Original study

Efficacy of Tibialis Posterior Strengthening Exercise with Obesity Reduction Program in Flexible Flatfoot among Obese School Children

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Abstract

Background: Flat foot (Pes Planus), is characterized by a reduced or absent medial longitudinal arch. Flat foot can be caused by many factors, including obesity, wearing shoes, weakness of muscles. Flat foot in obese children is mainly caused by the presence of a plantar fatty pad under the medial longitudinal arch of the foot.

Objective: To compare the Efficacy of Tibialis Posterior Strengthening Exercise with Obesity reduction program In Flexible Flatfoot among Obese School Children.

Methodology: A Randomized control trial (RCT) was conducted on 50 obese subjects with flexible flat foot. Experimental group received both the intervention, and control group received only obesity reduction programme. The tibialis posterior strengthening exercise is performed for 30 minutes per day for 5 days a week for a period of 6 weeks. Obesity reduction programme performed for 30 minutes for 5 days a week for a period of 6 weeks.

Result: There was a significant difference was noted within the Group- A and Group B. Hence, TPSE with ORP was found to be more effective compared to ORP to improve foot arch and physical activity level among obese school children with flexible flat foot.

Conclusion: Tibialis posterior strengthening exercise with obesity reduction program was found superior to only obesity reduction program in improving foot arch height and physical activity level among obese school children with flexible flat foot.

Key worlds*: Flexible flat foot, obesity, medial longitudinal arch, foot posture index-6, children physical activity questioner.*

Introduction

Flat foot (Pes Planus), is characterized by a reduced or absent medial longitudinal arch. In this condition the entire foot sole comes in complete or near – complete contact with the floor or ground surface during all weight-bearing activities.[1] Normally foot arch formation begins with a range of 2 to 5 years and is commonly addressed in the children.[2,3]

There are two types of Flat foot. One is flexible flatfoot and other is stiff flatfoot. During non-weight bearing medial arch will be present in the flexible flat foot, but the medial arch disappears when standing. The medial longitudinal arch is absent during weight bearing and non-weight bearing in stiff Flatfoot.[4] The Medial Longitudinal Arch is supported by both Dynamic and Static Stabilizer [1,4]. The arch of the foot is maintained by shape of the bones, ligaments,

muscles, tendons that play a major role in supporting arche.

There are many kinetic and kinematic changes in flat foot compared to normal foot. Among these pathomechanic alterations, forefoot adduction, major forefoot plantarflexion, hind foot eversion, peak forefoot plantarflexion, tibial internal rotation, major rear foot eversion excursion, major rear foot eversion velocity, sub-talar joint eversion and less abduction of the forefoot during toe-off phase are prominent.[6,8]

Tibialis posterior tendon: the key dynamic support of the medial longitudinal arch of the foot. Dysfunctional tibialis posterior contributes in the development of an acquired flatfoot. Tibialis posterior tendon courses just posterior to the medial malleolus inserting into the navicular tuberosity (on the medial aspect of the foot). The tibialis posterior tendon is the primary dynamic stabiliser of the medial longitudinal arch, and its contraction results in inversion and plantar flexion of the foot and serves to elevate the medial longitudinal arch.[(8)]

According to exercise prescription program recommended by American college of sports medicine (**ACSM**) for children and adolescents the physical activity intervention focused on at least 60-minute moderate/vigorous physical activity per week. The intervention program included physical activity components; physical exercise improvement, extracurricular physical activity for obese/overweight students. Aerobic exercise (FITT) - frequency-5 days per week, intensity- moderate, time = 30-minute, type = walking and cycling.[12]

The weight gain affects foot structure and function, this can be explained by the changed foot structure and decreased foot and ankle muscle strength in obese individuals. For obese individuals, weight reduction or increasing weight physical activity could be an effective approach, not only to decrease the risk of health-related diseases, but also to affect positively the foot structure and function. Therefore, the aims of our study were to determine the efficacy of tibialis posterior strengthening exercise with obesity reduction program in flexible flatfoot among obese school children.

Method

Research design

Randomized controlled trial, with two parallel group of allocation ratio 1:1.

Participants

Inclusion Criteria: Age between 7 to 14 years of age. Both male and female subjects with flexible flat foot, BMI between 25 to 30 and Grade 2 and 3 in foot structure assessment.

Exclusion Criteria: Presence of foot pain at the time of examination. History of lower limb injury (i.e., musculoskeletal injuries during the previous 6 month). Congenital foot or leg abnormalities. Unequal lower limb and Rigid pes planus.

Sampling: Simple random sampling method

Blinding: Assessment regarding outcome measure was conducted by assessor blind to exercise allocation.

Study duration: 6 weeks

Study setting: Higher secondary schools.

Sample size: 50

Experimental procedure:

Ethical clearance was obtained from the concerned ethical committee. Informed consent was taken from 50 participants who fulfilled the inclusion criteria. Baseline assessment was done at the commencement

of the protocol. Criteria. Baseline assessment was done at the commencement of the protocol. Then the participants were allocated to one of the two groups according to the inclusion criteria.

