ORIGINAL RESEARCH

IJPHY

COMPARISON OF FOOT TAPING VERSUS CUSTOM-MADE MEDIAL ARCH SUPPORT ON PRONATED FLATFOOT IN SCHOOL GOING CHILDREN

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ABSTRACT

Background: Flatfoot may exist as an isolated pathology or as part of a larger clinical entity. These entities include generalized ligamentous laxity, neurologic and muscular abnormalities, genetic conditions, collagen disorders and structural disorder. Flat foot is found to be associated with pronated foot. The objective of the study is to compare the effectiveness of foot taping versus custom-made medial arch support on pronated flatfoot in school going children.

Methods: 60 students out of 130, aged 10 to 12 years were selected on the basis of inclusion criteria and divided into three groups from two different higher secondary schools at Srikalahasti, in Chittoor district, Andhra Pradesh. Group-A received custom-made medial arch support and foot strengthening exercises, Group-B received kinesio taping and foot strengthening exercises , Group-C received foot strengthening exercises for 4 weeks. The values of navicular drop test were taken after 4 weeks of study. The pre and post-test values were compared and results were tabulated.

Results: All three groups showed significant improvement in navicular drop separately. No significant difference was found in the post-test values of group-A, group-B, group-C ($p>0.05$). However, the reduction of navicular drop was slightly more in group-B subjects treated with kinesio tape and foot strengthening exercises when compared with other two interventions.

Conclusion: The study concluded that foot taping, custom-made medial arch support and foot strengthening exercises were found to be effective on pronated flatfoot in school going children aged 10 to 12 years.

Key words: Flatfoot, navicular, flat foot, medical arch, pesplanus.

Received 04th March 2015, revised 07th April 2015, accepted 08th May 2015

www.ijphy.org

DOI: 10.15621/ijphy/2015/v2i3/67021

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INTRODUCTION

Flatfoot (pesplanus) is a medical condition in which the entire sole of the foot comes into complete or near complete contact with the ground. Although the most common form is the physiological flatfoot, if it progresses to a more severe grade then the deformity can lead to the development of symptomatic flatfoot, which has an effect on function[1] and lead to subjective complaints. However, the real significance of the clinical findings is frequently misjudged.

Flatfoot may exist as an isolated pathology or as part of a larger clinical entity.[2] These entities include generalized ligamentous laxity, neurologic and muscular abnormalities, genetic conditions, collagen disorders and structural disorder. Flatfoot is associated with pronated foot.[3,4] The configuration of the arch is determined by age, height, weight, foot progression angle, sex, joint hyper mobility, hind foot alignment, and occurrence of physiological knock knee.[5,6] Medial arch improves with increasing age, up to 6 years it improves very quickly, up to 10 years slowly, and without significant change thereafter.[7,8,9]

Flatfoot is common in children though its prevalence has been found to decline as they grow. The incidence of flatfoot was found to be higher in school children of the affluent urban dwellers in India. The prevalence of pediatric pes planus has been reported to be between 2.7 % and 12.3 %.[15] Mild to moderate flatfoot was 44 % in pre-school children aged 3 to 6 years but was down to 24 % in children aged > 6 years.[10] Pathological or rigid flatfoot has a prevalence of <1 % and can be due to congenital coalition, arthritis, vertical talus, post-traumatic structural abnormalities, causing morbidity and poor performance.[11,12] In India few studies have been done on incidence of flatfeet. One such study reports the incidence of flat foot in school children[13] is18.26%. Under weight bearing conditions, the medial longitudinal arch of a flexible foot is depressed and the subtalar joint is pronated with the calcaneus assuming a valgus position. When weight bearing ceases, the arch remodels to a slightly more arch shape compared to the loaded situation. There is a controversy regarding the treatment and correction of this condition including whether it should be treated or not.[14]

Wenger et al 1989 have suggested that the flexible flat foot in young children will be self-correcting, requiring no treatment expect for those with congenital defects or neurological problems.[15] Rose et al 1990 suggested that those subjects who fall outside the normal range of parameters of flat foot require some form of treatment.[16] In 1967, Shapiro and Rhee conducted screening at a time when unsubstantiated opinions about foot conditions were accepted, rather than tested.[17] As a result, the findings must be seen in that light. The screenings examined 8,995 children over a two year period, and found the most frequently encountered problems to be postural or orthopedic, and frequently this was flatfeet.

