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ORIGINAL RESEARCH

Occurrence of adult acquired flat foot among diabetic patients in Rawalpindi and Islamabad: a cross-sectional descriptive study

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Abstract

Human foot is a biological masterpiece, which is strong enough to support the body weight and flexible enough to adjust to various surfaces. Foot postural deviation can alter the alignment of the entire body. The collapse of the medial longitudinal arch of the foot causes one of the most prevalent deformities i.e. flat foot. Diabetic patients are more prone to have flat foot due to degeneration of posterior tibial tendon over the course of their disease. The aim of this study was to determine the occurrence of adult acquired flat foot and assess the disability of flat foot among diabetic population in Rawalpindi and Islamabad, Pakistan. In this cross-sectional descriptive study, 384 diabetic patients aged 35-60 year were enrolled after obtaining informed consent. Non-probability convenience sampling technique was employed. The data was gathered by performing navicular drop test to determine the presence of flat foot, assessment of posterior tibial tendon dysfunction through single heel rise test and by using foot function index questionnaire to assess pain, disability and activity limitation. Based on results of the study, posterior tibial tendon dysfunction was observed to cause the appearance of low navicular height leading to flat foot in 58.33% of the population. Moreover, there is a moderate tendency of occurrence of flat foot among diabetic population in the absence of other risk factors such as hypertension, obesity, steroids use and previous foot trauma etc. With regard to the functionality measured by foot function index, it was implied that the functional status of the patient was reduced because of the pain, disability and activity restriction in the presence of flat foot.

Keywords: Adult-onset diabetes mellitus, flatfoot, medial longitudinal arch, podiatry, posterior tibial tendon dysfunction.

Introduction

The foot has complex biomechanics providing composed mobility, a smooth walk, and effective force transmission via the lower leg. It helps to maintain posture and steady movement by transferring force from lower limb to the ground (Taddei et al., 2018).

Body weight is evenly transferred between the two feet because of flexible arches, which are built in such a way that dysfunction and weakness in one arch can also impact the other arches. Pes planus known as flat foot, is one of the most prevalent foot deformities. In this malformation, the medial longitudinal arch, one of the tallest and most shock-absorbing arch, is eventually flattened. The deformity is also referred to as a fallen arch because the collapsed arch causes the foot to make direct contact with the ground (Ozdinc & Turan, 2016).

Patients who come into any musculoskeletal practice frequently have flat feet as a concern. The flatfoot can be acquired or develop through time. Developmental flatfoot is typical in pediatric population and can

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infrequently continue undiagnosed until adulthood. Although immaturity is the typical cause of childhood flatfoot, there are numerous other causes as well, including coalition, neuromuscular disorder, laxity syndromes, and many others. After skeletal maturity, the medial arch may become partially or completely flat, which can cause acquired flatfoot. It could be comparatively asymptomatic or it might cause severe dysfunction and symptoms that are incapacitating enough to render patients helpless (Flores et al., 2019).

The frequency of flat foot varies greatly over the world. According to study regarding the prevalence of flatfoot in the general community, flat foot affects 26.26% of the general population. Prevalence appears to vary with age, population type investigated, and presence of co-morbidities (Pita-Fernandez et al., 2017). Similarly, the distribution of foot deformities in Nigerian population observed that unilateral flat foot deformity was the most prevalent (20.1%) while around 10% presented with multiple feet deformities (Adeniyi et al., 2015).

Moreover, posterior tibial tendon insufficiency is considered as the primary cause of adult acquired flat foot. According to the evidence, the loss of flexibility of tibial tendon as a result of degeneration renders it incapable of supporting the foot (Rungprai & Maneeprasopchoke, 2021).

