Effect of Osteopathy Techniques on Flexible Pes Planus-Induced Foot Pain in Overweight and Obese Individuals

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ABSTRACT

Background: The prevalence of flexible flat foot, particularly among overweight and obese individuals, presents a significant challenge due to associated foot pain and compromised mobility. Flexible flat foot refers to a condition characterized by the partial or total collapse of the medial longitudinal arch of the foot during weight-bearing activities, leading to altered biomechanics and increased strain on supporting structures. This condition often results in discomfort, pain, and limitations in physical activity, significantly impacting the quality of life of affected individuals. This study aims to evaluate the effect of osteopathy techniques on reducing foot pain in overweight individuals.

Methodology: A pre-and post-single-group experimental design was employed to compare the outcomes of osteopathic treatment before and after the intervention. 42 participants with flexible flat foot-induced foot pain were recruited in the study based on inclusion and exclusion criteria using a convenient sampling technique. A total of 3 Osteopathic sessions were administered at a one-week interval. Pre-test & post-test values were measured using the Visual Analog Scale (VAS), the Navicular Drop Test (NDT), and the Foot Function Index (FFI).

Results: Statistically significant ($p < 0.001$) improvement was observed in Flexible flat foot-induced foot pain in overweight and obese individuals.

Conclusion: This study's findings highlight the promising role of Osteopathic Techniques in alleviating foot pain associated with flexible flat feet in overweight/obese individuals. Through soft tissue techniques, Osteopathic Techniques offer a viable therapeutic approach for enhancing foot function and reducing pain in this population.

Keywords: Flexible pes planus, foot pain, Obese, Osteopathy

1. INTRODUCTION

Flexible pes planus is a condition that advances over time and is commonly observed in children and adults.[1] The prevailing cause of progressive flexible pes planus is attributed to ligamentous laxity [2] and dysfunction of muscular structures, exceptionally prolonged insufficiency of the tibialis posterior muscle as highlighted by Kulig, Lee, Reischi, & Noceti-DeWit in 2014.[3]

Advanced flexible pes planus alters the lower extremity movement patterns, including excessive calcaneal eversion and internal tibial rotation.[4] These changes result in pain in the anterior leg, foot arch, and navicular tuberosity due to repetitive use of the tibialis anterior and posterior muscles.[2]

Obesity and being overweight result from an energy discrepancy between what we consume and expend, Excess adipose tissue can lead to pathological fat storage. Adult-onset overweight often results from incorrect eating patterns, a sedentary lifestyle, and other external factors. Additionally, during developmental years, certain foot dimorphisms, mainly flat feet, may be associated with obesity and overweight.[5]

The occurrence of flat feet in adults has been documented to range between 13.6% to 26.62%.[6] [7] The accompanying deformities associated with flat feet can result in pain, instability, uneven pressure distribution on the soles, walking difficulties, and foot fatigue. [8] These effects can significantly impact daily activities, leading to reduced walking speed, shorter strides, decreased cadence, and prolonged stance duration [9], ultimately diminishing functionality and overall quality of life. [7][8][9]

In cases of flexible pes planus, the navicular drop tends to be larger than the rigid pes planus. This is because individuals with flexible pes planus exhibit a normal arch when sitting, whereas those with rigid pes planus lack the arch in both standing and sitting positions.[2]

Flatfoot is problematic only when symptomatic, causing pain along the posterior tibial tendon, sometimes with swelling. Pain may also arise from issues with the spring ligament, bone or joint abnormalities, or misalignment, leading to irritation and pressure points.[10]

The foot is composed of seven tarsal bones, four metatarsals, and 14 phalanges, designed to provide both flexibility for adapting to uneven surfaces and rigidity for efficient propulsion during movement. Key ligaments supporting the arch around the navicular bone include the superomedial and inferomedial calcaneonavicular, talocalcaneal interosseous, plantar naviculo-cuneiform, plantar first metatarso-cuneiform, and anterior superficial deltoid ligaments. These structures are essential for maintaining proper foot articulation and function.[11]

The navicular bone plays a pivotal role in advanced flexible flatfoot (pes planus), serving as central support for the medial longitudinal arch. This arch includes the calcaneus, talus, navicular, three cuneiform bones, and the first three metatarsals. Stabilization is aided by the tibialis posterior muscle and its tendon, which inserts into the navicular tuberosity.[12]