The terms "flatfoot" and "foot pronation" are often used interchangeably. Foot pronation is a combination of eversion, dorsi flexion and abduction of the foot. This condition often occurs in patients who lack a supportive medial arch. Foot pronation causes a compensatory internal rotation of the tibia or femur (femoral anteversion) [18] that upsets the patellofemoral mechanism. Fallen arches produce biomechanical malalignment in foot which inadvertently produces unequal forces. These asymmetrical forces imposed during activities can eventually result in significant cumulative trauma to the foot or ankle complex, knees, hips and low back. Thus resulting in abnormal kinetic chain stresses on pelvis and spine.

Kirby in 1987 first proposed that abnormal subtalar joint (STJ) rotational forces (i.e., moments) were responsible for many mechanically based pathologies in the foot and lower extremity and that abnormal subtalar joint axis spatial location was the primary cause of these pathological subtalar joint moments.[19] A foot with a medially deviated subtalar joint axis was suggested to be more likely to suffer from pronation-related symptoms since ground reaction force (GRF) would cause increased magnitudes of external subtalar joint pronation moments. Medial and lateral deviations of the subtalar joint axis were also proposed to cause changes in the magnitudes and directions of subtalar joint moments that are produced by contractile activity of the extrinsic muscles of the foot.[19,20] (Figure 1) .

When subtalar joint axis spatial location was combined with the mechanical concept of rotational equilibrium, a new theory of foot function, the "Subtalar joint axis location and rotational equilibrium (SALRE) theory of foot function," emerged to offer a coherent explanation for the biomechanical cause of much mechanically based pathology of the foot and lower extremity.[19-21]

In 1992 , Kirby and Green first proposed that foot orthoses functioned by altering the Sub talar joint moments that were created by the mechanical actions of ground reaction force (GRF) acting on the plantar foot during weight bearing activities.[22] They hypothesized that foot orthoses were able to exert their ability to "control pronation" by converting Ground Reaction Force (GRF) acting lateral to the subtalar joint axis into a more medially located orthosis reaction force (ORF) that would be able to generate increased subtalar joint supination moments during weight bearing activities.

The more prevalent research on the biomechanical effects of foot orthoses on running, recent studies have shown that foot orthoses significantly affects the biomechanics of walking. Decreased rearfoot pronation and decreased rearfoot pronation velocity with varus-wedged orthoses and increased rearfoot pronation with valgus-wedged orthoses were shown in subjects that walked on varus-wedged and valgus –wedged foot orthoses.[23, 24]

Garcia-Rodriguez, (1999) found that corrective footwear confines the foot in a rigid mould that limits the normal function of intrinsic and extrinsic muscles of the foot. The insole arch supports removes the usual alternating stimuli that strengthen the foot muscles that maintain arches.[25] Several studies believed that medical shoe is most appropriately used for flexible flat foot children[26] and found that medial support in a shoe may provide increased foot stability and reduce maximal pronation.[27,28]

Ankle taping was reported to correct malalignment of the foot depending on mechanical and physiological effects by ability of taping to stiffen ankle joint and limits hypermobility and improves gait pattern. [29, 30]

Existing evidence supports that tape changes foot and leg posture through increasing navicular bone height, medial longitudinal arch height, calcaneal eversion and alteration of plantar pressure patterns.[31]

Kase et al claimed that different applications of kinesio tape can facilitate or inhibit a muscle, limit edema and pain, or assist lymphatic drainage.The research examining these claims, especially muscle facilitation and inhibition, has had conflicting results. Research has supported the effect of kinesio tape on increasing strength of muscles. Kinesio tape has also been found to aid in obtaining proper alignment in the body, increase the active range of motion in joints with weakened muscles, and affect the timing of activation of muscles.

