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RESEARCH ARTICLE

The Use of Digital Red Fluorescence in The Diagnosis of Acne

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Abstract

There are many methods for diagnosing acne, but there is no generally accepted standard for diagnosis. One of the mechanisms of the pathogenesis of acne is considered to be increased sebum formation. We studied sebum formation in 62 patients with severe acne using the UVRF method.

KEYWORDS

Acne, severity, red fluorescence.

INTRODUCTION

Acne is a chronic inflammatory disease of the pilosebaceous units in humans, with multiple etiological and pathogenic factors. Increased sebum production, follicular hyperkeratinization, inflammation, and colonization by Propionibacterium (P. acnes) are the four main pathogenic factors in the development of acne. No proven association has been established between smoking and the occurrence of acne [2].

Increased sebum production, hormonal disturbances, hyperkeratinization of the pilosebaceous ducts, excessive growth of Propionibacterium acnes (P. acnes), and inflammation around the pilosebaceous follicles are considered the main pathogenic factors in the development of acne [11]. P. acnes is a commensal organism of the normal skin flora, most commonly found in sebaceous areas [7]. The role of P. acnes in the pathogenesis of acne remains a subject of discussion to this day [10].

P. acnes is a Gram-positive, non-motile, aerotolerant anaerobic bacterium that is a normal inhabitant of human pilosebaceous units [4]. Acne is not considered a classic infectious disease; however, immunological reactivity against P. acnes may contribute to the development of inflammation in acne.In 2004, characterization of the complete genome sequence of P. acnes, encoding 2,333 predicted genes, provided important insights into its role in acne pathogenesis. Genome analysis revealed the bacterium's pathogenic potential, including factors involved in the degradation of host molecules (such as sialidases, neuraminidases, endoglycoceramidases, lipases, and pore-forming factors), as well as mechanisms contributing to cellular adhesion and/or inflammation [3].

Sebum provides a favorable microenvironment for the colonization of skin bacteria, as a result of which P. acnes produces porphyrins in the form of coproporphyrin III and protoporphyrin IX [6]. These are known endogenous metabolites of propionibacteria that can provoke perifollicular inflammation by stimulating the production of cytotoxic squalene oxide and the release of keratinocyte-derived IL-8 [9].These proinflammatory metabolites are native fluorophores and exhibit strong fluorescence in the ultraviolet A (UVA) range, appearing as follicular orange-red fluorescence [1, 8]. A limited number of studies have reported the use of

photographic methods to assess the relationship between P. acnes colonization, fluorescence intensity of lesions, and the severity of facial involvement. There is evidence of a positive correlation between P. acnes density, acne severity, and the amount of sebum in the affected areas [5].

In addition, it has been found that follicular colonization by P. acnes, along with sebum accumulation, leads to the production of porphyrins in the form of coproporphyrin III and protoporphyrin IX. These proinflammatory metabolites are native fluorophores and exhibit strong fluorescence in the ultraviolet A (UVA) range, manifesting as follicular orange-red fluorescence known as ultraviolet-induced red fluorescence (UVRF).

The aim of our study was to determine the presence of sebum and the level of porphyrins using red fluorometry in patients with severe acne.

METHODS

In our study, we used one of the modern methods for assessing sebum production in the skin—digital fluorescence imaging. This procedure was performed on 62 patients in the facial area, including 34 patients with papulopustular acne (PPA) and 28 patients with comedonal acne (CA). All patients demonstrated a significant increase in skin pH in the facial region. The control group consisted of 20 healthy individuals.

We used the "Janus II" Facial Analysis System, which enabled comprehensive assessment of facial skin structure by scanning patients under ultraviolet light and observing fluorescence of skin areas—referred to as ultraviolet-induced red fluorescence (UVRF). The facial area was divided into five regions (forehead, both cheeks, nose, and chin). To ensure reliability of the results, zone segmentation in all patients was performed according to standardized criteria, taking into account all positioning parameters and settings of the examined area.Кожный жир дает свечение в ультрафиолетовом свете, а кожный жир с порфирином дает оранжевое свечение, что подразумевает метод UVRF.