The tibialis posterior tendon is the primary active stabilizer of the medial arch, while the plantar aponeurosis on the underside of the foot is essential for maintaining arch firmness. Dysfunction of the plantar aponeurosis can reduce the arch and increase pressure under the metatarsal heads. Ligament laxity and tibialis posterior muscle insufficiency are major contributors to the progression of flexible flatfoot.[13][14]

Flexible pes planus alters lower extremity mechanics, leading to excessive heel rolling (calcaneal eversion) and tibial internal rotation. During walking, the subtalar joint normally pronates until the metatarsal heads contact the ground, allowing rigid propulsion through the windlass mechanism.[4] In flexible pes planus, ligament laxity or muscle weakness prevents full supination, causing prolonged pronation and tibial internal rotation. Over time, these gait deviations can contribute to various lower extremity pathologies.[15][16]

In flexible pes planus, reduced navicular height and tibial internal rotation strain the tibialis posterior, anterior muscles, and plantar aponeurosis. During the transition from sitting to standing, the tibialis anterior, posterior, and plantar aponeurosis activate significantly. [17] Early activation of these muscles is crucial for stabilizing the foot and aiding shin rotation at the ankle. [18] Prolonged stress can lead to tibialis anterior inflammation, foot arch discomfort, and pain at the medial navicular tuberosity. [16]

Flexible flat foot is a common condition marked by the loss of the medial longitudinal arch during weight-bearing, along with excessive foot pronation and eversion. Symptoms include foot pain, fatigue, and discomfort in the arch and heel, as well as lower limb fatigue, ankle instability, and altered gait mechanics due to compromised foot structure. This condition is linked to musculoskeletal issues like plantar fasciitis, Achilles tendinitis, and medial tibial stress syndrome, impacting quality of life and function. [19] Foot pain is often a dull ache in the arch, heel, or medial foot, worsened by prolonged weight-bearing or high-impact activities. The pain's etiology involves biomechanical abnormalities, soft tissue inflammation, and increased stress on the foot’s supportive structures. Management strategies, including orthotics, footwear modifications, strengthening exercises, and activity modification, aim to improve foot alignment, alleviate symptoms, and enhance function. [20]

Osteopathic techniques play a vital role in promoting tissue healing and adaptation in the foot by leveraging the body's natural physiological mechanisms. [21] A key component of this process is improving circulation, which ensures efficient oxygen and nutrient delivery to tissues while aiding in the removal of waste products and toxins. [22] Techniques such as massage and joint mobilization enhance blood flow to injured tissues, supporting cellular metabolism and repair. [22]

By optimizing the function of blood vessels and capillaries, osteopathic treatments ensure an adequate supply of essential nutrients like proteins, vitamins, and minerals, which are critical for tissue repair and regeneration. [22, 23] These interventions expedite healing, alleviate inflammation, and facilitate tissue remodelling, involving the replacement of damaged tissue with new extracellular matrix components like collagen. [21, 24] As a result, injured foot tissues become more resilient, stronger, and better equipped to handle stress, leading to improved function and reduced pain over time. [24]

2. METHODOLOGY

This study utilized a pre- and post-single-group experimental design to assess the effects of an intervention. This design enables within-subject comparisons, ideal for evaluating outcomes in a homogeneous group, such as young adults with overweight or obesity and flexible pes planus-induced foot pain. Measuring outcomes before and after the intervention provided insights into its effectiveness.

A convenience sample of 42 participants was calculated using G*power software. After 6 participants dropped out, the final sample size was 36. Participants were recruited from Sri Sri University, Cuttack, Odisha.

The study was approved by the institutional ethical committee. All the methods were followed as per the ethical code of Helsinki.

2.1 Inclusion Criteria

1. Young adults aged 18–25 years.
2. Reported discomfort or pain during rest, standing, walking, or running.
3. Positive Jack Test.