Pain is typically felt along the posterior tibial tendon in the medial region of the hind foot, and is occasionally accompanied by effusion into the tendon sheath. Deep and plantar pain could indicate a spring ligament injury. The results of a clinical evaluation should reveal the nature of the deformity and if Chopart and Lisfranc joint-line deformities, as well as tibiotalar and subtalar joint deformities, are reducible. Joint stiffness is checked for as it may indicate osteoarthritis or synostosis coalition, and range of motion is evaluated (Toullec, 2015).

Futhermore, in diabetes mellitus and hypertesion, due to the degenerative processes and altered blood circulation with high levels of glucose, the tendon loses its function and becomes weaker. Thus, tibial tendon insufficiency results in flat foot. Futhermore, the diabetic patients have reduced sensations so they might not be able to notice their foot collapse and deformity. A more severe collapse without noticing can lead towards more flattening of the foot and can cause a severe foot problem (Akhtar et al., 2019).

The patients with significant hind foot abnormality and pes planus, in which the medial longitudinal arch is completely dropped, may consider changing their footwear. Extra-deep shoes are the best type of footwear for patients with posterior tibial tendon dysfucntion. To provide support to the arch foot and for proper foot positioning orthotics including foot insoles, braces, cast orthoses, foot splints may be commonly prescribed. It's important to remember physical therapy to prevent fibular tendon retraction and to strengthen the toe flexors to make up for weak posterior tibial muscles (Herchenröder et al., 2021).

As flat foot causes significant pathologies like arthritis, LBP, knee pain, bone spurs and pelvic malalignments, so early recognition of its risk factors and presence of flat foot would be an advantage to the individuals as early efforts can prevent negative health risks in these patients. This study determined the frequency of occurrence of flat foot in diabetic patients. General population will be benefited from this study as this will gain insight about the posterior tibial tendon degeneration can lead to flat foot, its earliest signs and risk factors which may be helpful in its early detection and prevention.

The main objective of this study was to determine the prevalence and disability index of adult acquired flat foot among diabetic population in Rawalpindi and Islamabad, Pakistan.

Methods

This descriptive cross-sectional study was conducted at Awan Physiotherapy and Health Clinic Rawalpindi and We Care Physical Therapy Clinic Islamabad, Pakistan. The data was collected through non-probability convenience sampling technique. The sample size was calculated as 384 through Open Epi software using the epidemiological data available on website of Pakistan Bureau of Statistics. The title of the research project no. FUCP/932-9/DPTF1809 was granted approval by the Ethical Review Committee Foundation University School of Health Sciences (FUSH) no. FF/FUMC/215-244/Phy22.

Participants

For inclusion criteria, the diagnosed diabetic patients with duration of >5years, including both female and male participants, ranging from 35-60 years of age were recruited. Participants with BMI>25kg/m2, any previous trauma or surgery of foot, congenital flat foot, Charcot foot, on steroids treatment and having other

neuromuscular, cardiovascular and musculoskeletal comorbidities, factures, pregnancy were excluded from study. Informed consent was occupied from all participants.

Procedure

The data was assembled by performing navicular drop test to determine the occurrence of adult acquired flat foot. Similarly, clinical assessment of posterior tibial tendon dysfunction was done by performing single heel rise test. Pain, disability and activity limitation was assessed by using Foot Function Index questionnaire.

Navicular drop test

The navicular drop test measures the distance which navicular tuberosity moves from sitting position to standing full weight bearing position. This test is used to evaluate height of medial longitudinal arch. Firstly, navicular tuberosity was marked. The patient sat on the chair with most of his weight on the opposing limb. The height of the navicular bone was measured with the subtalar joint in neutral. Finally, the patient adapted standing position with equal weight on both feet and another measurement of the navicular height was taken. The navicular drop accounts for the variation between the first and second measurements. Foot pronation is said to be excessive when it differs by more than 10 mm (Sung, 2018).

