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A Study to Compare the Effectiveness of Intrinsic Foot Muscle & Tibialis Posterior Strengthening Exercise and Talo-Navicular Joint Mobilization with Conventional Exercises in Young Individuals with Pes Planus

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Abstract: ***Objective: The objective of this study is to compare the effectiveness of intrinsic muscle and tibialis posterior muscle strengthening exercises and talo-navicular joint mobilization technique along with conventional exercises in young individuals with pes planus. Background of the Study: Flat feet also called pes planus or fallen arches is a postural deformity in which the arches of the foot collapse, with the entire sole of the foot coming into complete or near complete contact with ground. There are 10 intrinsic muscles located in the sole of the foot. They act collectively to stabilize the arches of the foot, and individually to control movement of the digits and talo-navicular joint forms the medial arch center, collapse of which leads to flat foot. Materials and Methodology: A comparative study was done to compare the effect of IMF and TP strengthening exercise and talo-navicular joint mobilization along with conventional exercise by dividing the subjects into two groups. The inclusion criteria were age group of 18-25, both type of Pesplanus, navicular drop test positive and the exclusion criteria were anyone having other orthopedic condition, other neurological conditions etc., Procedure: Group A consists of 10 subjects who were trained with IMF and TP strengthening exercises and Group B consists of 10 subjects who were trained with talo-navicular joint mobilization along with conventional exercise. Outcome measures of foot disability and foot arch height were measured using Foot Posture Index and Foot Function Index. Results: On comparing the pre and post values within the groups and post values between the Group Aand Group B, t-value of Group B showed significantly ($p \leq 0.05$) better effect than Group A. Conclusion: This study concludes that Group B, who was given talo-navicular joint mobilization along with conventional exercise is more effective than Group A, who were given IMF and TP strengthening exercises.***

Keywords: Pes planus, foot muscles, Foot Posture Index, Foot Function Index, talo-navicular joint, joint mobilization, strengthening

1.Introduction

Pes planus (flatfoot) is one of the common orthopaedic problems, usually caused by a decrease or disappearance of the medial longitudinal arch (MLA) of the foot. Biomechanically, it has also been defined as the eversion or pronation of the heel accompanying the forefoot supination]. Apart from the changes in the hip, knee, and lumbar region biomechanics, bone, ligament, intrinsic, and extrinsic muscle strengths play an important role in the formation of pes planus due to the height of the MLA [3].

Among foot structures, the arches are important for foot stability and resilience. In particular, the medial longitudinal arch (MLA), consisting of the first metatarsal, medial cuneiform, navicular, talus, and calcaneus bones, is a primary weight-bearing and shock-absorbing structure (Neumann, 2011). Pes planus (or flatfoot) develops as the MLA decreases (Pandey et al, 2013) and is largely divided into rigid type and flexible type. Rigid type includes states in which the MLA has dropped regardless of bearing weight, while flexible types occur when the MLA is formed without bearing weight but disappears during weight bearing (Kuhn et al, 1999). A flexible pes planus is caused by tibialis posterior dysfunction, foot bone malformation, ligament loosening, Achilles tendon shortening, and foot muscle weakness (Huang et al, 1993; Leung et al, 1998; Murley et al, 2009). These deformation leads to excess pronation n of the foot during weight bearing and cause plantar flexion and adduction of the talus bone and the valgus of the calcaneus bone (Pandey et al, 2013). Abnormal peripheral information from the foot affects muscle performance necessary for body posture and position control (Shumway-Cook and Horak, 1986) and stable maintenance on the base of support (Franco, 1987). Such abnormalities in the MLA leads to loss of the functional stability of the foot (Franco, 1987), which in turn causes balance problems (Hertel, 2002; Hillstrom et al, 2013; Tsai et al, 2006

