Association of Plantar Fasciitis with Lipid Profile and Glucose Level: A Case-Control Study

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Research Article

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Abstract

Background

Hyperlipidemia is associated with tendon disorders and biomechanical changes through tissue deposition. In the present study, we seek the relation of plantar fasciitis (PF) with lipid profile parameters and fasting blood sugar (FBS) levels.

Methods

In a case-control study, we enrolled 68 patients with a clinical diagnosis of PF in the case group and 136 individuals without PF in the control group. Patients' height, weight, body mass index (BMI), FBS, lipid profile including low-density lipoprotein (LDL), high-density lipoprotein (HDL), total cholesterol, and triglyceride (TG) laboratory tests were also checked as the main study variables to be compared between the two groups. The mean difference of each variable between the two case and control groups was tested using an independent t-test. Correlation coefficient analyses were used to calculate the correlation of patients' BMI with lipid profile and FBS levels to evaluate the BMI variable as a confounder.

Results

Patients with PF had higher levels of total cholesterol (p=0.001), LDL (P= 0.004), and TG (P=0.02). HDL (P=0.13) and FBS (P=0.24) levels did not differ between two groups. Odds ratio calculation showed that patients with serum levels of LDL >130 mg/dl and total cholesterol > 200 mg/dl were 3.7 and 1.8 times more likely to develop PF, respectively. We found no association between lipid profile parameters and BMI in either of the two groups.

Conclusions

Our findings show higher levels of serum lipid profile parameters in patients with PF. Thus, it supports the modification of LDL, TC, TG, and glucose levels when managing PF.

Trial Registration:

The study does not include intervention.

Introduction

Plantar heel pain is a common condition, which affects 10% of the population in their lifetime (1, 2). More than one million patients are reportedly treated for plantar fasciitis (PF) in the US (3). The condition is

more frequently observed among athletes and middle-aged people (4, 5). The leading theory regarding PF etiology is the biomechanical overuse (6), resulting from prolonged standing or running with a chronic degenerative process (7). Some non-modifiable factors associated with PF, are plantar fascia thickness and calcaneal spur (8). However, given the widespread prevalence and the considerable economic burden (9) of PF, identifying more modifiable risk conditions other than higher body mass index, or activity level, that previously determined (10) is worthy of investigation. Hyperlipidemia was associated with tendon disorders like Achilles, lateral epicondylitis, and rotator cuff tendinopathies (11–13), and thus, it may have a role in the pathophysiology of PF as well. A systematic review with 17 studies and 2612 patients showed a relationship between an individual's lipid profile and tendon health (14).

As deposition of cholesterol in tendon leads to persistent and mild inflammation, it can result in chronic tendon degeneration and biomechanical changes and attenuation of healing capacity (15, 16) which might similarly affect the fascia. Diabetes is also associated with tendinopathies due to a poor healing process (17). One recent study reported the positive role of total cholesterol in PF development (18). Taking together, we were curious whether other lipid profile parameters and blood glucose levels are associated with PF. Thus, we could consider the strategy of improving body healing capacity through the modification of these factors.

In the present study, we, therefore, aimed to compare the 1) total cholesterol, 2) LDL cholesterol, 3) HDL cholesterol, 4) Triglyceride, and 5) fasting blood glucose (FBS) level between two groups of patients with and without PF in a case-control study. Our primary null hypothesis was no difference in the lipid profile and blood sugar levels between patients with plantar fasciitis and healthy individuals.

Materials And Methods

Study Setting and Design

This case-control study was performed in Imam Reza hospital, Mashhad city, Iran, between 2017 and 2019.

Patients

We enrolled 68 patients with the clinical diagnosis of plantar fasciitis in the case group and matched 136 individuals with a ratio of 2:1 in the control group. Inclusion criteria were the age range between 18-60 years, PF clinical diagnosis including: start-up pain (pain during first steps after getting up in the morning or after longtime sitting and reduce in pain with ambulation) with tenderness at the medial insertion of the plantar fascia to the calcaneus, and symptom duration of less than three months. In addition, the patients with a history of trauma to the heel, injection, or surgery due to prior heel pain, systemic arthritic problems (e.g., rheumatoid arthritis, systemic lupus erythematosus), ESR >20, and a positive CRP were excluded from the study. The criteria for matching were age (+/- 3 years) and gender. The control group was recruited from an orthopedic outpatient clinic, and they have reported no history of heel pain and diagnosis of plantar fasciitis in their lifetime.