Toe curling exercises (towel crunches, marble pickups) are usually prescribed to strengthen the intrinsic foot muscles; however these tend to recruit the long toe flexors (Flexor Hallucis and Flexor Digitorum Longus) as opposed to the intrinsic foot muscles.[32] Short foot training, i.e shortening the foot without curling the toes, targets the plantar intrinsic muscles (Abductor Hallucis) and prevents excessive lowering of the medial longitudinal arch. It intensifies and optimizes the sole's contact with the floor.[33]

There is sufficient evidence in the literature supporting the use of custom-made medial arch support, taping and foot strengthening exercises for the treatment of pronated flat foot. But limited evidence stating which of the treatment is more beneficial out of medial arch support and taping. Thus, this study aims to find out a more effective and beneficial treatment for pronated flat foot in school going children.

PROCEDURE

Prior to data collection ethical approval was granted from the respective schools head-masters. Details of the research were sent to parents or guardians with the appropriate information about the assessment, intervention and follow-up. Informed consent form for participation of the students was collected from their respective parents. The children also accepted to participate in the study. Before dividing into groups, 130 students aged 10 to 12 years were screened with Foot Posture Index (FPI-6). 60 students were selected on the basis of inclusion criteria and divided into three groups. Inclusion criteria is School children aged 10 to 12 years with pronated flatfoot, Subjects who scored $> \pm$ 6 on the Foot Posture Index-6, Navicular drop $\geq$10 mm the height of the navicular tuberosity in relaxed calcaneal stance.The School children with physical deformities, recent injury in lower limbs,with fixed-foot deformity (such as clubfoot or surgery in the past) and children with an allergic reaction to kinesiology tape. Every child was made to remove his or her shoes and stand on the foot stool and the assessment was done using the Foot Posture Index (FPI-6) to evaluate and diagnose the pronated flatfoot. During assessment, anthropometric measures such as height by stadiometer, weight by standard weighing machine and waist circumference by translucent non stretchable measuring tape was taken.

MEASUREMENT OF NAVICULAR HEIGHT:-

To measure the navicular height, navicular drop test was performed with the help of a thick white index card. It was placed parallel to the child's feet (maintained in a subtalar neutral positon) inner aspect of the hindfoot, with the card 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 and the floor was measured during sitting and standing.

Figure-1: Measuring the navicular drop in sitting position

The child was made to sit in a chair in functional sitting position with hip and knee maintained at 90^0-90^0 and feet resting on floor. In this position, navicular tubercle was marked on the card with the marker. Then the child was made to stand in weight bearing position, the navicular tubercle position was marked. Throughout the procedure, the card was parallel to the feet of child. The children whose difference between sitting and standing position of navicular tubercle was more than 10 mm were selected for the study. The diagnosed 60 subjects were allotted into three groups in group-A (20 subjects) group-B (20 subjects) and group-C (20 subjects)

Group-A:-

Custom-made medial arch support with measures of 11cms x 4 cms and height of 1cm for pronated flatfoot was administered for 20 subjects. The medial arch support was glued to the sole of the shoes. The children wore the arch support in their shoe for nearly 8 hours in a day. The patient was asked to do foot strengthening exercises twice a day with 3 to 5 repetitions of each exercise for 4 weeks. Review was taken after four weeks.

Figure-2.1: Medial arch support fixed to the shoe insoles

Figure-2.2: Rising of medial arch of foot with medial arch support

Group-B:

Taping was administered for 20 subjects. The child's skin was checked for sensitivity one day prior to the application of taping. A part of the tape was applied over the lower leg posterior aspect and next day the area was examine for irritability, redness and blisters only those in allergic are included for the study. Subjects were made to lie in the prone position with knee flexed at 90^0. Foot was placed in subtalar neutral position, minimal inversion and neutral dorsiflexion. Taping was done in prone with 3 or 4 "I" tapes, 2 inches wide.

