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Prevalence of Posterior Tibialis Tendon Dysfunction in Individuals with Flatfeet

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Abstract

Posterior Tibialis Tendon Dysfunction is a condition which is progressive in nature usually associated with an over pronated foot (flatfoot). PTTD can be caused due to trauma, overuse, obesity, and degeneration as the age of individual progresses. It can be a debilitating condition in its later chronic stages severely affecting the ADL's of an individual if not identified in its earliest stages. The older adult population with 13.6 % of flatfeet individuals were observed to have 10% prevalence rate of PTTD whereas the younger population with flatfeet prevalence rate of 11.5% were under assessed for same and the magnitude or prevalence of dysfunction was not assessed or recorded in literature. This study therefore was conducted with the objective to identify individuals with PTT dysfunction in its earliest stages. As an earlier detection may help prevent or halt the progression of PTTD in its advanced severe stages in younger individuals with age 18 to 25 years with flatfeet. The assessment of the individuals for PTTD was done using the Johnson and Strom criteria which is a widely used classification for clinical diagnosis of this dysfunction. The data obtained was analysed using appropriate statistical test. The results concluded documenting a prevalence rate of 18.54 % which is higher as compared to that mentioned in literature in older women.

Keywords: Flatfeet, Overpronated foot, PTTD (posterior tibialis tendon dysfunction)

Introduction:

Flatfoot is one of the most common condition observed in adults with prevalence rate of 13.6 % in young adults aged 18 to 21.(1) Adult flatfoot is defined as foot condition that persist or develop after skeletal maturity and is characterized by partial or complete loss of medial longitudinal arch.(2) Painful symptomatic presentations associated with flatfoot include: generalized lower limb pain; increased lower limb fatigue, Achilles tendinopathy, osteoarthritis, patellofemoral disorders and hip pain which usually occurs due to biomechanical changes. The biomechanical changes due flatfeet alters knee joint rotation, laxity. When hyper pronation occurs the talus plantar flexes and adducts on calcaneus causing the tibia to follow the talus medially resulting in a compensatory increase in internal tibial rotation. The mechanical efficiency and relative contribution of the muscles to knee joint stabilization are likely affected if the muscle orientation or length tension relationship sufficiently altered. The compensatory activity both proximal and distal to knee may occur to control for decreased foot stability and increased internal tibial rotation with excessive tibial rotation and excessive pronation leading to muscular fatigue and overuse. A study conducted by Neville C. et al Comparison of Changes in Posterior Tibialis Muscle Length Between Subjects With Posterior Tibial Tendon Dysfunction and Healthy Controls During

Walking. It examined the kinematics of foot in abduction, adduction, dorsiflexion and plantar flexion in seventeen subjects with stage 2 PTTD along with 10 healthy controls. A three dimensional motion analysis technique was used was used to for the kinematic input into a general model of PT length. The study concluded with results that the length of tibialis posterior was greater during all the phases of gait as compared with healthy normal. And compared between the phases the length was greater in preswing phase.

As the electromyographic studies performed suggested that flat arched group exhibited increased activity of the major muscle tibialis posterior and decreased activity of peroneus longus. [(6)] Biomechanically posterior tibial tendon plays an important role in normal hindfoot function. It plantarflexes and supinates the foot and prevents valgus deformity. Overuse of this tendon leads to tendinitis. Many authors have described the stages of progression from peritendinitis to elongation and degeneration of tibialis posterior tendon and fixed valgus deformity which are associated with flatfeet. The degenerative changes that occur in this tendon lead to symptoms like pain and progressive weakness and if not identified will progress to deformity of foot and degenerative changes in surrounding foot structures.

According to literature the prevalence of posterior tibialis tendon dysfunction (PTTD) is 10% in older adults. The same age group holds a prevalence rate of 13.6% that is affected with flatfeet with many cases undiagnosed due to lack of awareness.[(1)] As classified by Johnson and Storm, PTTD is progressive and classified in 4 stages, the fourth stage attributed by author Myerson. The first stage usually presents with tenderness along the length of posterior tibialis tendon and increased tenderness at the navicular tuberosity. It also presents with minimum amount of loss of strength, an individual with initial stages of PTTD may be able to perform 8 to 10 heel raise but not more. The hindfoot flexibility that is adduction of hindfoot may be absent or present.

The second stage also presents with pain, moderate amount of loss of strength, too many toe signs on observation and a progressive deformity may give a presentation of loss of hindfoot mobility. The third stage by Johnson and Storm presents with pain with individual not able to perform a single heel raise due to pain and severe loss of strength. This stage usually presents with fixed deformity and increased tendon length is classification is based on clinical and anatomic findings. Along with diagnosis of PTTD it adds to guiding the treatment and provides useful prognostic information. It has served widely for classification for adult flatfoot deformity.

The prevalence study conducted in past showed great paucity in explaining the procedure of classifying the flatfoot deformity and diagnosis of PTTD. As the most widely used classification given by Johnson and Storm, provides a scope to identify the individuals in earlier stages which can further facilitate the early conservative treatment of PTTD and preventing the progression of same it is important to screen individuals with flatfeet for PTTD and identify its magnitude of same in these individuals. There is paucity of the prevalence rate of PTTD in individuals ranging from 18 to 25 in spite of 11.5 % of its population affected with flatfeet which is as high as in older adults.