Single heel rise test

This test is helpful in assessing muscular function in static weight bearing position. It is highly recommended for diagnosing posterior tibial tendon dysfunction. The patient was asked to perform heel rise with raising one heel at a time. The test was declared positive if the patient was not able to rise heel with hind foot falling in eversion, which suggested that the posterior tibial tendon was not active enough to invert the hind foot progressing to posterior tibial tendon dysfunction (Durrant et al., 2015).

Foot Function Index questionnaire

This questionnare consisted of 3 subcategories comprising of pain, disability, and activity restriction. In addition, nine questions were asked about foot pain in a variety of circumstances, such as when wearing shoes or going barefoot. The maximum score for the pain component is 90. Similarly, nine questions were asked from disability subcategory which suggested difficulties doing various functional activities due to foot issues including trouble mounting stairs, are all related to this. The maximum score for the disability component is 90. Lastly, five questions were inquired about the activity limitations. Thus, the maximum score for this component is 50. Moreover, the final score of the scale is 230 suggesting more points depicting more pain, disability, and activity restriction (Sierevelt et al., 2018).

Data Analyses

In this cross-sectional descriptive study, SPSS version 21.0 was used for descriptive analysis. Quantitative variables were reported in form of mean and standard deviation while qualitative variables were described in form of frequencies and percentages.

Results

The demographics of this study showed the target age range of 35-60 years with mean age was 49.22±6.28 years. Out of 384 participants, around 208(54.2%) were females and 176(45.8%) were males. Mean duration of the diabetes was 7.25±3.27. Moreover, around 141(36.7%) were using oral medication and 243(63.3%) were administering insulin as the treatment choice.

Moreover, the frequency of flat foot came out as 58.33% out of which 42.9% participants possess unilateral and 15.3% participants had bilateral flat foot. Moreover, right side flat foot was 25.2% and left side flat foot was 17.7%. Thus, the result showed that posterior tibial tendon dysfunction with flat foot was more persistent particularly on the right foot (Table 1).

Table 1
Frequency distribution of flat foot.

Variables	n (%)
Unilateral Flat Foot	
Right Flat Foot	97(25.2%)
Left Flat Foot	68(17.7%)
Total	165(42.9%)
Bilateral Flat Foot	59(15.3%)
Flat Foot	224(58.33%)

The outcome measure used for assessment of posterior tibial tendon insufficiency was single heel rise test. Around 41.1% showed positive right and 38.3% depicted positive left single heel rise test by hind foot falling in eversion (Table 2).

Descriptive statistics related to foot function index with individual scores of three categories are mentioned in the Table 3. The results portrayed high scores for

both pain and disability while the activity limitation depicted low score respectively.

Table 2
Single heel rise test.

	n (%)
Right Single Heel Rise Test	
Positive	158(41.1%)
Negative	226(58.9%)
Left Single Heel Rise Test	
Positive	147(38.3%)
Negative	237(61.7%)

Table 3
Descriptive statistics of foot function index.

FFI	Mean ± SD	Minimum	Maximum
Pain	36.37 ± 20.19	.00	85
Disability	41.16 ± 24.13	.00	90
Activity Limitation	12.12 ± 10.01	.00	50
Total Score	89.18 ± 51.18	.00	196

Discussion

This study was proposed to determine the occurrence of adult acquired flat foot in diabetic patients due to posterior tibial tendon dysfunction. The results depicted that the posterior tibial tendon dysfunction demonstrated by the loss of pronounced hindfoot inversion during single heel rise test was persistant with the loss of the longitudinal arch leading towards the appearance of flat foot.

The posterior tibial tendon is considered as the most cardinal invertor of the foot, contributes in upholding the medial longitudinal arch and is paramount stabilizer or invertor of the hindfoot. Its dysfunction can cause immergence of degenerative tears, tenosynovitis and avulsion of its insertion on the navicular tuberosity. Similarly, a characteristic deformity occurs comprising of forefoot abduction, hindfoot valgus or eversion, loss of the longitudinal arch leading towards the appearance of flat foot (Watanabe et al., 2013).

