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Research Article

Prevalence and Associated Factors of Flat Feet among Patients with Hypertension; Findings from a Cross Sectional Study Carried Out at a Tertiary Care Hospital in Sri Lanka

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Abstract

Background: Hypertension is considered a risk factor for flat feet as it causes posterior tibial tendon dysfunction. The objectives of this study were to identify the prevalence and associated factors of flat feet among patients with hypertension.

Methods: A cross sectional study with systematic sampling was done in three selected hypertension clinics at the National Hospital of Sri Lanka. Patients with hypertension above 40 years of age with no other recognized risk factors were enrolled. Socio-demographic details and clinical information were collected using a pre-tested interviewer administered questionnaire. Arch index was obtained by a static footprint on the Harris mat. Body weight and height were measured using standard instruments. Body Mass Index was calculated. Descriptive statistics, Independent t- test, Chi-square test and Pearson correlation were used for data analysis.

Results: Of the 403 participants enrolled, 53.8% were

females. The mean arch index of right and left sides were 0.26883 ± 0.3477 and 0.26993 ± 0.03484 respectively. Overall prevalence of flat feet was 51.6%; it was right sided in 32% and left sided in 37.7%. Higher Body Mass Index was associated with presence of flat feet (p=0.001) and arch index (p<0.001). There was no significant association with gender or duration of hypertension.

Conclusions: Prevalence of flat feet among patients with hypertension seems to be greater than reported in non-hypertensive individuals with otherwise similar characteristics. Increasing body mass index even below the threshold of 30 kg/m^2 seems to be associated with higher risk.

Keywords: Flat Feet; Hypertension; Prevalence; Arch Index

Abbreviations: AI: Arch Index; BMI: Body Mass Index; PTTD: Posterior Tibial Tendon Dysfunction; SD: Standard Deviation; SPSS: Statistical Package for Social Sciences

1. Introduction

A change in the shape of the foot, which results in the foot losing its normal arch when standing, is referred to as flat foot [1]. Flat foot could be congenital or acquired [2-3]. Flat feet that develop in an adult following skeletal maturity is known as adult acquired flat foot deformity (AAFD) [4-5]. This condition may develop due to injury, illness or prolonged stress to the feet [6]. AAFD leads to pain and tenderness in and around the ankle, development of arthritis [4], a wide range of deformities such as valgus deformity of the hind foot, mid foot abduction, hind foot valgus, forefoot abduction, ankle valgus and tightening of the heel cord [7]. Insufficiency or dysfunction of the posterior tibial tendon had been considered the commonest cause of AAFD [8]. This muscle with certain other muscles pulls the talus upwards and adducts the mid tarsal joint and supports the spring ligament to form the arch [4, 9]. When the posterior tibial tendon progressively fails, gradual flattening of the arches occurs.

Hypertension, diabetes or obesity have been reported in 52% of individuals with posterior tibial tendon dysfunction (PTTD) in one study [10] and 60% [11] of patients with PTTD in another [11]. The prevalence of posterior tibial tendon rupture parallels the degenerative processes of aging, hypertension, diabetes mellitus and obesity [10-11]. It is presumed that atherosclerotic arterial disease in hypertension leads to impaired blood supply to the posterior tibial tendon resulting in its dysfunction [9, 12]. Prevalence of flat foot is highly variable worldwide. Studies have shown that 26.26% of the general population suffers from flat feet [13]. A study by Lauterbach et al, 2010 has mentioned that the patients with associated co-morbidities have a prevalence of 37% [14]. Prevalence seems to change with age, the type of population studied and the presence of co-morbidities. Though hypertension is considered in the literature as a risk factor, separate studies have not been done to assess prevalence of flat feet among patients with hypertension. The objectives of this study were to assess the prevalence and associated factors of flat feet among patients with hypertension.

2. Materials and Methods

This was a clinic based, cross sectional study conducted among patients attending three selected hypertension clinics at the National Hospital of Sri Lanka, the largest tertiary care hospital in the country. Ethics approval for

this study was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Colombo, Sri Lanka (ERC: UCP/AL/13/273). Only investigators had access to the data collected for the purposes of this study. Informed written consent was obtained from the participants prior to enrolment. The study was carried out over a period of two years from July 2016 to July 2018. Patients older than 40 years with diagnosed hypertension (Documented office systolic blood pressure >140 mmHg or diastolic blood pressure >90 mmHg) were screened for inclusion in to the study. Individuals with diabetes mellitus, obesity (Body Mass Index >30 kg/m^2), osteoarthritis, spondylo-arthropathies, oedema in ankle region or foot, rheumatoid arthritis, congenital flat foot deformity, previous trauma or surgery to the leg or foot, long term steroid therapy or steroid injections and engagement in an occupation requiring long-term standing were excluded from the study. Since obesity had been already recognized as a risk factor for flat feet, association between Body Mass Index (BMI) and prevalence of flat feet was assessed only among people with BMI <30 kg/m^2.

