# THE EFFECTIVENESS OF CONVENTIONAL THERAPY WITH INTRINSIC FOOT MUSCLES EXERCISE VERSUS CONVENTIONAL THERAPY WITH GLUTEAL MUSCLES STRENGHTHENING EXERCISE ON PAIN AND IMPROVING BALANCE AMOUNG PES PLANUS PATIENTS.

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*Abstract-*

**INTRODUCTION AND BACKGROUND:**

**Pesplanus is also called as flat foot, which is the loss of medial longitudinal arch of the foot. A Condition in which the entire sole of the foot touches the floor while standing. Prevalence of flat foot seems to be 28% at certain age groups. Pes planus is more prevalent in children and females. All typically developing infants are born with flexible flat feet, with arch development first seen around 3 years of age and then often only attaining adult values in arch height between 7 and 10 years of age.**

**The etiology of pes planus has several factors implicated and can be either congenital and acquired. Among many interventions for subject with pesplanus, intrinsic foot muscle exercises and gluteal muscles strengthening exercises are claimed to be important interventions. Researchers have demonstrated evidence for the use of exercise in the treatment of pesplanus. However the opinions about efficacy of these exercise regime differ. Hence the purpose of the study is to compare the effectiveness of conventional therapy with intrinsic foot exercise versus conventional therapy with gluteal muscles strengthening exercise for pesplanus to reduce pain and improve balance.**

**AIM: A Comparative study on the effect of conventional therapy with intrinsic foot muscles exercise versus conventional therapy with gluteal muscles strengthening exercise on pain and improving balance among pesplanus patients.**

**METHODOLOGY: Subjects were equally divided into 2 groups with 15 subjects on each group randomly. In Group A, Subjects were treated with conventional therapy with intrinsic foot exercise and Group B, Subjects were treated with conventional therapy with gluteal muscles strengthening exercise. Cryotherapy was given conventionally for both the groups, its helps reduce pain. Interventions were given for 6 weeks for both the group. The outcomes were measured by VAS for pain and Berg Balance scale for balance.**

**RESULT:The data were tabulated and analysed statistically. The result showed that all outcome measurements got improved statistically in group A and B. However, group B showed significant improvement $p<0.005$ compared to group A. The conventional therapy with gluteal muscles strengthening group B showed significant result compare to other group.**

**CONCLUSION:There is significant improvement in balance and pain reduction in 6 weeks. The alignment, strength and stability of hip has got a influence on foot alignment and its biomechanical activities, which is mediated by some reflexes on foot. This could be a reason for conventional therapy with gluteal muscle strengthening is more effective in reducing pain and improving balance.**

**Moreover, the weakness of gluteal muscles can result in rotation of hip joint internally this could in turn result in foot pronation and become the cause for pesplanus. Hence, by strengthening gluteal muscles, the hip can be stabilized. This counteracts gravity`s hip adduction torque and maintain proper leg alignment controlling adduction and internal rotation of the thigh and externally rotates the alignment of the lower extremity and help reducing foot pronation. However, intrinsic foot exercises also seem to provide dynamic foot support, helping to control the speed and amount of pronation and stabilize the arches further locally.**

*Key Words:* **Intrinsic foot exercise, gluteal muscles strengthening exercise, pesplanus, VAS, berg balance scale.**

## INTRODUCTION

Human feet are the first structure in the kinematic chain that comes in contact with the ground for all our functions and performance over earth. Although the feet occupy only 5% of the areas of the human body, they control postures through afferent information obtained through the sense of the soles, provide stability for maintenance of balance, and absorb impacts. The body weight normally falls on the center of the foot, and balance is maintained by the muscle activity of the foot. If the foot becomes diseased or deformed, the foot adapts to perform its functions under the conditions of disease or deformity. All typically developing infants are born with flexible flat feet, with arch development first seen around 3 years of age and then often only attaining adult values in arch height between 7 and 10 years of age.

There is also an indirect functional connection has been theoretically established between muscles that control the hip and foot. Weakening of the gluteus maximus has been associated with foot deformities as a causative factor as this induces the hip joint to

internally rotate and the foot to pronate. Association between pronation of foot and flat foot has been extensively researched and mostly concluded to be significantly related. Within the sole of the foot, there are three arches, which include lateral longitudinal arch, the medial longitudinal arch (MLA), and the transverse arch.

Pesplanus is a relatively common foot deformity that refers to the loss of the medial longitudinal arch of the foot, resulting in this region of the foot coming closer to the ground or making contact with the contacting the ground. The deformation into flatfoot is induced when the medial longitudinal arch (MLA) has descended because the arch had been excessively relaxed to the extent that the arch cannot be maintained and causes the feet to be excessively pronated compared to normal feet so that heel eversion appears and the weight load is shifted inward to compress the MLA. Pesplanus can be either congenital or acquired. It is estimated that about 20% to 37% of the population has some degree of pes planus.

