Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i4.5930

EFFECTS OF 8-WEEKS SYSTEMATIC CORRECTIVE EXERCISE PROGRAM ON BODY POSTURE AND STABILITY IN PRONATION DISTORTION SYNDROME

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ABSTRACT

Background: A postural entanglement in the lower extremitythat initiates with feet contorting to hyper-pronation, leading to other dysfunctional patterns, is known as pronation distortion syndrome. Exaggerated movement of feet causes forced progression of internal tibial rotation and knee adduction while disturbing body kinetics and gait mechanics.

Objective: The purpose of this study was to determine the effects of an 8-Weeks Systematic Corrective Exercise program on Body Posture and stability in Pronation Distortion Syndrome

Methodology: The study was a randomized controlled trial. It was administered at Riphah International University and Ibrahim Medical Centre Lahore. A convenience sampling technique was utilized to collect the data. A total of 38 subjects were enrolled in the study. All 38 participants were equally divided into two groups. Group A was treated with a conventional and systematic corrective exercise program. Group B underwent conventional treatment consisting of Non-biomechanical functional exercises only. All the participants underwent three sessions per week for 8 weeks.

Results: After eight weeks of intervention, the experimental group exhibited significant improvement regarding the Functional movement screening test, navicular drop and valgus ankle angle with p-value <0.001. Group A exhibited mean age of 21.72 ± 2.19 with a mean BMI of 19.08 ± 2.99kg/m2 as compared to the mean 22.16 ± 2.35 years for age and 21.32 ± 4.92kg/m2 BMI of group B. The post-treatment mean value of FMS was 20.33 ± 0.90; ND was 9.60 ± 1.12 with a p-value of <0.001,which declares significant improvement to group B.

Conclusion: This study trial concluded that based on all findings and results, participants responded considerably more significantly in the systematic corrective exercise program than the control group that received conventional treatment. On the contrary, Body posture factors lordosis and knock knees didn't show a sufficient reduction in any groups.

Keywords: Distortion, Exercise, Pronation, Posture, Navicular, functional

1. INTRODUCTION

A usual disruption of body mechanics due to a lower extremity disorder that mainly involves the anterior part of the leg is pronation distortion syndrome. This deformity characterizes the disturbance in anatomical factors making the talus head, and navicular bones move into more inward and downward orientation. This phenomenon alters the body's centre of gravity, forming flat feet. This alteration causes pain and disturbance in the foot's tarsal, proximal and distal parts [1]. Distortion in the lower extremity causes excessive foot pronation that causes the tibia to rotate inward, further accelerating thighs to move inward, resulting in knock knees (genu valgum). This ultimately leads to problems in the lumbopelvic region and causes increased lordosis and anterior pelvic tilt [2].

It is a condition that can be triggered by various reasons like joint laxity, neurological or muscular restrictions, ligament laxity and excessive motion [3]. It targets 10 to 25% of adults and, if ignored, can cause deformities reported to be 46 to 80% in both clinical and institutional situations [4]. The deformed structures are mostly the foot arch, lateral foot column, and forefoot. According to previous literature, other associated conditions may also arise, such as cuboid fracture, instability, stiffness and degenerative arthritis. These factors gradually result in poor functional outcomes and patient mobility [5].

Pronation distortion syndrome tends to convert in cuboid injuries when several factors have constantly progressed. The instability of metatarsal joints, ill-fitted orthotics and shoes, insufficient exercise recovery and disproportionate body weight are significant factors causing a disturbance in the overall lower extremity kinetic chain [6]. All these defects causing postural alterations result in subtalar joint pronation, forefoot inversion, and midtarsal joint unsteadiness,leading directly to improper dynamic stabilization. The process causes inter-joint miss-coordination and inadequate joint kinematics [7].