Therefore the objective of study was:

- To find the prevalence rate or the magnitude of dysfunction in the age group of 18 to 25 years for its early screening so as to prevent its progression in further stages.

Methodology:
Source of Data collection: Ramaiah Medical College Campus

Method of Data Collection:
Population : Subjects with flatfeet
Sampling technique : Convenience Sampling
Type of Study: Cross Sectional study
Study Setting: Ramaiah Hospitals and campus

Inclusion criteria:
1. Students with flatfeet (FPI score 6-12)
2. Age 18-25
3. Gender : Both Male and Female

Exclusion criteria:
1. Recent falls
2. Acute ankle sprains (1 week old)
3. Any musculoskeletal condition (gout, plantar fasciitis)

Outcome measures:
1. Johnson and Strom Classification

Materials Used:
1. Chair
2. Pain Pressure Algometer
3. Pen
4.

Figure 1: The above picture is of subject standing in starting position before testing

Figure 2: The above picture is subject performing a heel single heel raise

Figure 3: The above picture is of assessment on observation for flexibility of hindfoot

Figure 4: The picture below is of Pain Pressure Algometer

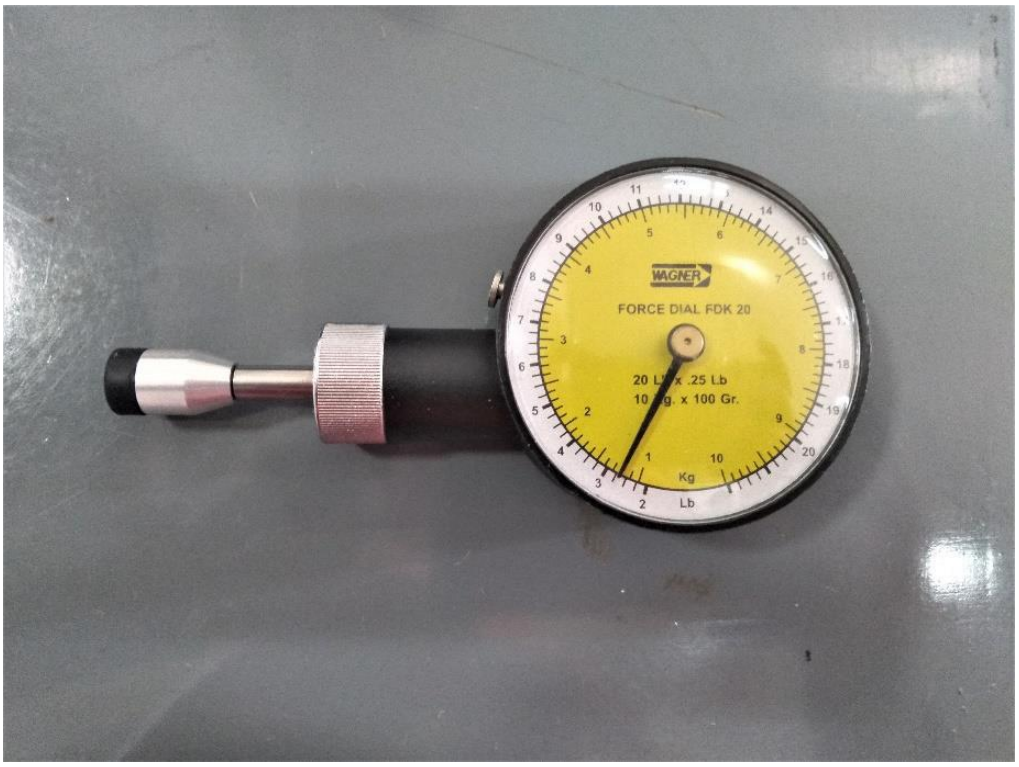
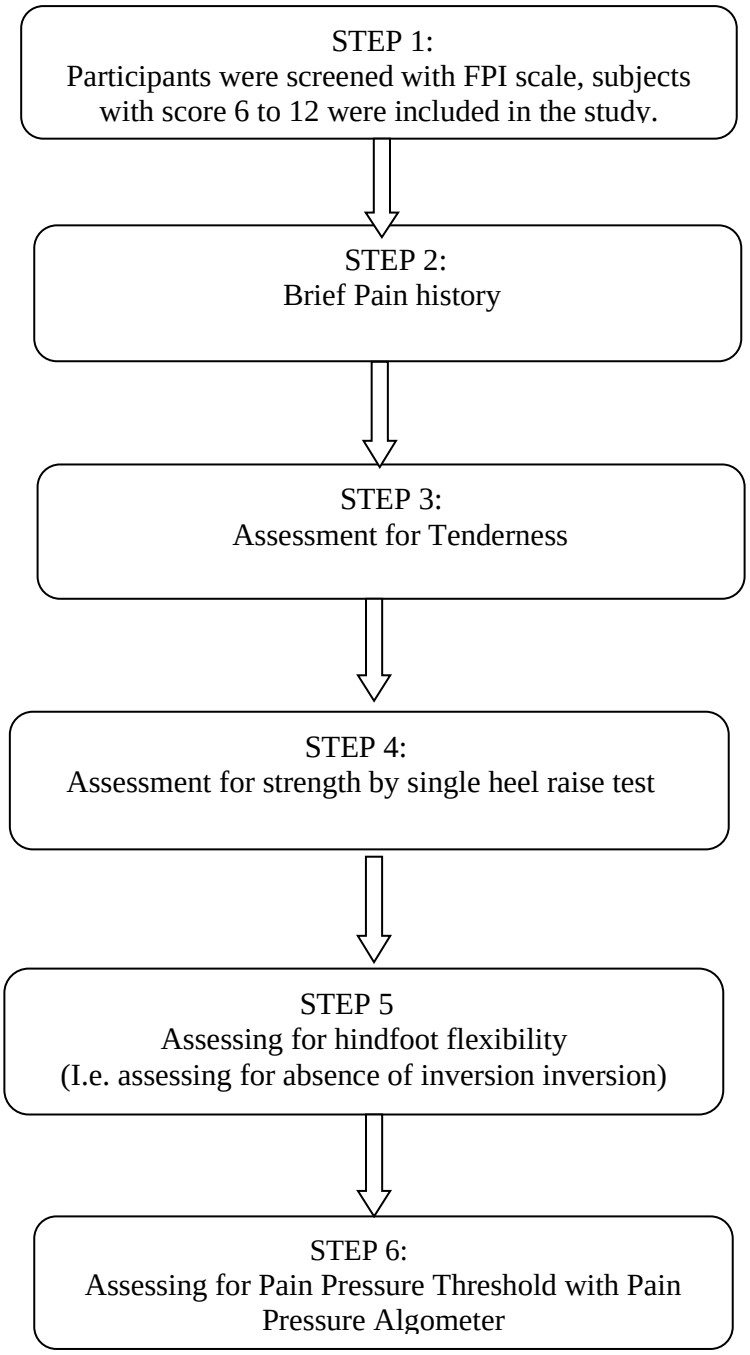


