ISSN: 2690 - 9189

Research Article

International Journal of Orthopaedics Research

Effect of UCBL and Medial Longitudinal Arch Support in Balance and Functional Performance in Bilateral Flexible Flat Feet in Patients Aged Between 16 And 20 Years

Shyam Mohan Shukla[1], Tapas Priyaranjan Behera[1*], A M R Suresh[1], Manda Chauhan[1], Smita Jayavant[1] and Dimple Kashyap[2]

[1]Pandit Deendayal Upadhyaya National Institute for Persons with Physical Disabilities (Divyangjan), 4, Vishnu Digamber Marg, New Delhi- 110 002, India

[2]Department of Physical medicine and Rehabilitation, Kalawati Saran Children's Hospital, Bangla sahib Road, New Delhi-110001, India.

[*]Corresponding author
Tapas Priyaranjan Behera, Pandit Deendayal Upadhyaya National Institute for Persons with Physical Disabilities (Divyangjan), 4, Vishnu Digamber Marg, New Delhi- 110 002, India,

Submitted: 21 May 2021; **Accepted:** 10 June 2021; **Published:** 27 July 2021

Citation: *Shyam Mohan Shukla, Tapas Priyaranjan Behera, A M R Suresh, Manda Chauhan, Smita Jayavant and Dimple Kashyap (2021) Effect of UCBL and Medial Longitudinal Arch Support in Balance and Functional Performance in Bilateral Flexible Flat Feet in Patients Aged Between 16 And 20 Years. Int J Ortho Res, 4(2): 56-62.*

Abstract

Purpose: *Moulded foot orthoses have been shown to be successful in treating such injuries and reducing the symptoms by realigning the foot anatomy, controlling excessive pronation and reducing internal tibial rotation. Numerous prophylactics or therapeutic devices, such as motion control shoe, orthoses, orthotic devices, inserts and others, have emerged to limit the pronation range during running. In evaluating the effect of these devices to control pronation during running, orthopaedics and biomechanics researchers often investigate the rearfoot kinematics, or to be specific, the calcaneal motion in respect to the talus bone. Previous researches showed that the effects are still unclear however some orthotic inserts are useful in relieving heel and plantar fasciitis pain. The purpose of this study is to identify among UCBL and Medial Arch Support which is a better prescription option for Pes planus.*

Materials and Method: *An incidental simple randomised sample of 30 participants (30 Bilateral Flexible Flat Feet) were recruited for the study with age range from 16 to 20 years. There were 21 male and 9 female patients in the study. There was no drop out during the study. Participants were allocated to two groups by random allocation based on the fitment of UCBL and arch support (UCBL prescribed for Group A and Medial arch support prescribed for Group B). Pre and post interventional tests- balance and functional parameters was taken before the fitment of orthosis and after four-week of usage of the prescribed orthotic treatment and the said pre and post interventional data was analysed for statistical significance.*

Result: *One-way ANOVA test shows a significant difference between groups at p<0.000. Posttest between the parameters (Berg balance and TUG) shows that UCBL has a high statistical significance than medial arch support in improving balance and functional parameters at p<0.000 at t value -6.942.*

Conclusion: *A comparison of balance and functional parameter results in the tested orthoses indicated that the UCBL orthosis significantly increased the stability of people with flexible flatfoot, and it has improved balance and functional parameters in total among those with flatfeet. It seems that creating mobility in the midfoot area of the foot orthosis may cause a balance disturbance in patients with flatfoot. It is recommended that other balance parameters such as sway of the center of pressure and the long-term effects of orthoses may also be investigated.*