Individuals with flexible flat feet are likely to be at risk of developing pronation distortion syndrome. In pronation distortion syndrome, the victim faces collapsing of the longitudinal arch at the middle part of the foot, raising the tendency of supination and pronation. However, the restoration occurs after body weight removal [8]. Pronated feet disturb the kinematic coupling due to reprehensible walk pace technicalities and lead to irregular coordination, arbitrating joint angle from normal. This gradually disturbs joint synchronization,which usually determines mobility. As a result, the glutes suffer from under-activation with tight hip and ankle muscles [9].

In individuals with flexible flat feet, the subtalar joint remains in pronation even after loading response. The transverse tarsal joint doesn't lock and delays the next re-supination step. The delay causes extreme stress on plantar ligaments. In addition to the disturbance in hips, knees, and pelvis, FFF increases knee joint Q angle and erector spinae myoelectric activity. In the stance phase of walking, distortion causes a more significant peak plantar flexor ankle moment and inverter moment [10].

Deformations of feet are most of the time associated with injuries of the ankle and knee. In children and youth, pronation distortion syndrome has also given rise to valgus or plano-valgus feet deformity. Girls are prone to Kohler's disease, especially those with improper shoes. Among adults, Pain syndrome of the ankle joint can also appear because of permanent distortion. In some patients, swelling occurs on the back of the foot and the Achilles tendon. This may also sometimes cause the patients to limp or walk on their toes [11].

A healthy foot is essential for proper and good posture and ambulation. Tissue strain, acceleration of overuse injuries, poor functionality and disability in the lower limb are common issues which come as baggage with FFF, thus reducing the quality of life [12]. Growing children are more vulnerable to all the kinetic changes and disturbances than adults. Pronated feet will have a tight Achilles tendon that will further encourage the feet to roll inward. In this case, particular exercise regimes such as heel cord strengthening, golf ball roll, towel curl exercises and corrective programs could be beneficial [13].

In clinical practice, excessive pronation can be identified by navicular drop measurement, radiological study, and footprint analysis [14]. Certain factors like obesity, gender, body mass index, co-morbidity and foot size may contribute to pronation of feet. It has also been said that flat feet diminish with age after adjusting with other covariates. The application of corrective insoles remains debatable among researchers [15].
When a person is working, his or her body weight is supported by the feet, acting as a liver. Exaggerated foot pronation and ligamentous laxity occurring in the distal portion of lower extremitiescan be avoided by implementing closed chain kinetic exercises with the help of loads, thus increasing the strength and stability of lower limb proximal muscles. This study evaluated how eight weeks of systematic corrective exercises affect body posture and stability in people with pronation distortion syndrome.

2. MATERIALS AND METHODS

This single-blinded randomized control trial was approved by the ethical research committee of Riphah International University (REC/RCR & AHS/22/0132) registered under (IRCT #NCT05347186). The study was conducted at Riphah International University and Ibrahim Medical Center, Lahore. The study was completed in a duration of 10 months after approval from the ethical committee. A total of 38 participants by convenience sampling technique fulfilling the inclusion criteria were recruited into two groups by lottery method,with 19 participants in each group. The inclusion criteria for this RCT were participants aged 18 to 25 years, a Navicular drop test of more than 10mm and Recognizing flexible flat feet without any signs of pain. In contrast, participants with inbred anomalies such as clubfoot, common peroneal nerve injury, and any visible foot deformity were excluded from the study.

RANDOMIZATION

Once the aforementioned inclusion and exclusion criteria were taken into account, potential participants were considered. They were requested to participate in the study. Written informed consent was taken, and subjects were randomly assigned into two groups. Each participant was requested to draw a card from the box; the box was filled with 38 cards, of which 19 cards were marked with the number one and 19 were marked with the number 2. Participants who took a card with number one were allotted to Group A, and those who picked a card with number two were placed in Group B. Group A received Systematic corrective exercises and non-biomechanical functional exercises. In contrast, Group B received Non-biomechanical functional exercises.

