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CHANGES IN PHYSICAL PROPERTIES OF SKIN IN PATIENTS WITH INSUFFICIENT THERAPEUTIC CONTROLLED DIABETES MELLITUS

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Abstract

Cutaneous complications are common in diabetes. Previous assays suggest that hyperglycemia and decreased insulin signal/secretion are involved in the impairment of skin function. ***Objective:*** *To evaluate the biophysical characteristics of skin - including transepidermal water loss (TEWL), water content, sebum and skin elasticity - in patients with insufficient therapeutic controled diabetes mellitus (HbA1c>6.5%) and compares them with healthy non-diabetic controls.* ***Methods****: This case-control study was conducted on 22 patients with diabetes and 22 age- and sex-matched healthy people. The biophysical properties of skin including stratum corneum (SC) hydration, sebum content, TEWL and skin elasticity were measured and compared between the two groups at different locations of the body.* ***Results****: The measurement of SC hydration was significantly lower in patients with diabetes. Sebum content, TEWL and skin elasticity showed no significant differences between groups.* ***Conclusion****: Diabetes affects some functional properties of skin that may be responsible for the cutaneous manifestations of diabetes.*

key words: *cutaneous complications, diabetes mellitus, cutometry.*

Background

Diabetes mellitus is characterized by impaired insulin production and/or signaling, elevated plasma glucose and a predisposition toward chronic complications involving several tissues. Among the chronic complications of diabetes, the dermatological complications are the least thoroughly studied, although skin is the largest organ of the human body. Several diabetes-associated skin lesions and complications have been described so far [1, 2].

Skin serves as an interface between a host's inner and outer environments. Among its functions it also act as mechanical barrier against micro-organisms and the penetration of noxious products, which means a very important protection. There are few studies in literature focused on the state of the stratum corneum (SC) in patients with diabetes. Physical properties of SC are important for its

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functions: hydration state, transepidermal water loss (TEWL), sebum content and elasticity. This may now be measured with special devices. The aim of this study was to evaluate the biophysical characteristics of skin - including transepidermal water loss (TEWL), water content, sebum and skin elasticity - in patients with insufficient therapeutic controled diabetes mellitus (HbA1c>6.5%) and compares them with healthy non-diabetic controls.

Study Objective

The objective of this study was to evaluate the biophysical characteristics of skin - including transepidermal water loss (TEWL), water content, sebum and skin elasticity - in patients with insufficient therapeutic controled diabetes mellitus (HbA1c>6.5%) and compares them with healthy non-diabetic controls.

Material and method

We included in this study 22 patient diagnosed with diabetes, with insufficient therapeutic controled diabetes mellitus (HbA1c>6.5%), these forming the study group. Participated in the study patients diagnosed with type 1 or 2 diabetes mellitus who came for periodic medical examination for diabetes or were hospitalized in Diabetes Department of Cluj County Hospital. Control group were patients without diabetes hospitalized in Internal Medicine Department or healthy volunteers. Control group was composed of 22 age- and sex-matched healthy people. The biophysical properties of skin were measured: stratum corneum (SC) hydration was measured at 3 sites (volar side of left forearm, anterolateral side of left hip and dorsal side of left foot) sebum content was measured at 2 sites (volar side of left forearm and left leg), TEWL was measured at one site (right forearm) and skin elasticity was measured at 4 sites (back of the right hand, volar side of right forearm, anterolateral side of right thigh and angle of the right eye).

For cutometric measurement we used the Multi Probe Adapter Systems ® (product of Courage+Khazaka, Germany), with 4 measuring devices (figure 1): Corneometer ® CM 825 - for determining the degree of skin hydration, Tewameter ® TM 300 - to determine transepidermal water loss, Sebumeter ® SM 815 - to determine the amount of sebum and Cutometer ® MPA 580 – for skin elasticity evaluation. The device is connected to a computer and each probe has its own Windows compatible program to display data. Statistical analysis was performed using the statistical package SPSS v.17.0 and Data Analysis module of Microsoft Excel. For describing the numerical variables we used the mean and standard deviation. For the statistical tests, the 0.05 (i.e. 5%) two-tailed level of significance was considered.

Before measurements, participants were kept for about 15 minutes at 20-24 ºC and humidity of 30-45%.

The study was approved in advance by the Ethics Comittee of ”Iuliu Haţieganu” University of Medicine and Pharmacy Cluj-Napoca, being conducted in compliance with the priciples of the Declaration of Helsinki. All the subjects were informed about the objectives and methods of the study and singned the Inform Consent Form in two copies (one for the patient and one for our files).

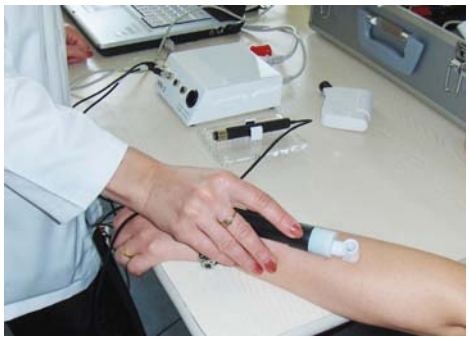

Figure 1. Mesurement of transepidermal water loss by Tewameter ® TM 300 and Multi Probe Adapter Systems ® (product of Courage+Khazaka, Germany).

Results

The study included 22 patient diagnosed with diabetes, these forming the study group. Control group was composed of 22 age- and sex-matched healthy people.

