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ORIGINAL ARTICLE

Effects of silicone insoles combined with different exercise methods in individuals with flexible pes planus

Esnek pes planuslu bireylerde silikon tabanlıkların farklı egzersiz yöntemleriyle birlikte uygulanmasının etkileri

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Abstract

Purpose : Presence of a pes planus foot deformity negatively affects the balance of the individual, revealing disturbances and different balance strategies. In this situation, the training of intrinsic muscles is of great importance. The purpose of this study is to investigate the effects of intrinsic strengthening and dynamic balance exercises in participants having flexible pes planus.
Methods: Forty-five participants with pes planus aged 18 to 35 years were enrolled in the study, and the first group underwent intrinsic foot muscle strengthening training with short foot exercises (SFE) and used insoles. The second group trained using the dynamic balance board, which promotes dynamic balance and used insoles. The third group used only insoles. The total duration of treatment was 8weeks/3days. The degree of foot deformity was assessed with the medial longitudinal arch (MLA) angle, measurements of subtalar angle. Navicular drop test was assessed with foot pronation level. Foot posture assessed using Foot Posture Index (FPI) Static balance was assessed with the Flamingo Balance Test and dynamic balance was assessed using the BOBO Health Platform with Gaming®, a technology-based system designed to measure dynamic postural control.
Results: After the intervention, statistically significant improvements were observed in the medial longitudinal arch angle and foot posture index scores in Group 1. SFE were found to improve foot arch, subtalar angle, navicular level, and foot posture index scores, as well as static and dynamic balance($p \le 0.05$). No significant changes were observed in the medial longitudinal arch, foot posture index, or balance parameters with the use of silicone insoles alone ($p > 0.05$).
Conclusion: The use of silicone insoles in addition to exercise therapy in the management of flexible pes planus improves balance and foot posture.
Keywords: Pes planus, Insole, Balance, Exercise

Öz

Amaç: *Pes planus ayak deformitesinin varlığı, dengeyi olumsuz etkileyerek küçük postüral bozukluklara ve farklı denge stratejilerinin gelişimine yol açmaktadır. Bu durumda, intrinsik ayak kaslarının güçlendirilmesi büyük önem taşımaktadır. Bu çalışmanın amacı, esnek pes planusa sahip bireylerde intrinsik kas güçlendirme ve dinamik denge egzersizlerinin etkilerini araştırmaktır.*
Yöntem: *Çalışmaya pes planusu olan, 18–35 yaş aralığında 45 katılımcı dahil edildi. Birinci grup kısa ayak egzersizleri (KAE) ile intrinsik kas kuvvetlendirme eğitimi aldı ve silikon tabanlık kullandı. İkinci grup dinamik dengeyi geliştiren balance board egzersizleri yaptı ve silikon tabanlık kullandı. Üçüncü grup ise yalnızca silikon tabanlık kullandı. Tedavi süresi 8 hafta ve haftada 3 gün olacak şekilde planlandı. Ayak deformitesi; medial longitudinal ark açısı ve subtalar açı ölçümleriyle değerlendirildi. Ayak pronasyon seviyesi navicular düşme testiyle değerlendirildi. Ayak postürü ayak postür indeksi (API) ile, statik denge Flamingo Denge Testi ile, dinamik denge ise dinamik postüral kontrolü ölçen BOBO Health Platform with Gaming® cihazı kullanılarak değerlendirildi.*
Bulgular: *Müdahale sonrasında Grup 1'de medial longitudinal ark açısı ve API skorlarında istatistiksel olarak anlamlı iyileşme gözlendi. Kısa ayak egzersizlerinin; ayak arkını, subtalar açıyı, naviküler seviyeyi ve API skorlarını iyileştirdiği, ayrıca statik ve dinamik dengeyi artırdığı bulundu ($p \le 0,05$). Yalnızca silikon tabanlık kullanımının ise medial longitudinal ark, API ve denge parametrelerinde anlamlı bir değişiklik oluşturmadığı saptandı ($p > 0,05$).*
Sonuç: *Esnek pes planusun yönetiminde silikon tabanlık kullanımının egzersiz tedavisine ek olarak kullanılması, dengeyi ve ayak postürünü iyileştirmektedir.*
Anahtar kelimeler: *Pes planus, Tabanlık, Denge, Egzersiz*

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INTRODUCTION

Pes planus (flatfoot) is generally defined as valgus of the hindfoot, disappearance of the medial longitudinal arch (MLA) in the midfoot, and supination of the forefoot relative to the hindfoot when the foot is loaded. MLA height is the most important measurement for determining the degree of pes planus.[1] Staheli classified pes planus into physiological and pathological types. Physiological pes planus, also known as flexible pes planus, is a common and benign condition characterized by collapse of the arch due to ligamentous laxity. In pes planus, the head of the talus is displaced medially and plantar side relative to the navicular.[2] This displacement stretches the arcuate tendon of the tibialis posterior muscle, leading to a reduction in MLA height.

