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Metabolic Syndrome in Patients with Plantar Corns and Calluses: A Case-Control Study

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ABSTRACT

Background: Corns and calluses are localized plaques of hyperkeratotic tissue over sites that are subjected to continual trauma. In this study, we aimed to investigate the presence of metabolic syndrome (MS) in patients suffering from plantar callosities.

Materials and Methods: Between February-December 2021, 32 patients with plantar callosities and 36 healthy subjects frequency-matched for age and sex were included in the study, which was designed as a prospective controlled study. Demographic, clinical and biochemical characteristics of the patients and the controls were recorded.

Results: Thirty-two patients with a mean age of 40.56±13.87 years and sex-age-matched 36 healthy controls with a mean age of 41.25±13.15 years were enrolled in the study. MS was present in 59.4% of the patient group. Hypertension (HT) was present in 28.1% of the patient group. Presence of MS and HT were significantly higher in the patient group than the control group ($p<0.05$). Waist circumference, triglyceride, fasting insulin and Homeostatic model assessment of insulin resistance levels were significantly higher in the patient group than in the control group ($p<0.05$). HDL cholesterol levels were significantly lower in the patient group that in the control group ($p<0.05$). It was determined that MS was more common in male patients and patients with unilateral lesion ($p<0.05$). The number of callosities in patients with MS was lower than in patients without MS ($p<0.05$).

Conclusion: Evaluation of MS may be recommended in patients diagnosed with corns and calluses. Studies about molecular mechanism of callus formation and common mechanisms with MS are needed to elucidate the pathogenesis of callus formation.

Keywords: Corn, Callus, Metabolic syndrome, Insulin Resistance, HOMA-IR

Introduction

Callosities are localized plaques of hyperkeratotic tissue over sites that are subjected to continual trauma [1]. These lesions, which are quite painful, significantly affect the quality of life of individuals by affecting person's gait and choice of footgear or activities [2]. It is commonly observed in palms and soles and one of the most frequent problem, especially in older people. Inadequate shoes, foot deformities and high levels of activity may induce callus formation by mechanical stress. The formation of callosities is suggested to be a protective response to trauma for protecting the underlying tissues [3].

Callosities may be seen clinically as corns and calluses [2]. A corn is a circumscribed lesion with permanent hyperkeratosis and a central conical core of keratin which causes pain and inflammation. This central core distinguishes the corn from the callus [4]. Corns are devided into two subtypes: The hard corn (heloma durum) and the soft corn (heloma mole). The hard corns, which is described

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as dry corns, are frequently localized on the dorsolateral aspect of the fingers. The soft corns are frequently localized interdigitally, especially in the fourth interdigital space of the foots and characterized with macerated plaques. However a callus is a broad based, diffuse hyperkeratotic plaque frequently located on the plantar surface of metatarsophalangeal joints [2].

Histopathologically, the increase in keratinization and lower rate of desquamation have been shown to cause to the thickness of stratum corneum [3]. The thickness of stratum corneum and stratum granulosum, a decrease in keratinocyte density, abnormal rete ridge patterns are the most prevalent histopathological changes in calluses [3,5].

The exact cause of callus formation in the molecular aspect has not been proven. Kim et al. [6] reported that hyperproliferation and incomplete cornification and differentiation of keratinocytes, and increased expression of adhesion molecules may be the reason of callus formation.

We observe in dermatology outpatient clinics, that patients with callus are more overweight than other patients. Various growth factors and inflammatory mediators are suggested to be stimulated in tissues exposed to mechanic stress, and it may induce callus formation [1]. Weight actually increases the pressure on the feet and may promote callus formation. We also know that inflammation is higher in overweight and especially in patients with metabolic syndrome (MS).

We aimed to investigate MS in patients suffering from plantar callosities. To the best of our knowledge, there is no study in the literature evaluating this relationship.

Materials and Methods

The study was approved by Erzincan Binali Yildirim University Scientific Research and Publication Ethics Board (decision number: 02/08, date: 26.01.2021). A prospective controlled study was carried out between February-December 2021. Patients over 18 years diagnosed with plantar callosities in dermatology outpatient clinic; and age- and sex-matched healthy people as controls were included in the study. Written informed consent was obtained from all the patients and the controls.

Patients <18 years and patients with other chronic and/or any systemic inflammatory diseases were excluded for patient and control groups.

The age, sex, habits of smoking, the duration of the disease, lesion localization, number of lesions, type of callosities (corn/callus), body mass index (BMI kg/m^2), waist circumference in cm were recorded. Blood pressure was measured manually in both arms after 10 minutes of rest. Fasting blood glucose (FBG), triglycerides (TG), total cholesterol, low-density lipoproteins (LDL-cholesterol), high-density lipoproteins (HDL-cholesterol), fasting insulin were measured after 12-hours fasting.

The diagnosis of MS was evaluated according to the criterien established by Society of Endocrinology and Metabolism of Turkey, NCEP ATP III and World Health Organization [7,8,9].