The characteristics of study group were as follows: the mean age of the study group was 50 years with a standadrd deviation of ±11.43 years. Four out of 22 patients were men (18.18%) and 18 were women (81.81%). 8 patients from the study group were diagnosed with type 1 diabetes mellitus (36.36%) and the rest of the group (63.63%) were type 2 diabetic patients. The large majority (21 out of 22 patients, 95,45%) were insulintreated patients. The HbA1c value was 9.09±1.54 and the capilary glycemia a jeun in the day when measurements were performed was 180.2±49.74 mg/dl.

Table 1 shows the results of physical properties measured: the stratum corneum hydration at 3 sites (volar side of left forearm, anterolateral side of left hip and dorsal side of left foot); sebum content at 2 sites (volar side of left forearm and dorsal side of left foot); transepidermal water loss was measured at one site (right forearm) and skin elasticity at 4 sites (back of the right hand, volar side of right forearm, anterolateral side of right thigh and angle of the right eye) (table 1). The sebum content, TEWL amd elasticity showed no significant difference between two groups in any of locations assessed in this study *(P*>0.005). When the stratum corneum hydration of the skin was compared between the two lots, statistical differences resulted in the degree of hydration at all three sites assessed in the study: forearm (*P*=0.02), hip (*P*<0.001) and foot (*P*=0.02).

Table 1. Stratum corneum hydration, sebum content, TEWL and skin elasticity in patients (n=22) and controls (n=22)

Varible	Control group (mean ±SD)	Study group (mean ±SD)	*P*-value
Age (years)	47.8±12.37	50±11.43	0.55 – NS
BMI (kg/m^2)	27.34±6.05	3156±7	0.04 – S
Hydration (a.u.-arbitrary units)	*volar side of left forearm*		
	33.93±7.97	28.67±6.63	0.02 - S
	anterolateral side of left hip		
	31.04±7.81	22.76±6.3	<0.001 - S
	dorsal side of left foot		
	32.37±8.33	26.20±8.98	0.02 - S

Sebum (spots/cm^2)	*volar side of left forearm*		
	2.04±3.45	1.40±2.17	0.47 - NS
	dorsal side of left foot		
	1.5±3.83	0.29±0.46	0.17 - NS
TEWL (mg/cm^2/h)	*right forearm*		
	11.47±6.2	8.44±3.12	0.06 - NS
Elasticity (mm)	*back of the right hand*		
	63.26±13.14	62.52±13.14	0.86 - NS
	volar side of right forearm		
	66.73±12.17	68.47±10.76	0.63 - NS
	anterolateral side of right thigh		
	78.42±10.75	81.42±17.04	0.52 - NS
	angle of the right eye		
	51±5.84	51.94±8.96	0.71 -NS

NS – unsignificant difference between groups; S – significant difference between groups.

Discussion

The exact mechanism causing the various pathological conditions in skin is not known. It is usually assumed that most diabetes complications are induced due to elevated glucose levels associated with this disease. Nevertheless, the diabetic status includes, in addition to hyperglycemia, abnormal insulin signaling/secretion. Some skin lesions, like acanthosis nigricans, are directly associated with states of insulin resistance [3]. However, the most common dermatological complications associated with diabetes are impaired wound healing, foot ulcers, increased incidence of skin infections and xerotic skin [4, 5]. Several pathogenic mechanisms have been suggested to be involved in the development of diabetic complications; these include diabetic microangiopathy, premature aging of the skin fibroblasts, immune-mediated processes, changes in basement membrane structure and function, and others [6, 7]. Insulin has been demonstrated in earlier studies to be an essential growth factor for cultured keratinocytes and it has a substantial influence on their proliferation [8] and migration [9]. It has also been demonstrated that insulin regulates the keratinocyte differentiation [10]. Keratinocytes constitutively express insulin receptor exhibiting an insulin glucose uptake system [11].

The functional properties of stratum corenum properties have been investigated in diabetes. In an assay, Sakai et al. found a decrease water content of SC without impairment of TEWL in streptozocin-induced diabetes mice. Moreover, no special changes in the size or number or of sebaceous glands were seen in these mice [12]. In another study by Sakai et al., they suggested that patients with diabetes mellitus tend to show a reduced hydration state of startum corneum without any impairment of the SC barrier function [13], as we observed in our study. The same obsevation were made by Seirafi et al. in a study published in 2009 [14]. In a previous study we have published, we observed that type 2 diabetic patientes treated with oral therapy showed no difference in SC hydration [15]. We have found in our study that diabetic patients with insufficient therapeutic control had a significant decrease in water content of SC measured by skin capacitance, but without impairment of TEWL. However, reduced SC hydration, coupled with normal barrier function, as observed inpatients with diabetes, mirrors the phenomenon that develops in aged persons [16]. Sebum content was not

influenced by uncontrolled diabetes at the sites of measuement (forearm and foot) and our results are similiar with results of the Seirafi et al. However, a trend to reduse skin surface lipid content on the forehead was observed in previous studies [13, 14, 16].

The elasticity of facial skin is diminished in patients with diabetes [17]. The same results were observed by Seirafi et al, but they have not found significant difference in leg measurements. In the present study we found that there is no significant diference in skin elasticity between diabetics and controls. The difference in our measurements and other cited references might be due to different devices used to measure skin elasticity (we used Cutometer® MPA 580, which is a worldwide acknowledged standard device to measure elasticity and they used Reviscometer® RVM 600, which is a very interesting tool to measure the direction of the collagen and elastin fibres in the skin).

Conclusion

Insufficient therapeutic controled diabetes mellitus affects some functional properties of skin that may be responsible for the cutaneous manifestations of diabetes. It produces an impaired stratum corneum hydration, at least in certain parts of the body. TEWL and sebum content was no influenced by insufficient therapeutic controled diabetes. We found no difference in skin elasticity measured by cutometry.

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