Structural or functional deterioration, or complete loss of the MLA, reduces the foot's ability to absorb ground reaction forces, decreases its effectiveness in maintaining balance, causes difficulty in walking, and leads to reduced muscle endurance.[3] Decreased MLA height disrupts balance and subjects the muscles and bones responsible for counteracting external forces to greater stress, further impairing balance.[4] Structural deformities in the foot can alter sensory input to higher centers, causing problems in the foot, ankle, and other joints of the lower extremity. During walking, these deformities may lead to impaired balance, early fatigue, and muscle soreness as the intrinsic and extrinsic muscles work harder to compensate for deficits in foot stability.[5]

Conservative treatment is the first-line approach for pes planus, including activity modifications, exercises, manipulations, serial casting, weight loss, shoe changes and modifications, and foot orthoses. Several methods are used to strengthen the intrinsic muscles of the foot, such as towel curls, picking up objects, shin curls, unilateral balance activities, and the short foot exercise (SFE)[6,7] SFE is prescribed in sports and rehabilitation settings to strengthen the intrinsic muscles, address claw toe and hammer toe deformities, and improve body stability during walking.[8] The exercise involves drawing the metatarsal heads toward the heel while keeping the long toe flexors relaxed.[8] Strengthening the abductor muscles has also been shown to play a role in controlling excessive pronation during walking.[9,10]

Arch-support insoles have been shown to improve foot malalignment, correct dynamic posture, support leg alignment, reduce pain, and normalize gait.[11] Silicone insoles have gained popularity in recent years. Their soft and flexible structure conforms to the shape of the foot without significantly altering pressure distribution. They have high resistance to compressive forces, are effective in shock absorption, and are low-cost. Their softness and thin profile make them easily accepted by participants, provide notable sensory advantages, and allow for easy placement and use inside shoes.[12]

Flexible pes planus, which are common among young individuals, is thought to negatively affect balance, resulting in subtle instabilities and altered balance strategies. In such cases, intrinsic muscle training is of great importance. Moreover, the sensory advantages and shock absorption capacity provided by silicone insoles may yield additional benefits for balance and functional performance when combined with intrinsic muscle strengthening and dynamic balance exercises. The primary hypothesis of this study was that combining silicone insoles with intrinsic foot muscle strengthening exercises or dynamic balance training would yield greater improvements in MLA, Foot posture index (FPI), and balance parameters compared to using silicone insoles alone. A secondary hypothesis was that silicone insoles alone would primarily benefit static balance, with limited effects on dynamic parameters. Therefore, the aim of this study was to investigate the effects of intrinsic muscle strengthening and dynamic balance exercises performed in combination with silicone insoles on foot posture, balance, and functional performance in individuals with flexible pes planus.

METHODS

Ethical considerations

Ethical approval for our study was obtained from the Clinical Research Clinical Research Ethics Committee of the authors affiliated institutions (19.03.21) and study conducted between 1.07.22-1.06.23. Written informed consent was obtained from all participants, and our study was conducted in accordance with the Declaration of Helsinki. This study was conducted in the Faculty of Health Sciences, in the laboratory of the Department of Physical Therapy and Rehabilitation. This manuscript was prepared in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Sample size and randomization

The sample size was calculated using the G-Power program. In the power analysis performed considering the mean values of the sample study, it was calculated that a total of 45 participants should be included in the study, with an effect size of 0.84 at a significance level of p 0.001 and a power of 95%.[13] Participants were randomly closed envelopes divided into three groups (1-15 numbers: Group 1, 16-31 numbers: Group 2, 32-47 numbers: Group 3). Each group consists of 15 participants.

