the participants with normal arched feet and flexible flatfeet were diagnosed on basis of sit to stand navicular drop test (SSNDT).

Sit To Stand Navicular Drop Test (SSNDT) (Brody 1982):

The sit to stand navicular drop test is useful to diagnose flatfeet. It was calculated by difference between height of navicular from the floor when the subtalar joint is neutral in non-weight bearing (sitting position) and the height of navicular from the floor when in relaxed stance in a full weight bearing position.

Measurement procedure:

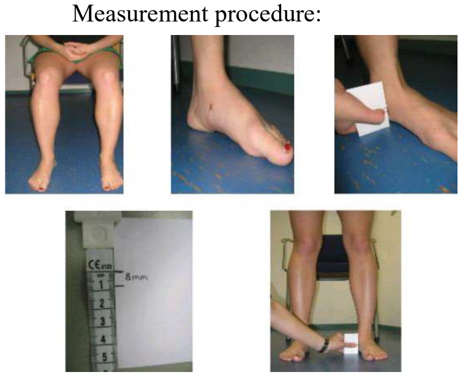

Figure 1: (?Sit to stand navicular drop test)(SSNDT)

- The subject was placed in a sitting position with their feet flat on a firm surface with knee flexed to 90* and ankle joints in neutral position.
- The most prominent point of the navicular tubercle while maintaining subtalar neutral position was identified and marked with a pen.
- Place the index card on the floor vertically passing the navicular bone and the level of most prominent point of the navicular tubercle was marked on card.
- Then the individual was asked to stand without changing the position of the feet and to distribute equal weight on both feet.
- In the standing position the most prominent point of navicular tubercle relative to the floor was again identified and marked on the card.
- Finally, the difference between the original height of the navicular tubercle in sitting position and weight bearing position was assessed with a tape measure rendering the ND amount in millimeter.

6-9 mm distance is considered as normal arched feet. Less than 6 mm is considered as flatfeet. After diagnosis of flatfeet both the group (group A and group B) was asked to perform Y balance test.

For calculation of Y balance score limb length of all subjects was taken.

To measure Limb Length

The subject was in supine position. Distance between anterior superior iliac spine and ipsilateral medial malleolus was measured by measure tape.

Y Balance Test[14,15]

All the subjects was explained about test procedure. Subjects were asked to keep their non-testing leg on the center of the grid. Patient was asked to reach in all three directions (anterior, posteromedial and posterolateral) by great toe of testing leg as much as he can. Distance covered by the subjects in all three direction was recorded. Then same procedure was repeated for another leg.

Figure 2: Y balance test

Score of Y balance test was calculated by following formula.

$$\text{Score of Y Balance Test} = \frac{Anterior + Posteromedial + Posterolateral}{3 \times Limb\ Length} \times 100$$

RESULTS

Unpaired t-test revealed that there were not significant differences (P >0.05) between groups.

Table1: mean, standard deviation and unpaired t test

	Mean	SD	Sample size	P value	Inference
Normal	86.89	8.15	10	0.791	NS
Flatfeet	85.61	6.97	10		

NS = not significant

DISCUSSION

In this study, there is no significant difference in dynamic balance between two groups. Most of people activity is performed in dynamic balance areas. Therefore, in this research it was decided to evaluate dynamic balance.

Joints, skin and muscles are the main sources of proprioception, foot shape characteristics can affect the angle of skin, joint and muscle tension and therefore can affect afferent feedback for postural control and balance of the body. Therefore, in this research, the association between foot characteristic and dynamic balance were investigated. However, this study did not show any strong association between foot characteristic and dynamic balance. Dynamic balance can be affected due to loose planter ligaments and low muscular mass leads to loss of stability mechanisms. But it can be compensated because the studies shown patients who have normal foot arches or even increased arch when there is no weight bearing, but upon connection with the supporting surface and putting pressure and weight on the lower extremity, the arch decreases and foot flattens, These patients had a better balance compared to others. This can be attributed to increased contact points in foot during weight bearing, which results in increased stimulation of plantar cutaneous receptors among others.

In studying the arch height, it was discovered that when the arch height is less, the balance is better. These results are consistent with the study of Lin CH, et al. probably due to increased connection points of the foot with the ground, which in turn improves proprioception and balance[15].