2.1. Group A:

A. Systematic Corrective exercises for the experimental group

1. **Restraint exercise or self-release:** To release tension and tightness of the gastrocnemius muscle, soleus muscle, biceps femoris and IT band, a foam roller was used for 30 seconds.
2. **Static stretching drills**: The subject was asked to stretch his or her soleus, gastrocnemius and iliopsoas muscles to maximum limit without feeling any pain with a thera band or assistance from a therapist. Hold the stretch for 30 seconds.
3. **Resistance exercises**: To strengthen dorsiflexion, inversion and adduction of the knee, extension and external rotation of the hip, workout of extrinsic and intrinsic with the help of the thera band exercise band.
4. **Integrative exercises include the star balance test that assesse**s body posture and stability on all planes and resistive exercises. The experimental group was instructed to participate in the activity program one day after the pre-test (three sessions per week for two months). Initial warm-up for 10 minutes was advised restraint exercise for 10 minutes, stretching, strength, and integrative exercises for 35 minutes, and cool-down for 5 minutes [16].

B. Non-biomechanical Functional Exercises

2.2. Group B:
CONTROL GROUP
Non-biomechanical Functional exercises (NBF) consisted of Dorsal and plantar flexion of metatarsal phalangeal joints.

2.3. OUTCOME MEASURES
2.3.1. Functionalmovementscreentest.
To evaluate functional capacity and endurance FMS test is devised and used as a proper program. This test consists of 7 movement patterns for stability and mobility assessment. It comprises deep squat activity in which hips are below the height of knees, hurdle step that challenges proper stride mechanics, inline lunge to assess flexibility, shoulder mobility, active straight leg raise, trunk stability push up and rotatory stability. The FMS composite score's interrater test-retest and interrater reliability resulted in an ICC of 0.76[17].

2.3.2. Navicular drop
Clinically this test is required to evaluate a range of eversion of the foot and sagittal distortion of the midfoot. The subject was asked to sit on a chair with feet hanging wholly or loosely buoyant. The evaluator placed the individual's foot in neutral rotation. The examiner grabbed the inside of the ankle and rotated it internally and externally; this helped detect the distinction of the navicular bone. After this, the distance between the navicular bone stature and the floor was measured and considered. The subject was asked to stand upright to keep their feet grounded. Distance from the navicular bone to the floor is measured again. Both the values were determined and compared at the end, which measures the extent of the navicular bone [18].

2.3.3. Valgus angle by goniometer
The angle behind the ankle is called the valgus angle or hindfoot valgus angle; it is determined by drawing a line from the midline of the bottom third of the leg and the midline of the heel while the individual lies on his or her stomach. Following the procedure, the subject was asked to stand up,soa goniometer was used to measure the angle again. The normal angle is 180 degrees, and a value greater than nine is overpronation. The reliability for angle dorsiflexion is 0.12-0.73 ICC, and the validity is 0.51-0.83 [19].

DATA ANALYSIS
Data wereanalyzed using SPSS version 25. Tests for the Normality of data showed that Data was normallydistributed ($P>0.05$).Parametric tests were applied accordingly. In parametric tests, Independent t-tests and paired t-tests were applied across the group comparison and within the group comparison, respectively.

3. RESULTS
Based on inclusion and exclusion criteria, 56 participants were recruited in this study trial. A sample size of 38 patients was calculated via the EPITOOL sample size calculator. Thirty-eight subjects fulfilled the inclusion criteria, and the total sample of 38 participants was divided into treatment and control groups. Group A, the treatment group, received systematic corrective exercises and conventional treatment of non-biomechanical functional exercises (NBF). Group B performed non-biomechanical functional exercises. All participants received 24 sessions and threeweekly treatment sessions for two months (8 weeks). After a drop out of two participants, data of 36 participants were analyzed SPSS 25. Significant differences were monitored using an independent sample T-test across the group. Between the groups, a significant difference was assessed using Paired sample T-test.