Figure 5: The above picture is of assessment Pain Pressure Threshold with Pain Pressure Algometer

Procedure of Data Collection:

An ethical clearance was obtained from ethical committee (MEU-PT/EC/07/2018) of Ramaiah Medical College and Hospitals. Subjects were recruited from Ramaiah campus. Both male and female between the age group of 18 to 25 year satisfying inclusion criteria were enrolled in the study. Subjects who complained of heel pain or have been diagnosed with any condition of foot except flatfeet were included. Purpose of this study was explained and an informed consent was obtained from all the subjects enrolled in the study

Figure 6: Flow diagram of procedure of the study



Inclusion criteria:
Students with flatfeet
Age :18-25
Gender : Male and Female

Exclusion criteria:
Recent falls and fractures
Acute ankle injuries
Any chronic musculoskeletal conditions

Outcome Measures:
Johnson an Strom Criteria

Material :
Pen
Chair
Pain Pressure Algometer

Method
A total of 62 subjects with bilateral flatfeet were included in study after a FPI screening was administered. Individuals falling in range 6 to 12 of FPI (Foot Posture Index) scale and a brief pain history were included. These subjects were further assessed based on Johnson and Storm criteria and were administered with Pain Pressure Algometer for identifying the pain threshold values in the individuals diagnosed with PTTD.
Clinical Evaluation:

The Johnson and Strom Criteria:

Stage 1 and 2
1. Swelling and tenderness: Mild to marked swelling and tenderness along posterior tibial tendon
2. Single Heel-rise test: Mild to marked weakness
3. Observation on single heel raise test: absence of inversion (flexible deformity)

Description:
The Johnson and Storm classification for clinical diagnosis of PTTD was formed in 1989. It was widely used clinically for diagnosis of symptomatic flatfeet and for PTTD.

- It consist of 3 stages and the 4th stage which was attributed to author Myerson.
- The subjects are examined for stage 1 and 2 for components that is tenderness absent or present on palpation, strength to be examined by single heel raises and inversion test (absence or presence of inversion on single heel raise) for assessing mobility of hindfoot.

Interpretation:

1. Tenderness: Evaluated on palpation:

To be reported to be absent or present along the course of the posterior tibialis tendon.

2. Strength: Functional strength testing:

Assessed by single heel raise (assessed individually on each feet).
Individual foot able to perform 8 or less than 8 considered to have significant strength loss and marked weakness.

