

Effectiveness of tibialis posterior strengthening exercise on flexible pes planus in female kathak dancers at the end of 6 weeks: An experimental study

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Abstract

Introduction: Kathak is a very complex dance form in which greater emphasis is laid on foot work thus putting substantial amount of stress over the feet, which further leads to reduced medial longitudinal arch of feet. In previous studies regarding flexible pes planus, intrinsic muscle strengthening have been regarded as intervention and least focus is on extrinsic muscle strengthening.

Aim: This study aimed to investigate the effect of tibialis posterior muscle (extrinsic muscle of foot) strengthening on flexible flat feet among the female Kathak dancers.

Method: Screening of 75 Kathak dancers was done for the study on the basis of inclusion and exclusion criteria. And Hubscher's maneuver was used as diagnostic criteria for flexible pes planus. Participants were assessed for flexible flat feet via navicular drop test. Each participant received 6 weeks tibialis posterior strengthening protocol with 5 sessions per week. Among 75 participants 4 participants left the study.

Result: Tibialis posterior strengthening had significantly improved the medial longitudinal arch in female kathak dancers by difference of 3.504 to 4.13mm for left foot and 4.018 to 4.658 mm for right foot.

Conclusion: The result of this study provide evidence to suggest that tibialis posterior muscle strengthening may improve the medial longitudinal arch in female kathak dancers.

Keywords: kathak dancers, pes planus, medial longitudinal arch, tibialis posterior muscle strengthening

1. Introduction

Flat foot (pes planus) 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 the ground. It is also called as hyper pronation or over pronation. Flexible flat foot medial longitudinal arch drops only when weight bearing, and normal medial longitudinal arch is seen when non-weight bearing ^[1].

1.2. Factors Leading to Pes Planus in Kathak Dancers

1. The normal stance position of Kathak dancers during the performance consists of overly turning out the feet. The forefeet are turned out even further than the foot axis, putting an additional strain on the inner side of the foot. This results in the typical, functional hyperpronated foot ^[2].
2. Repetitive tapping of foot over hard floors, leads to overuse of invertors i.e. tibialis posterior, flexor hallucis longus, flexor digitorum longus of the foot due to the strong contractions required by them on hard floors in order to have a controlled motion at the foot ^[2].
3. Presence of ankle bells (ghungroos) further add to the stress experienced by the foot. Each ankle bell weighs 1.5 kg. Daily use of these ankle bells overloads the connective tissues of legs and can lead to overextension, tendon strain and other connective tissue injuries during the performance ^[2].

1.3. Factors Responsible for Maintenance of Medial Arch

1. Shape of bones- talus acts as a key stone, 2. Intersegmental ties- ligaments and muscles, Spring ligament, Dorsal ligaments- interosseus talocalcaneal ligament, Tendinous extensions of tibialis posterior, 3. Tie beams or bow strings- connects two ends of an arch, Medial part of plantar aponeurosis, Medial part of flexor digitorum brevis, Adductor hallucis, flexor hallucis longus, flexor hallucis brevis., Medial part of flexor digitorum longus, 4. Slings- suspend the arch from above, Tibialis posterior, flexor digitorum longus, tibialis anterior and peroneus longus and Flexor hallucis longus is the bulkiest and strongest muscle supporting medial arch ^[3].

Previous studies suggested that 92.5% female Kathak dancers showed pes planus ^[2]. Therapeutic options for correction of pes planus mostly include intrinsic muscles strengthening exercises. Recent studies have concluded that both intrinsic and extrinsic strengthening is effective in pes planus.

2. Materials and Methods

The study recruited and followed the participants from September 2019 to February 2020. Total 75 participants were recruited at Gandharva Mahavidyalaya, Natraj nrityalaya, Sukruti kala Academy, Pune on the basis of inclusion, exclusion criteria and Hubscher Manoeuvre or

Jack's Test. It is a method of evaluating the flexibility of a pes cavus. It is also used to determine the timing and force needed to initiate Windlass. The test is performed with the patient weight bearing (standing) and the therapist dorsiflexes the hallux and watches for the formation of an arch [4].

2.1. Criterias

2.1.1. Inclusion Criterias

1. Female kathak dancers with flexible flat feet.
2. Female kathak dancers with minimum 2 years of dancing experience.
3. Female kathak dancers with age 18-35 years.
4. Tibialis posterior strength- Grade 3

2.1.2. Exclusion Criterias

1. Male kathak dancers.
2. Female kathak dancers with history of any recent surgery at lower limb, any neurological deficit, any congenital deformity which may affect the functionality of lower limbs.
3. Dancers who were inculcated in outdoor sports such as football, athletics, badminton, soccer, judo.

2.2. Outcome Measures

The navicular drop is defined as the change in height of the navicular bone when the foot moves from subtalar neutral non weight bearing to a relaxed weight bearing stance. Navicular drop is an important measurement used to describe foot function, pronation, and excessive movement seen in several pathologies. (Egloff M, 2015) Subtalar joint motion has been suggested to be the best clinical indicator to represent overall foot function, and can be assessed by measuring navicular drop [5]. (Eichelberger, 2015) The navicular drop test was first described by Brody(1982) [6], who noted that it was helpful in evaluating the amount of foot mobility, specifically foot pronation in runners [7, 8].