4. Positive Tip Toe Standing Test.
5. Navicular Drop Test showing >10 mm difference between sitting and standing.
6. BMI >25, indicating overweight or obesity

2.2 Exclusion Criteria

1. Congenital foot malformations.
2. History of structural/systemic pathologies (e.g., fractures, gout, diabetic neuropathies).
3. Use of pain medication during the study.
4. Ongoing physical therapy for lower limb or spine conditions.
5. Bone infections or other infectious foot conditions.
6. Osteoporosis or rigid pes planus.
7. Use of corrective footwear or orthopedic foot conditions (e.g., plantar fasciitis)

2.3 Instrumentation

A weighing machine, pencil, measuring tape, treatment table, stool, plain paper, and a 15 cm ruler were used for the study. The Navicular Drop Test (NDT) was employed for assessment.

2.4 Independent Variable

1. Osteopathic Manipulative Treatment (OMT)

2.5 Dependent Variable

1. Visual Analogue Scale (VAS)
2. Navicular Drop Test (NDT)
3. Foot Function Index (FFI)

2.6 Treatment Protocol

A total of 42 participants meeting the criteria were recruited from the Osteopathy Department of Sri Sri University. Written informed consent was obtained. Participants underwent three OMT sessions over three weeks, with pre-and post-intervention scores recorded for VAS, FFI, and NDT.

2.7 Treatment Procedure

The study was approved by the Institutional Review Board of Sri Sri University. Participants were briefed about the procedure and provided written consent. Of the initial 42 participants, 6 dropped out (3 due to time constraints, 2 due to distance, and 1 for personal reasons).

2.8 Intervention Protocol

1. Plantar Fascia Release [25]
2. Longitudinal Arch Spring [25]
3. Peroneus Longus Tender Point Release [25]
4. Tibialis Anterior Tender Point Release [25]
5. Knee Muscle Energy Technique [26]
6. Hip Muscle Energy Technique [26]
7. Iliopsoas Muscle Energy Technique [26]
8. Occiput Palpation of Primary Respiration [27]

2.9 Outcome Measures

Visual Analogue Scale (VAS)

- A validated tool for quantifying pain intensity, marked on a 10 cm horizontal line ranging from "no pain" to "worst possible pain." Reliable (internal consistency: 0.81–0.94, test-retest: 0.77) and valid for diverse clinical settings. [28][29]

Foot Function Index (FFI)

- A questionnaire with three subscales (pain, disability, activity limitation) using Likert scales. Reliable (internal consistency: 0.73–0.96, test-retest: 0.69–0.87) and valid for assessing foot function in musculoskeletal conditions. [30] [31] [32]

Navicular Drop Test (NDT)

- Quantifies medial arch collapse using the difference in navicular height between neutral and weight-bearing positions. Reliable and valid for assessing foot biomechanics in conditions like pes planus. [33][34][35]

3. RESULTS

3.1 Demographic details of Study Participants:

The mean age of the participants is 21.19 ± 1.50, the mean height is 171.4 ± 5.6, and the mean weight is 82.5 ± 19.95. (Table 1)

3.2 Comparison of Pre- and Post-intervention scores:

The comparison of pre-intervention scores (mean 6.81 ± 1.34) and post-intervention scores (mean 4.17 ± 1.0) of the Visual Analogue Scale showed a significant difference. ($p < 0.001$).

The comparison of pre-intervention scores (mean 28.1 ± 7.15) and post-intervention scores (mean 23.82 ± 6.58) of the Foot Function Index showed a significant difference. ($p < 0.001$).

The comparison of pre-intervention scores (mean 1.3 ± 0.16) and post-intervention scores (mean 1.1 ± 0.14) of the Navicular Drop Test right foot showed a significant difference. ($p < 0.001$).

The comparison of pre-intervention scores (mean 1.3 ± 0.19) and post-intervention scores (mean 1.0 ± 0.16) of the Navicular Drop Test left foot showed a significant difference. ($p < 0.001$). (Table 2)

Table 1: Demographics details of study participants

	n	Mean	SD
Age	36	21.19	1.5
Height	36	171.4	5.6
Weight	36	82.5	19.9

Table 2: Comparison of Pre- and Post-intervention scores of Visual Analogue Scale (VAS), Foot Function Index (FFI), and Navicular Drop Test (NDT)