Study design and participants

Participants were included in the study if participants having pes planus were 131° below the MLA, participants with flexible pes planus according to Jack's test (or Hubscher maneuver), between 18 and 35 years of age, and had not received previous treatment for pes planus.[14] Participants who had previously used orthotics, BMI >25, having leg length discrepancy, had an orthopedic injury to the lower extremity, and who did not wish to participate in the study were excluded from the study.[14]

Outcomes

Sociodemographic characteristics of participants participating in the study were evaluated using the Case Report Form.

Primary outcome

Foot posture was analyzed using the FPI. Participants stand in a relaxed position. Palpation of the head of the talus in the hindfoot, inclination below and above the lateral malleolus, pronation/supination of the calcaneus, ballooning at the talonavicular joint in the forefoot, MLA structure, and abduction/adduction of the forefoot relative to the hindfoot were evaluated. The total score obtained was recorded. The total score ranges from −12 to +12. According to this scoring system, a score between −12 and −5 indicates severe supination, −4 to −1 indicates mild supination, 0 to +5 is considered neutral foot posture, +6 to +9 indicates mild pronation, and +10 to +12 indicates severe pronation. The FPI-6 allows clinicians to determine whether the foot posture is more supinated or pronated and serves as an objective reference in treatment planning. [15,16]

Secondary outcomes

Measurement of the subtalar angle between the Achilles tendon and the midpoint of the calcaneus was measured while the participant stood on a high platform. The pivot point was assumed to be 1 cm below the medial malleolus, and this area was marked. An angle greater than 5 degrees in the pronation or supination direction was considered abnormal.[17]

Navicular Drop Test (Nd) is that the difference was calculated by measuring the distance between the navicula and the ground under two different conditions, weighted and unweighted. A difference greater than 1 cm was interpreted as medial longitudinal arch height approaching the ground more than normal, and it was assumed that the amount of pronation increased.[18] A navicular drops greater than 10 mm are typically considered indicative of excessive pronation and a reduction in medial arch height. This cut-off value, originally described by Brody, has been widely adopted in subsequent studies and clinical practice as a threshold to distinguish between normal and pathological foot pronation.[19]

The MLA angle is a measurement used to assess the height of the foot arch. During the measurement, the participant stand barefoot in a natural, upright position with body weight evenly distributed on both feet. The medial (inner) side of the foot is positioned to face the examiner. Three anatomical landmarks were marked: the medial malleolus (the bony prominence on the inside of the ankle), the navicular tuberosity (the most prominent point along the inner arch), and the first metatarsal head (the bony prominence at the base of the big toe). A line was drawn from the medial malleolus to the navicular tuberosity, and another line from the navicular tuberosity to the first metatarsal head. The angle formed at the navicular tuberosity by these two lines is recorded as the MLA angle. The measurement was taken directly with a goniometer.[20]

Static balance was assessed using the flamingo balance test. Before the test, the participant assumed the correct position to lift the selected foot on the balance material and maintain his balance. Each time the participant lost balance (touching the floor, releasing the foot), the stopwatch was stopped and restarted when the participant was ready 60 seconds. The total number of balance losses during this period was reported.[21]

Dynamic balance was assessed using the BOBO Gaming Health Platform®. With this system, which acts as a computerized power platform, evaluation and gradual treatment stages were applied. Evaluation was done on two legs with eyes open. Participants were asked to complete the games available on the platform. It offers dynamic balance training through a game module with 14 different difficulty levels. During the test, balance scores (%), stability durations, and the number of losses is recorded. The percentage values are determined based on the dynamic game scores. Although there are no established cut-off values yet, median scores have been used as reference points. In the Two-Leg Standing Test (TLST), an average score of approximately 21% is considered moderate-to-good, whereas scores approaching 100% in tests like the One-Leg Standing Test (OLST) indicate high stability. (https://www.bobo-balance.com/how-it-works)