Introduction

The arches of the foot, formed by the tarsal and metatarsal bones, strengthened by ligaments and tendons, allow the foot to support the weight of the body in the erect posture with the least weight. The medial arch is higher than the lateral longitudinal arch. It is made up by the calcaneus, the talus, the navicular, the three cuneiforms (medial, intermediate, and lateral), and the first, second, and third metatarsals. The medial longitudinal arch in particular creates a space for soft tissues with elastic properties, which act as springs, particularly the thick plantar aponeurosis, passing from the heel to the toes. Because of their elastic properties, these soft tissues can spread ground contact reaction forces over a longer time period, and thus reduce the risk of musculoskeletal wear or damage, and they can also store the energy of these forces, returning it at the next step and thus reducing the cost of walking and, particularly, running, where vertical forces are higher. Its summit is at the superior articular surface of the talus, and its two extremities or piers, on which it rests in standing, are the tuberosity on the plantar surface of the calcaneus posteriorly and the heads of the first, second, and third metatarsal bones anteriorly. The chief characteristic of this arch is its elasticity, due to its height and to the number of small joints between its component parts [1].

Foot plantar mechanoreceptors provide detailed information about contact pressure which is used for feedback mechanisms of the postural control system and balance. Interventions such as a foot orthosis may optimize sensory information from plantar soles and may improve balance. An orthosis may be able to improve balance for those people with flatfeet. Despite individual differences, biomechanics of the foot are considerably influenced by the form and shape of the medial longitudinal arch. Prescribing foot Orthosis for flat foot aims to optimize the natural orientation of the structure of the foot and its related function. This in turn protects the medial longitudinal arch from abnormal stresses, preventing further deformity while attempting to promote optimal foot function and stability. Foot Orthoses can aim to promote and/or control foot pronation and lower limb alignment due to the coupling mechanism of the subtalar joint and tibia. In addition, they can also aid in improving the direction and function of the arch [2].

Flat foot (Pes Planus) is defined as a partial or total collapse of the medial arch of the foot. It has been classified into two categories, namely, flexible and rigid flatfoot, based on the presence or absence of the arch in non-weight bearing position. It may develop unilaterally or bilaterally. The medial longitudinal arch of the foot plays a critical role in the normal mechanics of the foot. Any increase or decrease in this osteo-ligamentous arch changes the normal function of the foot and triggers damage to the feet and the whole body. Flexible flat foot is described as a reduction in the height of the medial longitudinal arch and may occur from abnormal foot pronation. The condition may be congenital (occurring at the time of birth) or acquired (developing over time, most often as a result of age or injury). Pes planus is a medical condition where the curvature of medial longitudinal arch is more flat than normal and entire sole of the foot comes into near complete or complete contact with the ground. The height of the medial longitudinal arch is most important measurement in determining the degree of Pes Planus [3].

UCBL (University of California Biomechanics Laboratory or University of California Berkeley Laboratory) orthosis is a maximum control foot orthosis that was developed in 1967 at the University of California Biomechanics Laboratory, The UCBL orthosis is used to stabilize a flexible flatfoot deformity. This orthosis differs from other foot orthoses in which it fully covers the heel with molded heel cup which holds the heel in neutral position. Moreover, the UCBL orthosis also supports the medial longitudinal arch of the foot. This orthosis is commonly used in flexible deformity that foot is flexible enough to be held in a neutral position comfortably. If the foot is rigid, the UCBL is made to the shape of the foot and the goal is to prevent further deformity. The UCBL orthosis is made of a rigid material, usually thermoplastic, molded over a model of the foot created by casting the foot. The foot section of the orthosis usually extends to a line just behind the heads of metatarsal bone. The trim line of the orthosis is below the malleolus, so, the orthosis is not seen outside of the shoe. The common complications from using this orthosis are pain, skin redness, and abrasion. These complications can be eliminated by the good fitting of the orthosis [4].

Medial arch-heel support was found to be effective in reducing maximum eversion angle in dynamic trials but not static trials. In walking, the inserts successfully reduced the maximum eversion angle by 2.1 degrees in normal subjects and by 1.5–2.0 degrees in pronators. The inserts showed a trend to bring the over-pronated feet of pronators back to the normal eversion range. In running, the insert with low medial arch-heel support significantly reduced maximum eversion angle by 3.6 and 3.1 degrees in normal subjects and pronators respectively. The inserts successfully restored normal eversion in 84% of the pronators. arch-heel support are inserts effective in reducing ankle eversion in walking and running, but not in standing. In walking, there is a trend to bring the over-pronated feet of the pronators back to the normal eversion range [5].