Adeniyi et al. conducted a study to investigate the prevalence of various foot deformities in diabetic patients. The various foot deformities were: claw toe, hammer toe, hallus valgus etc. Among all, pes planus was the most prevalent deformity present in the diabetic population, with a prevalence of about 20.1% (Adeniyi et al., 2015). In the present study, around 58.3% of the diabetic patients had flatfoot. The higher prevalence in the current study may, however, was because of the recruitment of the older population as the flat foot may had preceded with the chronicity of diabetes.

Navicular drop is described as a change in height of navicular bone when the foot moves from non-weight bearing position to weight bearing stance. The normal value of the test suggested by Brody DM et al. Was lesser than 10mm (Adhikari et al., 2014). The current study also considered Navicular Drop of >10mm as positive test for flat foot.

Consistent values for the prevalence of flat foot have been reported by numerous studies. A study conducted by Aenumulapalli et al. demonstrated bilateral flat foot as 13.6% assessed by the application of Navicular drop test (Aenumulapalli et al., 2017). This can be attributed to the similar method used to assess the flexibility of the arches of foot, as the prevalence of bilateral flat foot was 15.3% in the present study. This method has been declared as a valid and reliable one as compared to foot print and visual assessment methods applied by various researchers.

An study conducted by Gonzalez et al. suggested that the foot problems continue to be highly prevalent (38.8%) in diabetic patients which advocates the importance of foot assessment through podiatry. The study also indicated that diabetic patients had greater likelihood to suffer from foot pathologies including foot deformities, dermal and nail changes. (Gonzalez-Martin et al., 2019).

Evidence suggested that the type and content of collagen with respective orientation of fibres are related to PTTD. The structure of collagen changes with the increasing age. An increased mucin production causes degeneration of the collagen fibres inside the tendon. In this way, the strength of the tendon is compromised grossly. Due to posterior tibial tendon dysfunction, the ligaments and joints become fragile thus causing flatfoot to develop (Erol et al., 2015). In present study, 41.1% and 38.3% patients presented with positive single heel rise test for right and left foot respectively. The increased prevalence may be related to the stage and chronicity of tendon's dysfunction. Moreover, in stage III and IV of PTTD, flat foot deformity occurs with the hind foot valgus deformity and patient being unable to perform single heel rise test.

Similarly, Godoy et al. has demonstrated that the collagen related changes are accelerated in patients with hypertension, obesity and other metabolic diseases. Additionally, It was revealed that the diabetes rushes the aging process of collagen, exhibited by increased collagen stiffness, cross-linkage, and collagen stabilization (Godoy-Santos et al., 2021). Futhermore, diabetes affect the blood supply to tendon and cause various structural abnormalities (Knapp & Constant, 2022).

Conclusion

The results of the present study quantified the prevalence of flat foot in diabetic patients. The prevalence depicted that there is a great tendency of emergence of flat foot among patients with diabetes due to posterior tibial tendon dysfunction in the absence of other risk factors like neuromuscular, cardiovascular and musculoskeletal comorbidities and obesity. From this study, it was concluded that the prevalence of bilateral flat foot was 15.3% when using the navicular drop test. With regard to functionality measured by foot function index it was implied that the presence of flat foot reduces the functionality of diabetic patients.

Authors' Contribution

Study Design: Ateeqa YOUNIS, Madiha ASHFAQ; Data Collection: Faiza WAHEED, Onaisa FAROOQ, Aliya ASHRAF ; Statistical Analysis: Ateeqa YOUNIS, Haniya IQBAL ; Manuscript Preparation: Ateeqa YOUNIS, Annam SABA.

Ethical Approval

The title of the research project no. FUCP/932-9/DPTF1809 was granted approval by the Ethical Review Committee Foundation University School of Health Sciences (FUSH) no. FF/FUMC/215-244/Phy22.

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Conflict of interest

We have no conflict to declare.

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