Moreover, development of heel valgus results in limited contact of the heel with the ground surface; therefore, fewer sensory receptors participate in sending necessary information to maintain balance. In this regard, a similar study was performed by Cobb et al[16].

It seems that Decreased arch height do not have much effect on the indicators of dynamic balance evaluated by the Y Balance test.

CONCLUSION

There was not a significant difference in dynamic balance between flexible flatfoot group (A) and normal arch group (B).

So, Dynamic balance is not affected in flatfeet individuals.

LIMITATIONS OF THE STUDY

Small sample size, Size of foot was not considered.

REFERENCES

1. Cote KP, Brunet II ME, Gansneder BM, Shultz SJ. Effects of pronated and supinated foot postures on static and dynamic postural stability. Journal of athletic training. 2005 Jan 1;40(1):41.
2. Hedayati R, Shargh MH, Soltani T, Saeb M, Ghorbani R, Hajihasani A. The Relation Between Clinical Measurements of Plantar Characteristics and Static and Dynamic Balance Indices. Middle East Journal of Rehabilitation and Health. 2014 Oct;1(2).
3. Ali MM, Mohamed MS. Dynamic Postural Balance in Subjects with and without Flat Foot. Bulletin of Faculty of Physical Therapy. 2011;16(1).
4. Dr.Martin Luther King Jr Drive North. Keeping Children's Feet Healthy. The foot and ankle associates of north Carolina
5. Ho MT, Tan J. The effect of foot structure and functional foot stability on the gait patterns of the foot.
6. Akram pashnameh, Rahim mirnasouri, Bijan goodarzi. Relationship between Some of the Lower Extremity Deformities with Static and Dynamic Balance in Female Students of Dorud Islamic Azad University. Eropean academic research vol. I, Issue 10/ January 2014.
7. Bressel E, Yonker JC, Kras J, Heath EM. Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes. Journal of athletic training. 2007 Jan 1;42(1):42.
8. Karthikeyan G, Jayraj SJ, Narayanan V. Effect of Forefoot Type on Postural Stability–A Cross Sectional Comparative Study. International journal of sports physical therapy. 2015 Apr;10(2):213.
9. Das B, Tedla JS, Narayan A. Normative Data for Foot Posture Index (FPI-6) and

Association of Foot Posture with Anthropometric Parameters in School Children from Mangalore: A Cross Sectional Study. International Journal of Research and development of Health. 2014;2(3):107-15.

10. Obrien DL, Tyndyk M. Effect of arch type and Body Mass Index on plantar pressure distribution during stance phase of gait. Acta of Bioengineering and Biomechanics. 2014;16(2).
11. Rashad, G. , Elimy, D. , Elgendy, M. , Elshiwi, A. , Ghazy, M.. "Evaluation of Postural Stability in Patients with Flat Feet: A Controlled Trial". World Academy of Science, Engineering and Technology, International Science Index, Sport and Exercise Sciences (2015), 2(10), 235.
12. McPoil TG, Cornwall MW, Medoff L, Vicenzino B, Forsberg K, Hilz D. Arch height change during sit-to-stand: an alternative for the navicular drop test. Journal of foot and ankle research. 2008 Jul 28;1(1):1.
13. Plisky PJ, Gorman PP, Butler RJ, Kiesel KB, Underwood FB, Elkins B. The reliability of an instrumented device for measuring components of the star excursion balance test. North American journal of sports physical therapy: NAJSPT. 2009 May;4(2):92.
14. Coughlan GF, Fullam K, Delahunt E, Gissane C, Caulfield BM. A comparison between performance on selected directions of the star excursion balance test and the Y balance test. Journal of athletic training. 2012 Aug;47(4):366.
15. Lin CH, Lee HY, Chen JJ, Lee HM, Kuo MD. Development of a quantitative assessment system for correlation analysis of footprint parameters to postural control in children. Physiological measurement. 2005 Dec 19;27(2):119–30.
16. Cobb SC, Tis LL, Johnson BF, Higbie EJ. The effect of forefoot varus on postural stability. Journal of Orthopaedic & Sports Physical Therapy. 2004 Feb;34(2):79-85.