It is of two forms;

- Flexible flat foot - the arch of the foot is intact on heel elevation and non-bearing but disappears on full standing on the foot,
- Rigid flat foot - the arch is not present in both heel elevation and weight bearing.

The foot intrinsic muscles consist of several smaller muscles located at the bottom of foot to stabilize and protect the bones and joints of the foot. Weak foot intrinsic muscles can cause a lower arch height and foot over-pronation. When the foot intrinsic muscles are weak and unable to support the foot properly, they can be the major causative factor for flat foot and require intrinsic foot muscles strengthening exercises.

Gluteal muscle strengthening: The gluteal muscles (maximus, medius, minimus) stabilize the hip by counteracting gravity's hip abduction torque and maintain proper leg alignment by eccentrically controlling adduction and internal rotation of the thigh. Re-activating the gluteal muscles will re-establish correct muscle recruitment patterns and enhance strengthen performance.

**STATEMENT OF STUDY**

Flat foot is a commonly observed disorder, where the height of the medial longitudinal arch determines the degree of pesplanus. Prevalence of flat foot in adults is 11.25%.

The purpose of the present study is to examine the effects of conventional therapy with intrinsic foot muscle exercises to that of the effects of conventional therapy with gluteal muscles strengthening exercises among pronated flat feet on the development of arch.

**AIM OF STUDY**

The aim of study is to examine and compare the effects of conventional therapy with intrinsic foot muscle exercises to that conventional therapy with gluteal muscles strengthening exercises for pesplanus to reduce pain and improve balance

**NEED FOR THE STUDY**

Flat foot can be corrected by various types of foot strengthening exercises methods, current study aims at finding out the most beneficial and effective exercise program for correction and arch development of flat foot in adults.

The need of the study is to check whether adding up gluteal muscle strengthening can give a better improvement in arch development when compared to intrinsic foot muscle strengthening.

**OBJECTIVES**

- To evaluate the improvement in balance and reduction in pain in patients with flat foot using gluteal muscles strengthening exercises with conventional therapy.
- To evaluate the improvement in balance and reduction in pain in patients with flat foot using conventional therapy with intrinsic foot muscles exercises.
- To compare the effect of conventional therapy with intrinsic foot muscle strengthening exercises over the effect of conventional therapy with gluteal muscles strengthening exercises on Improvement in balance and reduction in pain in patients with flat foot.

**HYPOTHESIS :**

- **Alternative hypothesis :**

There is a significant difference between the effect of Conventional therapy with intrinsic foot muscle exercises and conventional therapy with gluteal muscles strengthening exercises on pes planus to reduce pain and improve balance.

- **Null Hypothesis** :

There is no significant difference between the effect of conventional therapy with intrinsic foot muscle exercises and conventional therapy with gluteal muscles strengthening exercises on pesplanus to reduce pain and improve balance.

**OPERATIONAL DEFINITIONS**

**Flat foot:**

The height of medial longitudinal arch determines the degree of flat foot. In Non-Weight bearing, this arch appears, but when assuming a weight bearing the arch disappears and the flat foot becomes evident.

**Over pronation:**

Over pronation of foot occurs when the heel strikes the ground and the foot rolls inward more than the ideal 15%. Because of over pronation in the foot, shock absorption is minimized and the foot and the ankle may have trouble stabilizing the body.

**Brody's navicular drop test:**

It is a test used to measure changes in the height of medial longitudinal arch.

**DESIGN AND METHODOLOGY**

STUDY DESIGN:

Experimental study design was selected to conduct this study.

STUDY SETTING:

The study took place at Thanthai Roever college of Physiotherapy, Perambalur.

STUDY DURATION:

The study was conducted 6 days per week for about total of 6 weeks.

SAMPLING METHOD:

Convenient sample selection method was used to for the subject selection and the subjects were allocated into groups using Random allocation method.

SAMPLING SIZE:

A total number of 30 samples were selected. The samples were randomly allocated either to Group A (or) Group B each consisting 15 subjects.

- **GROUP A** = 15 ( conventional therapy with Intrinsic foot muscle strengthening exercises )
- **GROUP B** = 15 (conventional therapy with gluteal muscles strengthening exercises )

SAMPLING CRITERIA:

INCLUSION CRITERIA:

The subjects with the following criteria were selected for the study

- Navicular drop > 10 mm
- Age = 18-25 years
- Gender = both male and female
- Subjects willing to participate.

EXCLUSION CRITERIA:

- The subjects with the following criteria were expelled from the selection.
- Arthritis
- Foot or ankle surgery
- Diabetes
- Any foot abnormalities
- Any present cuts on the lower extremity
- Noncooperative subjects.