Intervention

In addition to silicone insoles, the first group received intrinsic foot muscle strengthening training. In this group, includes strengthening exercises consisting of 7 basic exercises that we had prepared for the SFE were performed on our participants.[22] SFE program were performed according to the methods of Prentice and Kaminski.[17] Within the exercise protocol implemented in this study, SFE targeted the intrinsic foot muscles, which are classified as active components of the foot core system. These exercises contribute to enhancing neuromuscular control of the foot and ankle. Considering that increased pronation may cause shortening of the gastrocnemius muscle, stretching this muscle was intended to improve its functional performance. To facilitate learning how to elevate the medial longitudinal arch and to strengthen the intrinsic foot muscles, the short foot exercise was performed. Participants were instructed to perform the exercise in a seated position without weight-bearing for the first two weeks, and then in an upright standing position for the subsequent six weeks. Participants were instructed to shorten their foot in an anterior-posterior direction while actively attempting to bring the head of the first metatarsal to the heel without curling the toes. A stability trainer (Thera-Band, USA, blue) was used to ensure adequate ground friction and avoid slipping during the performance of the SFE. According to the principle of progressive overload, the intensity of the exercise was divided into 2 levels. In weeks 1-4, the SFE was performed in a sitting position and then in a standing position in weeks 5-8. The performance of the SFE in sitting was based on previously published methods: seated position with both feet on the stability trainer, keeping the hips, knees, and ankles in 90º of flexion to stabilize the body. In weeks 5-8, the SFE was performed in a one-legged standing position on the stability trainer to provide resistance from body weight. In both seated and standing positions, the SFE was held for 5 s, with 12 repetitions forming 1 block, and 3 blocks completed per training session, with a 2-min rest period between blocks. Three sets were performed 3 times a week. The second group was treated under the supervision of a physiotherapist for 30 minutes, 3 days a week, with the 'BOBO Play Health Platform® ' which, in addition to the silicone insoles. The 'BOBO Gaming Health Platform®' was used with 8 different weight bearing games in the directions A-P, M-L by grading the difficulty level.18 The total duration of treatment was 8 weeks/3 days per week (24 sessions). The third group used only silicone insoles. The silicone insoles were prefabricated, non–custom-made devices and were selected solely according to participants' shoe size, without individual biomechanical modification. The insoles were manufactured from medical-grade silicone material, providing shock absorption and flexible support to the plantar surface of the foot. No additional corrective elements, such as medial arch wedges or posting, were incorporated. The primary aim of the silicone insole intervention was to provide passive support to the medial longitudinal arch and enhance plantar load distribution during daily activities, rather than to actively modify foot biomechanics through therapeutic exercises. Participants were instructed to place the silicone insoles inside their regular daily footwear and to use them consistently