Variables	Scores		t-value	p-value
	Pre	Post		
Visual Analog Scale	6.81±1.34	4.17±1.02	15.546	<0.001
Foot Function Index	28.1±7.15	23.82±6.58	11.602	<0.001
Navicular Drop Test right	1.3±0.16	1.1±0.14	9.035	<0.001
Navicular Drop Test left	1.3±0.19	1.0±0.16	11.009	<0.001

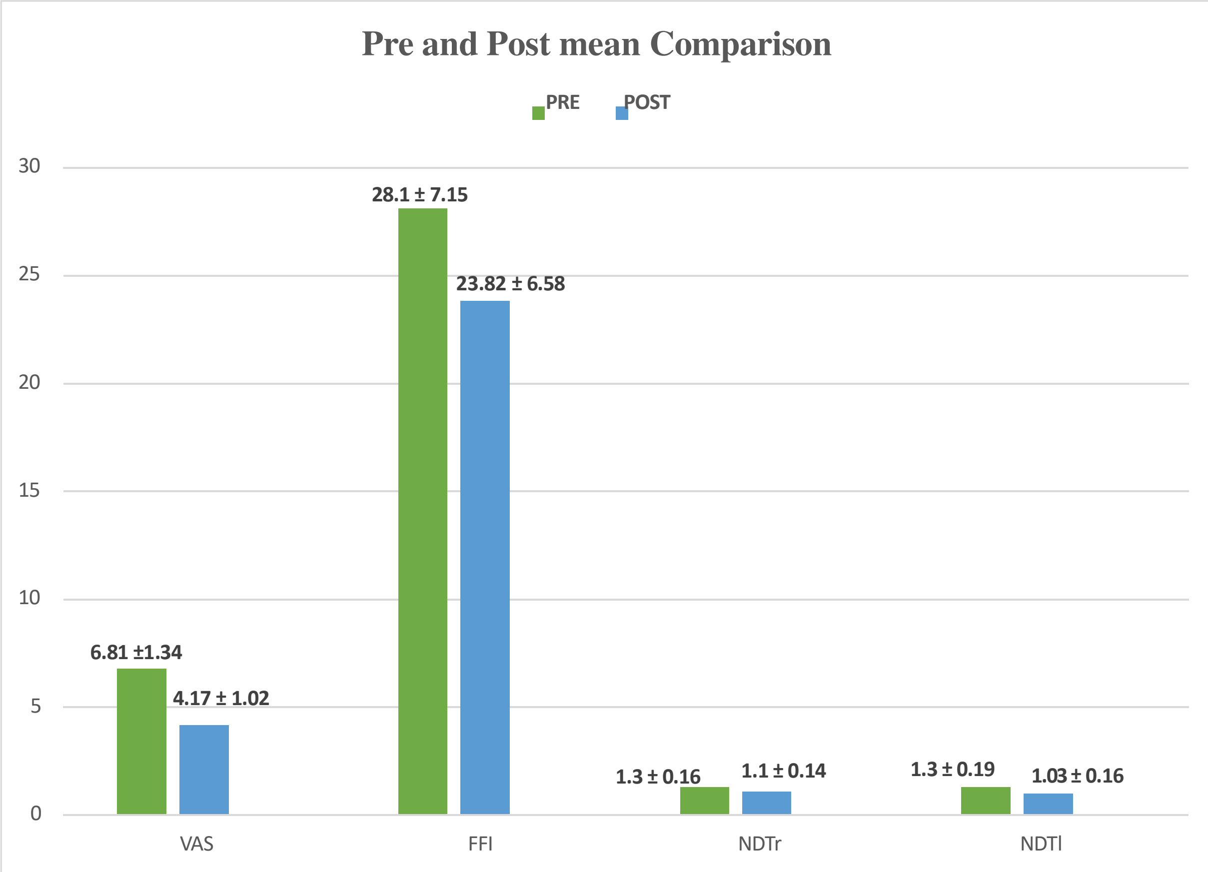

Figure 1: Comparison of Pre- and Post-intervention scores of Visual Analogue Scale (VAS), Foot Function Index (FFI), and Navicular Drop Test (NDT)

4. DISCUSSION

This study analyzed the efficacy of Osteopathic Manipulative Treatment (OMT) in 36 obese individuals with flexible flat foot-induced foot pain. A high retention rate (36 out of 42 participants) highlights the intervention's feasibility. Participants, with a mean age of 19 years and BMI of 27.93, reflected a population at risk due to rapid growth and increased weight.

