Lower limb strength, power and flexibility of back line in young adults with pronated feet

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Abstract- Abstract- **Background -** Feet bear entire body weight. Transmission of weight is mainly through the heel to the ground and then through the arches of foot and base of toes. Alteration in the arches can cause pronated, supinated or neutral foot postures. Foot posture is known to have an effect on the proximal biomechanical link of lower extremity. Thus, this study aims at exploring the effect of pronated foot posture on the proximal strength and flexibility.

Methods - 86 individuals between the age group of 18 – 35 years with pronated and neutral arch feet were included in two groups of 43 each, differentiated by FPI-6. Both the groups were assessed for their strength using the Single leg Triple Hop Distance test and, for their flexibility using the Toe Touch test.

Results- There was no statistically significant difference with respect to strength and flexibility between the two groups.

Conclusion - Thus from the present study it can be concluded that pronated foot posture does not alter the strength, power of lower limb and the flexibility of back line.

Index Terms- Pronated-feet, Triple Hop Distance, Flexibility, Kinetic Chain, Strength.

I. INTRODUCTION

The foot is the distal most structure of the biomechanical link in the lower limb. Depending on the activity, the foot and ankle provide a foundation of either stability or mobility to the distal extremity[1].

Feet bear entire weight of the body. The transmission of weight is mainly through the heel to the ground and then through the arches of foot and base of toes.

The arches – There are three arches of the foot namely the medial arch, lateral arch and the transverse arch. The structure of bones and the musculature around the ankle and foot supports these arches. There can be alterations in the arches due to various factors causing decrease or increase in the arch height, causing pronated supinated or neutral foot.

Prevalence of pronated foot is 13.6% in general population[2].Tejashribhoir et al, studied the prevalence of flat foot in physiotherapy students in the 18 to 25 years age group and concluded that the prevalence was 11.25%. Pronation of foot causes the medial longitudinal arch to drop, the calcaneus everts and the talus goes into plantar flexion adduction[3]. Pronated foot is also related to a hypo-mobile gastro soleus complex[1].

Abigail Grover Snook studied 'The relationship between excessive pronation as measured by navicular drop and isokinetic strength of the ankle musculature' and concluded that there was reduced concentric strength of the plantar flexors in subjects with pronated foot as compared to normals[4].

According to the anatomy trains concept the entire body is linked[5]. Thus studying the effect of pronated foot posture on the proximal biomechanical link becomes essential.

II. RATIONALE FOR STUDY

Foot posture is known to have an effect on the proximal biomechanical link of lower extremity[6, 7, 8]. It is seen that with foot pronation, the tibia internally rotates, knee goes into valgus, hip internally rotates and the pelvis tilts anteriorly[9]. These structural alterations can cause changes in the muscle strength and power. Thus this study aims at studying the effect of pronated foot posture on triple hop distance which is a valid predictor of lower limb power and strength[10]. It is a simple clinical tool which can be used to assess the same without consuming much time and use of any sophisticated equipment.

Foot pronation causes reduced flexibility of the calf muscles but its effect on the proximal link is not much explored[1]. According to a newer concept 'The anatomy trains', entire body is linked. There are 5 trains- the superficial front line, deep front line, lateral line, oblique line and the superficial back line[5]. The superficial back line links from the plantar aspect of toes to the occiput. This creates a possibility that the proximal structures may be affected due to foot pronation. Therefore this study aims at studying the effect of pronated foot posture on toe touch test which is a valid predictor of flexibility of the posterior structures (especially hamstrings and lumbar spine) [11].

There may be an influence of flat foot on the strength and flexibility of the lower extremity[1, 4]. Therefore in patients with lower extremity strength or flexibility deficits, along with the conventional therapy their distal biomechanical link i.e. the foot posture too should be evaluated. This would give a holistic approach to the treatment.

III. METHODOLOGY AND DATA COLLECTION

This was a cross sectional analytical study with a duration of 6 months. A total of 86 individuals between the age group of 18 – 35 years were included in the study. 43 had pronated feet – included in group A and 43 others had neutral arch feet - included in group B; which was classified using the FPI -6. The sample size

was calculated based on a pilot study with 10 participants in each group, and power fixed at 80% and confidence interval at 95%.
Inclusion criteria – (i) Healthy young adults in the 18 to 35 age group. (ii) Subjects giving written consent.