Moulded foot orthoses have been shown to be successful in treating such injuries and reducing the symptoms by realigning the foot anatomy, controlling excessive pronation and reducing internal tibial rotation [6]. Numerous prophylactics or therapeutic devices, such as motion control shoe, orthoses, orthotic devices, inserts and others, have emerged to limit the pronation range during running. In evaluating the effect of these devices to control pronation during running, orthopaedics and biomechanics researchers often investigate the rearfoot kinematics, or to be specific, the calcaneal motion in respect to the talus bone. Previous researches showed that the effects are still unclear [7]. Scherer showed that orthotic inserts are useful in relieving heel and plantar fasciitis pain, however, Gross and co-workers showed no improvement or even increased symptom severity in runners being prescribed with orthotics [8, 9]. Moreover, there are many types of commercially available orthotic in the market, including half insert or full insert, with different degree of support in medial and lateral arch-heel regions [10].

Therefore, the effect of orthotic inserts is product-specific, thus, biomechanical and functional evaluation of orthotic inserts is necessary before the inserts are introduced to the market. Need of this study is to identify among UCBL and Medial Arch Support which is a better prescription option for Pes planus.

Experimental Hypothesis
There is statistical significance between UCBL and Medial Longitudinal Arch Support in improving balance and functional performance in flexible flat feet.

Null Hypothesis
There is no statistical significance between UCBL and Medial Longitudinal Arch Support in improving balance and functional performance in flexible flat feet

Materials and Methodology
The study, a randomized trial, was conducted at Pt. Deendayal

Up adhyaya National Institute for Persons with Physical Disabilities (Divyangjan), New Delhi, India. Participants were allocated to groups that received UCBL and Medial Longitudinal Arch Sup¬port.

Figure 2: UCBL

Methods

Incidental simple randomised subjects with Flexible Flat Feet were participants for the study. The inclusion criteria for the study were bilateral flexible flat feet, both male and female subjects with an age range 16-20 yrs., no associated orthopedic, neurological or mental disorders and any known history of fractures or implants in the last 3 years were recruited. All the subjects should be able to understand the given command. Subjects were excluded if they had inadequate ROM and strength, and not fulfilling the inclusion criteria.

A total number of 30 participants (30 Bilateral Flexible Flat Feet) were recruited for the study with age range from 16 to 20 years. There were 21 male and 9 female patients in the study. There was no drop out during the study. Participants were allocated to two groups by a random allocation sequence. One group (Group A) fitted with UCBL and another group (Group B) fitted with Medial Longitudinal Arch Support. Each group consists of 15 participants. The Study design was experimental (Comparative) study.

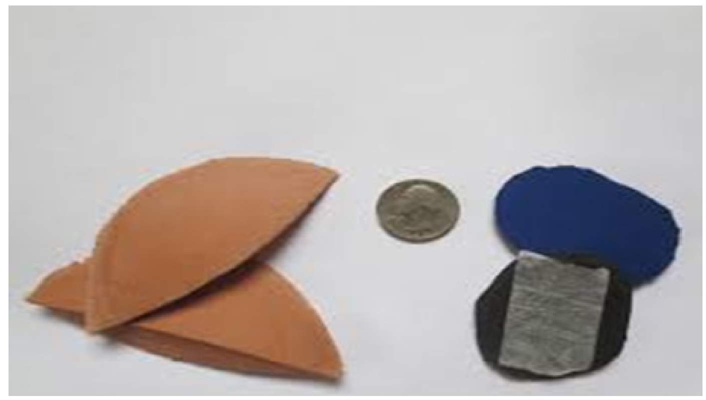


Figure 3: Medial arch support.