Post-intervention comparisons showed significant improvements in pain (VAS), foot function (FFI), and arch support (Navicular Drop Test) scores ($p < 0.001$). These findings align with prior research affirming OMT's effectiveness in reducing foot pain and improving function.[10]

This study demonstrated significant pain reduction, exceeding the clinically meaningful threshold of 30%, as measured by the Visual Analogue Scale (VAS). These findings align with Younger, McCue, and Mackey's criteria for clinically significant pain relief, emphasizing the practical benefits of osteopathic techniques in managing foot pain in overweight/obese individuals with flexible flat feet.[36]

Soft tissue techniques, including massage, myofascial release, and tender point release, effectively reduced muscle tension, tightness, and adhesions, which are common in obese individuals due to altered foot biomechanics. Excess weight leads to increased strain, excessive pronation, reduced arch support, and heightened pressure on specific areas like the heel and forefoot. These factors often cause imbalances and myofascial restrictions in the tibialis anterior and posterior muscles. By promoting relaxation, breaking adhesions, and restoring mobility, the osteopathic interventions in this study significantly alleviated pain and enhanced overall foot function in this population.[23]

Working on the plantar fascia likely resulted in a reduction in the altered fascial tissue length, which could have, in turn, led to segmental pain modulation.[37] When pressure is applied and stretching is performed, the release technique for plantar fascia triggers the release of natural pain-relieving substances called endogenous opioids in the body. These opioids, akin to endorphins, enkephalins, and dynorphins, are activated, thereby acting as natural painkillers. They are bound to specific receptors in the spinal cord and brain, resulting in the blocking of pain signal transmission and, consequently, reducing the sensation of pain. Thus, the plantar fascia release technique assists in producing internal pain relief and alleviating foot discomfort.[37]

Only a few studies have explored the efficacy of Osteopathic Manipulative Treatment (OMT) for Flat foot-induced foot pain in non-obese individuals. So far, only one study by Kim

(2013) has addressed flat foot-induced foot pain osteopathically and found after plantar fascia release corroborates this study's results.[10] Osteopathic Manipulative Treatment (OMT) has demonstrated promise in managing other musculoskeletal conditions, such as plantar heel pain. Ajimsha et al. (2012) conducted a Randomized Control Trial (RCT) showcasing the effectiveness of myofascial release, a component of Osteopathic Manipulative Treatment (OMT), in reducing pain and enhancing function in individuals with plantar heel pain.[21] The Quality of Life decreases in individuals with flexible flat foot-induced foot pain.[10,21,38] This study used the Foot Function Index (FFI) to measure the quality of life. After giving the Osteopathic Manipulative Treatment (OMT), the Foot Function Index (FFI) scores decreased. The reduction of scores must have been due to the enhancement of circulation, which refers to the movement of blood throughout the body, delivering oxygen and nutrients to tissues while removing waste products and toxins. Osteopathic manipulative techniques, such as fascia release and joint mobilization, can help improve blood flow to the injured tissues in the foot. Increased circulation brings more oxygen and nutrients to the injury site, which are essential for cellular metabolism and tissue repair. [23,39]

By supporting these physiological processes, osteopathic techniques can accelerate tissue repair, reduce inflammation, and promote tissue remodeling in the foot. Tissue remodeling involves the removal of damaged or dead tissue and depositing new extracellular matrix components, such as collagen, to strengthen and repair the injured area. As a result, the injured tissues in the foot become stronger, more resilient, and better able to withstand stress and strain, leading to improved function and reduced pain over time.[39] Till now, we could not find any literature evaluation on the quality of life in flat foot-induced foot pain in obese individuals. The results of our study show that Osteopathic Manipulative Treatment (OMT) can be given in Flexible flat foot-induced foot pain in obese individuals to improve their quality of life. Functional Flat Foot can be measured by using the Navicular Drop Test (NDT). This study included participants with bilateral flat foot.