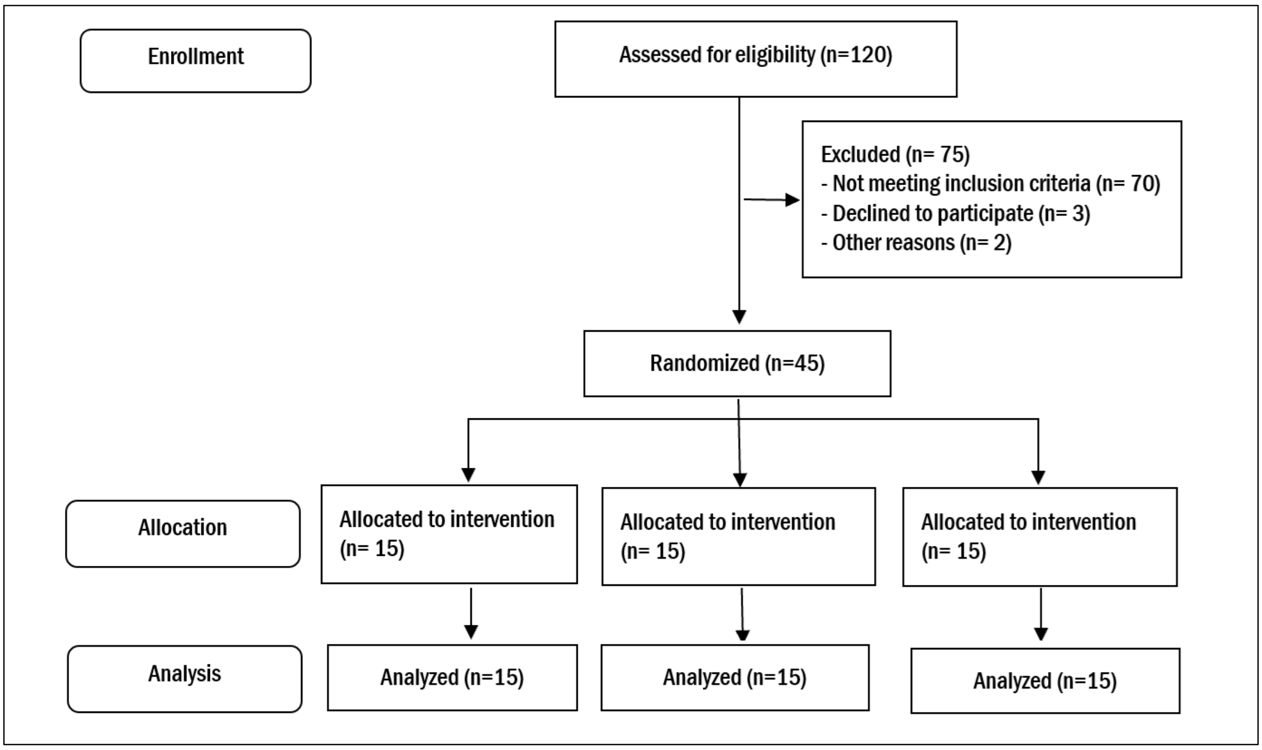

Figure 1. Study flowchart.

throughout the entire study period during all weight-bearing activities. No restrictions were imposed on walking distance or daily activity level. Compliance with insole use was monitored through participant self-reports during follow-up visits.[23] All measurements taken barefoot.

Statistical analysis

Statistical Package for Social Sciences (SPSS) Version 24.0 (SPSS inc., Chicago, IL, USA) was used for statistical analysis, and $p<0.05$ was considered statistically significant in all analyses. Whether the data were suitable for normal distribution was determined by Kolmogorov Smirnov. For all variables, between-group comparisons among the three groups were performed using the Kruskal–Wallis test. Within-group pre- and post-treatment differences were assessed using the Mann Whitney U test. Changes were also analyzed between groups using the Kruskal–Wallis test. Continuous variables were reported as mean±standard deviation. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 120 participants were screened for eligibility and after excluding 75 participants, because it did not meet the inclusion criteria, 45 participants were enrolled in the study. 15 participants were randomized to the strength exercises arm, 15 participants were randomized to balance exercise arms, and 15 participants were randomized to only using insoles arm. Thus, a total of 45 participants completed 8 weeks of follow-up. The participant's disposition has been depicted in Fig. 1. ($p > 0.05$)

The baseline demographic characteristics (age, gender, BMI) and assessment results (MLA-Subtalar Angle-Navicular Drop Test, Static Balance, Dynamic Balance) of the groups are shown in Table 1. There was no statistical difference between groups in terms of baseline assessments ($p > 0.05$).

According to the results, after the treatment in the study, a significant difference was found between the angles of the MLA between the groups (Table 2), navicular drop score, and static balance parameters improved all groups. FPI score, subtalar angle and dynamic balance improved Group 1 and Group 2 ($p \leq 0.05$).

The difference in changes between groups is shown in Table 3. The change in MLA in Group 1 was recorded as statistically significant ($p<0.05$).

DISCUSSION

The primary hypothesis of this study was that combining silicone insoles with intrinsic foot muscle strengthening exercises or dynamic balance training would yield greater improvements in MLA angle, FPI, and balance parameters compared to using silicone insoles alone. A secondary hypothesis was that silicone insoles alone would primarily benefit static balance, with limited effects on dynamic parameters. The results supported the primary hypothesis; Group 1 (silicone insoles + short foot exercises) demonstrated the greatest improvements in MLA angle, FPI, subtalar angle, and both static and dynamic balance. Group 2 (silicone insoles + dynamic balance training) also improved in FPI, subtalar angle, and dynamic balance, albeit to a lesser extent in MLA compared to Group 1. In contrast, Group 3 (silicone insoles alone) showed improvements only in navicular drop test scores and static balance, without significant changes in dynamic balance or MLA. These findings suggest that active interventions combined with silicone insoles are superior to passive insole use alone for enhancing both foot posture and functional stability in individuals with flexible pes planus.

Nielsen et al. examined the effectiveness of nonsurgical treatment approaches in 64 adult participants with flatfoot deformity.[14] They retrospectively evaluated participants treated over a 27-month period with methods such as taking anti-inflammatory medications, physical therapy approaches, and using orthotics. Approximately 87.5% of the participants achieved success with physical therapy approaches, and using orthotics. Our study investigated the efficacy of nonsurgical orthotics and exercise applications in a similar group of participants. Unlike Nielsen et al., our participants did not present with pain-related symptoms; therefore, treatment effectiveness in the present study was evaluated primarily through changes in foot posture and balance parameters rather than pain-related outcomes.

