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IMMEDIATE EFFECT OF CORRECTIVE FOOT ORTHOSIS ON SPATIAL AND TEMPORAL VARIABLES OF GAIT CYCLE IN FEMALES WITH FUNCTIONAL FLATFEET AGED 20-30 YEARS: AN OBSERVATIONAL CROSS-SECTIONAL STUDY

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ABSTRACT**:** *{Purpose} The study examined the effect of corrective foot orthosis on spatial and temporal variables of the gait cycle in females with functional flat feet aged between 20 to 30 years. {Subjects and Method} 30 females who had been diagnosed with functional flat feet. The subject's step length, stride length, base of support, and cadence were measured using the chalk powder footprint method prior to and after wearing the orthosis. {Result} Step length (p value: <0.0001), Stride length (p value: <0.001), Base of support (p value: <0.004) and cadence (p value: <0.011) increased significantly. {Conclusions} Corrective foot orthosis has a positive effect on spatial and temporal variables of the gait cycle in females with functional flat feet aged 20–30 years.*

Keywords- *Flat feet, Gait Performance, Orthosis.*

I. INTRODUCTION

Pes planus, or flat foot, is the loss of the medial longitudinal arch of the foot, heel valgus deformity, and medial talar prominence [1]. This is often observed with the medial arch of the foot coming closer (than typically expected) to the ground or making contact with the ground [1]. The medial longitudinal arch is made up of the calcaneus, navicular, talus, first three cuneiforms, and first, second, and third metatarsals. It is supported by the soft tissues of the spring ligament (plantar calcanea navicular ligament), deltoid ligament, posterior tibial tendon, plantar aponeurosis, and flexor hallucis longus and brevis muscles. Dysfunction of any portion of the medial longitudinal arch may result in acquired pes planus [2]. The main factors that contribute to an acquired flat foot deformity are excessive tension in the triceps surae, obesity, posterior tibial tendon dysfunction, or ligamentous laxity in the spring ligament, plantar fascia, or other supporting plantar ligaments. [2] Flexible flat feet is generally asymptomatic and do not cause pain. However, it may occasionally cause pain after rigorous walking or intense sports activity. This may be due to reduced arch strength, increased load, or a combination of the two. In gait with midtarsal (MT) joint locking, the transition in the foot from pronation to supination is an important function that assists in adapting to uneven terrain and acting as a rigid lever during push-off. [3] During pronation, the MT joint unlocks, providing flexibility to the foot during the gait cycle and assisting in maintaining balance. [3] If the foot remains pronated, it would lead to hypermobility of the midfoot and place greater demand on the neuromuscular structures that stabilise the foot to maintain an upright stance. It has been concluded that postural stability is affected by foot position in both static and dynamic conditions [3].

Herchenroder (2021) studied orthoses by evaluating stance and plantar pressure and concluded that there was a lack of evidence for the effect of foot orthoses on flatfoot in adults [18]. Foot orthoses are crucial as they help in treating dysfunction of the lower extremities, as the study by Yinghu Peng (2020) showed that there was a significant decrease in the peak ankle eversion angle and ankle eversion moment. This study concluded that with a reduction in the patellofemoral joint and ankle contact force, it could potentially inhibit flatfoot-induced lower limb joint problems [20]. There were studies like the one done by A.K.L. Leung (2005), which showed an immediate reduction in the degree and duration of abnormal pronation during the stance phase, thus causing decreased strain on the plantar ligaments and a decrease in abnormal tibial rotation after the use of an orthosis [9]. According to a study by Hyuck Soo Shina (2014), the stride length, step length, cadence, and BOS are significantly lower [25] in people with flat feet. The reasons for lowered values were: 1] diminished dorsiflexion and increased eversion of the hindfoot; 2] decreased plantarflexion of the forefoot; 3] loss of varus thrust in the forefoot; and decreased ROM with decreased hallux dorsiflexion [25]. There are studies that support the effect of corrective foot orthosis in the management of functional flat feet and show increased gait velocity, stride length, and decreased stance time when the foot orthosis is used [24] but there are also studies that report no significant results in these parameters after the use of corrective foot orthosis.