The first piece of tape was anchored on the lateral midfoot and then diagonally under calcaneus and medially around posterior ankle. This piece of tape helped to maintain calcaneus in a more neutral position and limit calcaneal eversion. The second piece of tape was anchored on medial midfoot and brought diagonally under calcaneus and laterally around posterior ankle which assisted to "lock" calcaneus in position or "close the loop" for sensory input. The third piece of tape extended from the lateral midfoot, over navicular and up the medial distal third of the lower leg, just above the malleolus which supported the midfoot.

The fourth piece of tape was applied to facilitate peroneus longus from origin to insertion and the first ray was brought down (plantarflexion)

Along with the taping, the patient was asked to do foot strengthening exercises twice a day with 3 to 5 repetitions of each exercise for 4 weeks. The tape was changed every 3 days for 4 weeks.

Figure - 3.1: first piece of tape

Figure-3.2: Second piece of tape

Figure-3.3: Third piece of tape

GROUP-C:

Subjects in this group C- 20 received the foot strengthening exercises twice a day with 3 to 5 repetitions of each exercise for 4 weeks. Foot strengthening exercises for all the groups were demonstrated and made to perform once in front of the researcher. Exercises were advised to be performed at home twice a day with 3 to 5 repetitions for 4 weeks. The exercises were as follows:

1. Position and procedure: - Sitting on a chair or low mat table with feet on the floor. Place a number of small objects, such as marbles or dice, to one side of the involved foot. Have the patient pick up one object at a time by curling the toes around it and then placing it in a container on the other side of the foot. This emphasizes the plantar muscles as well as inversion and eversion.
2. Patient position and procedure: - Sitting or standing, with the feet on the floor. Have the patient curl the toes against the resistance of the floor. Place a towel or tissue paper under the feet, and have the patient attempt to wrinkle it up by keeping the heel on the floor and flexing the toes.
3. Patient position and procedure: - Sitting, with the feet on the floor. Have the patient attempt to raise the medial longitudinal arch while keeping the fore foot and hind foot on the floor; lateral rotation of the tibia should occur but not abduction of the hips. The activity is repeated until the patient has consistent control, then it is performed while standing as a progression.

Figure-4.1: Curling of toes with inversion and eversion of foot

Figure-4.2: Curling of the toes Against resistance

Figure-4.3: Foot on the floor attempt to raise medial longitudinal arch

Figure-5: Materials used in the study

DATA ANALYSIS

The collected data were recorded and tabulated. The data was analyzed using statistical package for social science (SPSS-20.0) to present the finding of the study- comparison of foot-taping versus custom-made medial arch support on pronated flatfoot in school going children, identified through foot-posture index-6 (FPI-6) and navicular drop test by using Paired t-test. ANOVA is used to compare multiple means, and see if the difference between multiple sample means is significant.

TABLE-1: Comparison between pre and post-test values of navicular drop test in all groups

	Mean		t-test value	p-value
	Pre-test	Post-test		
Navicular drop test on left foot medial arch support (GROUP-A)	11.86	10.05	7.693	.000
Navicular drop test on right foot medial arch support (GROUP-A)	11.71	10.14	7.778	.000
Navicular drop on Left foot taping (GROUP-B)	11.90	10.05	4.796	.000
Navicular drop on Right foot taping (GROUP-B)	11.85	10.00	4.975	.000
Navicular drop Leftfoot exercise (GROUP-C)	11.85	10.90	3.329	.004
Navicular drop Right foot exercise (GROUP-C)	11.85	10.35	5.430	.000

TABLE-2: Navicular drop test values –left foot fourth week post test

Interventions		Mean difference	Std. Error	df Between groups	F Value	Sig.
Medial arch	Kinesio Taping Exercise	-.750 .100	.609 .609			
Kinesio Taping	Medial arch Exercise	-.850 -.100	.609 .609			
Exercise	KinesioTaping Medial arch	.850 .750	.609 .609	2	1.164	.350