Parameters Studied

- Berg Balance scale
- Timed up and go test (TUG)

Interventional Modality

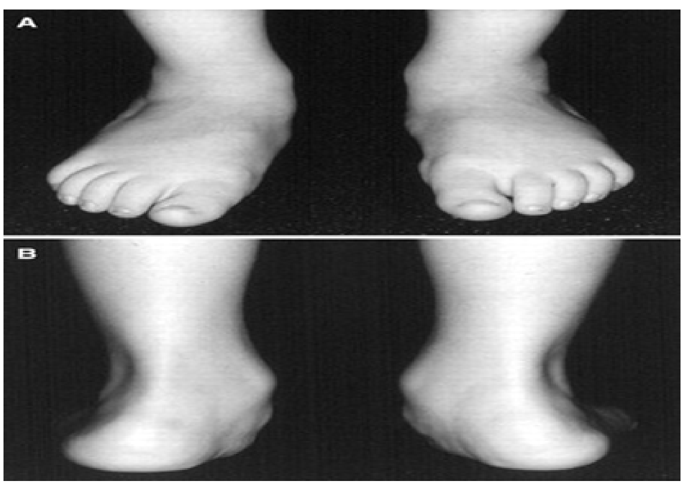


Figure 1: Showing flat feet.

Procedure of Study

The subjects with flexible Pes Planus reporting to the study centre for orthotic treatment were first screened through the inclusion and exclusion criteria. The individuals were explained about the study procedure. The subject fulfilling the criteria were included in the study and the informed consent was signed with them individually.

Firstly, the subjects were assessed and evaluated. The demo¬-graphic data like age, gender was taken after which subjects were assigned to groups based on the fitment of UCBL and arch support (UCBL prescribed for Group A and Medial arch support prescribed for Group B). Prior to each test- balance and functional parameters, participants were given 5- 10 minutes practice time to be acclimatized about the test procedure. Furthermore, in order to become familiar with test procedures, all the participants were asked to perform the tests at least one time before the recording of the data (Pre interventional data). Post interventional tests- balance and functional parameters was taken after four-week of usage of the prescribed orthotic treatment and the said pre and post interventional data was analysed for statistical significance.

Protocol of Study

The testing of the subjects pre and post interventional recording were carried out in a fixed visual and acoustic environment. The participants were allowed to undergo the test at normal respiration without any stress or anxiety. The readings were tak¬en in normal climatic conditions at a fixed room temperature.

Data Collection and Analysis

The subjects 30 (20 males and 10 female) were tested at Pandit Deendayal Up¬adhaya National Institute for Person with Physical disabilities (Divyangjan), New Delhi, India. Ethical committee approval was sought as the study included human able-bodied volunteers as research subjects. Demographic data and pre/post interventional test scores were collected and maintained in an Excel Sheet. The Statistical Anal¬ysis was conducted using SPSS software (version 21). One-way ANOVA analysis was performed within and between groups (UCBL and Medial Arch Support).

Result

General Characteristics

CHARACTERISTICS	VALUE
GENDER	
MALE	20(66.6%)
FEMALE	10(33.3%)
AGE(Years)	
MALE	18
FEMALE	17.8
WEIGHT (kg)	
MALE	53.4
FEMALE	53.2