The participants were placed in a sitting position with their feet flat on a firm surface and with the knees flexed to 90 degrees 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 marker. Subtalar neutral position is established when talar depression are equal on medial and lateral side of the ankle. While maintaining subtalar neutral position with one hand, index card was placed on inner aspect of the hindfoot with the other hand and the card was placed from the floor in a vertical position passing the navicular bone. The level of the most prominent point of the navicular tubercle was marked on the card. The individual was then asked to stand without changing the position of the feet. In the standing position, the most prominent point of the 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 positions was assessed with a tape measure rendering the navicular drop amount in millimeters [9]. Normal values of navicular drop are mean ranged from 7.3 to 9.0 mm and greater than 9mm is considered abnormal [9].

Intra-tester and interrater reliability of navicular drop test based on Portney & Watkins general guidelines for reliability Coefficients (ICC=0.83-0.95) [10].

2.3. Procedure

2.3.1. Ethical Issues

Entire process of this research project was done by following the guidelines of Maharashtra University of Health Science. Synopsis proposal including procedure and methodology was approved by the Ethical committee of PES modern college of Physiotherapy at institution level. The safety of the participant was ensured by the researcher and strict confidentiality was maintained regarding patient information, their condition and the treatment.

2.3.2 Informed Consent

The researcher obtained informed written consent from all the participants those were the part of the study. All the participants were explained about the study and the nature of the assessment and treatment. They were given the liberty to quit being part of the study at any time if they wish to without having to give any reason for doing so.

2.4. Intervention

All the subjects received tibialis posterior strengthening exercise for 6 weeks, 5 days per week. At the end of 6 weeks reassessment for medial longitudinal arch height was done with navicular drop test.

1. Participants were asked to place his or her feet on the floor, forearm length apart, and sat with knee joints bent at a flexion angle of 80°.
2. The participants were asked to stabilize their leg by placing contralateral forearm between the knees and reinforcing it with the ipsilateral hand.
3. Elastic bands were looped around the medial and lateral sides of each subject's foot, tied up, and pulled laterally at an angle of 45° in relation to the floor (Kulig *et al.*, 2004).11
4. During the exercise, the feet were maintained flat, in contact with the floor, and moved as it they were sweeping the floor.

2.4.1. Progression

Sets and repetitions

- 3 sets, 10 repetitions
- 4 sets, 10 repetitions
- 3 sets, 10 repetitions
- 4 sets, 10 repetitions
- 3 sets, 10 repetitions
- 4 sets, 10 repetitions

Theraband was changed after every 2 weeks.

3. Results

3.1 Data analysis

The sample size was calculated a priori. It was based on probability of 92.5 % pes planus in female kathak dancers as suggested by previous studies. The data was entered in an excel spread sheet, tabulated and subjected to statistical analysis. Data was entered and analyzed with the help of Primer of Biostatistics application, checking effectiveness of tibialis posterior strengthening exercise on pes planus in female kathak dancers and post data analysis of Navicular drop test in female kathak dancers was done by using unpaired t-test.

3.2 Compliance with Study Protocol

Four participants did not complete the scheduled

intervention sessions. These participants also declined to attend the post-intervention assessments, so their data was not included in statistical analysis. Remaining 71 participants completed the intervention sessions up to 6 weeks.

4. Discussion

Kathak dancers have to exhibit footwork throughout their performance. It forms a very essential component of their performance and helps in showing the various kinds of emotions throughout the dance. It is the only medium to give rhythms to the dance along with ghungroos. Any difficulty in performing these foot movements can drastically affect the performance of a Kathak dancer. These difficulties can be attributed to the musculoskeletal changes in their foot which occurs due to their dynamic foot postures during the performance. Foot Postural deviations toward pronation in Kathak dancers could be related to the basic mudra of these dancers in which they stand erect with the feet placed together. In the beginning of the performance and in between different steps, the dancers have to stand with both their feet facing away from each other and pointing outwards thus forming the walls of an isosceles triangle and the heels of both the feet nearly touching each other thus forming the tip of an isosceles triangle [2]. These positions put the foot into a pronated position. With repetition the foot slowly attains a deviation towards pronation and gets stable or fixed into a pronated position. With passage of time the dancers develop a habit and tend to maintain this abducted position of foot even outside the dance studio during various daily activities such as standing, walking, etc. thus directing the posture of the foot during both static and dynamic weight bearing towards pronation [2]. The present study was done to see the effectiveness of tibialis posterior strengthening exercise on pes planus in 75 female kathak dancers between the age group of 18-35 years. Among the 75 subjects, 4 subjects were drop outs. Thus, the data analysis was carried out for 71 subjects. Subjects were included in study on the basis of Hubscher’s maneuver [4] and inclusion and exclusion criteria. All the subjects