Pes planus treatments are divided into surgical and conservative treatments. Conservative treatments include taping, orthosis, special shoes, and foot muscle exercises. Among these treatments, foot muscle exercises have been reported to reduce excessive pronation, strengthen the foot muscles, and improve foot functions (Panichawit et al, 2015) and have the advantages of helping restructure the foot and being simple to perform (Jung et al, 2011; Lynn et al, 2012). Foot muscles are subdivided into intrinsic and extrinsic muscles. Intrinsic foot muscles assist standing postures and balance during gait and support the MLA during push-off in the stance phase (Neumann, 2011). Exercise interventions for intrinsic muscle strengthening include toe curls (TC), shin curls, picking up objects with the foot, unilateral balance activities, and short foot (SF) exercises (Anderson et al, 2004; Prentice, 2009). Among these exercises, TC and SF exercises are most recommended (Abdo and Iorio, 1994; Freiberger et

al, 2007; Liebenson, 2001).

The foot is the terminal joint in the lower kinetic chain and the body weight is borne through two half columns of the foot with the medial border of each foot raised from the ground. The arch is controlled by the combined action of talonavicular joint and the subtalar joint which helps in the interaction between leg and foot rotations.

There are many techniques to measure the medial longitudinal arch (MLA). Clinical measurements of Arch Index (AI), Navicular Height (NH) and Foot Posture Index (FPI) provide valid information regarding the structure of the medial longitudinal arch. There are many treatments available for flat foot which includes strengthening of the intrinsic and extrinsic muscles of foot, stretching of the Achilles tendon, taping and orthosis or use of wedge to correct the foot posture, mobilizing the bones of the midfoot and faradic stimulation for the foot.

2.Aim and Objective of the Study

The objective of this study was to find the comparative effects of talo-navicular mobilization and foot intrinsic and extrinsic muscle strengthening in subjects with flatfoot. In flat foot, since the foot is pronated mobilization must be given in order to improve or increase the medial arch and muscle strength.

A study has shown that talo-navicular mobilization for the foot has effects on navicularbone and it has reported to increase the arch height by 2-5%. [32] There is paucity of literature on strengthening for the intrinsic muscles of the foot for flat foot. So, a comparative effect of these treatments on the navicular height and arch index in subjects with flat foot was done to find out which one was superior to the other.

Parameters of the Study:

The outcome is measured in different ways to make sure that there is increase in MLA height and improved functional activity, these are measured from first sitting as before (pre-test) andafter (post-test) treatment on both groups.
The measures include,

Foot Posture Index (FPI) Foot function index (FFI)

Approval was obtained from the Institutional Ethical Committee prior to the commencement of the study. Each subject was explained in detail about the study and informed consent was obtained prior to the commencement of the data collection. A structured proforma was used to obtain the demographic characteristics of the study subjects. Both the feet of the study subjects were first visually inspected.

Measurement tools:

Foot posture index:

Postural deviations were observed using foot posture index scale. In this scale talar head, supra and infra navicular angle, calcaneal curve, medial longitudinal arch, abduction /adduction of the rear foot. For determining the foot posture index ask the subjects to stand still to observe the deviations in the angles of the foot. After taking each score on the foot posture index scale of 6 components, (0) is given for neutral, (+2) is given for pronated, (-2) is supinated. The final score was a whole number between-12 to +12. Pre and post treatment score of foot posture index was calculated.

Foot Function index:

A Foot Function Index was developed in 1991 to measure the impact of foot pathologyon functions in terms of pain, disability, and activity restrictions.

The FFI consist of 23 self-reported items divided into 3 subcategories on basis of patient values: pain, disability, and activity limitation. The pain subcategory consists of 9 items and measures foot pain in different situations, such as walking barefoot vs walking with shoes.

The disability subcategory consists of 9 items and measures difficulty performing various functional activities because of foot problems, such as difficulty climbing stairs. The activity limitation subcategory consists of 5 items and measures limitations in activities because of foot problems such as staying in bed all day. Recorded on a visual analogue scale (VAS), scores range from 0 to 100mm, with higher scores indicating worse pain. Both total and subcategory scores are calculated.