Table 1 showed socio-demographic variables like Age, Weight, Height and BMI across two study groups. The treatment group participants' mean age was 21.72 ± 2.19 years compared to the control group's 22.16 ± 2.35 years. The participants' mean weight in the treatment group was 53.38 ± 7.30 kg compared to 54.05 ± 6.27 kg in the control group. The treatment group's mean height was 1.67 ± 0.11 m compared to 1.61 ±0.15 m in the control group. The mean BMI of participants in the treatment group was 19.08 ± 2.99kg/m2 compared to 21.32 ± 4.92kg/m2 in the control group.

Table 2 showswithin Group Comparison of FMS, Navicular Drop Test and Valgus angle of the ankle. Results showed that the mean pretreatment value of FMS in Group A was 17.33 ± 1.81; in group B, it was 18.27 ± 2. Similarly, the mean of post-treatment FMS in group A was 20.33 ± 0.90; in group B, it was 19.27 ± 1.84. The pretreatment mean of ND in group A was 10.75 ± 0.86, and the post-treatment mean was 9.60 ± 1.12. Similarly, the pretreatment mean of ND in group B was 11.23 ± 1.12 and the post-treatment mean was 10.10 ± 1.52 with a p-value of less than 0.000. The p-value demonstrated that ND was improved in both groups, but in Group A, the treatment group showed more improvement than the control group.The pretreatment mean of the valgus angle in group A was 10.45 ± 1.09, and the post-treatment mean was 8.66 ± 0.65. Similarly, the pretreatment mean of valgus angle in group B was 10.03 ± 1.27 and the post-treatment mean was 9.09 ± 1.18 with a p-value of less than 0.000. The p-value demonstrated that the treatment group showed a slight improvement compared to the control group.

Table 3 showsthe Across Group Comparison of FMS, Navicular Drop Test and Valgus ankle angle. An Independent T-test was applied. , the pretreatment mean of FMS in group B was 18.27 ± 2.10, and the post-treatment mean was 19.27 ± 1.84 with a p-value of 0.03. the mean pretreatment value of ND in Group A was 10.75 ± 0.20, while in Group B, it was 11.23 ± .26 with a p-value of 0.26. The pretreatment mean of the valgus angle in group A was 10.45 ± 1.09, and the post-treatment mean was 8.66 ± 0.65. Similarly, the pretreatment mean of valgus angle in group B was 10.03 ± 1.27, and the post-treatment mean was 9.09 ± 1.18 with a p-value of 0.18.

4. DISCUSSION

This research aimed to determine the effects of systematic and functional corrective exercise on body posture and stability among University going individuals who were knowingly and unknowingly victims of pronation distortion syndrome. After the thorough intervention for eight weeks and data analysis, the study's findings suggest that participants in the experimental/treatment group who underwent conventional treatment and a systematic exercise program illustrated better outcomes. Functional movement screening and navicular drop tests performed betterpost-treatment than in the control group.

The in-attendance study is consistent with the prior researchof Michael J Walker's clinical analysis in which the FMS tool was taken to check movement efficiency and predict time loss injuries, specifically in active duty service members. That research recorded an age difference of 25.2 ± 3.8 with a mean difference of BMI of 25.1 ± 3.1 kg/m^2. The selected population exhibited improvement to 2.5 points; similarly, this study shows enhancement in FMS component tests measurement to 3 points [20].

The functional movement screening test evaluates individuals' performance in a challenging position to rule out any imperfect locomotory and stabilizing movements. Its maximum score is 21, which predicts efficient mobility. In this study, the post-treatment mean difference for FMS was 3 points in group A, which perfectly enlightens a significant reduction in the destabilization of 7 movement patterns compared to the control group, which showed 1 point of improvement [21]. Functional movement screening average post-test mean difference was 3.0 ± 1.53, improved by 3 points in the treatment group; similarly, the difference for the navicular drop test was 1.15 ± 0.60mm compared to the control group, which had a difference of 1.13 ± 0.99mm.