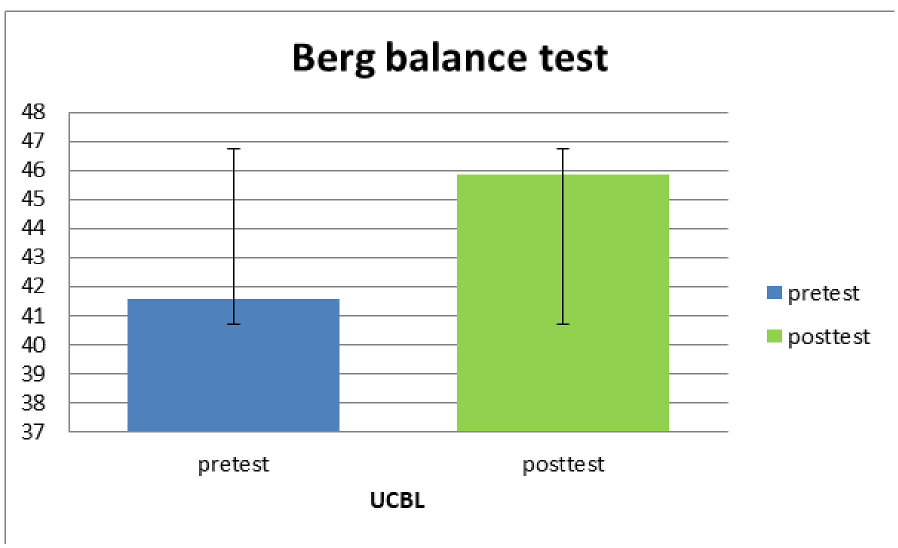
UCBL Effect

One-way ANOVA shows a significant difference (p=0.00) between groups. Post (Berg balance test) shows that UCBL help in maintaining balance (p=0.000) and t value -6.942

Group Statics

Table 1: UCBL Effect Mean and standard deviation in degrees

	UCBL	N	Mean	Std. Deviation	T value	P value
Berg Balance test	Pre test	15	41.6000	1.59463	-6.942	0.000
	Post test	15	45.8667	1.76743		



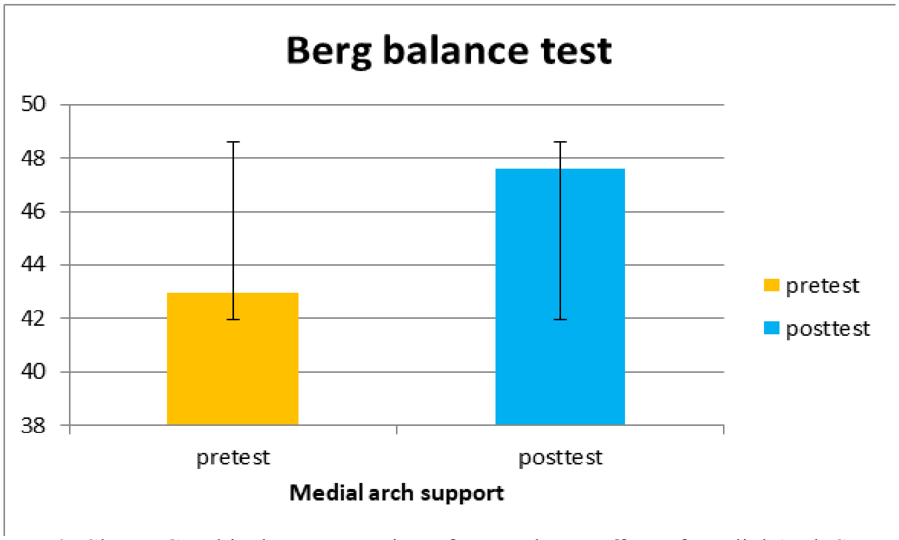
Graph 1: Shows Graphical presentation of pre and post effect of UCBL

Medial Arch Support

One-way ANOVA shows a significant difference (p=0.00) between groups. Post (Berg balance test) shows that Medial arch support help in maintaining balance (p=0.000) and t value -5.965.

Table 2: Medial Arch Support effect mean and standard deviation in degrees.

Medial Arch Support	N	Mean	Std Deviation	T value	P value
Pre test	15	42.9333	2.21897	-5.965	0.000
Post test	15	47.6000	2.06328		