Statistical Analysis

The Statistical Package for Social Sciences 22.0 was used for statistical analysis. Ratios of categorical variables between patient and control groups were tested by chi-square test. The distribution of variables was evaluated by the Kolmogorov-Smirnov test. For normally distributed data, t-test was used for independent groups and Mann-Whitney U was used for data not normally distributed. A p value of <0.05 was considered statistically significant.

Results

Thirty-two patients [female (n=23), male (n=9)] with a mean age of 40.56±13.87 years and sex-age-matched 36 healthy controls [female (n=27), male (n=9)] with a mean age of 41.25±13.15 years were included in the study. Of the patient 59.4% (n=19) had callus, 9.4% (n=3) isolated corn, 31.2% (n=10) mixed type callosities. Callosities were located on unilateral foot in 59.4% (n=19), on bilateral foots in 40.6% (n=13) of the patients. MS was present in 59.4% of the patient group. Hypertension (HT) was present in 28.1% of the patient group. Presence of MS and HT were significantly higher in the patient group than the control group (p<0.05). Smoking was statistically significantly higher in the patient group compared with the control group (p<0.05). The demographic and clinical properties of patients were shown in Table 1.

When metabolic control variables were compared between the patient and the control group, waist circumference, triglyceride, fasting insulin and homeostatic model assessment of insulin resistance (HOMA-IR) levels were significantly higher in the patient group than in the control group (p<0.05). HDL cholesterol levels were significantly lower in the patient group that in the control group (p<0.05). There was no significant difference regarding BMI, LDL cholesterol, FBG between the patient and control group. MS parameters of the patients and controls were shown in Table 2.

The relationship between demographic and clinical characteristics of the patients and the presence of MS in the patient group were evaluated and shown in Table 3. It was determined that MS was more common in male patients and patients with unilateral lesion (p<0.05). The number of callosities in patients with MS was lower than in patients without MS (p<0.05). There was no significant difference between the presence of MS and habit of smoking, age, and the lesion type (p>0.05).

Table 1. Descriptive and disease-related characteristics of the patients and controls

	Patient (n=32)		Control (n=36)		Total (n=68)		x^2/p
	n	%	n	%	n	%	
	Mean ± SD		Mean ± SD		Mean ± SD		t/p
Age (year)	40.56±13.87		41.25±13.15		40.92±13.40		-0.210/0.835
Sex							
Female	23	71.9	27	75.0	50	73.5	0.085/0.771
Male	9	28.1	9	25.0	18	26.5	
Duration of the disease (year)	31.16±36.19						
Type of lesion							
Callus	19	59.4					
Corn	3	9.4					
Mix type	10	31.2					
Number of lesions	2.19±1.53						
Lesion localization							
Unilateral	19	59.4					
Bilateral	13	40.6					
Smoking							5.333/0.021*
Present	11	34.4	4	11.1	15	22.1	
Absent	21	65.6	32	88.9	53	77.9	
Hypertension							6.364/0.012*
Present	9	28.1	2	5.6	11	16.2	
Absent	23	71.9	34	94.4	57	83.8	
Metabolic syndrome							9.768/0.002*
Present	19	59.4	8	22.2	27	39.7	
Absent	13	40.6	28	77.8	41	60.3	

*p<0.05, x^2: Chi-square test, t: T-test, SD: Standard deviation

Table 2. Comparison of metabolic control variables of the patient and the control group

	Patient group (n=32)	Control group (n=36)	
	Mean ± SD	Mean ± SD	
Body mass index (kg/m^2)	28.54±5.15	27.08±4.79	t=1.207 p=0.232
Waist circumference (cm)	90.65±13.75	80.69±10.03	z=-3.179 p=0.001*
Triglycerides (mg/dL)	154.00±63.04	123.50±73.06	z=-2.458 p=0.014*
Low-density lipoproteins (mg/dL)	125.03±31.96	115.50±36.67	z=-1.555 p=0.120
High-density lipoproteins (mg/dL)	45.34±9.82	52.61±10.80	t=-2.889 p=0.005*
Fasting blood glucose (mg/dL)	104.71±29.66	98.27±26.94	z=-1.469 p=0.142
Insulin (IU/mL)	17.01±11.52	13.04±18.74	z=-2.838 p=0.005*
HOMA-IR	4.58±3.60	4.18±10.09	z=-3.023 p=0.003*

*p<0.05, t: T-test in independent groups, z: Mann-Whitney U test, SD: Standard deviation, HOMA-IR: Homeostatic model assessment of insulin resistance

Table 3. Comparison of disease-related characteristics of individuals in the patient group with the presence of metabolic syndrome (n=32)