Exclusion criteria – (i) Recent musculoskeletal injuries of lower limb and spine (within 1 year of participation in study). (ii)Neuromuscular impairment or congenital musculoskeletal anomalies. (iii) Athletic or regular physical exercise.
Both the groups were assessed for their strength using the Single leg Triple Hop Distance test and, for flexibility of backline using the Toe Touch test.

IV. PROCEDURE

Approval was obtained from the ethics committee prior to commencement of the study. The study was explained to all participants and Informed consent taken from all subjects. The demographic data was collected as per the Case Record sheet. The participants underwent the FPI-6 and were divided into two groups based on the scores i.e. if more than six then in Group A- the pronated foot group and if the score is between 0 to +5 then in Group B- control group (neutral arch).

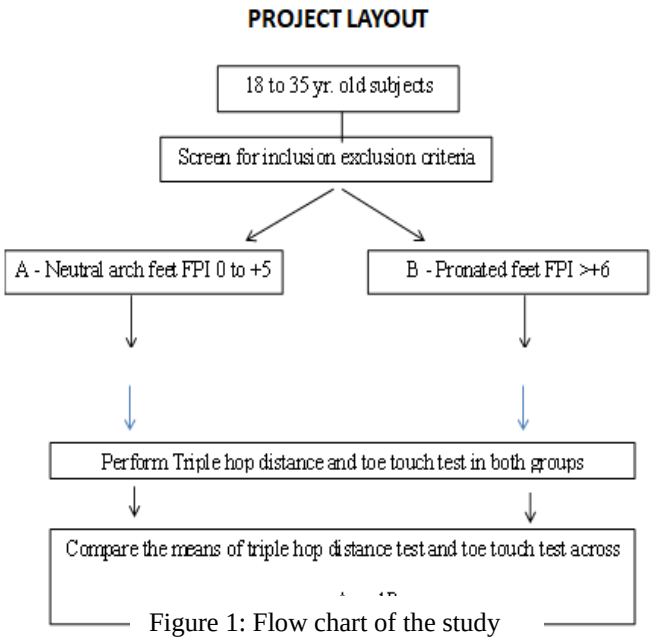

Figure 1: Flow chart of the study

A. Triple Hop Distance Test

Test procedure: Subject s tanding on single leg (without footwear) at the start point of the measuring tape stuck on the ground. They were asked to take three hops in succession and the distance at the end of three hops was recorded (corresponding to the great toe on the tape). Three attempts were allowed, and average of the three was taken as final score on both sides[10].

B. Toe touch Test

Test procedure: Subject standing on a 20cm long stool and bending down from the back without bending the knees. Measurement was taken by a measuring tape from the toes to the tip of the middle finger. The scores above the toe level were taken as positive and that below the toe level were taken as negative. Average of two attempts was recorded[11].

The means of the triple hop test and the toe touch test respectively were compared between both the groups.


Figure 2: Triple Hop Distance Test

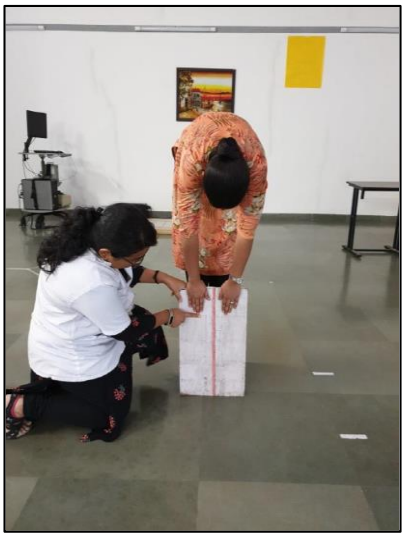
Figure 3: Toe Touch Test

V. RESULTS AND ANALYSIS

Data was entered using MS Excel 2010 and analyzed using Graph pad instat software version 3.1. The Kolmogorov and Smirnov test was used to test for normal distribution of the data. The unpaired t test and Mann Whitney U was used for normally and not normally distributed data respectively. P value of <0.05 was taken as statistically significant.

There was no statistically significant difference between the two groups when compared for Triple Hop Distance and Toe touch.