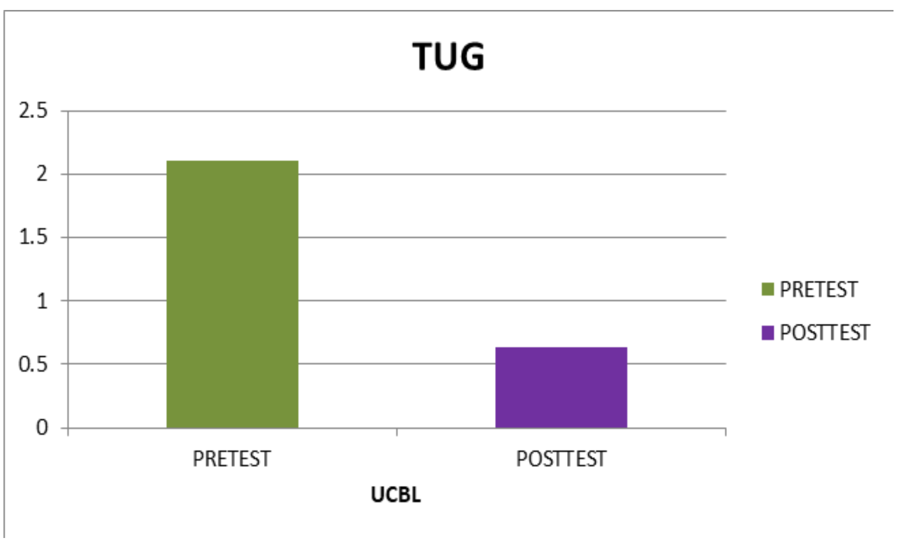
Graph 2: Shows Graphical representation of pre and post effect of Medial Arch Support.

UCBL Effect in TUG Test

One-way ANOVA shows a significant difference (p=0.00) between groups. Post (TUG Test) shows that UCBL help in maintaining balance (p=0.000) and t value 10.210

Table 3: Shows pre and post mean and standard deviation in degree.

UCBL	N	Mean	Std. Deviation	T value	P value	P value
TUG test	Pre test	15	2.1000	.50709	10.210	0.000
	Post test	15	.6333	.22887		



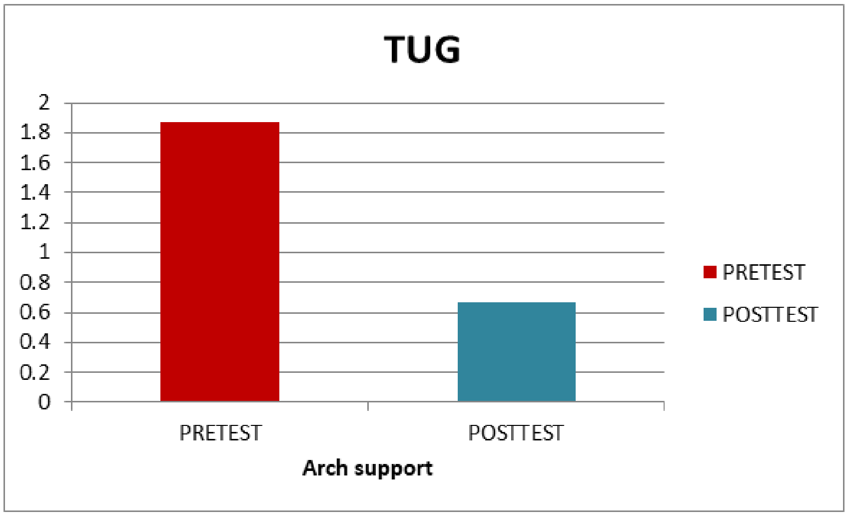
Graph 3: Shows graphical representation of pre and post effect of UCBL in TUG test.

Medial Arch Support

One-way ANOVA shows a significant difference (p=0.00) between groups. Post (TUG Test) shows that Medial arch support help in maintaining balance (p=0.000) and t value 7.315.

Table 4: Show pre and post effect of Medial arch support in TUG Test.

Arch support	N	Mean	Std Error Deviation	T value	P value
Pre test	15	1.8667	.61140	7.315	0.000
Post test	15	.6647	.17707		



Graph 4: Shows Graphical representation of pre and posttest of Medial Arch Support in TUG Test.

Discussion

The center of body mass tends to internally shift in those people with flatfoot due to the fall of the medial longitudinal arch. Orthosis are prescribed to reduce pronation of the foot and to return it to its natural posture, which will shift the center of mass of the body to its normal position. This may cause alterations in the balance strategy adapted by each participant. This finding was inconsistent with the result of Landsman, but was consistent with that of Orteza *et al*., Akbari *et al*., and Gross *et al*., The decrease in the sway caused by some orthoses might be related to their structures [9].