All subjects had undergone two measurements: one on entry to the study (pre-test) and one after the 6 weeks of intervention period (post-test).

Procedure

The experimental group (Group A) has participated in the tibialis posterior strengthening exercise program five days in a week for 6 weeks, each session for 30 minutes and then obesity reduction program which includes 30 minutes moderate intensity aerobic training exercise explained to the subjects & home-based program sheet/booklet given to them.

The control group (Group B) has received only obesity reduction program which includes 30 minutes moderate intensity aerobic training exercise program five days in a week for 6 weeks and provided with home-based program sheet/booklet.

Exercise protocol:

Tibialis posterior strengthening exercise

Tibialis posterior strengthening exercise Subjects performed all the exercises in barefoot and each exercise have concentric and eccentric phase.

1) **Closed chain resisted foot adduction**

· Subjects should be seated with their knees maintained at a forearm's apart and flexed approximately 80 degrees with feet on the ground.

· The subject was asked to stabilize their leg by placing the contralateral forearm between the knees and reinforcing it with the ipsilateral hand.

· An elastic band of silver colour is looped around the distal and medial foot being evaluated.

· The elastic band is stretched laterally to full tension, while maintaining a 45-degree angle of inclination with the floor.

· The therapist has to hold the elastic band and maintain the same tension

· From the abducted position, the subject has to slide their forefoot into adduction and then slowly returned to the starting position.

2) **Unilateral heel raise (heel raise)**

· Starting position of patient: standing with single leg and knee extension

· To procedure; slowly raise their toes and after 30 second return back to normal position.

3) **Open chain resisted (foot supination)**

· Starting position: sitting – knee extension and foot placed over the stool

· Subject has to place a sliver colour elastic band around the foot at the level of the metatarsal heads and slowly pulled over the band in their opposite shoulder.

· The other leg is used for balance opposite leg and remained on the floor.

· The subjects to performed foot plantar flexion and inversion against the resistance band and after which they slowly returned to the starting position.

· Treatment plan: 30 minutes per time, 5 times per week for 6 weeks.

Obesity reduction Program

· The ORP which includes 30 minutes moderate intensity aerobic exercise program five days in a week for 6 weeks and provided with home-based program pamphlet

· Pamphlet as follows:

A. School- based interventions

1) High importance on physical activity

• Daily 60 minutes of physical activity important in children health.

• This type of exercise should be followed; vigorous intensity exercise-daily/weekly 3 times, moderate intensity exercise-daily and activities of bone and muscle strengthening exercise-daily/weekly 3 times.

2) Making healthy choice available and banning un- healthy food

· Avoid junk food and un -healthy food

· Reduce sedentary time

· Encourage physical activity

3) Education about nutrition

· Encourage healthy eating habits

· Add plenty of vegetables, fruits, and low-fat or non-fat milk and whole-grain products.

· Encourage family members to drink lots of water

· Consumption of sugar and saturated fat should be restricted.

B. Home- advice for obesity reduction program

· Limits on television time

· Improve habits of frequent physical activity

· TV/computer time should be restricted to maximum 2hours per day.

Statistical Analysis

Baseline demographic and clinical characteristics were analysed using median and interquartile range. In this study the Wilcoxon signed rank test, Mann Whitney U test were used as a statistically tool for detecting the significant difference within and between the group A (TPSE with ORP) and group B (ORP). Descriptive statistics (mean and standard deviation) were also calculated for all the measurements consideration for the study.

Table: 1 Baseline characteristics of participants: (Mean ± Standard deviation (M ± SD))

Characteristic	Group A (TPSE+ORP) *	Group B (ORP)*
Male	7	6
Female	5	6
Age	11.52±0.89	11.64±1.38
BMI* ((M ± SD	27.6±1.9	28±1
Navicular drop (M ± SD)	1.5±0.75	1.1±0.9
Foot Posture Index (M ± SD)	8±0.5	7±1.5
CPA-Questionnaire*(M ± SD)	2.4±0.35	2.5±0.4

*Abbreviation used: TPSE+ORP-tibialis posterior strengthening exercise and obesity reduction programme, ORP-obesity reduction programme, BMI-body mass index, CPA-Q- children physical activity questionnaire.

Table: 2 Comparative effectiveness of Group A (TPSE+ORP) versus Group B (ORP) on Flexible Flat Foot using Foot Posture Index-6 score.

Outcome measure (FPI-6)	Pre-test (mean± SD)	Post-test (mean ± SD)	Difference (mean± SD)	P value
Group A (TPSE + ORP)	7.88±0.58	6.12±0.71	1.76±0.58	.00001
Group B (ORP)	7.4±1.01	6.48±1.44	0.72±0.44	

The above table 2 shows that pre -test and post -test difference value of foot posture index-6 scale from baseline to post test for both the Group A (TPSE+ORP) and Group B (ORP). Mann Whitney U test was done to calculate the statistical significance and found to be .00001 which is significant $P < .05$.

Table:3 Comparative effectiveness of Group A (TPSE+ORP) versus Group B (ORP) on physical activity using children physical activity questioner.