Descriptive Data

The mean age of the participants was 47±11 and 49±12 in the case and control groups, respectively. (P=0.32). The female-male ratio was 2.6:1, which was equal in two groups. 64.9% and 35.1% of the patients had unilateral and bilateral involvement, respectively. The obtained results showed no difference in the lipid profile parameters level between males and females in either of the groups.

Variables

First, all patients in case or control groups were asked to sign the consent form. After being enrolled, Demographic data of age, sex, unilateral or bilateral involvement, and CBC, ESR, CRP lab tests were recorded. Patients' height, weight, body mass index, fasting blood sugar (FBS), lipid profile including low-density lipoprotein (LDL), high-density lipoprotein (HDL), total cholesterol, and Triglyceride laboratory tests were checked at the first visit and saved in a coded excel file. Blood samples were obtained from control and case groups within seven days of examination.

The upper limit of normal values:

1. Cholesterol: 200 mg/dl
2. HDL Cholesterol: 40 mg/dl
3. LDL Cholesterol: 130 mg/dl
4. Triglyceride: 150 mg/dl
5. Fasting Blood Sugar (FBS): 100 mg/dl

Statistical analysis

To find a meaningful difference between two independent groups using a t-test with a medium effect size of 0.5, alpha error=0.05, power=90%, and allocation ratio=2/1, the sample size was 64 for the case and 136 for the control group. Data were entered and analyzed using the SPSS software version.[22] For statistical calculations, the normality of variables was investigated for the interval variable. Mean difference of each variable between the two groups of case and control will be tested using independent t-test. As a case-control study, we will calculate the odds ratio to quantify the strength of association between plantar fasciitis and elevated lipid profile. The odds ratio is the ratio of these two: odds of developing the disease given exposure is De/He and developing the disease given non-exposure is Dn/Hn. Two events are independent if and only if the OR equals 1.

Spearman's and Pearson's rank correlation coefficients were used to calculate the correlation between the variables. A P-value less than 0.05 was considered statistically significant.

Ethical Approval

The Ethics Committee approved the study protocol of Mashhad University of Medical Sciences, Mashhad, Iran (approval code: IR.MUMS.fm.REC.1394.93). In line with the research ethics principles, informed consent was obtained from all the participants, and all of them were assured that their information would remain confidential. Furthermore, the subjects were ensured that they could withdraw from the study at any time.

Results

Correlation Between Cholesterol Level and PF:

Patients with PF had a higher total cholesterol level with a mean of 193 mg/dl (range 134-275) than the control group with total cholesterol of 172 mg/dl (range 117-221) (*P=0.001*). Hypercholesterolemia (TC> 240 mg/dl) was detected in 23% of patients (16 cases) and 13% (18 cases) of our control group. LDL level was significantly higher in patients with plantar fasciitis than in the control group (*P= 0.004*). The HDL level was not different between the two groups (*P=0.13*) **[Table 1]**. Patients with serum levels of LDL >130 mg/dl and total cholesterol > 200 mg/dl are 3.7 and 1.8 times more likely to accompany PF, respectively **[Table 2]**.

Association Between Triglyceride Level and PF:

TG level was significantly higher in patients with plantar fasciitis than in the control group (*P=0.02*) **[Table 1]**. Patients with serum levels of TG > 100 mg/dl are 1.3 times more likely to accompany PF **[Table 2]**.

Association Between Glucose Level and PF:

FBS level was not different between patients with plantar fasciitis compared to the control group (*P = 0.24*) **[Table 1]**. Patients with serum levels of FBS > 150 mg/dl are 1.2 times more likely to accompany PF **[Table 2]**.

Association Between BMI and Lipid Profile Parameters:

We found no association between lipid profile parameters and body mass index in either of the two groups **[Table 3]**.

Discussion

The etiology of plantar fasciitis (PF) is not clearly understood, and many factors may have contributed to the pathophysiology of this disorder. A relationship between hyperlipidemia and tendon disorders has been reported in several studies, which we speculate to have a role in the pathophysiology of PF. This study investigated whether patients with PF were more likely to have a higher lipid profile than healthy controls.

Limitations: The systematic bias of blood lipid analysis as a standardized laboratory procedure is low. However, the blood collection process may introduce bias. Blood samples were taken from the patients at various times the following fasciitis. In addition, we might have a selection bias, since the control group was selected from patients referred to an orthopedic clinic with a musculoskeletal problem, and they may not be a true representative of the general population. Future studies with sampling from the general population would eliminate this bias.

Discussion of Key Findings: We found that patients with plantar fasciitis would be more likely to have higher TC, LDL, and TG levels than patients with musculoskeletal problems other than PF. On the other hand, there was no correlation between lipid profile parameters and BMI among patients, indicating the observed association between PF and lipid profile parameters was not confounded by their BMI. This combination of findings supports the modification of LDL, TC, TG, and glucose levels when managing PF.