The findings purported that the high effectiveness of systematic corrective and functional exercises were noted in group A compared to Non-biomechanical functional exercises in group B. These results and analysis are backed by the findings of Mulligan et al. in 2013. On the contrary, Mulligan monitored the navicular drop test in resting position and stance, whereas in this study, the subject was asked to stand and the difference in ND while sitting and weight bearing was noted down as the actual value [22]. In contrast to the significant improvement in the present study's navicular drop and functional movement screening test, the prior study concluded with complete recovery with minimum chances of recurrence. After eight weeks of intervention, participants in the present study found themselves much more stable than before the treatment, but thorough rehabilitation training is neglected.

Golchini et al. argued that corrective exercise workouts substantially improved ankle proprioception in individuals with pronation distortion deformity. Similarly, in this study, significant improvement was observed in the treatment group, and the subject's post-treatment mean value was 8 degrees compared to the control group. Systematically planned appropriate exercises and timely muscle contraction are beneficial in preventing hyper pronation [23].

Overall, the research trial concluded that the systematic corrective exercise program and conventional treatment of NBF for improving and preventing pronation distortion syndrome had high effectiveness than other interventions, as NBF alone doesn't target rectification of hyper pronation, hyperlordosis, knock knees and navicular drop. FMS showed considerable vast significance against corrective exercise programs. Corrective exercises aimed at increasing longitudinal arch, reducing hind foot angle, maintaining accurate alignment and preparing individuals for efficient physical activity.

5. CONCLUSION

Based on all findings and results, this study trial concluded that participants with pronation distortion syndrome responded considerably to both systematic corrective exercise program and non-biomechanical functional exercisesregarding navicular drop and FMS. However, more significant improvement was seen in the corrective exercise program than in NBF exercises.

LIMITATIONS & RECOMMENDATIONS

The only limitation of the current trial was the oversight of upper body kinetics and pelvic disorientation affected by pronation distortion syndrome. It is recommended to compare the corrective exercise program with short foot exercises and the exercises mentioned in this study can be advisable to improve the static and dynamic balance of people affected by malformation of feet.

CONFLICT OF INTEREST

There was no conflict of interest in the current study.

Table1: Comparison of Demographics of Participants

Study Groups		Minimum	Maximum	Mean ± SD
Group A (treatment group)	Age	18	25	21.72 ± 2.19
	Weight	42	65	53.38 ± 7.30
	Height	1.43	1.83	1.67 ± .11
	BMI	15.45	26.16	19.08 ± 2.99
Group B (control group)	Age	18	25	22.16 ± 2.35
	Weight	42	64	54.05 ± 6.27
	Height	1.28	1.83	1.61 ± .15
	BMI	14.42	30.51	21.32 ± 4.92

Table 2: Within Group Comparison of FMS, Navicular Drop Test and Valgus angle of ankle (paired T-test)

Groups	Pretreatment FMS	Post-treatment FMS	Pretreatment NDT	Post-treatment NDT	Pretreatment Valgus angle	Post-treatment Valgus angle

Group A	17.33 ± 1.81	20.33 ± 0.90	10.75 ± .20	9.60 ± .26	10.45 ± 1.09	8.66 ± 0.65
Group B	18.27 ± 2.10	19.27 ± 1.84	11.23 ± .26	10.10 ± 0.36	10.03 ± 1.27	9.09 ± 1.18
P value	<0.001		<0.001		<0.001	

Table 3:Across Group Comparison of FMS, Navicular Drop Test and Valgus angle of Ankle (Independent T test)

Groups	Pretreatment FMS	Pretreatment NDT	Pretreatment Valgus angle	Post treatment FMS	Post treatment NDT	Post treatment Valgus angle
Group A	17.33 ± 1.81	10.75 ± .20	10.45 ± 1.09	20.33 ± 0.90	9.60 ± .26	8.66 ± 0.65
Group B	18.27 ± 2.10	11.23 ± .26	10.03 ± 1.27	19.27 ± 1.84	10.10 ± 0.36	9.09 ± 1.18
P value	0.15	0.15	0.29	0.03	0.26	0.18

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