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Are Tension-type Headaches Associated with Flexible Flat Feet? A Cross-sectional Study

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ABSTRACT

Background: Several peripheral and central factors are believed to contribute to the pathology of tension type headache (TTH). The current study aimed to identify a connection between TTH and flat feet.

Methods: In this cross-sectional comparative study, a total of 61 people with chronic TTH (13 male and 48 female) and 61 matched controls participated. The frequency of flat feet in the two groups was the primary outcome of this study. The presence of myofascial trigger points in the head and neck areas and the degree of neck disability were also assessed in both groups. Pearson's chi-square test and logistic regression models were used to determine the relative contribution of demographic and clinical predictive variables to the TTH.

Results: The chi-square test showed that frequency of flat feet, uni- or bilateral, was significantly higher (x^2=17.5, df=2, P<0.001) in the TTH group compared with the control group. Further analysis revealed that people with flat feet are 4.32 to 5.05 times more likely to develop TTH than people who have normal foot posture. The probability of developing TTH was 7.93 times higher in participants with 4 or more trigger points than in participants with less than 4 trigger points. Similarly, the probability of participants with a Neck Disability Index score of 4 or more developing TTH was 11.96 times higher than those with a score less than 4.

Conclusion: The current findings indicate a probable link between the presence of flat feet and chronic TTH.

Introduction

Tension-type headache (TTH) is characterized by a bilateral, persistent, compression pain felt around the head. It has a mild to moderate intensity which can persist from 30 minutes to 7 days [1]. TTH is usually divided into episodic (frequent and infrequent) and chronic types. People who have the infrequent episodic form of TTH experience pain for 1 day or less per month, while in people with the frequent episodic form, the frequency of pain is between 1 to 14 days per month. Compared to the episodic form, both frequency and duration of pain are higher in the chronic form of TTH (15 or more days per month for over 3 months) [2].

TTH is the most prevalent type of headache worldwide and is observed in all age groups. The episodic form of TTH has a prevalence of between 10% and 25% in children and adolescents and of 38% in adults [2]. The prevalence of the chronic form is lower than that of the episodic form [2].

The etiology of TTH is still not clear; however, several peripheral and central factors are believed to contribute to

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the pathology of TTH. Changes in central pain sensitivity, decreased antinociceptive activity, and mental tension are frequently mentioned as important central factors [3]. The peripheral factors may be related to biomechanical changes in the head/neck/shoulder complex. For example, previous works have reported greater forward head posture and reduced neck mobility in patients with TTH when compared to healthy controls [4]. It is well known that poor posture of the neck can change the length and strength of cervical soft tissues [5], which can, in turn, affect the temporomandibular joint and activity of the masticatory muscles [6]. Such biomechanical changes might explain pericranial myofascial tenderness, which is a common finding in TTH [7].

The human body is a functional unit with complex interactions between several body segments. A change in the structure or function of any body segment will inevitably lead to an adjustment in other segments [8]. It has been shown that there is a relationship between spinal curve and head and neck posture [9]. There is also evidence that the position of the spine and pelvic alignment can be affected by foot posture. For example, excessive foot pronation is considered a risk factor for biomechanical dysfunction of the pelvis and low back pain [10-12]. Furthermore, it can change the timing and intensity of lumbopelvic muscle activation [13].

Based on these findings, it can be speculated that a change in lower limb alignment might trigger postural adjustment in upper parts of the kinematic chain, particularly the neck and head. In an EMG study, Valentino et al. found a correlation between the plantar arch and activity of the masticatory muscles [14]. In another interesting study which tested 22 children, children with more pronated foot were found to have a shorter vertical face dimension [15].

Despite its high prevalence, much remains unknown about the underlying mechanisms of TTH. Considering the relationship between TTH and head and neck posture as well as the kinematic relationship between lower limbs and spine curvatures, we conducted this cross-sectional comparative study to identify the connection between TTH and flat feet. We hypothesized that a higher rate of flat feet would be observed in patients with TTH in comparison with healthy controls. We further hypothesized that the degree of neck disability, number of trigger points in the head and neck area, and type of flat foot (uni- or bilateral) might be good predictors of developing TTH. According to our latest research, no studies have determined a cut-off point for incidence of tension headaches. Thus, we have provided predictive cut-off values for the variables in the development of TTH.

Methods

Study Design

This cross-sectional study was undertaken to determine the rate of flat feet in a group of patients diagnosed with chronic TTH compared with a matched control group.

Participants

We recruited the patients from a neurological clinic using convenience sampling. Inclusion criteria for the TTH group included: (1) a neurologist-confirmed diagnosis of TTH according to International Headache Society criteria [16], and a history of TTH for more than 3 months. The healthy controls were recruited as friends or relatives of the patients. Both groups were matched for age and gender. The following individuals were excluded from the study: (1) those who had a history of ankle or foot fracture or surgery, (2) those who had rigid flat feet, and (3) women who were pregnant or breastfeeding. Rigid flat foot was determined by comparing the medial arch in loaded and unloaded positions. All participants signed an informed consent form approved by the local medical ethics committee. This study was approved by the Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.REC.13926148).