Following Osteopathic techniques like Fascia release, Longitudinal Arch, Knee Muscle Energy Technique (MET), Hip Muscle Energy Technique (MET), Iliopsoas Muscle Energy Technique (MET), and Occiput Primary Respiration Mechanism (PRM) technique, the internal rotation biomechanical chain would have reversed, allowing the plantar arch to redevelop, which must have led to decrease in the score of Navicular Drop Test (NDT) in left and right foot. Thereby causing a reduction in the Flexible flat foot-induced foot pain. A study by Kim (2014) showed that a Flexible Flat Foot causes an excessive calcaneal eversion and an internal rotation of the tibia. As a part of the compensation for tibial internal rotation, tibialis anterior muscles and plantar aponeurosis have to overwork. Due to this, the femur rotates internally, and the femoral head shifts posteriorly. Due to the shift of the femur, the pelvis rotates anteriorly, and due to the change of pelvic position anteriorly, the center of body mass moves anterior to the position. To achieve equilibrium of the postural balance, the thoracic spine extends, and the chest is fixed in an inhaled position. As a result of the endeavors to gain postural balance where the pelvis is tilted anteriorly in the sagittal plane, the iliopsoas muscle becomes tensed. Due to the attachment of the iliopsoas muscle at the lumbar spine, the tension in the iliopsoas muscle lets the lumbar spine shift anteriorly. Affecting the spine, this chain continues till the occiput and thus causes internal rotation dysfunction in the occiput. [10,40]

The study conducted by Kim (2013) indicated an improvement in the navicular drop test, although this improvement did not reach statistical significance. This lack of statistical significance could potentially be attributed to several factors, including the relatively small sample size and the limited duration of the treatment intervention. [10] Applying the Muscle Energy Technique (MET) on the knee induced post-isometric relaxation in its internal rotator muscles, including the Gracilis, Sartorius, Semimembranosus, and Semitendinosus muscles. This relaxation likely led to reversing the valgus knee alignment and subsequent lengthening of these muscles. The same mechanism likely occurred at the hip, leading to a reversal of the biomechanical chain. This suggests that post-isometric relaxation induced by the Muscle Energy Technique (MET) at the hip resulted in alterations in muscle length and tension similar to those observed at the knee. Consequently, this mechanism contributed to improving adaptations in the biomechanical chain caused by a collapsed arch, potentially resulting in decreased abnormal tension in the Tibialis Posterior Muscle, which supports the medial longitudinal arch. Ultimately, these effects may have led to an enhancement in the medial longitudinal arch structure.[41]

4.1 Limitations

Our study highlights the effectiveness of Osteopathic Manipulative Treatment (OMT) in alleviating foot pain caused by flexible flat feet in overweight and obese individuals. However, several limitations should be considered.

The small sample size (42 participants, with 6 dropouts) may limit the generalizability of our findings. The absence of a control group hinders the ability to establish a direct causal relationship between OMT and observed improvements. Reliance on self-reported measures, such as the Visual Analogue Scale (VAS) and Foot Function Index, introduces potential bias, emphasizing the need for objective assessments like gait analysis.

We also did not evaluate participants' footwear, which can significantly influence foot mechanics and pain. Additionally, the lack of long-term follow-up data restricts insights into the sustainability of OMT benefits over time. Finally, the applicability of our results may be constrained by the specific demographic and health profiles of the study population.

Future research should address these limitations through larger randomized controlled trials, objective outcome measures, long-term follow-ups, and diverse participant groups to strengthen the evidence supporting OMT in this context.

5. CONCLUSION

In conclusion, this study provides compelling evidence supporting the efficacy of OMT in managing foot pain associated with flexible flat feet in overweight/obese individuals. The findings underscore the feasibility and acceptability of OMT as an intervention in this population, with significant improvements observed in pain reduction, foot function, and biomechanical parameters following treatment. While these results are promising, it's important to acknowledge the study's limitations, including the relatively small sample size, absence of a control group, reliance on self-reported outcomes, lack of footwear assessment, and short-term follow-up. Addressing these limitations in future research endeavors will enhance the validity and generalizability of findings in this field. Overall, this study contributes valuable insights into the potential of OMT as a therapeutic approach for managing foot pain in overweight/obese individuals with flexible flat feet, highlighting the need for further research to explore its effectiveness in diverse populations and settings.

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