received tibialis posterior strengthening exercise for 6 weeks, 5 days per week. At the end of 6 weeks reassessment for medial longitudinal arch height was done with navicular drop test. Panichawit *et al* (2015) implemented intrinsic and extrinsic muscle strengthening exercises for flexible pes planus patients and reported that foot functions improved [12]. DA-BEE LEE, JONG- DUK CHOI (2016) implemented foot intrinsic muscle and tibialis posterior muscle strengthening exercise for plantar pressure and dynamic balance in adults with flexible pes planus and reported that the experimental group had significantly lower plantar pressure of medial heel area than the control group in stand ($p<.05$) [13]. In this study after analyzing the post intervention data, it showed that the tibialis posterior strengthening exercises had significantly improved the medial longitudinal arch in female kathak dancers. Improvement in navicular drop height 4.018 to 4.658 mm for right foot and 3.504 to 4.13mm for left foot is observed as tibialis posterior muscle acts as a sling which suspends the medial longitudinal arch from above.

5.1. Limitations

Male population was not included in this study. Strengthening of other extrinsic muscles was not included in this study.

5.2. Future Scope of Study

Study can be carried out in different population. Large number of samples can be used to confirm the result of the study. Other techniques for tibialis posterior strengthening can be used. Strengthening of other extrinsic muscles can be done along with tibialis posterior muscle.

6. Conclusion

The result of this study provides evidence to suggest that tibialis posterior muscle strengthening can improve the medial longitudinal arch in female kathak dancers.

Table 1: Statistical analysis for navicular drop in both right and left foot

Outcome	Experimental group				Difference	
	(N=75)		(N=71)		(N=71)	
	Week 0		Week 6		After 6 weeks	
Navicular drop (mm)	Right foot	Left foot	Right foot	Left foot	Right foot	Left foot
Mean	14.1mm	9.7mm	12.9mm	9.1mm	4.018 - 4.658 mm	3.504 – 4.13 mm
SD	2.443	1.5498	2.213	1.302		

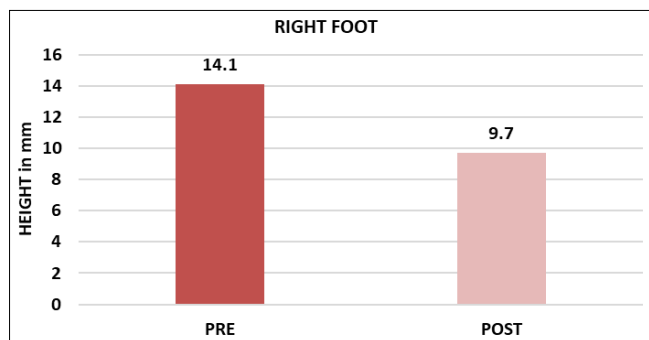


Fig 1: Navicular drop in right foot

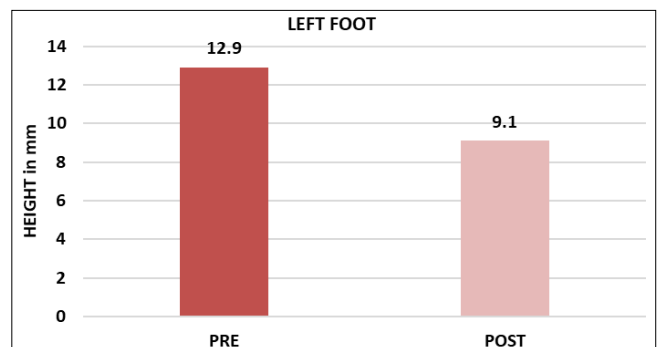


Fig 2: Navicular drop in left foot

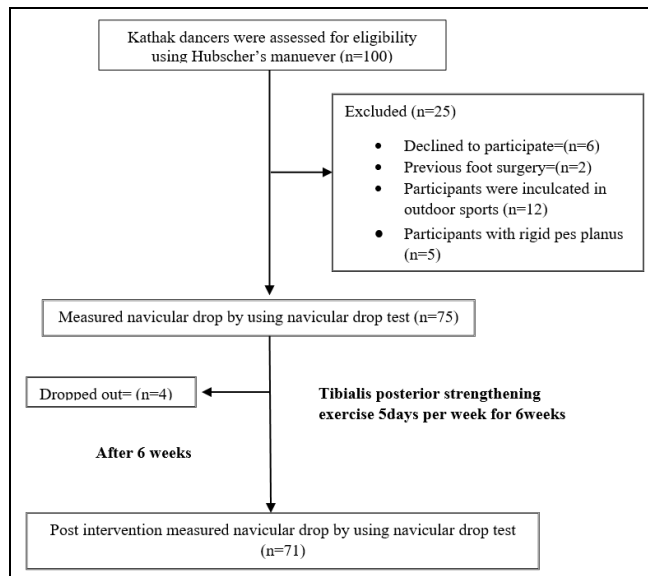


Fig 3: Design and flow of participants through the trial

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