TOOLS FOR DATA COLLECTION:

**Materials used :**

- Navicular drop test (Index card, pen, metal ruler).

**Tool used :**

- VAS
- Berg balance scale
- Pen
- Index card

**Selection method :**

Height of MLA was measured using navicular drop test ratio before the start of flat foot strengthening exercises protocols as pretest at the beginning of the study and as post-test at the the end of the study at 6th week.

**Navicular drop test :**

The height of the navicular tuberosity is measured in neutral and relaxed stance positions, and the amount of the excursion was measured. Subjects were made to sit in the comfortable position in height matched chair with feet placed flat on the ground on the sub talar joint neutral position was obtained with palpation method. The position of the navicular tuberosity was marked on the

index card. Subjects were made to stand with full weight bearing through the lower limbs equally and the sub talar joint neutral position was achieved during pronation and supination of sub talar joint as the medial and lateral aspect of the head of the talus becomes prominent respectively. Then the position of the navicular tuberosity was marked on the same index card.

**Procedure :**

30 subjects with pesplanus were selected based on inclusion and exclusion criteria and were divided into 2 groups of 15 subjects each.

The subjects were clearly explained about the techniques procedure via demonstration and the informed consent was sighed pre test assessment of pain taken using VAS scale and recorded.

After assessment ,30 participants were divided into group A and group B with 15 participants in each group . The treatment protocol done for 6 weeks .from first day cryotherapy Group A receive intrinsic foot muscles exercise, Group B receive gluteal muscles strengthening exercises. Post test assessment was taken for both the groups and was recorded. The procedure was carried out for 6 weeks.

**BOTH GROUP A AND B GIVEN CRYOTHERAPY :**

Both group A and B receive cryotherapy of immersion method .subjects were immersed their lower limb in a bucket. The bucket contain 50% ice cube with 50% ice water .

Duration : 5 to10 minutes.

The study subjects performed their respective exercises three times per week in the laboratory and two times per week at home for six weeks. The subjects who performed both gluteus maximus and toe spread exercises did three sets of 20 repetitions of exercises that selectively strengthened the gluteus maximus in the prone position and 100 repetitions of toe spread exercises in the sitting position while maintaining both the hip joints and the knee joints at 90° flexion. The subjects in the other group performed only 100 repetitions of toe spread exercises alone.

**Group A:**

Intrinsic muscle strengthening exercises

- Short foot exercise (10 seconds hold, repeat 5 times, 2 sets).
  Make sure all toes are in touch with the ground .now focus on your big toe .press the tip into the ground and watch the arch of that foot increase , as the ball of your foot lifts from the ground.

- Heel raise (10 seconds hold, repeat 15 times, 2 sets).
  While standing , lift your heels as high as you can. You can use a chair or wall to help support your balance hold the upper position for 5 seconds , and then lower back down to the floor.

- Toe curls (no hold, repeat 10 times, 2 sets).
  Sit in a straight backed chair with your feet flat on the floor. Lay a kitchen towel or hand towel on the floor in front of you so the short end is at your feet. Put the toes of one foot on the end of the towel and scrunch your toes so you pull the towel toward you .

- Toe extension (hold for 5 seconds, repeat 10 times, 2 sets)
  Sit with your feet flat on the floor, lift your toes and spread as far apart as possible , trying to get them all to the same height .

**Group B:**

Gluteal muscle strengthening exercises

- Clamshell (10 seconds hold, repeat 10 times, 2 sets).

Lie on your side with knees bent and stacked on top of one another. Your lower arm supports your head and the other one monitors the position of your pelvis. Roll forward slightly so that the top hand is in front of your hip bone on the bottom .tighten abdominal muscles slightly.lift top knee away from the bottom knee while keeping ankles together as far as you can without moving your pelvis .return to the start position and repeat . roll over and do the other side.

- Side lying hip abduction (10 seconds hold, repeat 15 times, 2 sets).
  Lie down on the floor on your side. Rest your head on your arm. Keep your feet together and lift your top leg up so that your knees are separated. keep your hips steady. Slowly lower your back down.

- Hip external rotation exercise (no hold, repeat 5 times, 2 sets).
  Lie down on your stomach with both legs extended. place your palms flat on the floor under your chin. Keep your left leg extended. gently lift your right knee off the floor.

- Quadruped exercise (no hold, repeat 10 times, 2 sets).
  Start on yours hands and knees. Raise your right arm off floor and reach ahead. Raise your rightbleg off the floor . For added challenge , raise your left arm and your right leg at the same time.