Procedure:

This study included 20 young adults (9 males and 11 females) with unilateral or bilateral pes planus. The subjects were divided into two groups. Group-A consider as experimental group. (Foot intrinsic muscle and tibialis posterior muscle strengthening training; FTST) that performed intrinsic foot muscle and tibialis posterior muscle strengthening exercises and Group-B consider as control group that was given talo-navicular mobilization along with conventional exercises. The subjects were randomly assigned to one of the two groups. The subjects in the present study signed a written agreement related to the experiment and volunteered to participate in the study. Subjects were informed about the procedure, merits, and demerits of the treatment. Consent is obtained from each subject for voluntary participation.

Group A:

Foot intrinsic muscle strengthening exercises along with tibialis posterior strengthening:

No. of patients: 15

Study duration: 4 weeks **Treatment sessions:** 4 days / week **Treatment duration**: 30 minutes.

Group B:

Talo-navicular mobilization along with conventional exercise.

No. of patients: 15

Study duration: 4 weeks **Treatment session**: 4 days/week **Treatment duration**: 40 minutes

Foot Posture Index (FPI)

Rearfoot Score	−2	−1	0	1	2
Talar head palpation	Talar head palpable on lateral side but not on medial side	Talar head palpable on lateral side/slightly palpable on medial side	Talar head equally palpable on each side	Talar head slightly palpable on lateral side/palpable on medial side	Talar head not palpable on lateral side/but palpable on medial side
Curves above And below the malleoli	Curve below the malleolus either straight or convex	Curve below the malleolus concave but flatter/shallower than the curve above the malleolus	Both infra and supra malleolar curves roughly equal	Curves below malleolus more concave than the curve above malleolus	Curve below malleolus markedly more concave than curveabovemalleolus
Calcaneal inversion/ eversion	More than an estimated 5° inverted (varus)	Between vertical and anestimated 5° erted (varus)	Vertical	Between vertical and an estimated 5° everted (valgus)	More than estimated 5° everted (valgus)
Forefoot score	**−2**	**−1**	**0**	**1**	**2**
Talo-navicular congruence	Area of TNJ markedly concave	Area of TNJ slightly, but concave	Area of TNJ flat	Area of TNJ bulging slightly	Area of TNJ bulging markedly
Medial arch height	Arch high and acute angled posteriorly	Arch moderately highandacute posteriorly	Arch height normaland concentrically concave	Arch lowered with some flattening in central position	Arch very low with severe flattening in central position
Forefoot Abd/add	No lateral toes visible, medial toes clearly visible	Medial toes clearly visible, more visible than lateral	Medial and lateraltoes equally visible	Lateral toes clearly more visible thanmedial toes	No medial toes visible and lateral toes not visible

Foot Function Index

Section 1: To be completed by patient Name: Age: Date: Occupation: Number of days of foot pain: (this episode)		
Section 2: To be completed by patient This questionnaire has been designed to give your therapist information as to how your foot pain has affected your ability to manage in every day life. For the following questions, we would like you to score each question on a scale from 0 (no pain) to 10 (worst pain imaginable) that best describes your foot over the past WEEK. Please read each question and place a number from 0-10 in the corresponding box.		
	No Pain 0 1 2 3 4 5 6 7 8 9 10 Worst Pain Imaginable	
1		0
2	In the morning upon taking your first step? When walking?	0
3	When standing?	0
4	How is your pain at the end of the day? How severe is your pain at its worst?	0
5		0
Answer all of the following questions related to your pain and activities over the past WEEK, how much difficulty did you have? Disability Scale		
	No Difficulty 0 1 2 3 4 5 6 7 8 9 10 So Difficult unable to do When walking in	
6	the house?	0
7	When walking outside?	0
8	. When walking four blocks? When climbing stairs?	0
9	. When descending stairs	0
10	. When standing tip toe?	0
11	. When standing tip toe?	0