Socio-demographic details and clinical information were collected using a pre-tested interviewer administered questionnaire. Information from the medical records and clinic books was referred to verify information and minimize recall bias. Static foot prints were obtained in fully weight bearing relaxed position using the Harris mat to measure arch index. A chair was given to hold while standing if they had tendency to fall. A foot axis was drawn from the centre of the heel to the tip of the second toe, and the footprint was divided into equal thirds (excluding the toes) by constructing lines tangential to the foot axis. Foot print of each side was obtained three times and the average was taken as the final measure. The arch index was taken as the ratio of area of the middle third of the footprint to the entire footprint area. A higher ratio of the arch index indicates a flat foot. An arch index between 0.21 to 0.28 was considered normal [15], as based on the findings from a study by Menz et al, 2012 where a large sample of participants with a study population similar to this study was included. The body weight and height were measured using the standard procedure and BMI was calculated. Data entry and analysis was done using the Statistical Package for the Social Sciences (SPSS) software (version 23). Descriptive statistics were used to define prevalence of flat foot and other socio-demographic factors. Independent sample t-test, Chi-square test and Pearson correlation were used to assess associations.

3. Results

The study population comprised 403 participants. Demographic characteristics of the population are shown in Table 1. Mean age of the participants was 66.54 ± 10.79 years. The participants were considered to have flat feet if there was evidence that even one of the feet had an arch index above the normal (i.e. >0.28). Table 2 represents summary of the arch indices of the participants with the percentages of the individuals with normal arch, low arch and high arch in right and left feet separately. Based on this, 51.6% (n=208) individuals had flat feet. One hundred and thirty-four (64.4%) of them had unilateral flat foot whereas remaining 35.6% had bilateral flat feet. The prevalence of flat feet amongst females and males were 53.9% and 48.9% respectively (p=0.32). Duration of hypertension was not associated with the prevalence of flat feet (p=0.31). Higher BMI was significantly associated with increased prevalence of flat feet, even after including participants with BMI <30 kg/m^2 only (p=0.001). Table 3 shows the

association between Body Mass Index (BMI) and duration of hypertension with the occurrence of flat feet. When Pearson correlation was calculated, there was no association between duration of hypertension and the arch index either on the left (p=0.44, r=0.039) and right (p=0.81, r= -0.012) foot. Association of BMI with the left (p<0.001) and right (p< 0.001) feet arch indices was statistically significant and showed a positive correlation for both right (r=0.196) and left (r=0.192) sides.

Variable	**Number**	**Percentage**
Age (years)		
40-50	27	6.7%
51-60	75	18.6%
61-70	169	42.1%
71-80	87	21.5%
81-90	45	11.1%
Gender		
Male	186	46.2%
Female	217	53.8%
Duration of Hypertension (years)		
<5 years	184	45.7%
5-10 years	144	35.8%
11-15 years	40	9.9%
16-20 years	19	4.7%
>20 years	16	3.9%
BMI (kg/m^2)		
<18.5kg/m^2	50	12.4%
18.5-24.9kg/m^2	249	61.8%
25.0-29.9kg/m^2	104	25.8%

Table 1: Characteristics of the population.

			Nature of the Arch*					
			Normal		**Low/Flat feet**		**High**	
Side	**Mean**	**SD**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Right	0.26883	0.0347	266	66	129	32	8	2
Left	0.26993	0.0348	229	56.8	152	37.7	22	5.5

*Normal arch = 0.21 to 0.28, Low Arch = >0.28, High Arch= <0.21

Table 2: Summary of arch index of the participants.

Parameter	Mean. SD			Significance
	Within total population	Group with flat feet	Group without flat feet	
BMI (kg/m^2)	23.526 ± 3.5600	24.098 ± 3.6871	22.915 ± 3.3214	0.001
Duration of hyper-tension (years)	8.0544 ± 14.68908	8.7707 ± 6.66654	7.2905 ± 19.96375	0.31

Table 3: Summary of the associations of Body Mass Index (BMI), duration of hypertension with occurrence of flat feet.