	Metabolic syndrome Present (n=19)	Metabolic syndrome Absent (n=13)	
	n (%)	n (%)	
Sex			x^2=8.658 p=0.004*†
Female	10 (43.5)	13 (56.5)	
Male	9 (100)	0 (0)	
Smoking			x^2=3.680 p: 0.072†
Present	4 (36.4)	7 (63.6)	
Absent	15 (71.4)	6 (28.6)	
Lesion localization			x^2=7.428 p=0.006*
Unilateral	15 (78.9)	4 (21.1)	
Bilateral	4 (30.8)	9 (69.2)	
Type of lesion			x^2=2.412 p=0.299
Callus	10 (52.6)	9 (47.4)	
Corn	3 (100)	0 (0)	
Mix type	6 (60.0)	4 (40.0)	
	Mean ± SD	**Mean ± SD**	
Age (year)	43.94±14.19	35.61±12.26	z=-1.576 p=0.115
Duration of disease (year)	2.29±3.09	3.04±2.95	z=-1.200 p=0.230
Number of lesions	1.42±0.60	3.30±1.79	z=-3.908 p=0.000*

*p<0.05, x^2: Chi-square test, †Fisher Exact test, z: Mann-Whitney U test

Discussion

MS is characterized with abdominal obesity, high levels of TG and FBG, low levels of HDL-cholesterol and presence of HT [10]. MS, which is stated to be seen with equal frequency in men and women, affects 30-40% of all people, the prevalence of MS is increasing especially because of sedentary lifestyle [11]. Cardiovascular diseases are the most common cause of death all over the world, and one of the most important causes of cardiovascular diseases is the presence of MS. Therefore, early diagnosis and prevention of MS are important.

Psoriasis vulgaris, hidradenitis suppurativa, acne vulgaris, acanthosis nigricans, androgenetic alopecia, atopic dermatitis, and rosacea are the disorders which are showed to be associated with MS in dermatology [12,13,14,15]. Although the exact cause of association between MS and cutaneous disorders is unknown, burden of inflammation is suggested to be the common mechanism of MS and dermatological diseases.

Callosity is a very frequent disease in dermatology practice, and we observe in dermatology outpatient clinics, that patients with callosities are more overweight than other patients. To the best of our knowledge, there have been no study in the literature examining the relationship between MS and callus formation. Repetitive trauma is the main reason for callus formation and weight may increase the pressure on the feet and may promote callus formation. We know that inflammation is higher in overweight and especially in patients with MS. The molecular mechanisms of callosities should be clarified, but inflammation may be an effective factor in callus formation.

In our study, the presence of MS in the patients with callosities was statistically significantly higher compared to the control group. Waist circumference, triglyceride, fasting insulin and HOMA-IR levels were significantly higher, however HDL cholesterol levels were significantly lower in the patient group than in the control group. Booth and McInnes [1] mentioned that mechanic stress in tissues stimulate various growth factors and cytokines, and it promotes callus formation. In patients with MS systemic inflammation is triggered especially by adipokines, and various growth factors are also promoted in insulin resistance, which is an important component of MS. The association of callus formation with MS can be explained by induced inflammation. However, Kim et al. [6] reported that hyperproliferation and incomplete cornification and differentiation

of keratinocytes, and increased expression of adhesion molecules may be the reason of callus formation. Stimulation of inflammation at the cellular level may also impair differentiation of keratinocytes.

In our study cigarette consumption was statistically significantly higher in the patient group compared with the control group. With chronic mechanic trauma, a repair mechanism begins in the skin, since the skin wants to protect the underlying tissues. Vascular structures also play a role in the supply of substances needed in this repair mechanism. Oxygen supply to the tissues is impaired with cigarette consumption, as well as vascular damage is seen in chronic cigarette consumption and increases the negative effects of MS. Impaired cellular differentiation and wound healing may promote callus formation. Clarifying the pathogenesis of callus at the molecular level may provide a clearer explanation of this relationship.

In our study, it was seen that we should be more careful in terms of MS in male patients with corns and calluses, patients with lesions on unilateral foot, and patients with fewer lesions.

Study Limitations

The main limitation of the study is small sample size.

Conclusion

According to our results, patients with corns and calluses may be evaluated in terms of MS. MS is the main cause for inducing cardiovascular diseases, which are the most frequent reasons for death. Therefore, early diagnosis and prevention of MS are crucial. The exact etiopathogenesis of the association of MS and cutaneous disorders has not been clarified, but it is important to elucidate the common mechanisms of MS and associated skin diseases, especially for the advancement of new therapeutic agents. Chronic inflammation and vascular damage may be the reason of callus formation. Although corns and calluses are common, there are limited studies on this subject. Studies about molecular mechanism of callus formation are needed to elucidate the pathogenesis of callus.

Ethics

Ethics Committee Approval: The study was approved by Erzincan Binali Yildirim University Scientific Research and Publication Ethics Board (decision number: 02/08, date: 26.01.2021).

Informed Consent: Written informed consent was obtained from all the patients and the controls.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: M.G.K, Ş.Ö., Concept: M.G.K, Ş.Ö., Design: M.G.K, Ş.Ö., Data Collection or Processing: M.G.K, Ş.Ö., Analysis or Interpretation: M.G.K, Ş.Ö., Literature Search: M.G.K., Writing: M.G.K.

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