3. Hindfoot mobility:

Assessed by individual performing single heel raise and observing the inversion of hindfoot.
To be reported as absence or presence of hind foot inversion

4. Pain Pressure Algometer:

Description:

The PPA is a handheld device with a pressure application display. They have a "maximum hold" function that shows or represents the maximum pressure obtained in single application. The devices have a 1-cm2 pressure application surface and display force readings in newton's or kilograms of force. The force application should be perpendicular to the body surface, and the rate should be constant at an approximate rate of 1 kg·cm−2·s−1 or 10 N·s−1 to increase reliability. The PPA are used for determination of "hot spot" tenderness and for diagnosis of any myofascial dysfunctions.
Procedure for performing the test includes assessing for pain on palpation which is reported with a score on VAS (Visual Analogue Scale). After assessing for VAS the individuals reporting pain on palpation are further evaluated with a Pressure Algometer.
For this evaluation patient sits on a table with the leg to be assessed on a stool as an easy access to the assessor. The patient is instructed about the procedure and reporting of pain. The pressure algometer is placed on the navicular tuberosity and holding it perpendicular to the area to be assessed. Pressure is placed applied until the individual reports of just slight elicited pain. The values are noted and then checked similarly on the other limb and values are noted. The value are noted down in kilograms

Statistical Analysis:

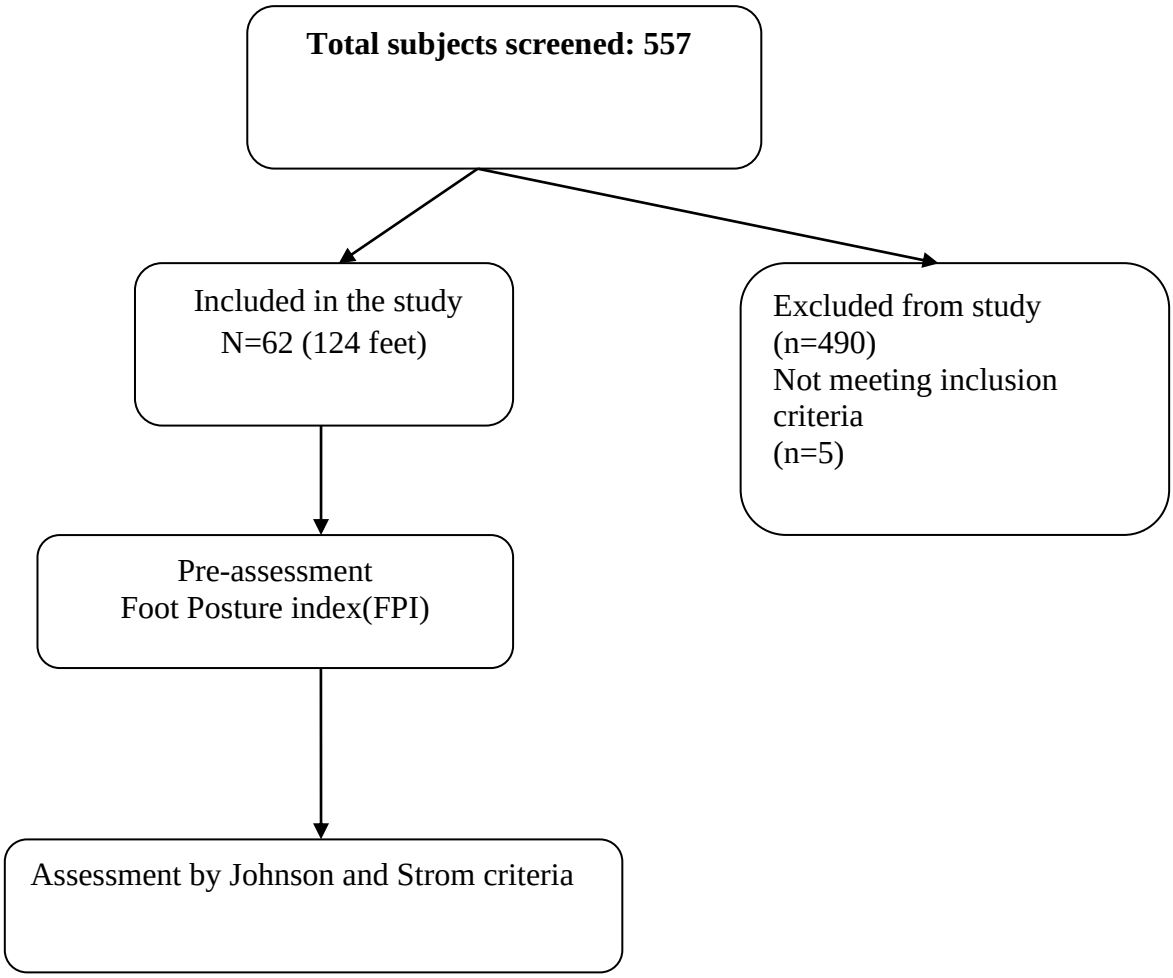
The statistical software namely SPSS was used for analysis of data. Microsoft word and Excel were also used to generate tables. The descriptive statistics were analysed and presented in terms of mean and standard deviation. The prevalence ratio was used to calculate the prevalence percentage of the PTTD in individuals with flatfeet.

Results:

Participant Recruitment:

Subjects from Ramaiah campus screened. Total of 557 subjects were screened with FPI out of which 67 subjects were selected having flatfeet, out of which 5 subjects were excluded due to heel pain and recent ankle sprains. The remaining 62 subjects were then assessed for tenderness, strength and hindfoot mobility.