Outcome Measures

The frequency of flat foot in the two groups was the primary outcome of this study. The presence of myofascial trigger points in the head and neck areas (hereafter referred to as TPs) and the degree of neck disability were also assessed in both groups to evaluate the independent association of TTH with these previously reported comorbidities [17].

Procedure

After collecting demographic information, the presence of uni- or bilateral flat feet was assessed using the navicular drop test. This is a valid and reliable test [18] in which the examiner marks the navicular tuberosity and measures the height of the navicular bone in non-weight bearing and weight bearing positions. To find the neutral position of the talus, the participant was asked to stand with feet in a relaxed standing position. The examiner palpated the head of the talus on the dorsal aspect of the foot. Then she asked the participant to rotate the trunk to the right and left. This motion caused the supination and pronation of the talus through medial and lateral rotation of tibia. If the foot is positioned so that the talar head does not bulge to either side then the subtalar joint will be in neutral position in weight bearing. The examiner first measured the height of the navicular from the floor in the neutral talus position and then in normal relaxed standing. The difference between the first and second measurements was considered the navicular drop. Any measurement greater than 10 mm is generally considered abnormal [19]; however, in this study, a difference of >8 mm was considered as flat foot. We chose 8 mm as the indicator, because all participants with a navicular drop of more than 8 mm had positive Feiss line tests in which the navicular tuberosity mark fell below the line. It is noteworthy that the examiner was trained by an expert physical therapist before data collection.

Pain and disability in the neck and head were assessed using the validated Iranian version of the Neck Disability Index (NDI) [20]. NDI is 10-item, scaled questionnaire which evaluates activities of daily living (7 items), pain (2 items), and concentration (1 item). Each item is scored from 0 to 5, and the total score is stated as a percentage. In this scale, higher values denote greater disability [21].

The upper trapezius, temporalis, and sternocleidomastoid muscles were also palpated to identify TPs. TPs were defined as localized tender areas or taut bands which cause radiation of pain in characteristic patterns in response to deep pressure [22]. All assessments were done by one examiner.

Statistical Analysis

The sample size of this study was computed using the sample size formula for comparing proportions of two groups, considering p1=58.3 (case) and p2=33.3 (control) based on a pilot study (24 cases in each group). Furthermore, we considered α=0.05 and power=80%. Ultimately, the sample size of 60 cases per group was determined. All calculations were performed in Medcalc software 13.

All statistical tests were performed with SPSS, version 20 (SPSS, Inc., Chicago, IL, USA). Normal distribution of data was assessed by Kolmogorov–Smirnov test. Descriptive statistics were used to summarize the demographic characteristics. Pearson's chi-square test for association was used to compare the groups regarding the prevalence of unilateral and bilateral flat feet. Logistic regression models were used to determine the relative contribution of demographic and clinical predictive variables to TTH. The outcome variable was the presence of TTH (case/control), and the possible predictor variables were age, gender, neck disability, number of TPs, foot posture (categorized into flat feet or normal), and type of flat feet (categorized into unilateral flat feet, bilateral flat feet, and no flat foot). A series of chi-square analyses were performed to ascertain the independence of the predictive variables. Because a significant correlation was found between TPs and neck disability, their predictive values were assessed separately using two multiple regression models.

To arrive at the best predictive model, backward stepwise algorithms were used to evaluate the significance of all interactions. Those variables with P≥0.1 were eliminated from the final model, and odds ratios with 95% confidence intervals (CI) were estimated. For variables that showed a significant association with TTH, the area under the receiver operating characteristic (ROC) curve and the associated 95% CI were calculated to determine the predictive cut-off values of those variables in the development of TTH. The significance level was set at P<0.05 for all tests.

Results

A total of 61 people with chronic TTH (13 males and 48 females) and 61 matched controls participated in this study. Distribution of data was normal. There was no statistically significant difference in mean age or BMI between the two groups (Table 1).

The chi-square test showed that the frequency of flat feet, uni- or bilateral, was significantly higher (x^2=17.5, df=2, P<0.001) in the TTH group compared with the control group (Figure 1).

Type of flat feet (P=0.87), age (P=0.58), and gender (P=0.33) were sequentially removed from the full model of the first logistic regression model. The remaining variables, i.e. foot posture (P=0.001) and number of TPs (P<0.001), were significantly correlated with TTH. Odds ratios indicated that people who have flat feet are 4.32 times more likely to develop TTH than people with normal foot posture. For this model, the area under the ROC curve was 0.745 (CI: 0.657-0.834), which can be considered fair. Based on the number of TPs, the optimal cut-off number for predicting the risk of TTH was the presence of more than 3 TPs in the neck and head areas with a 7.93-times (CI: 3.161-19.925) higher chance of developing TTH.