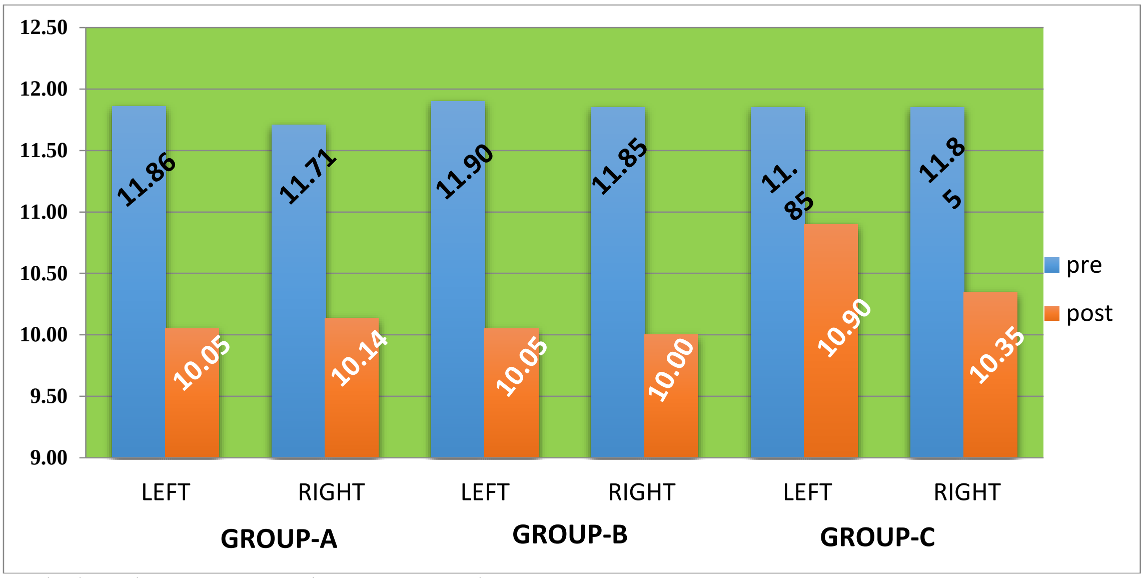
Since the $p > 0.05$, there is no significant difference between the three intervention groups.

TABLE-3: Navicular drop test values –right fourth week post test

Interventions		Mean difference	Std. Error	df Between groups	F Value	Sig.
Medial arch	Kinesio Taping Exercise	.250 -.100	.627 .627			
Kinesio Taping	Medial arch Exercise	-.250 -.350	.627 .627			
Exercise	Kinesio Taping Medial arch	.350 .100	.627 .627	2	.165	.843

Since the p >0.05, there is no significant difference between the three intervention groups.

GRAPH-II: Comparison of pre and post test values of navicular drop test for group-a, group-b and group–c for both left and right side foot



Group-A-Medial arch support and foot strengthening exercises
Group-B- Taping and foot strengthening exercises
Group-C- Foot strengthening exercises

RESULTS

According to the table 1, for the group A subjects treated with medial arch support, the pre test mean navicular drop of left foot is 11.86 and post-test value is 10.05. The pre-test mean navicular drop of right foot is 11.71 and the post-test value is 10.14. The comparison of pre and post-test values of navicular drop of left foot by paired 't' test showed that there was a statistically significant difference with 't' value 7.693 at $p<0.05$. Comparison of pre-test and post-test values of navicular drop of right foot by paired 't' showed that there was a statistically significant difference with 't' value 7.778 at $p<0.05$. For the group B subjects treated with kinesio taping, the pre-test mean navicular drop of left foot is 11.90 and post-test value is 10.05. The mean values of pre-test and post-test navicular drop were 11.85 and 10.00. Comparison of pre-test and post-test values of navicular drop of right foot by paired 't' test showed that there was a significant difference with 't' value 4.796 at $p<0.05$. Comparison of pre and post-test values of navicular drop of right foot by paired 't' test showed that there was a significant difference with 't' value 4.975 at $p<0.05$.For the group C subjects treated with foot strengthening exercises, the mean values of pre and post test navicular drop of left foot is 11.85 and 10.90. The pre-test and post test mean of navicular drop of right foot exercises were 11.85 and 10.35. Comparison of pre-test and post-test values of navicular drop on left foot by paired 't' test showed that there was a significant difference with 't' value 3.329 at $p<0.05$. Comparison of pre-test and post-test values of navicular drop of right foot by paired 't' test showed that there was a significant difference with 't' value 5.430 at $p<0.05$.