Figure 7: Participant Recruitment



Descriptive Results:

Total of 557 subjects were screened for obtaining a total of 62 subjects with bilateral flatfeet. Subjects were pre-screened with a FPI scoring scale. Subjects with scoring of 6 to 12 on FPI were included in study. Subjects were recruited in the study were in age range of 18 to 25 with minimum age 19 and maximum 25 the mean age calculated was found out to be 21.4 with standard deviation ±1.78.

Out of total 62 subjects, 124 feet were individually assessed for 3 components that is tenderness, strength and hindfoot mobility

Out of the total assessed 43.47% showed tenderness on the right feet whereas 56.52% in left feet similarly strength testing showed loss of tibialis posterior strength of 43.47% on the left feet and 56.52% on right.

The 3rd component assessed, hindfoot mobility showed loss of mobility 14% on left and 63% on right sided feet.

Table 1: Tenderness Assessment For Tibialis Posterior Tendon. (Criteria 1)

Tenderness	N=124	Right	Left
Present	23	13	10
Absent	101	49	52

Figure 8: Shows Presence Of Tenderness In 23 Feet Out Of The 124 Feet Assessed

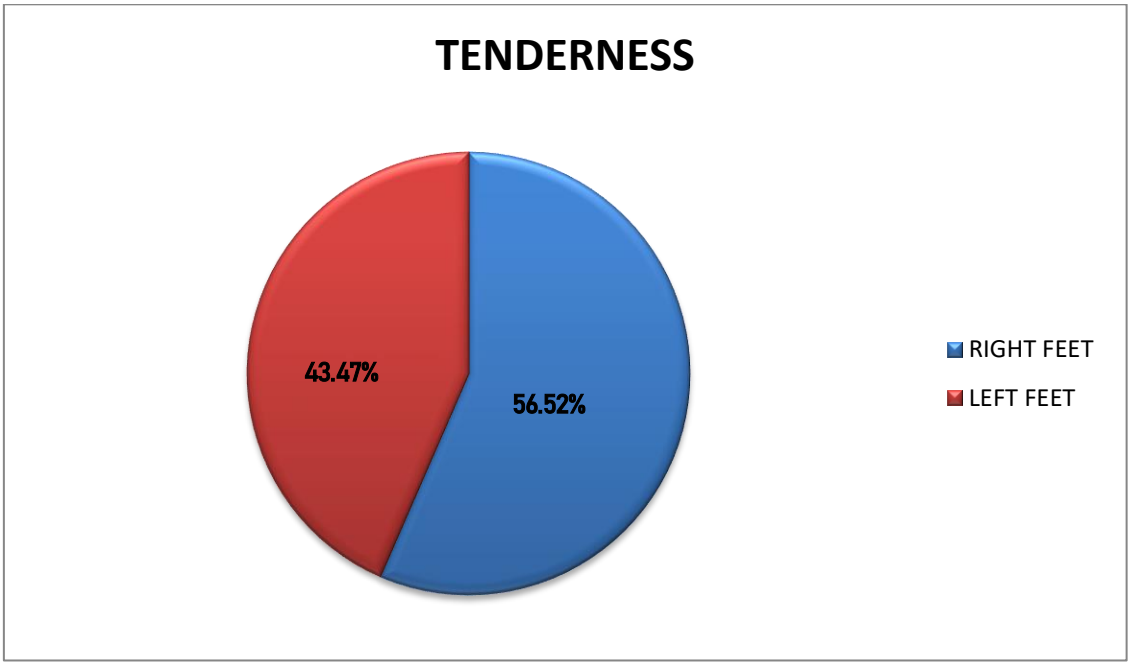


Table 2: Tibialis posterior Strength testing - Si Single heel raise test (criteria 2)

Heel Raises	N=124	Right	Left
Below	23 feet	13	10
Above 8	101 feet	49	52

Figure 9: Shows The Strength Present Based On Heel Raises Performed. Out Of 124 Feet Assessed 23 Were Able To Perform Less Than 8 Heel Raises Indicating Loss Of Strength.