Although there are many studies on the effect of orthosis on foot function, evidence is inconclusive on the effect of orthosis on spatial and temporal gait variables. Accordingly, this study is done to examine the immediate effect of corrective foot orthosis on the spatial and temporal variables of the gait cycle in females with functional flat feet within the age group of 20–30 years.

II. SUBJECTS AND METHODS

1.1 Subjects

This study was conducted from October 2023 to April 2023 on 30 females aged 20–30 years.

The inclusion criteria include:

- The subjects have no history of lower limb fractures or ligamentous injuries within the past 12 months and are not undergoing any physiotherapy treatment.
- Difference >10mm in Navicular Drop Test Measurement

Exclusion Criteria:

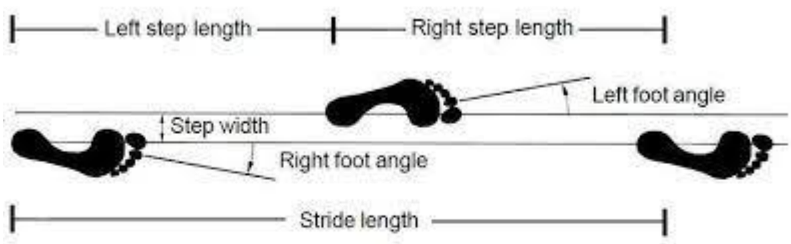
- Tarsal coalition.
- vertical talus.
- Generalised ligament laxity

- Sample size: 30 (As the mean standard deviation value of the parent article has very little difference between the pre and post values, the sample size will depend on the number of women fulfilling the inclusion criteria.)
- Sampling method: convenient sampling.
- Study setting: community

1.2 Method

The study was approved by the departmental review board of D.E. Society's Brijlal Jindal College of Physiotherapy, Pune. Informed and written consent was obtained from the subjects. The insoles were made of microcellular material. These semirigid types of orthoses were customised to fit their foot sizes. The insoles were designed to position the foot in a neutral position, thereby preventing excessive pronation.

The footprint method using chalk powder was used to measure the gait cycle [22]. Step length, stride length, cadence, and BOS were measured prior to and after wearing the orthosis.



All of the subjects walked two times at a self-determined speed, and the pre- and post-values were compared.

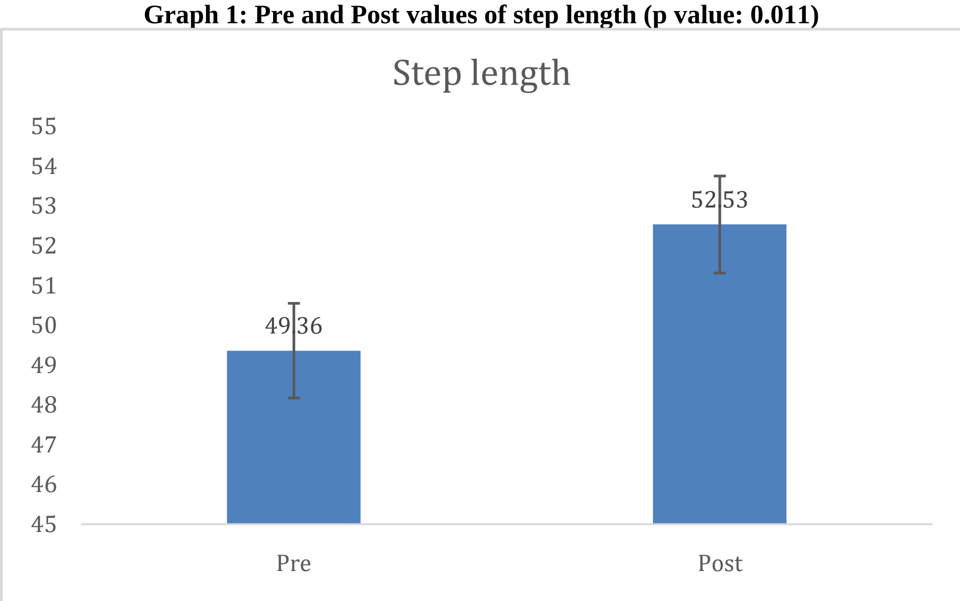
- Data analysis: The data were analysed using Microsoft Excel and Statistical Package for Social Sciences (SPSS) version 21.
  The data was analysed within the group. A non-parametric test, the Wilcoxon signed rank test, was performed as the distribution was not normal. (By histogram and Q-Q plots) The statistical significance was accepted for values of $p < 0.05$.