Table 2 shows the comparison of outcome values for navicular drop test within groups and between the groups by one way ANOVA. For left foot, the F-value is 1.164 at $p > 0.05$, thus stating that there is no significant difference between the groups.

Table 3 shows the comparison of outcome values for navicular drop test within groups and between the groups by one way ANOVA. For right foot, the F-value is .165 at $p > 0.05$. So, stating that there is no significant difference between the groups.

DISCUSSION

This study was done to compare the effect of foot taping versus custom-made medial arch support on pronated flatfoot in school going children. The outcome measure used in this study was navicular drop. Results of the study showed that custom-made medial arch support, taping and foot strengthening exercises were equally efficient for improving navicular drop in children with pronated flatfoot after 4 weeks.

Children with flatfoot may not present with a chief complaint of arch pain or heel cord tightness. Their symptoms may be disguised as tired or achy feet or complaints that they can't run as fast as the other kids. Generalized foot fatigue in children with flatfeet can be caused by overuse of both the intrinsic and extrinsic foot musculature.[34]

There should be an accepted treatment for patients with recognized disease. The normal physiological development sees reduced number of flatfoot posture with age, in a sense 'reversible' - but as a part of its natural history. Given too, that it is from commencement of the second decade of life, flatfoot posture is by definition less normal, and this is perhaps the age group where prevention and reversibility are best focused. In this study, children with pronated flatfoot are included with an aim to provide them care and improve their wellbeing.

Harking back to the issues that may modulate the natural history of pediatric foot posture development, it is useful to look at these factors in terms of those that might be able to respond to external effect (viz treatment). The factors were listed: muscle tone, connective tissue quality, strength, genetic factors, antenatal growth, obesity, gender, inheritance, shoe use.[35]

As a pragmatic approach, these factors have been categorized as 'easy' or 'difficult' to influence clinically. Strength [36, 37], obesity or overweight [38]and shoe use[39] are the 'easy' factors which may be altered so as to possibly influence foot posture and resulting gait.

According to Rose KJ and Riccio I et al (2009), muscle tone, connective tissue quality, genetic factors, antenatal growth, gender, and hereditary factors are 'difficult', if not impossible areas to change. Having both hypotonia and connective tissue hyper mobility may reduce with age. Blunty stated, if the paediatric flat foot cannot be definitively demonstrated to have definite and deleterious consequences in later life (when treatment can be instituted anyway), there may simply be no need for concern about the foot posture of healthy children. On the other hand, children who arrive at the end of their first life decade with very flatfeet, if usually asymptomatic, may be worth monitoring, strengthening, advising about footwear selection and overweight or obesity influence.

From this study it was found that, pronated flat foot is predominantly seen in boys (62 %) as compared to girls (38%) aged 10 to 12 years. In a study done by Murray KJ, it was found that developmental flatfoot across age groups approximate 45% in pre-school children and 15% in children with mean age of 10 years.[40]

Murray KJ (2006) stated that the rate of pediatrics flatfoot may be higher with joint hyper mobility, increased weight or obesity[41], in males, with specific neuromuscular[42] and genetic conditions (e.g. Down's syndrome) [43]or with a positive family history.

Group-A subjects with custom-made medial arch support and foot strengthening were comfortable and had no difference in their physical activities like running, jumping and walking whereas, a few subjects were uncomfortable. Initially some of the subjects had pain during their physical activities along the medial longitudinal arch, which subsided later on.

Comparison of pre-test and post-test values of navicular drop in Group-A subjects by paired 't' test showed that there was a statistically significant difference with 't' value on left foot as 7.693 at $p < 0.05$. Comparison of pre-test and post-test values of navicular drop right medial arch support and foot strengthening of Group-A subjects by paired 't' test showed that there was a statistically significant difference with 't' value as 7.778 at $p < 0.05$.

