Original Research Article

Study on Dynamic Balance in College students with Flat foot and with Normal Arched Foot using Y- Balance Test

Abstract

Introduction: Among grown-ups, mostly flat foot distortion is seen. It is described by average turn and plantar flexion of Talus; eversion of calcaneus crumbled average curve and snatching of the forefoot. In day-to-day life, to perform activity balance is the basic need and it plays an important role in maintaining body posture. Balance has been used as a proportion of lower limb work. A minor change in strength or any instability in muscles or joints of the lower limb can affect the balance. **Aim of Study:** The Aim of the study is to find out the Dynamic Balance in College Students with Flat feet and with Normal Arched feet using Y-Balance Test. **Materials and Methods:** A total of 60 Participants were taken from Krupanidhi College of Physiotherapy, Bangalore who fulfilled the inclusion criteria. Navicular Drop Test and Y-balance test were performed on all the participants. **Outcome Measures:** Navicular Drop test was used to differentiate Flat Foot and Normal Arched foot. Y-balance test was used to assess the Dynamic Balance. **Statistical Tool:** Unpaired t-test. Result: According to this study there is a significant difference in dynamic balance stability in students with Flat feet as compared to Normal feet, as the P-value for the Right foot is 0.0005 and for the Left foot is 0.004 and the Mean difference Right side is 6.75033 and for Left side is 8.6616. **Conclusion:** The study concludes that there is a deficit in Dynamic Balance among the students with Flat Foot as compared to Normal Arched Foot.

Keywords: Flat foot, Arched Foot, Y-Balance test, Navicular Drop test

1. Introduction

The foot is the essential portion for maintaining the body balance and even the minor changes in foot may lead to postural imbalance. The foot provides a narrow base of support [1]. The supplementing structures of lower leg foot complex grant both security and versatility relying upon conditions following on it. During prolonged standing or any other activities foot is capable of accommodate more amount of stress. The foot should be stable and adjustable both at a same time in order to provide stability during sports activity [2].

The most common deformity in adults is Flat foot. Ideally Flat foot is characterized by medial rotation and Plantar Flexion of Talus; eversion of Calcaneus collapsed medial arch and abduction of forefoot [3]. The prevalence of flat foot is not sure, but some authors researched and found that predominance of adaptable flat foot in kids (2-6 years) is 21% to 57% and in elementary school kids is 13.4% to 27.6% [4]. While the rate of prevalence of flat foot in students with age 18-25 years is 11.25% [4].

In outer countries, flat foot is a common problem. In India, children who attend the clinic for having flatfoot are from wealthy families, and they mostly wear shoes and heels. In India, children from the urban populations were scarce to complain about the flat foot. The reason behind this is the muscles have to work more to keep the slippers attached to feet rather than in fancy shoes which are closed-toe [5].

In day-to-day life, balance is a basic necessity to perform the activity and perform sports skills [6]. To identify the lower extremity function, static and dynamic balance in the body are measured [7]. Balance has a vital role in maintaining the body, as the straight body is not very stable, and the reason for this instability is that COG lies on the top of the foot [8]. The person with flatfoot will undergo many problems after pro-longed standing and will feel more pain than a normal arched foot [8].

The minor changes in strength or instability in muscles or joints of the lower limb can affect the balance, as the balance is directly related to feedback and movement strategies of any lower body joints. Balance is more in the closed chains as compared to open kinematic chains [9].

1.1 Sit to Stand Navicular Drop Test:

For assessment of lower limb mobility most commonly used technique is the Navicular Drop test. Brody was the first to state NDT. He noted that the length of the Navicular bone is subtracted from the length of the Navicular bone in a relaxed standing position. A study has reported the reliable value of NDT is 6-9mm [10].

1.2 Y-Balance Test:

Many test are there for evaluating dynamic balance; one of them is Star Excursion Balance Test (SEBT). The modified version of SEBT is Y Balance Test. It was developed to overcome drawbacks of SEBT like repeated measurement and improve the standard of the test.