12	. When climbing curbs?	0
13	. When running or fast walking?	0
14		0

None of the time 0 1 2 3 4 5 6 7 8 9 10 All of the time

15	Use an assistive device (cane, walker, crutches, etc) indoors?	0
16	Use an assistive device (cane, walker, crutches, etc) outdoors?	0
17	Limit physical activities?	0

Section 3:

To be completed by physical therapist/provider SCORE: /170 x100=_% (SEM 5, MDC 7) SCORE: Initial_Subsequen Discharge_Number of treatment sessions: Diagnosis/ICD-9 Code:

Data Analysis:

Statistical Method

The data was analysed by paired t-test and unpaired 't' test. The collected tabulated and analysed by using descriptive and inferential statistics. The statistical package for calculated and analyse the above mentioned descriptive and inferential statistics.

Data was entered and analyzed using SPSS ver.20 software. The prevalence and demographic distribution of pes planus were expressed as percentages. Chi square test was to use compare the demographic data with pes planus incidence. A P value (<0.05) was considered statistically significant.

Table 1: Comparison between Group A and Group B post results of FPI

VARIABLES	FOOT POSTURE INDEX		t-value	p-value	difference
	GROUP A	GROUP B			
MEAN	5.90	5.50	3.6882	≤ 0.05	2.581
MEDIAN	10	10			
STANDARD DEVIATION	1.20	1.08			

Table 2: Comparison between Group A and Group B post results of FFI

VARIABLES	FOOT FUNCTION INDEX		t-value	p-value	difference
	GROUP A	GROUP B			
MEAN	66.067	58.667	3.3614	<0.01	2.763
MEDIAN	9	9			
STANDARD DEVIATION	3.872	7.772			

3.Results

The study sample comprised of 20 young adults. Among 20 individuals, 10 subjects were treated with IMF and Tibialis posterior strengthening program and 10 subjects were treated with Talo-navicular joint mobilization along with conventional exercises. Paired t-test was used to compare both FPI and FFI scores pre and post values before and after intervention, and unpaired t test was used to compare the post values of FPI and FFI. The score is improved in foot posture and strengthening of foot muscles in both groups (p <0.05).

Foot Arch Height:

The Foot Arch Height is measured subjectively using Foot Posture Index. The foot arch height of the strengthening training group (Group A) and talo-navicular mobilization along with conventional therapy group (Group B) before and after interventions were compared. Both groups showed significant differences in foot arch height before and after interventions, but Group B (t=16.0) showed increased foot arch height compared to Group A (t=7.9649). Data analysed and result indicates that joint mobilization along with exercise has improving foot posture, strengthening of foot muscles, prevent long term musculoskeletal issue and improving of walking pattern for flat feet in young individuals than strengthening exercise for foot muscles and arch activation of foot muscles.

Pain:

The Foot Pain is measured subjectively using Foot Function Index. The foot pain of the strengthening training group (Group A) and talo-navicular mobilization along with conventional therapy group (Group B) before and after interventions were compared.

Both groups showed significant differences in pain in the foot before and after interventions (p<.05), but Group B (p=0.0172) showed increased foot arch height compared to Group A (p=0.0001) and the t-value is 3.688.

Foot disability:

The disability of the foot is measured subjectively using Foot Function Index. The foot pain of the strengthening training group (Group A) and talo-navicular mobilization along with conventional therapy group (Group B) before and after interventions were compared. Both groups showed significant differences in pain in the foot before and after interventions (p<.05), but Group B (t=8.0077) showed increased foot arch height compared to Group A

(t=3.3614)

However, Group B subjects were able to overcome their significant disability sooner than the subjects in Group A. They were able to walk and stand for a long time after the interventions.

Their complaint of other disabilities was also improved after both the interventions.

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