**DATA ANALYSIS**

**DATA ANALYSIS -STATISTICAL METHODS**

The collected data were tabulated and analyzed using descriptive and interferential statistics.
To assess all the parameters, mean and standard deviation were used.
To find out the changes in pretest and posttest, **paired 't' test** of VAS and BERG BALANCE SCALE was adopted. Data analysis was done using statistical package of social science (spss) software version 28.0.
**Paired 't' test** was used to compare the mean values of all parameters.
The changes within the group were analyzed using paired 't' test and independent 't' test.

INDEPENDENT `t' TEST

| BBS | N | MEAN | SD | T | TABLE VAL | SIG P =.005 |
|---|---|---|---|---|---|---|
| PRE TEST | 15 | 40.2 | 5.23 | 3.25 | 0.993 | 0.004 |
| POST TEST | 15 | 49.8 | 1.96 | | | |

$$t = \frac{\overline{X1} - \overline{X2}}{S}\sqrt{\frac{n_1 n_2}{(n_1 + n_2)}}$$

Where,

$$S = \sqrt{\frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_{2\_} 2}}$$

PAIRED `t' TEST

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

Where,

$$S = \sqrt{\frac{\sum d^2 - \left[\bar{d}\right]^2 \times n}{n-1}}$$

S=combined standard deviation
$d_1 \& d_2$ =difference between initial & final readings in Pretest and Posttest respectively.
$n_1 \& n_2$=number of patients in Pretest and Posttest respectively
$\overline{X_1} \& \overline{X_2}$ =Mean of Pretest and Posttest respectively

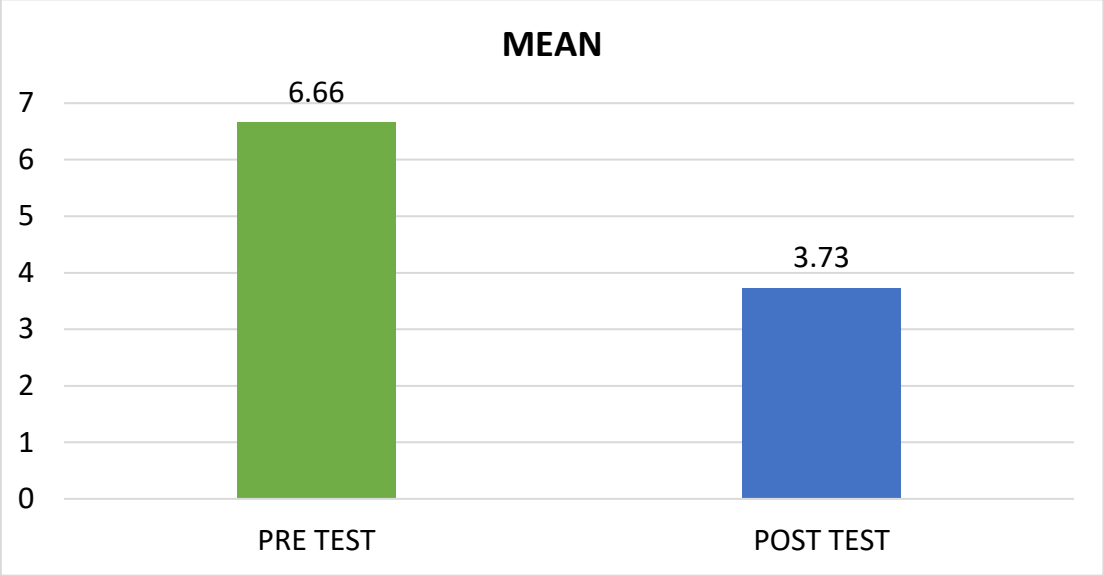
**TABLE-4.1**
**GROUP A - PRE AND POST TEST VALUES VAS (VISUAL ANALOG SCALE)**

The mean value of post test 3.73 with standard deviation 0.911 which is lesser than the mean value of the pre test 6.66 with standard deviation 1.863 and T – value 0.931 which is statistically significant with p<0.005.
This table infers that there was significant difference in pre and post-test values P<0.005.

**TABLE-4.2**
**GROUP A- PRE AND POST TEST VALUES OF BERG BALANCE SCALE**

The mean value of post test value 49.8 with standard deviation 1.96 which is greater than the mean value of the pre test 40.2 with standard deviation 5.23 and T-Value 0.993which is statistically significant with p<0.005.
This table infers that there was significant difference in pre and post-test values P<0.005.