Type of flat feet (P=0.87), age (P=0.63), and gender (P=0.24) were sequentially removed from the full model of the second logistic regression. The remaining variables, i.e. foot posture (P<0.001) and NDI score (P=0.001), were significantly correlated with TTH. Odds ratios indicated that people who have flat feet are 5.04 times more likely to develop TTH than people with normal foot posture. The area under the ROC curve for the model was 0.753 (CI: 0.665-0.842), which can be considered fair. Based on NDI scores, the optimal cut-off score for predicting the risk of TTH was a score of more than 3 on NDI with a 11.96-times (CI: 4.196-34.103) higher chance of developing TTH.

A summary of the final multivariate logistic regression models is presented in Table 2, and the ROC curves are presented in Figure 2.

Discussion

The current study assessed the association between TTH and the presence of flat feet. In line with our hypothesis, the results showed that the frequency of flat

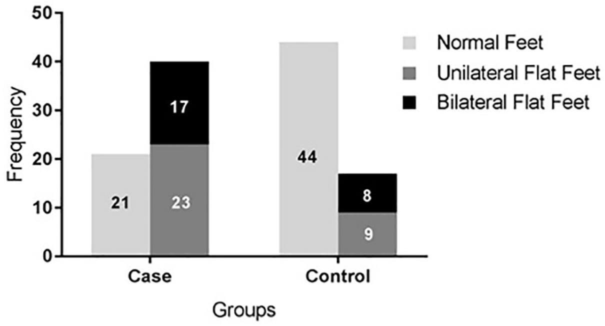

Figure 1: Frequency of normal feet and flat feet in tension type headache group (case) and healthy group (control)

Table 1: Demographic characteristics of participants

Variable		Average	Standard deviation	P value
Control group	Age (years)	36.7	11.3	0.7
Headache group		37.5	11.3	
Control group	BMI	24.7	5.69	0.87
Headache group		24.6	5.03	

BMI:Body Mass Index

Table 2: Results of two multivariate logistic regression models (Note: The results presented here include only the variables that show statistical significance in the final multivariate logistic model.)

Factor	Coefficient	SE	Wald	df	Significance	Odds ratio	95.0% CI for Odds ratio	
							Lower bound	Upper bound
Model 1								
Number of trigger points	0.234	0.064	13.569	1	0.000	1.264	1.116	1.431
Foot posture	1.463	0.443	10.934	1	0.001	4.320	1.815	10.283
Constant	-1.434	0.335	18.291	1	0.000	0.238		
Model 2								
NDI score	0.088	0.028	10.180	1	.001	1.092	1.035	1.153
Foot posture	1.619	0.420	14.877	1	0.000	5.047	2.217	11.488
Constant	-1.499	0.368	16.580	1	0.000	0.223		

NDI: Neck Disability Index; SE: Standard error of mean; df: Degree of freedom; CI: Confidence interval

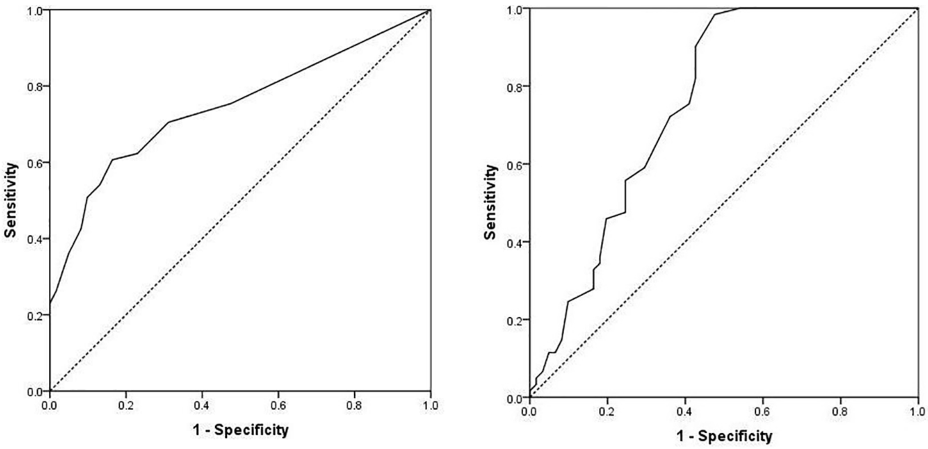

Figure 2: The ROC curves for the trigger point values (left) and Neck and Disability Index values (right)

feet was almost two times higher in patients with TTH than in healthy controls. Further analysis revealed that people with flat feet are 4.32 to 5.05 times more likely to develop TTH than people who have normal foot posture.