Many studies have been conducted on static stability depending on the foot type. The area of support with ground varies according to the shape of the foot. To provide stability, the foot plays a significant role. Hertel, et al. stated that in flatfoot there is more speed of the center of pressure, and the reason behind this is a reduction of static stability in flatfoot compared to the normal foot.

Cote et al. concluded that change in the foot shape would lead to the difference in dynamic balance. The difference is seen mainly in the anterior direction [11]. Many studies had been conducted on static balance deficit; hence this study was carried out on dynamic balance deficit among the college students with flatfoot and normal arched foot.

1.3 Aims and Objectives:

The main aim of this study is to compare dynamic balance between college-going students with flatfoot and normal arched foot using Y-Balance Test. And objectives are to measure dynamic balance in students with flatfoot using Y-Balance test. To measure dynamic balance in students with normal arch foot using Y-Balance test. To evaluate dynamic balance in students with flat foot and with normal foot and to compare dynamic balance.

2. Materials and methods

The present study was carried out in the Krupanidhi College of Physiotherapy, Bangalore, Karnataka. A consecutive number of 60 participants were included by using the Navicular drop test, out of which 30 were participants with normal foot, and 30 were participants with bilateral flat feet. This study was a case-control study. It was approved by the ethical committee of the institute. Diagnosis was based on Navicular Drop test.

2.1 Participants:

A total of 80 participants (45 females and 35 males) with age of 18-25 years were taken from Krupanidhi college of physiotherapy participants having bilateral flatfoot along with a no history of any lower extremity injury and with no history of congenital deformity were included. Participants with Unilateral flat feet, with any neurological or pathological problem of lower limb and spine, any age <40 years patients with active tuberculosis, bronchial asthma, interstitial lung diseases, malignancy, patients not giving consent, patients unable to do spirometer, pregnant and hemodynamically unstable patients were excluded from the study. BMI and Navicular drop test was performed on each and every participant. The screening was done, and participants having bilateral flat feet were included. Out of 80 studies was performed on 60 participants who met the inclusion criteria, out of which 30 participants were with bilateral flat feet, and 30 participants were with normal arched foot. After screening Y- balance test was performed.

2.2 Outcome Measures:

- Navicular Drop Test.

Intra-rater reliability (ICC = 0.82-0.93) and Inter-rater reliability (ICC = 0.68-0.89)

- Y-Balance Test:

Intra-rater reliability (ICC = 0.85-0.91) and Inter-rater reliability (ICC = 0.99-1.00)

2.3 Procedure:

Ethical clearance was taken from the ethical committee before starting the procedure. The permission from the Principal of Krupanidhi College of Physiotherapy, Bangalore, was taken. A total number of 60 subjects were selected. (30 subjects with flexible flat feet and 30 subjects with normal arched feet). Subjects were selected for the study by giving consideration to inclusion and exclusion criteria. All the subjects were explained about the goal of the study the test procedures and written consent was obtained. All the subjects were divided into two group according to feet type. Group A (n = 30) subjects were individuals with flatfeet, and group B (n = 30) subjects were individuals with normal arched feet. All the participants with normal arched feet and flexible flatfeet were diagnosed on the basis of sit to stand navicular drop test (SSNDT).

2.4 Sit to Stand Navicular Drop Test (SSNDT)

The sit to stand navicular drop test is useful to diagnose flatfeet. It will 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.

The subject was placed in a sitting position with their flatfeet on a firm surface with the knee flexed to 90° and 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 the card. A representative image of

the subject performing SSNDT is shown in Figure 1. 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 millimetre. 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. For calculation of Y balance score limb length of all subjects were taken.