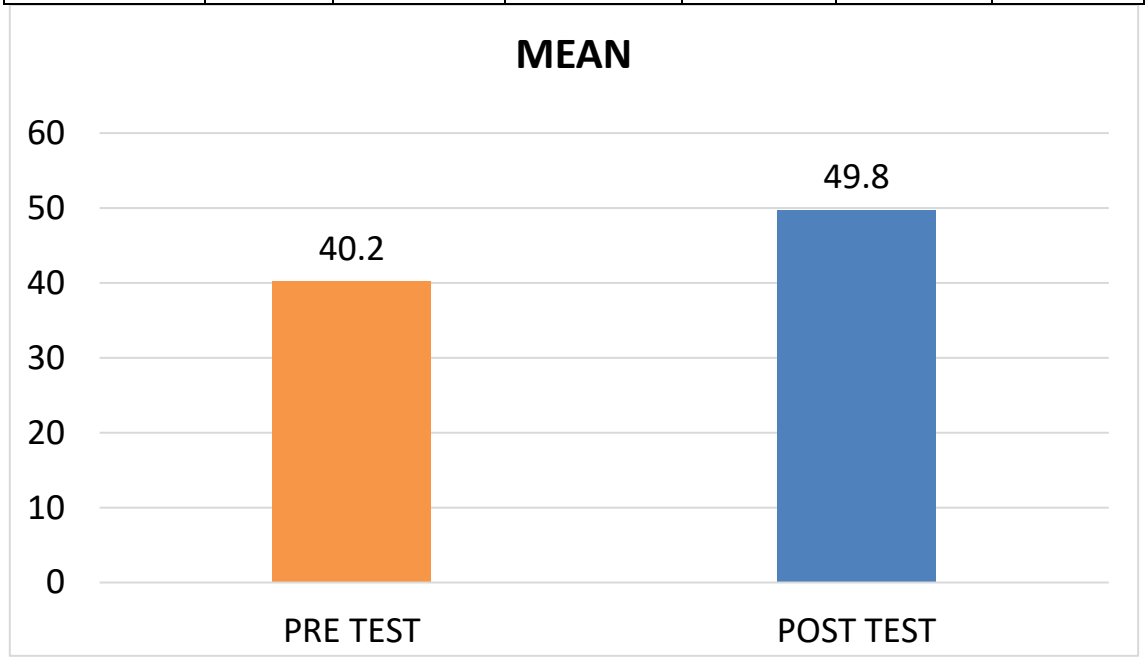
**GRAPH 4.a**




**GROUP A - PRE AND POST TEST MEAN VALUES OF VAS**

**GRAPH 4.b**

| BBS | N | MEAN | SD | T | TABLE VAL | SIG P =.005 |
|---|---|---|---|---|---|---|
| PRE TEST | 15 | 39.4 | 6.28 | 1.68 | 0.999 | 0.000 |
| POST TEST | 15 | 51.11 | 1.50 | | | |




**GROUP A - PRE AND POST TEST MEAN VALUES OF BERG BALANCE SCALE**

**TABLE-4.3**
**GROUP B- PRE AND POST TEST VALUES VAS (VISUAL ANALOG SCALE)**

The mean value of post test 3.33 with standard deviation 0.999 which is lesser than the mean value of pre test 7.53 with standard deviation 1.963 and T-value 2.125 which is statistically significant with p<0.005.

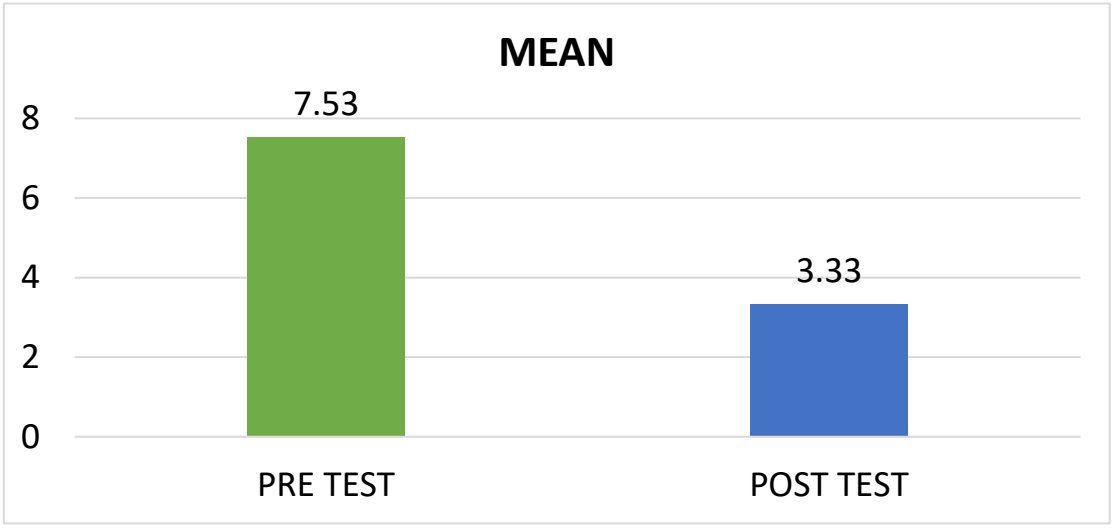
This table infers that there was significant difference in pre and post-test values P<0.005