III. RESULTS

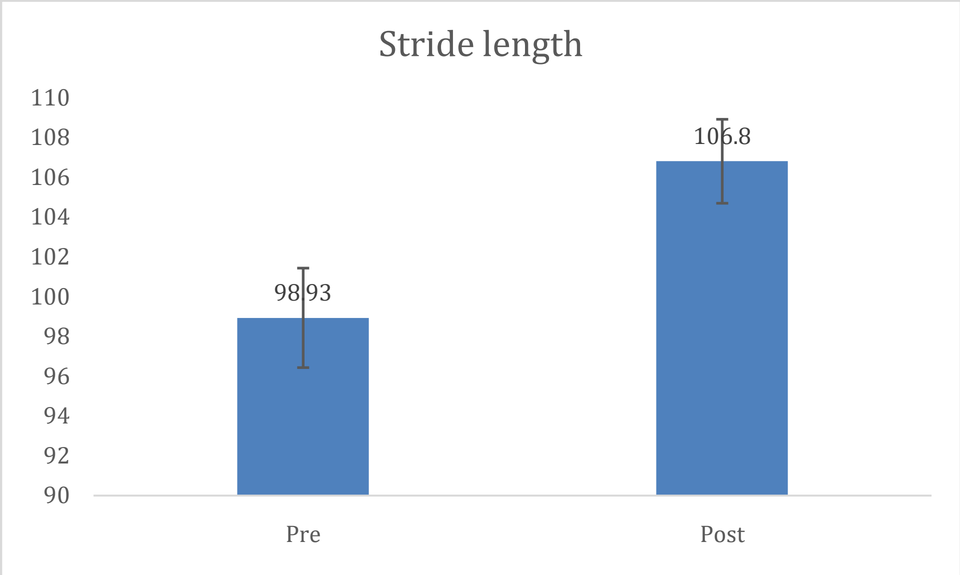
Table 1: Descriptive Statistics

Criteria	Median+/-SD
Age	24.00+/-1.76
BMI	21.61+/-1.61

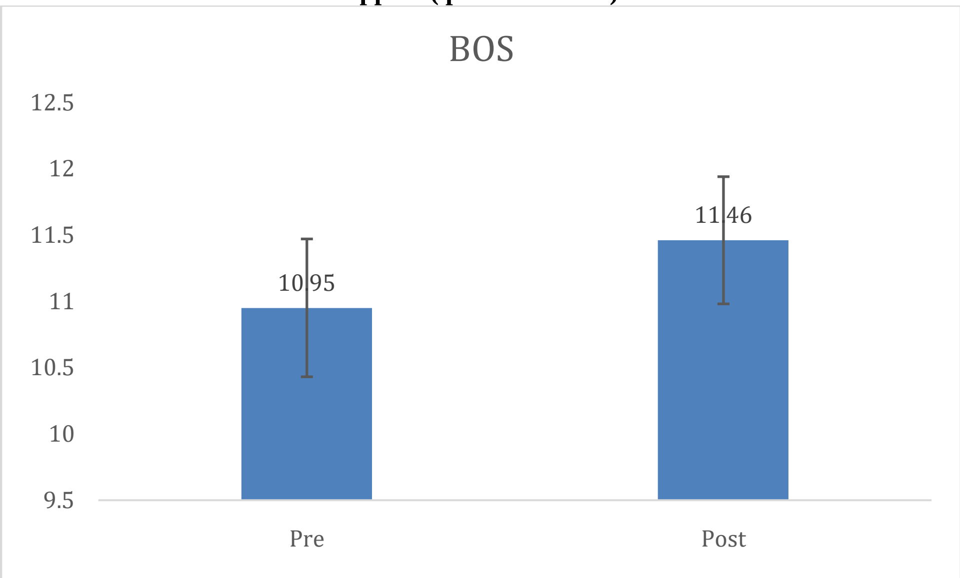
Graph 1: Pre and Post values of step length (p value: 0.011)