This can be because with the use of valgus insole, the arch is supported; hindfoot valgus corrected thus re-aligning the foot to neutral. Arch support reduces the degree and duration of abnormal pronation during stance phase and thus has the potential for decreasing strain in the plantar ligaments which may be therapeutic for the foot concluded by Bharati asgaonkar (2012).[44]

Group-B subjects were treated with kinesio taping and foot strengthening exercises. Comparison of pre-test and post-test values of navicular drop for Group-B subjects after right foot taping by paired 't' test showed that there was a significant difference with 't' value 4.796 at $p<0.05$.Comparison of pre and post-test values of navicular drop of Group-B subjects after right foot taping by paired 't' test showed that there was a significant difference with 't' value 4.975 at $p<0.05$.

Likewise, evidence suggested that taping reduces pronation, as indicated by shifts in midfoot pressure from medial to lateral as well as changes in forefoot and hind foot forces.[45]Also, taping stiffens the ankle joint and limits the hyper mobility and improves the gait pattern.[46, 47]

Group-C or the Control group received only foot strengthening exercises. Comparison of pre-test and post-test values of navicular drop of Group-C subjects by paired 't' test showed that there was a significant difference with 't' value 3.329 at $p<0.05$ for left foot. Comparison of pre-test and post-test values of navicular drop of Group-C subjects by paired 't' test showed that there was a significant difference with 't' value 5.430 at $p<0.05$ for right foot.

The results are in line with the study done by Mulligan et al in 2013 .They concluded that a 4 week short foot exercise training program emphasizing the recruitment of plantar intrinsic foot muscles may have value in dynamically supporting the medial longitudinal arch of foot.[48] However, Lynn et al in 2012 concluded that the short foot exercise is more effective than toe curling exercises at training the intrinsic foot muscle to maintain the height of the medial longitudinal arch during dynamic-balance tasks.[49]

During this study, we encountered some difficulties. The kinesio tape which was supposed to stay on the feet for 3 days, came off within 2 days due to sweating in the feet of some children and in a few children, it was difficult to make the tape stay as the edges came off due to repeated wearing and removing of socks during the school hours which made exercises difficult for the child.

All the three groups showed improvement in navicular drop. Although both medial arch support group and taping group showed greater improvements but the difference was not statistically significant. The results are similar to Samiha M et al who concluded that both foot taping and medical shoe are equally beneficial in improving gait parameters in children with Down's syndrome.

These results are supported by previous studies that explained the effects of medical shoes and foot taping separately. A number of studies believe that the medical shoe is most appropriately used for the flexible flatfoot children [50] and found that medial support in a shoe may provide increased stability to foot and leg and reduce the maximal foot pronation.[51]

The results of this study showed the comparison between the effects of custom-made medial-arch support, foot taping and foot strengthening exercises on navicular drop in pronated flatfoot. Effects of three interventions were insignificantly different from each other. The basic mechanism of all these three interventions is to support foot arches and reduces foot pronation, which explains the insignificant differences detected. Children with typical flexible flatfoot should not be burdened with enormous costs of arch support so, custom- made arch supports were used in this study.

There was no previous direct comparison between these interventions in children with pronated flatfoot aged 10 to 12 years. Further research is required to determine which factors at which age, are associated with symptomatic flatfeet, such that any possible prevention may be reasonably employed.

CONCLUSION

This study was done to compare the effect of foot taping versus custom-made medial arch support on pronated flat foot in school going children aged 10 to 12 years. There was a statistically significant reduction in the value of navicular drop in all the subjects with pronated flat foot in all the three groups. But no significant difference was seen when the effect of these three interventions i.e custom – made medial arch support, foot taping and foot strengthening exercises were compared to each other. Thus, the results of this study concluded that foot taping, custom-made medial arch support and foot strengthening exercises were found to be equally effective on pronated flat foot in school going children aged 10 to 12 years.

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Citation

Vadivelan, K., & Kiyanduru, G. (2015). COMPARISON OF FOOT TAPING VERSUS CUSTOM-MADE MEDIAL ARCH SUPPORT ON PRONATED FLATFOOT IN SCHOOL GOING CHILDREN. *International Journal of Physiotherapy*, 2(3), 491-501.