Significant effects were found in dynamic trials (walking and running) but not in static trials (standing). This may be due to the nature of the motion. In standing, both feet support the human body, in a symmetric way. Therefore, the lack of medial support of the right foot could be somewhat compensated by the support of the left foot, and vice versa. In dynamic trial, the maximum eversion angles were obtained during the single-leg stance phase of right foot. In this period of time, the left foot was in swing phase and could not provide any support to the body. Therefore, the right foot alone had to support the full body weight in walking, and even 2–3 times of the body weight in running. In such situation the medial arch-heel support become more demanding, and thus the effect of inserts was found significant in dynamic trials. Therefore, evaluation of inserts should be done in dynamics trials to demonstrate the effect in dynamic situation [11].

The result is potentially valuable within the body of existing evidence, particularly for practitioners, policymakers, and those presenting with symptoms of flexible flatfoot. The use of insoles or orthotics for flatfoot treatment appears to be a common practice, although limited evidence supports this practice in nonpathological pediatric populations. Nevertheless, (potentially) justifiable concerns exist regarding the methodology of the available evidence; this observation suggests that existing studies have generally included nonsymptomatic participants, measured outcomes that have not all been related to activities of daily living, and used types of insoles or orthosis that are different from those prescribed in clinical practice. Therefore, much of the existing literature has limited external validity for practitioners working with adults or children with symptomatic flatfoot. This research addresses 2 of these concerns by including symptomatic participants and outcome measures that are valid and reliable indicators of function and disability [12-15].

Mulford *et al*. observed BBS and TUG improvement in 67 healthy subjects (mean 69.9 years) wearing insoles with an arch support. Although in accordance with our findings, their results had a smaller effect size. This difference may be explained by the orthoses used in each protocol. Given that a greater concentration of mechanoreceptors has been observed in the MTP region, the additional use of a metatarsal pad in our protocol may have provided better afferent information. Percy *et al*. using a gait perturbation protocol, also observed an improvement of balance in 40 older adults (mean age 69 years) wearing insoles with edge elevations. However, Wilson *et al*. did not observe postural control improvement using a balance platform when comparing three groups of 10 patients with different foot orthoses (with a plain, grid or dimpled surface) vs CG without insoles. This disagreement may be due to the small number of participants in each group and the comparatively young ages of the subjects studied [16-24].

Conclusion

There is significance difference found in this study UCBL is more effective as compared to Medial Longitudinal Arch Support in maintaining Balance and functional performance related to mobility in flexible flatfeet.

A comparison of balance and functional parameter results in the tested orthoses indicated that the UCBL orthosis significantly increased the stability of people with flexible flatfoot, and it has improved balance in total among those with flatfeet. It seems that creating mobility in the midfoot area of the foot orthosis may cause a balance disturbance in patients with flatfoot. In this study, only the immediate effects of an orthosis on balance were investigated; the long-term effects of orthoses were not investigated. It is recommended that other balance parameters such as sway of the center of pressure and the long-term effect of orthoses also be investigated.

Limitation of the study

1. Relatively small sample size limits the study's generalization.
2. Sample was taken from hospital only.
3. Use of gait lab system may give the exact data for analysis.
4. Immediate orthoses fitting data's are taken.
5. Environmental conditions including temperature, humidity, ambient noise, and psychological condition may affect the result of the study.