**TABLE-4.4**
**GROUP B-PRE AND POST TEST VALUES OFBERG BALANCE SCALE**

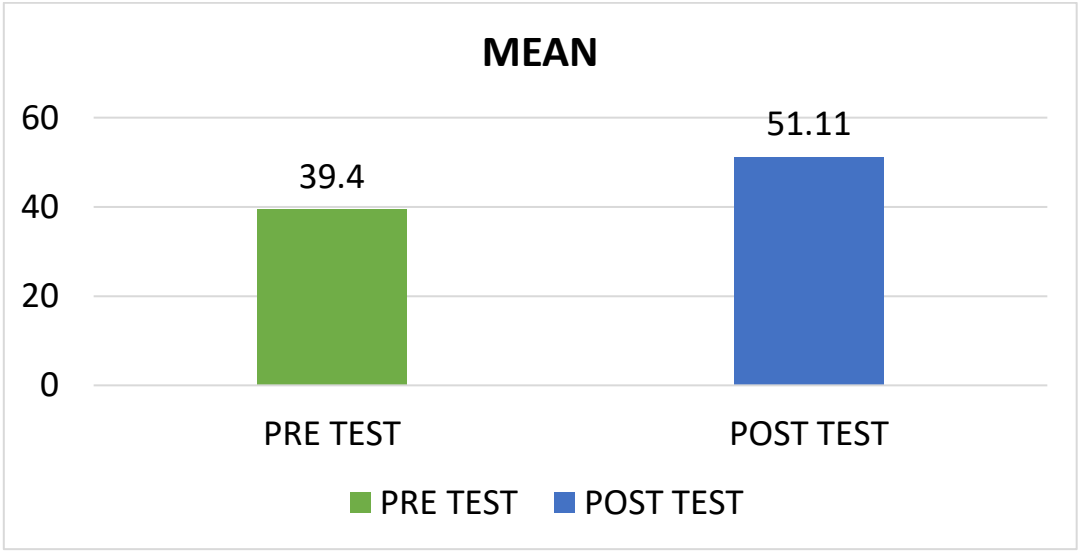
The mean value of post test 51.11 with standard deviation 1.50 which is greater than the mean value of pre test 39.4 with standard deviation 6.28 and T- value 1.68 which is statistically significant with p<0.005
This table infers that there was significant difference in pre and post-test values P<0.005.

**GRAPH 4.c**

**GROUP B -PRE AND POST TEST MEAN VALUES OF VAS**




**GRAPH 4.d**




**GROUP B-PRE AND POST TEST MEAN VALUES OFBERG BALANCE SCALE**

**TABLE-4.5**
**GROUP A and GROUP B-BETWEEN GROUP ANALYSIS OF GROUP A AND B USING VAS**

Table 4.5 shows the statistically outcome of post test scores of VAS for group A and group

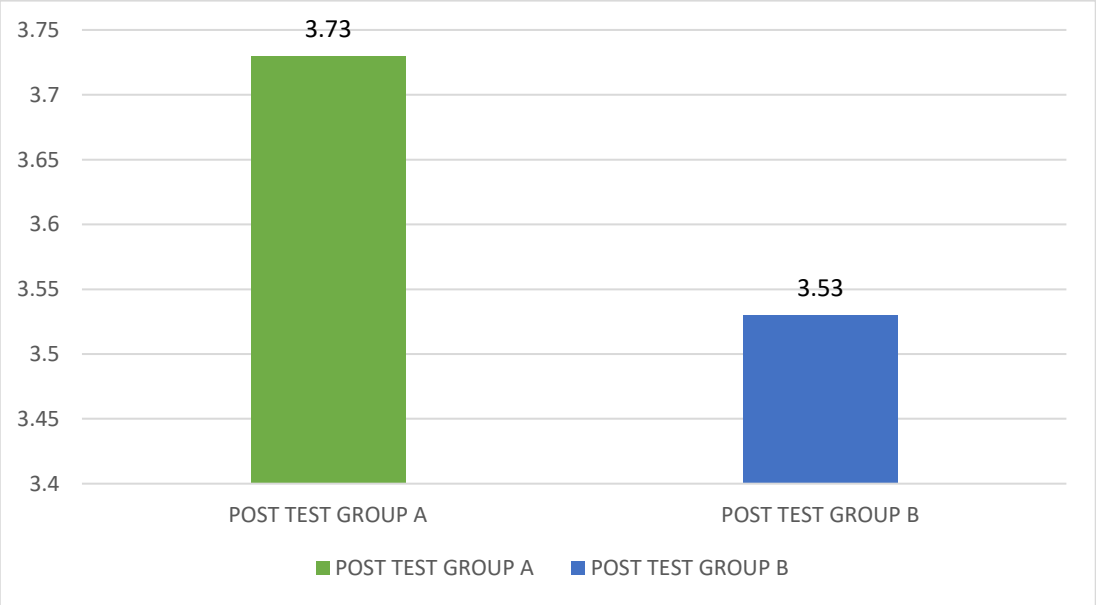
Table 4.5 shows the statistically outcome of post test scores of VAS for group A and group B. The VAS score of group A mean value of 3.73 and with SD 0.911 and group B mean value 3.53 with SD 1.965, T value of 0.323 which is statistically significant with $p<0.005$.