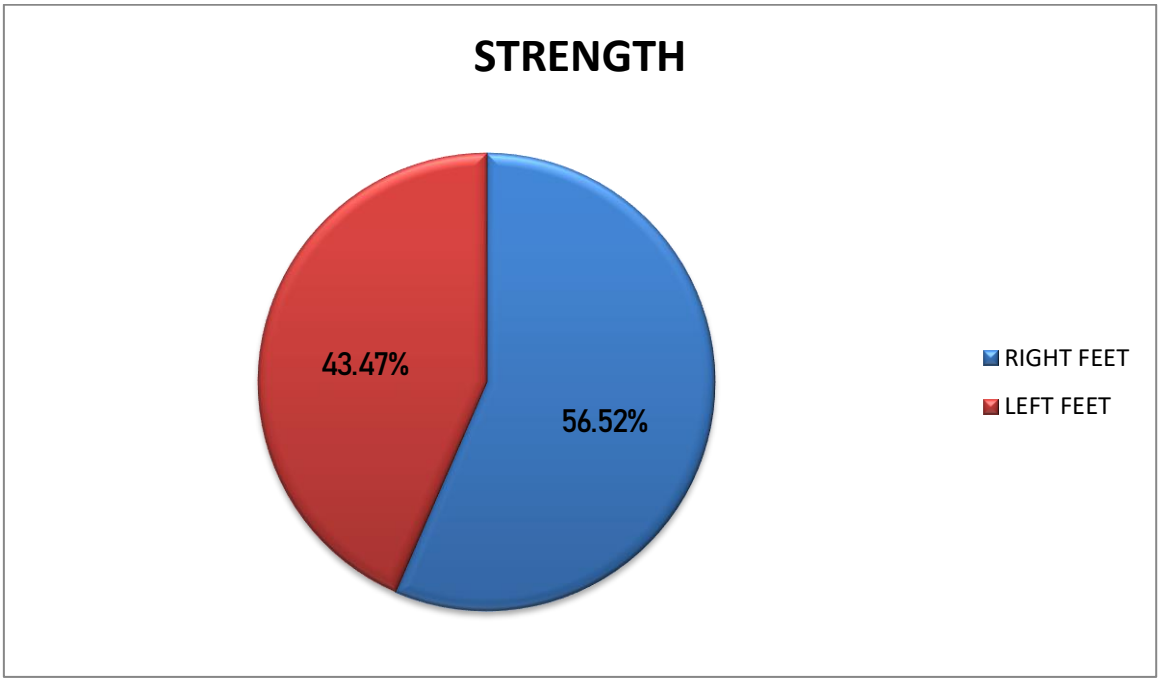
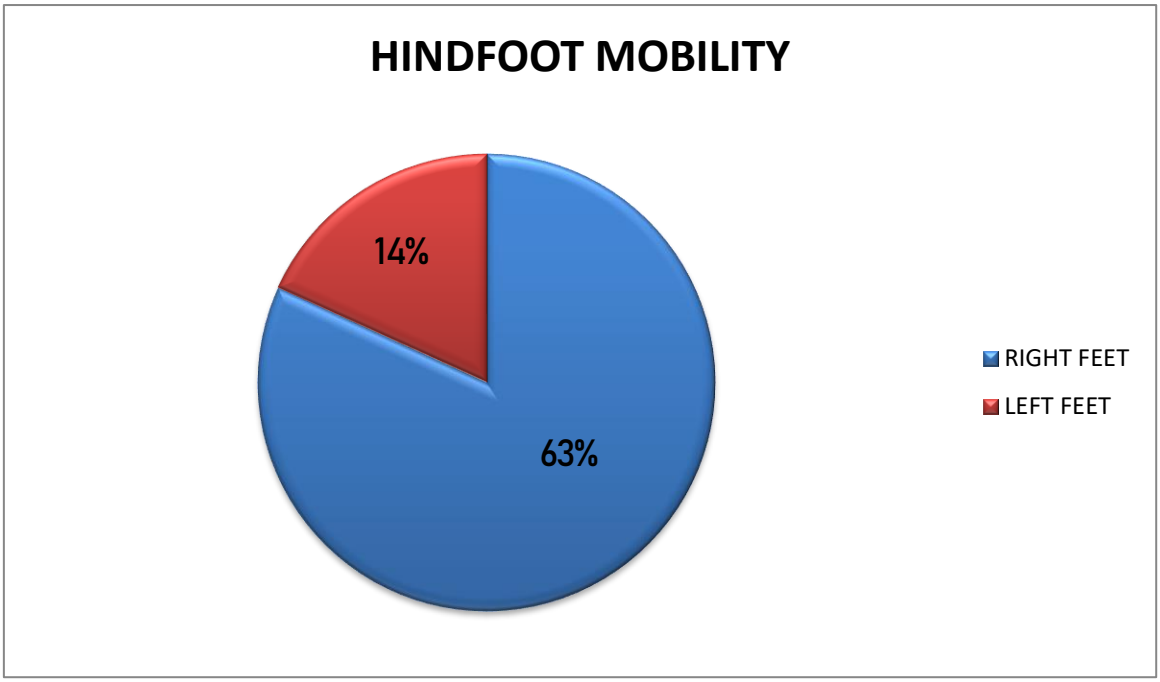


Table 3: Hindfoot Mobility - Inversion Test (Criteria 3)

Inversion of hindfoot	124 feet	Right	Left
Absent	47	24	23
Present	77	37	40

Figure 10: Shows The Results Of Presence And Absence Of Flexibility Of The Hindfoot In The Assessed Feet.



A total of 23 feet out of the 124 feet were seen to be positive for all 3 diagnostic criteria of Johnson and Strom that is tenderness accompanied by loss of strength and hindfoot mobility thereby by indicating Stage 1- Stage 2 PTTD cumulating a prevalence rate of 18.54% according to the prevalence ratio.