A systematic review showed higher rates of TC, LDL-C, and TG and lower HDL-C in people with altered tendon structure compared to those reported for healthy people (14). Ozgurtas et al. identified hypercholesterolemia in 74% of patients with Achilles tendon rupture (12). Abboud et al. reported significantly higher TC, LDL-C, and TG in patients with rotator cuff tears than normal rotator cuff tendons (11). The deleterious role of a cholesterol-rich environment in embryonic animal fibroblasts, tail tendon, and skin, as well as tendon biomechanics, is confirmed by animal studies (19). It seems that deposition of cholesterol in tendons leads to persistent and mild inflammation, and it may also change the extracellular matrix of tendons and fascia (20). This can result in chronic tendon degeneration and biomechanical changes. Metabolic parameters might rapidly worsen due to the limitation of physical activity resulting from plantar fasciitis, especially in those who have complete bed rest (21, 22). This phenomenon may have suggested the reverse causality between these two variables (i.e., lipid profile and tendon disorder). However, the strong association of LDL-C and TG with recent-onset pain provides strong evidence against reverse causation.

Conclusion

A higher level of serum lipid profile parameters was seen in patients with PF, which may be a risk factor for developing PF. Further studies should be designed to certify the cause and effect between hyperlipidemia and PF and the possible effect of lipid-lowering medicine on resolving the symptoms of this disorder.

The present study was a case-control study, and causation cannot be established based on such data. Therefore, it could not be claimed that there is a definitive relationship between plantar fasciitis and cholesterol levels. Long-term studies are required to determine stronger relationship between the level of lipid profile and fasciopathy.

List Of Abbreviations

plantar fasciitis (PF), fasting blood sugar (FBS), low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglyceride (TG), body mass index (BMI), complete blood count (CBC), c-reactive protein (CRP), erythrocyte sedimentation rate (ESR), odds ratio (OR)

Declarations

Ethics approval and consent to participate: Patients provided with informed written consent forms before they enroll. The study was approved by Research Ethics Committee of Mashhad University of Medical Sciences (approval number: IR.MUMS.fm.REC.1394.93) (https://ethics.research.ac.ir/) and was conducted in full compliance with the codes of ethical conduct from the declaration of Helsinki

Consent for publication: The present manuscript does not contain any individual person's data in any form

Availability of data and materials: Correspondence and requests for materials should be addressed to Daliribm931@mums.ac.ir.

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Authors' contributions: S-H. S-H conceived of the presented idea, and supervised the project. MD performed the statistical data analysis, and took the lead in writing and proofreading the manuscript. F. B and F. S enrolled patients, carried out the patients' data collection. A. M, M-H. E, and A-R. K contributed in methodology and resources. All authors have read and approved the final manuscript.

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Tables

Table 1. Comparison of lipid profile and glucose levels between two groups

Variable	**Case** (mean ± SD)	**Control** (mean ± SD)	***P-value***
FBS	92.94 ± 16.1	90.4 ± 9.3	*0.24*
TG	151.36 ± 80.5	119.26 ± 43.6	***0.02***
TC	193.84 ± 37.0	172.07 ± 18.9	***0.001***
LDL	110.70 ± 32.2	93.88 ± 10.9	***0.004***
HDL	56.65 ± 52.0	43.16 ±	*0.13*

FBS: Fasting Blood Glucose, TG: Triglyceride, TC: Total Cholesterol, LDL: Low-Density Lipoprotein, HDL: High-Density Lipoprotein

Table 2. The odds ratio of developing plantar fasciitis given to high values of blood sugar and lipid profile

	Odds ratio	**95% CI**
FBS	1.2	*0.38-4.0*
TG	1.3	*0.54-3.0*
TC	1.8	*0.67-4.7*
HDL	0.94	*0.28-3.1*
LDL	***3.7***	***1.5-9.2***

FBS: Fasting Blood Glucose, TG: Triglyceride, TC: Total Cholesterol, LDL: Low-Density Lipoprotein, HDL: High-Density Lipoprotein

Table 3. Correlation of BMI and lipid profile parameters

Variable	r coefficient	*P-value*
FBS	0.08	*0.64*
TG	0.08	*0.64*
TC	-0.05	*0.77*
LDL	-0.27	*0.31*
HDL	-0.36	*0.84*

FBS: Fasting Blood Glucose, TG: Triglyceride, TC: Total Cholesterol, LDL: Low-Density Lipoprotein, HDL: High-Density Lipoprotein