**TABLE-4.6**
**GROUP A and GROUP B-BETWEEN GROUP ANALYSIS OF GROUP A AND B USING BERG BALANCE SCALE**

| GROUP | ANALYSIS | MEAN | SD | t-VALUE | P-VALUE | LEVEL OF SIGNIFICANCE |
|---|---|---|---|---|---|---|
| VAS | POSTTEST | 3.73 | 0.911 | 0.323 | 0.002 | *** |
| | POSTTEST | 3.33 | 1.965 | | | |

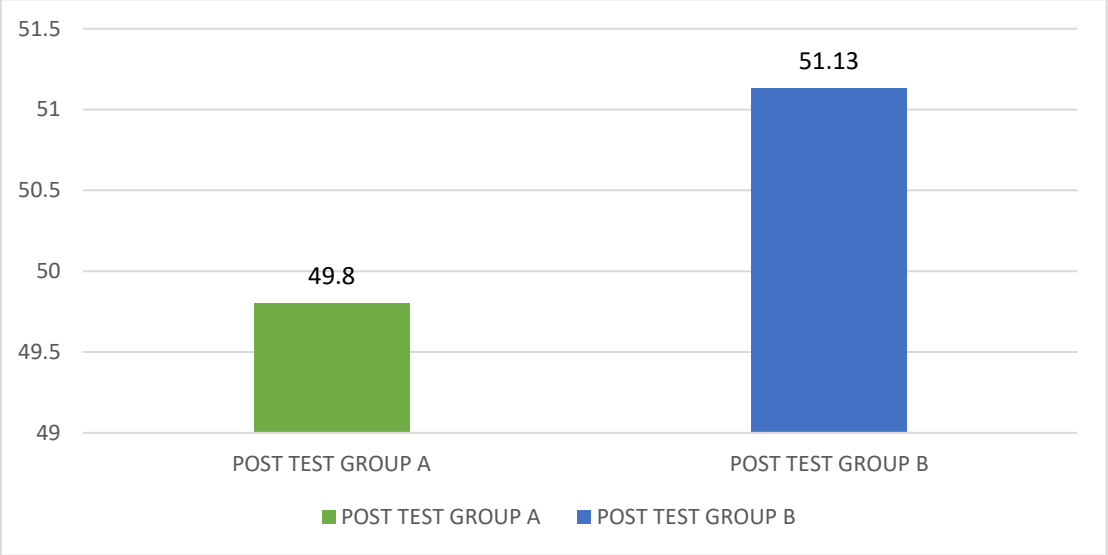
Table 4.6 shows the statistically outcome of post test scores of BBS for group A and group B. The BBS score of group A mean value of 49.8 and with SD 1.965 and group B mean value 51.13 with SD 1.5026 ,T value of 2.13 which is statistically significant with $p<0.005$.

**GRAPH 4.E**




**GROUP A AND GROUP B -PRE AND POST TEST MEAN VALUES OF VAS**

**GRAPH 4.f**




**GROUP A AND GROUP B - PRE AND POST TEST MEAN VALUES OF BERG BALANCE SCALE.**

**RESULT AND DISCUSSION**

**RESULT**

In between group analysis, of pre test of group A and group B was done to know the homogeneity of groups both visual analog scale and berg balance scale showed that there was no significant difference for VAS group A post test Mean value is 3.73 and group B post test mean value 3.73 and P value<0.002 for berg balance scale group A post test mean value is 49.8and group B post test mean value 51.11 and P value <0.003,which shows that there was equal clinical findings at the time of entry into the research.

Within group analysis was done for group A and group B for both scale. It showed significant improvement. For (group A) VAS mean value for pre test is 6.66 and mean value for post test is 3.73 and p value is <0.003 and berg balance scale mean value for pre test is 40.2 and mean value for posttest is 49.8and p value is <0.004. For (group B) VAS mean value for pre test is 7.53 and mean value for post test is 3.33 and p value is ,0.001 and berg balance scale mean value for pre test is 39.4 and mean value for posttest is 51.11 and p value is < 0.000. This clearly shows there has been significant improvement taken place in both with the given interventions. Both interventions were found to be beneficial for the pes planus.