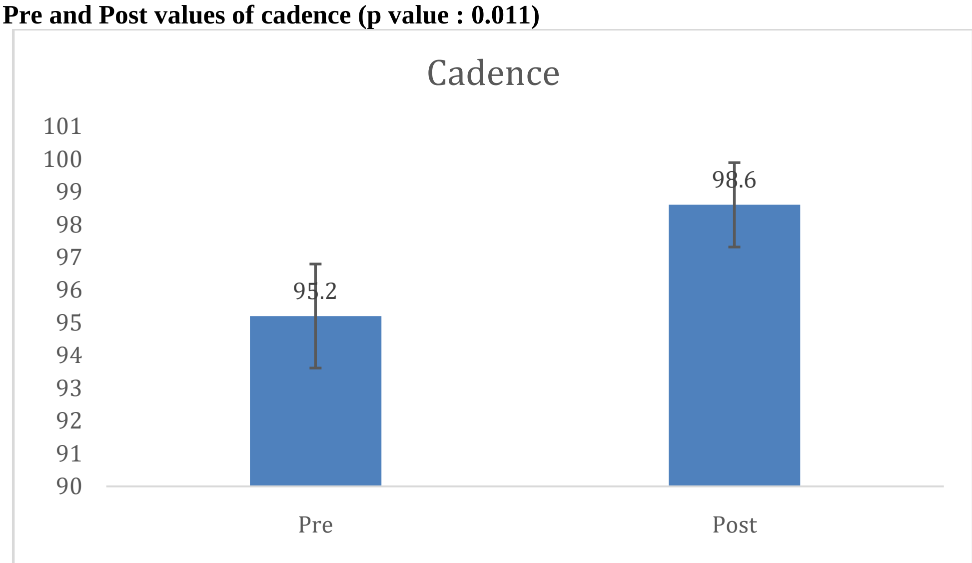
Graph 2: Pre and Post values of stride length (p value: 0.001)



Graph 3: Pre and Post values of base of support (p value : 0.004)



Graph 4: Pre and Post values of cadence (p value : 0.011)



IV. DISCUSSION

In this study, we compared the values of stride length, step length, cadence, and BOS prior to and after wearing orthoses in females with functional flat feet aged 20–30 years. Data analysis was done by using the median, as the median is generally used for skewed distributions. The mean is not a robust tool since it is largely influenced by outliners. The median is better suited for skewed distributions to derive a central tendency since it is much more robust and sensible.

The result showed an increase in cadence after the use of a corrective foot orthosis. The arch support insoles increase the pressure on the big toe, which assists in foot propulsion, and they also add more pressure on the 2nd to 4th metatarsal, which assists in foot propulsion, leading to increased cadence. The windlass mechanism may also be one of the factors contributing to increasing cadence, as arch support facilitates a more even distribution of weight [26] but assessing the arch deformation was beyond the scope of this study. The stride length and step length showed significant improvement after the use of corrective foot orthoses because of the increased pressure on the big toe during the push-off phase of the gait cycle [28] leading to increased foot propulsion. The use of a semi-rigid (microcellular) orthosis may be a factor in increasing the step length and stride length, as it is thought to help restore the elasticity of the foot arch [26] by reducing the pronation during walking. As the step length and stride length increase along with the cadence, which leads to reduced stance time and an increase in speed of walking. [26] The width of the base of support is improved because of the escalated step and stride length, leading to improved dynamic balance during the gait cycle.

In functional flatfoot resupination is delayed, the foot remains pronated after the foot flat phase of the gait cycle, due to which the midtarsal joint is not locked and the forefoot remains a mobile adapter instead of a rigid lever for propulsion [31]. leading to increased instability. Due to functional orthosis, the pronation is controlled, so the midtarsal joint is locked, which gives more stability while walking. It also reduces the risk of falling by increasing the stride length, step length [29], and base of support.

V. CONCLUSION

Corrective foot orthosis has a positive effect on step length, stride length, BOS, and cadence.

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