Discussion:

PTTD has been closely associated with flatfeet and is progression as widely described in literature. The degenerative changes seen include pain, weakness and even a deformity in its advanced stages. Tibialis posterior functions as a primary stabilizer of medial longitudinal arch and also as a midfoot inverter therefore causing elevation of the medial longitudinal arch transitioning the hindfoot and midfoot into a rigid structure. [(11)] As described by Johnson and Strom the symptoms observed in the dysfunction can be debilitating with wide range of conditions affecting the tibialis tendon. The advance stages are seen to have even more severe sequelae leading to arthritis and deformity.[(9)]

The rigid structure of the foot and its dynamic support are very essential for the foot to efficiently function to absorb body weight and its transmission and to act as a strong lever for forward propulsion of body during locomotion. Loss of this functions leads to affection of an individual's ability to perform gait. [(14)]

The disease or dysfunction is under-recognized as an entity also leading to misdiagnosis causing its progression into its further severe stages. [(15)] The main objective of the study was identifying the magnitude of problem so as to identify or screen the individuals with flatfeet for PTTD in its earliest stages i.e. stage 1 and stage 2 as stated by Johnson and Storm.

The classifications of PTTD presented in literature the oldest one is contributed by Johnson and Storm and widely used in clinical practice. In the present study individuals with flatfeet were assessed for presence of Posterior Tibialis Dysfunction. Individuals were assessed based on presence of pain,

strength and flexibility of foot as the assessed symptoms are critical in deciding the diagnosis. The individuals assessed in the study were flatfeet individuals with a Foot posture index score in the range 6 to 12. As mentioned in literature the association of flat feet and PTTD has long been researched due the roles that are played by each of the structure supporting the foot.

The individuals recruited in the study were in the age range of 18 to 25, also the age range that shows cases of symptomatic flatfeet as that in older individuals. A study conducted by Kohls-Gatzoulis on older woman in England above the age of 40 showed a prevalence rate of 10 % of PTTD in individuals with flatfeet. Some of the cases suffered from symptomatic foot but were never assessed for PTTD.(13)

As literature presents with some significant symptoms associated with each stage the typical and the commonly seen symptom is pain and tenderness. The presence of pain along the length of posterior tibialis tendon is a common symptom that appears even before the degenerative process sets in. Tenderness was assessed on palpation along the length of the tendon and also at the navicular tuberosity. There were 23 feet that showed positive sign for tenderness on palpation at the navicular tuberosity. The pain was the documented with VAS. The Pressure Algometer was used to assess the pain threshold of the same. The mean range of pain on VAS was from 4 to 7 (moderate amount of pain).

The strength is another significant debilitating factor and most crucial one. As according to Johnson and Strom the heel raise test performed on an individual feet gives an insight on the strength of the PT and its endurance to repeat the heel raise. In stage 1 and stage 2 patient is unable to perform more than 8 to 10 heel raises therefore indicating a loss of strength and ability of PT to lock the hindfoot joint and elevate the foot. Out of the 124 feet assessed individually 23 feet showed loss of moderate strength with individuals able to perform 8 to 10 heel raises. The individuals with pain and tenderness also complained of loss of ability to further continue the heel raises. There was presence of fatigue while performing the test and also a sharp pain around the medial aspect of pain along the length of the tendon while performing the heel raises.

As the experimental study conducted by E.Uchiyama suggested that an abnormal gliding reaction in pre-existing flatfoot deformity may lead to PTTD and trauma to tendon. The hindfoot position plays an important role in stabilizing the foot. The gliding reaction is biomechanically hampered with a reduced hindfoot flexibility in a flatfoot deformity.(16) The deformity of the hindfoot is observed to worsen from the second of PTTD. In the current study the hind foot flexibility was assessed on observation when the individual was tested with a single heel raise. Absence of valgus was noted in 47 individuals out of which 23 feet previously complained of tenderness and loss of strength.

As literature showed that dysfunction was mostly observed in women in the current study too similar dominance was noted. The far effects of PTTD in women are also a causal factor for affection of the proximal muscles, the study conducted by Kulig et al concluded from the study that women having PTTD showed a significant impairment performance of bilateral hip extensor and abductor along with affection of strength and endurance. The study also mentioned there was a possibility of affection of the unaffected foot as the PTTD affected foot worsens further.(17) The current study observed dominance of women and according to literature may lead to affection of hip and proximal muscle affection if not intervened as earlier as possible. An early intervention has been suggested so as to halt the further preventable stages of PTTD and the conditions associated with PTTD.

The interventions that were suggested by most of the authors that contributed to the PTTD classification mostly were conservative. The systematic review in 2018 showed that eccentric strengthening in

combination with orthoses showed moderate effects when compared with concentric exercises and orthoses in combination and stretching along with orthoses alone.[18]

The Posterior Tibialias tendon dysfunction being a progressive disease which not only affects the foot but also leads to biomechanical dysfunction proximally in its advance stages as it worsens, it is strongly recommended that a screening test to be used as tool to identify PTTD and assess the integrity of the tendon in individuals with PTTD

Limitation of the study:

- Only medical students were included in the study. To identify the magnitude of the dysfunction in the whole of similar age group, individuals from different professions with flatfeet should be recruited and screened for PTTD.