Outcome measure CPA-Q	pre test (mean ± SD)	post test (mean ± SD)	Difference (mean± SD)	P value
Group A (TPSE+ORP)	2.48±0.2	3.44±0.26	0.99±0.262	.0278
Group B (ORP)	2.6±0.37	3.36±0.34	0.77±0.23	

The above table 3 shows that pre -test and post -test difference value of CPA-Q score from baseline to post test for both the Group A (TPSE+ORP) and Group B (ORP). Mann Whitney U test was done to calculate the statistical significance and found to be .0278, which is significant $P <.05$.

Table 4: FPI-6 and CPA-Q scores at pre and post -test changes within Group A (TPSE+ORP)

S.NO	Variables	Pre-test	Post-test	Difference	p-value
1	FPI-6	7.88± 0.58	6.12±0.71	1.76±0.58	.00001
2	CPA-Q	2.48±0.2	3.44± 0.26	0.95±0.26	.00001

The above table 4 shows that pre -test and post -test difference value of Group A (TPSE+ORP) Wilcoxon signed- rank test was done to calculate the statistical significance and found to be FPI-6 and CPA-Q score as p- value is .00001, which is significant p<.05.

Results

50 subjects were included in this study. The result suggests that there is difference in FPI-6 when compared between the Groups, and it is also found to be statistically significant p=.00001(P<.05) and when compared between pre -test and post-test difference in Group A (TPSE+ORP) and Group B (ORP) for CPA-Q score was 0.99 and 0.77 respectively, at the duration of 6 weeks. The result suggests that there is difference in CPA-Q when compared between the Group, and it is also found to be statistically significant p=.0278 (P<.05) Hence, it proved that both the intervention was effective to improve arch height and physical activity level among obese school children with flexible flat foot. But, TPSE with ORP was found to be more superior in comparison.

Discussion

In this present study, main objective of the study was to find out the efficacy of tibialis posterior strengthening exercise with obesity reduction program in flexible flatfoot among obese school children. The study was interpreted based on the outcome measure used in this study. According to the result, when compared between the Group A (TPSE+ORP) and Group B (ORP) there was significant improvement in foot arch and physical activity level among Group A. But when compared within the Group A and Group B there was statistically significant difference in both the group.

Changes in foot arch height between the tibialis posterior strengthening exercise versus obesity reduction program

The result of the present study showed improvement in FPI-6 score between and within the Group A (TPSE+ORP) and Group B (ORP) at the duration of 6 weeks. When compared between pre -test and post-test difference in Group A (TPSE+ORP) and Group B (ORP) for FPI-6 score, both the groups showed statistically significant difference. The mean difference between both the groups shows that Group A (TPSE with ORP) difference in pre and post-test value is higher when compared with Group B (ORP).

The tibialis posterior tendon is the primary dynamic stabilizer of the medial longitudinal arch, and its contraction results in inversion and plantar flexion of the foot and serves to elevate the medial longitudinal arch, which locks the mid-tarsal bones, making the hind foot and midfoot rigid.

Thus, strengthening tibialis posterior muscle during sensory receptor activities and neuromuscular functions improves dynamic balance due to dynamic support of the foot medial area and static support of the intrinsic foot muscle[3].

In this current study there is improvement in medial longitudinal arch, muscular strength and function of the lower extremity. The intervention group required subjects were asked to do adduction, abduction of the foot and after that the subjects were asked to raise their heel and maintain in that position for 30 seconds, which may have contributed in improving the muscle strength of ankle plantar flexors.

Changes in physical activity level between the tibialis posterior strengthening exercise along with obesity reduction program versus obesity reduction program

The result of the present study showed improvement in CPA-Q between and within the Group A (TPSE+ORP) and Group B (ORP) at the duration of 6 weeks. When compared between pre -test and post-

test difference in Group A (TPSE+ORP) and Group B (ORP) for CPA-Q score was found to be statistically significant.

Price and Nester et al reported that obesity had an influence on foot morphology.[11] **Cimolin et al** reported that foot types were markedly different between obese and nonobese adolescents.[12] **Shultz et al**, investigating foot structure and functional characteristics in obese and nonobese individuals, reported finding a more flexible foot in obese individuals. Thus, it has been suggested that body weight plays an important role in foot flexibility and relationship has been found between the presence of a lower arch and increased body weight (**Butterworth Pa et al**)[13]. In this current study there is improvement in foot muscle strength and mild improvement in arch height and also found relationship between increasing body weight may influence negativity arch height. The previous study co-relates current study. Both weight reduction and increasing physical activity have been reported to be effective at improving foot structure and function. **(song .j.kane et al)**[14]

Conclusion

The study concludes that, the tibialis posterior strengthening exercise along with obesity reduction programme was found to be more superior in comparison to obesity reduction programme alone in improving foot arch and physical activity level among obese school children with flexible flat foot.

Limitations

It was school based intervention programme; certain difficulties were encountered like implementing exercise programme in school busy schedule during the pandemic year was restrictive. Due to the difficulties and the limited duration of the study the long-term follow up was not done.

Conflict of Interest: Nil

Refernces

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