4. Discussion

The overall results indicate that acquired flat foot deformity is prevalent in patients having hypertension while the duration of hypertension or gender has no association with flat feet or the arch index. Arch index can increase with increased BMI leading to flat feet. As no literature was available on the prevalence of flat feet in patients with hypertension compared to the general population the prevalence percentages between healthy adults and hypertension patients could not be compared. Since there is no literature on the prevalence of flat feet among healthy controls, data from healthy population was referred to for the purpose of comparison. A recent study has reported a 26.62% prevalence of flat feet among a healthy population aged 40 years and above, which comprises the same age group included in the current study and flat foot has been assessed by three gold standard methods as Clarke's angle, Chippaux-Smirak index and Staheli arch index [13]. Therefore, it can be presumed that patients with hypertension of the same age group are at a higher risk of getting flat feet as compared to healthy adults. However, contribution of other confounding factors should be taken into consideration prior to confirming this.

Posterior tibial tendon dysfunction is thought to be the main contributor of flat foot in hypertension. There is evidence from literature that patients with hypertension are at risk of developing PTTD as the rupture of posterior tibial tendon is parallel to the degenerative changes of hypertension [10]. Many studies have found that hypertension is a risk factor for PTTD [16-18]. As the tendon loses function, the medial longitudinal arch of the foot collapses leading to the occurrence of flat foot deformity [19]. In PTTD, only one side is typically affected and bilateral disease is rare [19]. The reason for predominant unilateral occurrence of flat feet in this study population may be the unilateral occurrence of PTTD. This further supports the suggestion that the most possible cause for flat foot in hypertension is PTTD. Flat foot deformity is associated with several other deformities and complications like knee valgus, excessive subtalar pronation, lateral tibial torsion, lateral patellar subluxation and excessive hip adduction [20], greater tibial internal rotation [21], decreased muscle activity during single leg standing [22], balance deficits, gait deviations, postural instability, weakening of the foot intrinsic muscles [23], increased injury risk, poor physical function [24], osteoarthritis of the foot and recurrent knee pain [25]. In addition, unilateral flat foot can cause a significant lateral pelvic tilt in the direction of the affected side which can have an effect on the posture and production of pelvic misalignments in standing position [26]. Therefore, recognition of the presence of flat feet in an individual and arranging necessary measures to prevent negative health

consequences will be beneficial. In addition, early recognition of risk factors and prevention of the occurrence of flat feet would be of advantage to the patient.

This study has shown that risk of flat foot increases with BMI even when individuals with obesity are excluded. It seems that increased body weight would be contributing to occurrence of flat feet even below this threshold. In previous studies it was shown that statistically significant, positive correlations between the BMI and flat foot deformity were observed in two study groups of the same age ranges as in our study [27, 28]. Increased BMI was shown to be associated with PTTD and heightened plantar pressures [10, 29]. Therefore, weight reduction to the ideal body weight might help to reduce the risk of flat feet in patients with hypertension. Duration of hypertension did not show a significant association with the occurrence of flat feet in this study population. Given the fact that PTTD which is the presumed aetiology for flat feet is related to atherosclerosis, an association with the duration of hypertension would have been expected. One possible explanation would be that it may be the severity of hypertension that can speed up the occurrence of flat feet rather than the duration. Further studies looking at association of flat feet with control of hypertension from the onset of disease would provide insight into this hypothesis.

This study has provided new knowledge on prevalence and associated factors of flat feet among patients with hypertension which is overlooked in clinical practice and literature. Further comparative studies with detailed risk factor assessment would enable measures to recognize, treat and prevent flat feet in this at-risk population.

Limitations

This hospital-based study did not include a healthy control group which would have allowed direct comparison of prevalence and risk factors. Normative values for the arch index values which were used in this study were different to the arch index values originally presented by Cavanagh and Rodgers in 1987 [30]. The values in a most recent and valid study done by Menz et al. [15] were used to categorize arch types because the sample was larger (n=602) and the study group matched the age group of our study than that of the one carried out by Cavanagh and Rodgers (Mean age = 30 years) [30]. Only one tool to measure the arch type has been used considering the large sample size and lack of extended contact time with study participants in the busy outpatient clinics. It would have been better if another tool like navicular height was used to improve the accuracy of diagnosing flat foot. Further studies across different communities using enhanced diagnostic tests would enhance the generalizability of our findings.

5. Conclusions

There is a tendency of higher prevalence of flat feet among patients with hypertension in the absence of other risk Factors. The risk of having flat feet increase with increasing Body Mass Index. Further head to head comparison studies and cohort studies would enable better characterization of risk factors.

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Conflicts of Interest

The authors do not have any conflicts of interests.

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