Table 1: Comparison of means of THD (right side) between groups A and B

Triple Hop Distance (right leg comparison)								
N= 86	n	Min	Max	Median	Mean	SD	Test	P value
GROUP A (Pronated feet)	43	141.00	582.66	289.00	286.93	77.492	Unpaired t test	0.8373 Not Significant
GROUP B (Normal feet)	43	186.00	438.00	291.66	289.81	48.876		

Table 2: Comparison of means of THD (left side) between groups A and B

Triple Hop Distance (left leg comparison)								
N= 86	n	Min	Max	Median	Mean	SD	Test	P value
GROUP A (Pronated feet)	43	124.00	554.50	267.16	276.13	79.758	Unpaired t test	0.9608 Not Significant
GROUP B (Normal feet)	43	164.33	456.00	272.66	275.37	63.290		

N= 86	n	Min	Max	Median	Mean	SD	Test	P value
GROUP A (Pronated Feet)	43	-20.000	24.500	7.500	4.610	11.685	Unpaired t test	0.2442 Not significant
GROUP B (Normal Feet)	43	-10.500	34.000	7.000	7.488	11.066		

Table 3: Comparison of means of Toe touch test in Groups A and B

VI. DISCUSSION AND CONCLUSION

Due to foot pronation there are changes expected in the proximal biomechanical link. The tibia rotates internally, knee goes into valgus, hip goes into internal rotation and pelvis is anteriorly tilted[9].

Due to all these structural changes occurring as a result of foot pronation, an alteration in the functional aspects of strength and power could have occurred. The results however show that there is no alteration of strength and power assessed as per the THD test. These findings are consistent with that of the study conducted by Zhao X et al, wherein there was no association of arch height with physical performance measures of force (tested by vertical jump height), agility and proprioception. The author attributed the occurrence of results pertaining to arch height and physical performance to the fact that, physical performance is an integrated result of multiple body systems and thus considering only arch height it is difficult to determine that it may play a pivotal role in physical performance[12].

Mahdi Vaez , Rooh Allah Ranjbar and Atefeh Kazemi studied the impact of foot posture on vertical jump in middle school boys. They too concluded that there is no difference between the vertical jump height scores between different foot postures[13].

Juan Francisco Are´valo-Mora, Maria Reina-Bueno, Pedro V. Munuera studied the influence of foot type on the Physical motor performance. The results achieved stated that there is no significant difference in the physical performance as a whole between different arch heights[14].

Their findings were in accordance with that of Tudor et al. where they found that low-arched and normal-arched children were equally successful at accomplishing the motor tests, and they concluded that flatfoot was not a disadvantage in sports performance in children aged 11 to 15 years[15].

However, Negrin argued that the structure and functionality of the normal foot gives it advantages in preventing injuries and trauma in children and adolescents[16].

Flexibility - Foot pronation causes reduced flexibility of the calf muscles but its effect on the proximal link is not much explored. According to a newer concept 'The anatomy trains', the entire body is linked[5]. This creates a possibility that foot pronation may affect flexibility of the structures proximally. The results however show that there is no alteration of flexibility assessed as per the Toe touch test. Although the results were not statistically significant, the difference between the means of the two groups was 2.87cm (The means being 4.61cm in pronated feet group and 7.48cm in normals)

Fiona Hawke, Keith Rome and Angela Margaret Evans studied the relationship between foot posture, body mass, age and ankle, lower-limb and whole-body flexibility in healthy children of 7 – 15 years. They concluded that the pronated feet individuals had greater lower limb and whole body flexibility as compared to other group, but not greater ankle joint flexibility. However, older children exhibited less lower-limb and whole-body flexibility, but not ankle joint flexibility[17]. The author expresses the need to carry out the study in growing stages through adolescence and

adulthood to comment on the exact effect. Also the outcome measure for testing the flexibility was taken as Beighton's score, which is usually used as an outcome measure for joint hypermobility.

It is proved that in pronated feet there is tightness of the posterior calf muscles[1, 18].

Due to foot pronation the plantar structures get stretched due to spreading of the foot structure. Thus the plantar fascia also gets stretched. According to the anatomy trains concept, the entire body is linked through a myofascial system. In pronated feet, even though the calf muscles get into tightness, the plantar fascia is actually stretched thus the tightness or lack of flexibility may not be carried higher up in the kinetic chain.

The mean age of the population studied in current study was around 22 years, which is the young active group of people. Thus due to regular use of large muscle groups, the foot pronation might not have affected the strength and flexibility.

Also the foot pronation may not show its effect on the proximal strength and flexibility at this small age but if the population is studied longitudinally over their years of development, the exact effect of foot posture on strength and flexibility may be observed.

VII. CONCLUSION

Thus from the present study it can be concluded that pronated foot posture does not alter the strength, power of lower limb and the flexibility of back line in young adults.

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