Fig. 1. Subject Performing SSNDT

2.5 To measure Limb Length:

The subject is instructed to be in supine position. Firstly, patient is asked to lift the hips and then place it back to normal, after that therapist stabilize the pelvis. Then by using measure tape, the limb length is measured from Anterior Superior Iliac crest to medial malleolus of tibia. The distance is measured in centimetres **Y-Balance Test:**

Many test are there for evaluating dynamic balance, one of them is Star Excursion Balance Test (SEBT). The modified version of SEBT is Y Balance Test. It was developed to overcome drawbacks of SEBT like repeated measurement and improve standard of test.

The major components for Y-balance Test are:

- Anterior
- Posteromedial
- Posterolateral

All the subjects were 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/she can. Distance covered by the subjects in all three direction was recorded. Then same procedure will repeated for another leg. 2 trials were given and data was collected.

3. Results and discussion

3.1 Result and Analysis:

Total 80 participants between age of 18-25 years were taken, out of which 20 participants were excluded and study was performed on 60 participants, out of which 30 participants were with Normal arched foot (Group B) and 60 participants were with Bilateral Flat Foot (Group A). In Group B there were 17 participants between age of 18-21 years and 13 participants between ages of 22-25 years. In group A there were 14 participants between age of 18-21 years and 16 participants between ages of 22-25 years. The mean of age groups, height and weight are shown in Table 1 which shows that there is no significant difference in their mean.

	NORMAL ARCHED FOOT (GROUP B)				**BILATERAL FLAT FOOT (GROUP A)**			
	AGE (years)		HEIGHT	WEIGHT	AGE (years)		HEIGHT	WEIGHT
	18-21 yrs	22-25 yrs	(cm)	(kg)	18-21 yrs	22-25 yrs	(cm)	(kg)
Mean	19.88	22.84	162	54.78	19.93	23.07	163	57.12

Table 1. Shows mean value of physical characteristics of both groups.

The mean of NDT are described in Table 2. The mean of NDT shows significant difference between both right and left normal and bilateral flat feet.

Table 2. Shows mean value of NDT of both groups:

	NDT RIGHT	**NDT LEFT**
NORMAL FOOT	7.33	7.66
FLAT FEET	4	4.33

The p-value and mean difference between the normal arched foot and bilateral foot is provided in Table 3. The mean difference between right Normal foot and right bilateral flat foot is 6.417 while between left normal foot and left bilateral flat foot is 5.81. The p-value for right normal foot and right bilateral flat foot is 0.005 while for left normal foot and left bilateral flat foot is 0.004. The mean difference for normal foot is more than the bilateral flat feet which indicates that the result of Y-balance test is more for normal foot, which indicates more stability for normal foot in comparison to bilateral flat feet.

Table 3. Between the group comparisons of Normal arch Feet vs Flat Feet on Y-Balance Test using unpaired t-test:

	MEAN	**SD**	**MEAN DIFFERENCE**	**P- VALUE**
NORMAL ARCH FOOT (RIGHT)	89.02	6.49	6.417	0.005
FLAT FOOT (RIGHT)	82.27	10.28		
NORMAL ARCH FOOT (LEFT)	94.3	12.65	5.81	0.004
FLAT FOOT (LEFT)	85.64	10.32		

3.2 Discussion:

Aim of this study is to compare dynamic balance between children with flat foot and children with normal arched feet using Y -balance test.

Mean values for right and left feet of flat feet group is 82.27 & 85.64 respectively. While mean values for right and left feet of normal arch group is 89.02 & 94.03 respectively.

In study the intergroup comparison was done using unpaired t-test. The p-vale of unpaired t-test was set at ≤0.05. P-value for right and left foot of normal & flat feet group was 0.005 & 0.004 respectively which shows that results are significant.

This study, there is 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.

In flat feet individuals, the angle is increased indicating that the foot is pronated. Since in flat feet, the average longitudinal curve of the foot seems smoothed, this makes the foot roll inwards so as to pick up contact with the floor and bolster the heaviness of the body and is the fundamental clinical element of pronation [12]. Thus calcaneus lies in valgus and external rotation relative to tibia and talus faces medially and downwards. There may also be associated midfoot sag due to dorsal subluxation of navicular on talus [13].