The higher frequency of flat feet in patients with TTH was expected. TTH seems to be related to musculoskeletal disorders [23]. Musculoskeletal dysfunctions, myofascial disorders, and abnormal postures are usually considered in the evaluation and treatment of TTH [17]. Previous studies have shown that forward head posture is more frequent in headache patients than in healthy people [24]. Forward head posture may lead to hyperextension of the upper cervical spine, flattening of the lower cervical spine, and rounding of the upper back as well as elevation and protraction of the shoulders [25].

Conversely, previous studies have reported that flat feet can lead to musculoskeletal disorders in proximal parts of the body. For example, flat feet can cause tibial torsion, which might consequently lead to pain and compensatory postural alternations in the lower limbs and spine [26]. Studies have reported significantly higher rates of flat feet in people with anterior knee and low back pain compared to controls [27, 28]. Rothbert found a relationship between skeletal displacement in the pelvis and face and asymmetrical bilateral foot pronation. He used a gravitational model to explain this correlation. According to this model, abnormal foot pronation causes the innominate bone to move anteriorly and downwardly. Such displacement of innominate bone may cause anterior rotation of the temporal bone and, consequently, displacement of the sphenoid and maxilla bone [15]. Furthermore, pronation of the subtalar joint consists of adduction and plantar flexion of the talus as well as eversion of the calcaneus. Talus adduction results in the internal rotation of the lower limb [29] and the calcaneal eversion associated with the plantar flexion of the talus, causing functional leg length discrepancy [30]. These two situations may alter the alignment of the pelvic girdle [31]. Bilateral calcaneal eversion leads to internal rotation of the hips, anterior pelvic tilt [31], and lumbar hyperlordosis [32].

The cervical, thoracic, and lumbar spine are biomechanically interrelated; thus, any postural changes in the thoracic and lumbar spine could result in changes in the cervical lordosis [33]. Farokhmanesh et al. claimed that the position of the pelvic and lumbar spine can affect the thoracic spine. Lumbar lordosis leads to thoracic kyphosis [34]. Increased kyphosis in the thoracic spine may cause forward head posture [35]. Therefore, it could be speculated that people with foot pronation might develop forward head posture, causing them to be more prone to TTH. In future research, it would be interesting to examine the association between flat feet and forward head posture.

Logistic regression models revealed that the number of trigger points and the NDI score were predictors of TTH. The probability of participants with 4 or more trigger points developing TTH was 7.93 times higher than that of participants with fewer than 4 trigger points. Similarly, the probability of participants with an NDI score of 4 or more developing TTH was 11.96 times higher than that of participants with a score less than 4. As mentioned earlier, flat feet might influence the biomechanics and motor control of the entire body. For example, it has been found that changes in the medial longitudinal arch can result in hyperactivity of the mastication muscles [14]. Myofascial disorders and the presence of trigger points in the involved muscles may arise from postural disorders and may thus lead to problems in motor control of the body [36]. The presence of myofascial trigger points may alter the activation pattern of the muscle involved and may cause abnormal movement patterns in the shoulder girdle [37]. Based on our findings regarding the relationship of the number of trigger points and NDI score with TTH, we propose that both neurologists and physical therapists consider these comorbidities when assessing patients with TTH. While the number of trigger points and NDI score were found to be predictors of TTH, type of flat feet (uni- or bilateral) was not a predictor factor. We hypothesized that unilateral flat feet would cause more postural asymmetries throughout the kinematic chain than bilateral flat feet and thus be a predictor for TTH; however, this was not supported by our results.

Unfortunately, the characteristics of TTH, such as intensity and frequency, were not recorded in our study, as such information could enhance the study's external validity. It should be mentioned, however, that headache was the main complaint of the patients referring to the neurology clinic, indicating that the patients' symptoms were severe enough for them to seek treatment. Another limitation of this study was that we focused only on the head and neck regions and did not examine probable co-morbidities in the lower spine. One other study demonstrated that low back pain is prevalent in patients with chronic TTH [38]. This limitation should be considered in future studies.

Determining the predictive cut-off point for the development of TTH can be important in preventing this problem. Because people with flat feet and more than 3 trigger points in the head and neck area are more likely to develop TTH, paying attention to this musculoskeletal problem would be important in clinical practice.

Conclusion

In view of our findings and earlier evidence, we believe that flat foot is related to the presence of cervical trigger points and neck pain-related disability. As trigger points in the neck and head region are related to TTH, there may be a link between flat foot and TTH. Compensatory postural alignment may explain trigger point generation in patients with flat feet. Therefore, it is expected that a greater postural disorder will cause a higher probability of developing TTH. The strength of the association between flat feet and TTH was revealed in this study; however, it should be taken into consideration in further research to identify the detailed issues about the association between flat feet and TTH.

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