A systematic review and meta-analysis conducted by Cheng et al. reported no significant difference in navicular drop test and foot posture index improvements when SFE were compared with control groups. The analysis indicated that only SFE programs lasting longer than six weeks resulted in significant improvement in the navicular drop test, which is consistent with the exercise duration in our study. Unlike existing clinical randomized controlled trials, this meta-analysis does not provide definitive evidence that SFE are fully effective in improving navicular drop test in participants with pes planus. It also emphasized the need for larger sample sizes to clearly determine the effects of SFE on pes planus. In contrast, our study demonstrated significant within-group improvements.[20]

Unver et al. showed that 6 weeks SFE provided a reduction in navicular drop, foot pronation, foot pain, and disability and increment in plantar force of medial midfoot in pes planus.[16] Rothermel et al. claim that the SFE is performed by having the participant elevate the MLA and, in a partial (seated position) or a full weight-bearing (double-leg and single-leg stance) position.[24] Also, SFE may contribute more benefits than other interventions as it affects flatfoot participants' foot alignment. Hence, the SFE is recommended as a beneficial dynamic support when facing flatfoot problems.[25] Parallel to literature, insoles might keep the MLA in the proper shape, which would probably lessen aberrant strains. It would not, however, increase muscle activity. By augmenting muscular support for foot structures and boosting proprioceptive feedback, strengthening foot muscles may help further break the link. As a result, intervention strategies that combine passive and active methods may be superior.[26] In our study showed that SFE elevated the MLA.

In another study, Kulig et al. investigated the effectiveness of using orthotics and resistance exercises in participants with tibialis posterior tendinopathy.[27] They randomly assigned 36 participants diagnosed with stage 1 and 2 tendinopathy into 3 groups. The 1st group was treated with orthotics and stretching

Table 1. Baseline assessments.

	Insole+Exercise (N=15)	Insole+BOBO (N=15)	Insole (N=15)	P
	Mean±SD	Mean±SD	Mean±SD	p
Age (year)	20.33±0.72	19.93±1.03	19.93±0.45	0.086
Gender (Women/Men) (n)	7/8	8/7	8/7	0.917
Body Mass Index (kg/m^2)	24.04±4.31	22.66±4.02	21.74+2.52	0.263
Medial longitudinal arc (º)	125.00±4.44	125.67±5.50	125.67±5.50	0.904
Foot Posture Index (FPI)	6.47±0.83	6.53±0.83	7.00±1.34	0.253
Subtalar angle (˚)	8.47±2.41	7.80±3.02	6.47±2.74	0.167
Navicular Drop Test (cm)	1.00±0.36	1.18±1.12	1.12±0.31	0.277
Static Balance (n)	6.00±1.73	6.80±1.42	7.20±2.45	0.243
Dynamic Balance (%)	25.93±9.85	30.60±11.72	29.40±13.56	0.619

Table 2. Comparisons between groups after treatment.

		Before Treatment	After Treatment	
	Groups	Mean±SD	Mean±SD	p
Medial longitudinal arc (º)	Insole+Exercise	126.67±5.55	138.33±7.92	<0.001
	Insole+BOBO	127.33±5.12	125.80±5.68	0.482
	Insole	125.67±4.90	125.33±4.37	0.563
Foot Posture Index	Insole+Exercise	6.47±0.83	2.53±1.50	0.001*
	Insole+BOBO	6.53±0.83	5.33±0.61	0.001*
	Insole	7.00±1.34	6.40±1.29	0.058
Subtalar angle (˚)	Insole+Exercise	8.47±2.41	6.33±1.87	0.003*
	Insole+BOBO	7.80±3.02	6.33±2.71	0.004*
	Insole	6.47±2.74	5.20±1.42	0.058
Navikular Drop Test (cm)	Insole+Exercise	1.00±0.36	0.58±0.24	0.001*
	Insole+BOBO	1.18±1.12	0.42±0.25	0.001*
	Insole	1.12±0.31	0.50±0.42	0.002*
Static balance (n)	Insole+Exercise	6.00±1.73	4.67±1.34	0.003*
	Insole+BOBO	6.80±1.42	3.93±1.33	0.001*
	Insole	7.20±2.45	4.93±1.43	0.004*
Dynamic balance (%)	Insole+Exercise	25.93±9.85	35.36±8.38	0.004*
	Insole+BOBO	30.60±11.72	37.66±9.39	0.014*
	Insole	29.40±13.56	32.06±7.75	0.329

*p<0.05.