However, in the between group analysis of post test revealed that group B showed much significant improvement than group A. This clearly favours my alternate hypothesis that 6 weeks of conventional therapy with gluteal muscles strengthening exercise (group B) were more beneficial compared to conventional therapy with intrinsic foot muscles exercise (group A) for patients with pes planus.

**DISCUSSION**

The present study was conducted to compare changes in height of medial longitudinal arch in adult subjects with flat foot. Subjects were randomly divided into two groups. Group A (control group) and Group B (experimental group). GROUP A subjects who performed conventional therapy with intrinsic foot muscle strengthening exercises and in GROUP B who additionally performed conventional therapy with Gluteus muscles strengthening exercises. The present study subjects were selected based on navicular drop test> 10mm.

The improvement found both in control (Group A) and experimental (Group B) while comparing before intervention and post intervention could be due to the clinical reason that the foot intrinsic muscles consists of several smaller muscles located on the bottom of the foot just as the core muscles around the spine are essential to stabilize and protect the spine, the foot intrinsic muscles must do the same for the many bones and joints of the foot. Intrinsic foot muscles play a role in stabilization of longitudinal arches of the foot with muscle recruitment occurring in response to increased loadings.

Recent studies have reported that the plantar intrinsic muscles act in a synchronous manner to provide postural support for the foot. In fact weak foot intrinsic muscles are weak and unable to support the foot properly, they must be strengthened. Flat foot occurs due to the deformation of arch in response to static dynamic loading. Weakening of foot intrinsic muscle can cause a lower arch height and over pronation. Since the muscles are relatively small and can only fight back with a small amount of force a longterm effects on dynamic postural stability can't be achieved.

Group B turned up with a better improvement in arch height probably because the muscles that control hip adduction and internal rotation is the hip abductors and hip external rotators. Strengthening of these muscles would have stabilized the hip by counteracting hip adduction torque and maintaining proper leg alignment by eccentrically controlling internal rotation of thigh and improving the medial longitudinal arch in flat foot.

In the present study, it could be seen that to improve arch, conventional therapy with gluteus muscles strengthening exercises are found to be more effective than applying
conventional therapy with intrinsic foot muscle exercises. The clinical reason for this study can be understood from the conclusions obtained from recent studies and there is a growing evidence that hip weakness can contribute to a number of problems including flat feet and excessive pronation. The position of the hip affects both the alignment of the leg and foot bones as well as the way forces travel through the leg. Hip weakness and poor control over the movement of the hip can lead to higher stresses on the structures further down the leg. If the lines of force points down toward the inside of the foot instead of over the center, the joints of the foot and ankle are under pressure to roll inward, with a foot to pronate and collapse of the medial longitudinal arch.

## LIMITATIONS AND RECOMMENDATIONS

### LIMITATIONS

- This study was limited only to the adult age group.
- The sample selected was of least appropriate size (small sample size)
- Duration of study was also the least appropriate time period. This was mainly intended to complete the project within the college study duration.
- Undertaking all measurements manually is an inherent strength of the current study although it is accepted that the introduced human error may be potential threat to reliability of the reading.

### RECOMMENDATIONS

- Sample studied were small and the study reduces the generalizability therefore study with a much larger population is recommended.
- This study suggests that to make the study more valid, a long term study with or without increase in frequency of training is needed.

## CONCLUSION

The result confirms that there is a significant improvement on the outcome measures for conventional therapy with gluteus muscles strengthening exercise.
Group A shows that there is statistically significant difference at p-value <0.0001 from pretest to post test using conventional therapy with intrinsic foot muscle strengthening exercise to improve height in medial longitudinal arch in both outcome measures. Similarly, Group B also shows that there is statistically significant difference at P-value<0.005 between conventional therapy with Gluteus muscles strengthening exercise on the both outcome measures (VAS & Berg balance scale).
This study also concluded that after 6 weeks of treatment Group B conventional therapy with Gluteus muscles strengthening exercise were of more effective in the treatment of flat foot compared to the Group A, which received conventional therapy with intrinsic foot muscle exercises. This explains the importance and the influence of hip muscles over foot dynamic anatomy and physiology. Hence, conventional therapy with gluteal muscles strengthening exercise were the most effective method of improving height of medial longitudinal arch than conventional therapy with intrinsic strengthening exercises in adults with flat foot.

## CONFLICTS OF INTEREST

We have no conflict of interest to declare.

## SOURCE OF FUNDINGS

We did not receive support from any organization for the submitted work.

## ETHICAL CLEARANCE

Approval was obtained from local ethics committee.

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