References

1. Hylton B Menz, Jamie J Allan, Daniel R Bonanno, Karl B Landorf, George S Murley, *et al*. (2017) Custom- made foot orthoses: an analysis of prescription characteristics from an Australian commercial orthotic laboratory 10:23.
2. Flat Feet Symptoms, Causes, Diagnosis, and Treatment Bottom of Formby Catherine Moyer, DPM , Reviewed by a board-certified physician ,Updated December 30, 2018
3. Aenumulapalli A, Kulkarni MM, Gandotra AR (2017) Prevalence of Flexible Flat Foot in Adults: A Cross- sectional Study. J ClinDiagn Res 11: 17-20. https://pubmed.ncbi.nlm.nih.gov/28764143
4. Woratee Dacharux, Navaporn Chadchavalpanichaya (2017) The Use of UCBL Orthosis in Patients with Flatfoot in Foot Clinic, Siriraj HospitalJ Med Assoc Thai 100: 800-807
5. Somaieh Payehdar (2014) Comparing the immediate effects of UCBL and modified foot orthosis on postural sway in people with flexible flatfoot 40: 117-122.
6. Nawoczenski DA, Cook TM, Saltzman CL (1995) The effect of foot orthosis on three-dimensional kinematics of the leg and rearfoot during running. Journal of Orthopaedics and Sports Physical Therapy 21: 317-327.
7. Razeghi M, Batt ME (2000) Biomechanical analysis of the effect of orthotic shoe inserts – A review of the literature. Sports Medicine 29: 425-438.
8. Scherer PR (1991) Heel spur syndrome. Pathomechanics and nonsurgical treatment. Biomechanics graduate research group for 1988. Journal of the American Podiatric Medical Association 81: 68-72.
9. Gross ML, Davlin LB, Evanski PM (1991) Effectivess of orthotic shoe inserts in the long-distance runner. American Journal of Sports Medicine 19: 409-412.
10. Nigg BM (2001) The role of impact forces and foot pronation: a new paradigm. Clinical Journal of Sport Medicine 11: 2-9.
11. Miko LM Lao, Chad WN Chan, Patrick SHYung, Kwai-Yau Fung, Pauline PY Lui, *et al*. (2014) Effect of medial arch-heel support in inserts on reducing ankle eversion: a biomechanics study 3:7.
12. Banwell H, Mackintosh S, Thewlis D (2014) Foot orthoses for adults with flexible pes planus: a systematic review. J Foot Ankle Res 7: 23.
13. Helen A Banwell, Shylie Mackintosh, Dominic Thewlis (2014) Foot orthoses for adults with flexible pesplanus: a systematic review 7:23.
14. Gross MT, Mercer VS, Lin FC (2012) Effects of foot orthoses on balance in older adults. J Orthopports PhysTher 42: 649-657.
15. Chen YC, Lou SZ, Huang CY (2010) Effects of foot orthoses on gait patterns of flat feet patients. Clin Biomech (Bristol,Avon) 25: 265-270.
16. Wrobel JS, Edgar S, Cozzetto D (2010) A proof-of-concept study for measuring gait speed, steadiness, and dynamic balance under various footwear conditions outside of the gait laboratory. J Am PodiatrMed Assoc 100: 242-250.
17. Bernard-Demanze S, Vuillerme N, Ferry M (2009) Can tactile plantar stimulation improve postural control of persons with superficial plantar sensory deficit? Aging ClinExp Res 21: 62-68
18. Corbin DM, Hart JM, McKeon PO (2007) The effect of textured insoles on postural control in double and single limb stance. J Sport Rehabil 16: 363-372.
19. Menz HB, Morris ME, Lord SR (2005) Foot and ankle characteristics associated with impaired balance and functional ability in older people. J Gerontol A BiolSci Med Sci 60: 1546-1552.
20. Cote KP, Brunet ME, Gansneder BM (2005) Effects of pronated and supinated foot postures on static and dynamic postural stability. J AthlTrain 40: 41-46.
21. Rome K, Brown CL (2004) Randomized clinical trial into the impact of rigid foot orthoses on balance parameters in excessivelypronatedfeet. Clinal Rehabil 18: 624-630.
22. Olmosted LC, Hertel J (2004) Influence of foot type and orthotics on static and dynamic postural control. J Sport Rehabil 13: 54–66.
23. Percy ML, Menz HB (2001) Effects of prefabricated foot orthoses and soft insoles on postural stabilityin professionals occerplayers. Am Podiatr Med Assoc 91: 194-202.
24. Hung YJ, Gross MT (1999) Effect of foot position on electromyographic activity of the vastusmedialis oblique and vastuslateralis during lower-extremity weight-bearing activities. J Orthop Sports Phys Ther 29: 93-102.