Also width of the foot is comparatively greater in flat feet. The possible reason being splaying of the forefoot, a condition where the intermetatarsal ligament is soft and loose, allowing the foot to spread. As the foot pronates and the longitudinal arch collapses, the transverse arch of the foot also will collapse. Once this happens, the metatarsal heads are aligned and this causes them to spread to make room [12].

Balance deficit is affected by not only neuromuscular control or joint proprioception but also affected by other factors like Foot position, footwear, poor posture, and decreased foot muscle strength [14]. Sachithanandam V, Joseph B, et al did a study on “the influence of footwear on the prevalence of flat foot” and observed that at whatever point the commonness

of level foot was low, that of high-curved feet was high. This was likewise found in the current investigation which recommends that factors helpful for the improvement of the curve improbable to cause level foot. A higher commonness was not seen in the more seasoned grown-ups which demonstrates that it doesn't create as a combined impact of weight- bearing. The most significant finding was the higher pervasiveness of level foot among grown-ups who started utilizing footwear in early lead to a low commonness of level foot and a high predominance of high-curved feet and the other way around. We accept that it is important to survey the commonness of both high-curved feet and level feet when examining the variables which may impact the improvement of the average longitudinal curve [14].

Most exercises an individual takes an interest in are practical, or dynamic, rather than static. In this way, notwithstanding very much acknowledged standard static-balance tests, we decided to likewise quantify a record of dynamic parity. The SEBT is a moderately new appraisal apparatus, depicted as a practical test that accentuates dynamic postural control, which has been characterized as the degree to which an individual can reach or lean without moving the foot and still keep up upstanding stance [15]. Henceforth, this test requires a mix of foot, lower leg, knee, and hip movement and forces more noteworthy requests on quality and joint scope of movement, notwithstanding proprioception and neuromuscular control inside the position leg to keep up offset while coming to with the contrary leg. Our outcomes comparative with this test uncovered that lone certain arrive at bearings were influenced by foot type. We accept this course reliant impact further backings our conflict that basic security portability of the foot, not proprioceptive changes, is the conceivable clarification for our discoveries [7].

The Y Balance Test was developed to address some of the limitations of the traditional SEBT testing methods. And arrive at marker, standard arrive at range from the beginning, characterized pass criteria, and the capacity of the arrive at pointer to stay over the measuring

tape after execution improve the reproducibility of the arrive at estimation. These highlights likewise permit the rater to concentrate on watching the subject, and, in this manner, better evaluate the subject's development quality [16].

Cowley and Marsden et al studied the changes in foot postures after a half marathon. They found that foot posture towards a more pronated position may have implications for foot function, and therefore risk of injury. This study group included school of physical education students and it was assumed that they were active in different sports; so it is important result to find relationship with foot posture. This may prompt some problems, since foot pose issues can cause balance insufficiency whether they are in sports movement or not. A few scientists (Dong-chaul et al; 2014) recommended some foot practice for individuals having foot stances issues to expand their parity capacity. This investigation results show the significance of distinguishing foot pose issues which is to adjust lack [17].

The study can be conducted in more wide range of age group and with more number of participants to get more accurate result and further exercise protocol can be added for further studies.

3.3 Clinical Implication:

- By using SSNDT flat feet can be detected. This will be helpful in bringing awareness in people about improper footwear.
- This study provides basis for prevention of consequences which can occur in individuals with flat feet in their later life.
- By knowing the amount of navicular drop, further footwear modifications can be advised.

4. Conclusions

The conclusion of this study is that there is significant difference in p value between both the groups which shows that there is dynamic balance deficit in college students with Flat feet in comparison with normal arch foot on Y- Balance test.

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