Isolation method.

Normal sebum and porphyrin-associated sebum together constitute total sebum. The proportion of porphyrin-associated sebum represents its share within the total sebum. A high porphyrin ratio indicates a high abundance of P. acnes in the sebum.

Method for calculating the porphyrin ratio:

(Number of porphyrin-associated sebum) / (Total amount of sebum) × 100 = porphyrin coefficient (%).

The indicators of the ratio of sebum production and porphyrin levels in five facial zones in patients with severe acne are presented in Table 3.13.

The table presents data on sebum production in patients with severe acne. The highest levels of sebum production were observed in the areas of both cheeks and the forehead. The sebum values in these regions were similarly elevated in both papulopustular acne (PPA) and comedonal acne (CA), with no statistically significant difference ($p > 0.05$).Porphyrin level indicators in the studied groups also showed variability. Statistically significant differences were observed between porphyrin levels in the forehead, left cheek, and the mean values between the two forms of acne (39.53 ± 1.26 vs 43.79 ± 1.34; 42.06 ± 0.92 vs 46.07 ± 1.29; and 35.16 ± 0.45 vs 37.10 ± 0.55, respectively; $p < 0.05$). The highest porphyrin levels were also recorded in the areas of both cheeks in both PPA and CA groups (46.11 ± 1.52 and 46.07 ± 1.29, respectively).

Sebum production and porphyrin levels in both papulopustular acne (PPA) and comedonal acne (CA) were significantly higher compared to those in the control group ($p < 0.001$ in both cases).

When calculating the porphyrin coefficient, no statistically significant differences were observed between PPA and CA. However, in both PPA and CA, this показатель was significantly higher compared to that of the control group ($p < 0.01$).

Table 3.13

The ratio of sebum production to porphyrin levels in five facial zones in patients with severe acne (n = 62).

	Mean	Продукция кожного сала

Group		Porphyrin level (a.u.)	Sebum (a.u.)	Porphyrin coefficient (%)
PPA (n = 34)	Forehead	39,53±1,26* **	138,56±2,29*	22,05±0,30*
	Nose	26,12±0,59*	110,32±1,46*	19,15±0,38*
	Chin	22,35±0,49*	102,32±1,44*	17,89±0,23*
	Right cheek	45,74±1,08*	144,71±1,93*	23,94±0,28*
	Left cheek	42,06±0,92* **	142,79±1,35*	22,69±0,30*
	Mean	35,16±0,45* **	127,74±0,94*	21,56±0,12*
CA (n = 28)	Forehead	43,79±1,34* **	141,64±1,94*	23,52±0,46*
	Nose	26,04±0,99*	112,75±1,76*	18,72±0,49*
	Chin	23,50±0,48*	103,54±1,06*	18,50±0,35*
	Right cheek	46,11±1,52*	148,54±2,40*	23,62±0,59*
	Left cheek	46,07±1,29* **	145,07±2,00*	24,07±0,54*
	Mean	37,10±0,55* **	130,31±1,09*	22,15±0,28*
Control (n = 20)	Forehead	13,60±0,76*	91,85±2,52*	12,93±0,68*
	Nose	10,65±0,74*	74,80±3,32*	12,53±0,66*
	Chin	10,50±0,64*	70,60±3,22*	13,06±0,66*
	Right cheek	13,60±0,94*	97,35±2,93*	12,28±0,81*
	Left cheek	13,20±0,85*	95,95±2,51*	12,02±0,61*
	Mean	12,31±0,44*	86,11±1,58*	12,51±0,39*

Note: The difference is statistically significant — u — Mann–Whitney test compared with the indicator: * vs control group ($p < 0.01$); ** papulopustular versus conglobate acne ($p < 0.05$).

CONCLUSIONS

The main indicator of increased sebum and porphyrin levels is the porphyrin coefficient, which can be indirectly considered a marker of elevated P. acnes levels on the skin of acne patients. This parameter was increased in almost all patients with severe acne. Therefore, it can be used to assess sebum levels, while the porphyrin coefficient may serve as an indirect indicator of increased P. acnes colonization.

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