Table 3. Comparison of group differences in pre- and post- 8-week treatment change scores (Δ).

	Insole+Exercise	Insole+BOBO	Insole	
	Mean±SD	Mean±SD	Mean±SD	p
Medial longitudinal arc (º)	13.33±7.52	0.13±1.13	0.07±0.46	<0.001
Foot Posture Index	-2.53±1.50	-1.20±0.56	-0.60±1.21	<0.001
Subtalar angle (˚)	-2.13±1.80	-1.46±1.45	-1.26±2.08	0.303
Navicular Drop Test (cm)	-0.42±0.29	-0.76±1.26	-0.62±0.39	0.235
Static balance (n)	-1.33±1.17	-2.86±1.59	-2.26±2.15	0.058
Dynamic balance (%)	9.33±10.12	7.06±8.85	2.66±9.23	0.094

exercises, the 2nd group was treated with orthotics, stretching exercises, and concentric progressive resistance exercises, and the 3rd group was treated with orthotics and stretching exercises. Participants were assessed before and after treatment with the foot function index and the 5-minute walk test. At the end of treatment, although improvement in foot function index was noted in all groups, the greatest improvement was seen in the 3rd group. Although our rating scales were different, the degrees of improvement in the groups we treated were similar on our outcome measures. Data obtained from two studies show that the use of specific exercise programs in addition to the use of orthotics for various foot problems increases the effectiveness of treatment. It should be noted that the insoles used in the present study were prefabricated silicone insoles, which differ from custom-made or rigid orthoses used in previous studies. Therefore, differences in material properties and corrective mechanisms should be considered when interpreting comparative outcomes.

Balance is the ability to control the body against the body's center of gravity changes in static and dynamic positions with minimal muscle activity. In this respect, maintaining balance and keeping center of gravity on the support surface is provided by coordination between appropriate neural mechanisms and the musculoskeletal system. The ankle strategy has an essential place in maintaining balance. The ankle strategy maintains ground balance by shifting the center of gravity around the ankle more slowly. Therefore, ankle muscle strength is important for maintaining balance.[28] In participants with pes planus, in addition to the inequality in the load distribution caused by the collapse of the medial arch support, the weakness of the muscle, tendon, and ligament structures, accompanied by biomechanical disorders, causes rapid fatigue and balance disorders in participants. As a result, the duration of participants with pes planus staying in balance decreases, and balance parameters are negatively affected. Telfer et al. reported in their study that changes in MLA negatively affected balance and walking ability.[29] Vadivelan reported that the dynamic balance ability of children with pes planus who received stretching and strengthening exercises and kinesiology taping for 4 weeks improved significantly compared to the group who did not.[13] Kim et al. studied the effects of insoles with different properties on static balance and found that participants with pes planus had poor static balance performance. However, the type and material of the insole may influence balance outcomes, and this should be considered when comparing results across studies.[4] Kim et al. found that the better one-foot balance of the athletes without pes planus coincides with the information in the literature that balance ability is poorer in participants with pes planus. In our study, we showed that the silicone insole does not affect the dynamic balance, but only the static balance. If SFEs or dynamic exercise can be added, we think that dynamic and static balance are positively affected as it improves the intrinsic muscles and MLA. Although silicone insoles alone did not lead to improvements in dynamic balance or MLA angle, they resulted in significant improvements in navicular drop and static balance. This suggests that silicone insoles may provide sufficient passive medial arch support to influence static postural alignment, while being insufficient to induce neuromuscular adaptations required for dynamic balance.

Limitations

This study has several limitations. Since the participants were young adults with flexible pes planus, the findings cannot be generalized to participants across different age groups. Additionally, the study did not account for cases in which participants exhibited uneven weight distribution between the feet due to variations in foot arch structure or the presence of pain. To address these limitations, future research should include participants from a broader range of age groups and clinical conditions.

Conclusion

This study demonstrated that the combination of short foot exercises and silicone insoles provided significant improvements in MLA angle, FPI, and dynamic balance in individuals with flexible pes planus. Within the scope of this 8-week intervention, the use of silicone insoles alone did not result in statistically significant improvements in most foot posture or dynamic balance parameters; however, when combined with strengthening or balance exercises, greater functional gains were observed. Long-term effects of insole use alone require further investigation.

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Conflicts of Interest: *None*

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