Future Recommendations:

- To study the pain pressure thresholds in normal individuals for Posterior tibialis tendon to understand and interpret the severity of PTTD

Conclusion:

- The present study documented that the prevalence rate of PTTD in individuals with flatfeet is 18.54% which is higher compared to that found in the previously conducted study in older women

Appendix :

RAMAIAH Medical College

ETHICS COMMITTEE
Reg. No. ECR/215/Inst/KA/2013/RR-16

MEU-PT/EC/07/2018 Date: 27/04/2018

CERTIFICATE OF ETHICAL CLEARANCE

This is to certify that **Ms. PALAV PRIYANKA NANDKISHOR** is a bonafide full time postgraduate MPT student in Musculoskeletal disorders and sports physiotherapy of this institution. She was admitted to this course in August 2017. The Ethics Committee has issued ethical clearance to the candidate to carry out the dissertation work titled **"Prevalence of posterior tibialis tendon dysfunction in individuals with flatfeet".** This Ethical Clearance is valid for a period of 1 year.

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ANNEXURES

ANNEXURE A

PARTICIPANT INFORMATION SHEET AND INFORMED CONSENT FORM

Name of Institution: Ramaiah Medical College, Bangalore.
Title of study: Prevalence of Posterior Tibialis Tendon Dysfunction in Individuals with Flatfeet.
Name of Principle Investigator: Priyanka Palav
Name..... Age..... Sex.....Faculty……

1. **Introduction**

1. I Ms. Priyanka Palav, student of the postgraduate Physiotherapy program in Ramaiah Medical College, Bangalore, want to investigate the Prevalence of Posterior Tibialis Tendon Dysfunction Individuals with Flatfeet as a part of my postgraduate thesis. There may be some words that you do not understand, please do not hesitate to stop me as we go through the information and I will take time to explain the same. Any queries that you may have will be answered by me.

2. Purpose of the research

Posterior Tibialis Tendon Dysfunction is a condition usually associated with individuals with flatfeet. The biomechanical changes due flatfeet may furtherworsen the condition therefore its early screening is important. There is enough literature stating the affection of tibialis posterior tendon but scarcity reporting the prevalence of it in 18 to 25 years of age individuals.

3. Type of Research Intervention

This study will be an Observational study. This study involves evaluation of individuals for flatfeet with FPI-6 and screening for pain at ankle. The pain then assessed by VAS and Pain Algometer at navicular tuberosity at insertion of tibialis posterior and reported.

4. Participant selection

Your participation in this research is entirely voluntary. It is your choice whether you want to participate or not. Whether you choose to participate or not, all the services you receive at this clinic will continue. If you change your mind at a later point you may stop participating even if you had agreed to participate earlier.

5. Procedures and Protocol

The procedure will start by screening the feet for overpronation with a FPI-6 outcome measure. The flatfeet are scored based on the FPI-6 scoring. If indicative of flatfeet or overpronation a brief history about the foot pain if present will be collected and VAS (Visual Analogue Scale) will be reported for the pain. Further the foot will be assessed based on the Johnson and Strom criteria.

A Pressure Algometer for quantifying the pain will be intervened on bilateral feet and the values obtained will be noted, the assessment based on the classification and the findings obtained will give further information about presence of Posterior Tibialis Tendon Dysfunction in flatfeet.

6. Duration
The assessment will be done in an hour duration on the day of evaluation.

7. Side Effects
The chances of side effects in this study are low.

8. Risks
There are no known risks by participating in this study.

9. Benefits
Early screening of dysfunction may help in identification on tibialis posterior involvement and early intervention to stall the progression of the condition10. Confidentiality
The information that we will collect from this research project will be kept confidential. It will not be shared with or given to anyone except for publishing

11. Right to Refuse or Withdraw
I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have asked has been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.
Name of Participant _____
Signature of Participant _____
Date _____

12. Statement by the researcher/person taking consent
I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands the procedure.
I confirm that the participant was given an opportunity to ask questions about the study and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent and the consent has been given freely and voluntarily.

Name of researcher/person taking the consent :

Signature of Researcher/person taking the consent:

Date:

ANNEXURE 2
ASSESSMENT PROFORMA

DEMOGRAPHIC DATA
NAME:
AGE:
GENDER:
HAND DOMINANCE:
OCCUPATION:
CONTACT NO:
PAIN HISTORY:

- Site of pain:
- Type of pain:
- Intermittent/Constant:
- Onset of pain:

Behaviour of symptoms:

- 24 hours pattern:
- Aggravating factors:
- Relieving factors:
- VAS SCORE: ….. /10

EXAMINATION:
Assessment based on Johnson and Strom Classification
1. Assessment for tenderness

Present /Absent
2. Assessment for strength (single heel raises)

More than 8 heel raises / Less than 8 heel raises
3. Assessment for hind foot flexibility

Presence of valgus / Absence of valgus
□□Pressure Algometer: Pain Pressure threshold……Values in kg/cm2

(Quantification of pain on the affected side)

Acknowledgement :
I owe my gratitude to the **Dr. Medha Y. Rao**, Principal and Dean, Ramaiah Medical College and hospitals for providing me the required facilities for the study.
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Author biography

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