Computerized morphometric analysis of acne lesions

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Synopsis

An evaluation system of acne lesions by means of morphometric computerized analysis is presented. The method allows (even in relation to a treament): a quantitative evaluation which is effective even in the case of a high number of lesions; the evaluation of the dimensions of individual lesions and of the area they occupy even in relation to a skin area which has been chosen as sample (area %).

Riassunto

Sistema di valutazione delle lesioni da acne attraverso analisi morfometrica computerizzata. Questa metodica consente (anche in relazione al trattamento) una valutazione quantitativa efficace anche nel caso di un gran numero di lesioni, nonché la valutazione delle dimensioni delle lesioni individuali e dell'area occupata, in relazione anche alla zona di epidermide scelta a campione (area %).

Résumé

Nous illustrons une méthode d'évaluation des lésion acnéeiques basée sur une analyse morphométrique informatisée. Cette méthode nous permet d'obtenir (même lorsque associée à des soins de la peau) une évaluation quantitative que est est valable même en présence de beaucoup de lésions; en outre elle nous permet de mesurer les dimensions de chaque lésion et de la portion de tissu épitélial qu'elles occupent même en rélation avec une zone de la peau prise comme échantillon.

Synopse

Hier wird ein Forschungssystem für Aknebeschändigungen gezeigt, das sich auf eine morphometrischen Analyse durch Datenverarbeitungsmaschinen stützt. Diese Methode ermöglicht (auch in Zusammenhang mit einer Therapie) eine grössenmässige Bewertung durchzuführen, die auch im Falle mehrerer Beschädigungen wirkungsvoll sein kann, und dann auszuwerten wie hoch die individuellen Beschädigungen und ihre Ausdehnung auf die Haut im Zusammenenhang mit der Hautfläche, die als Muster genommen wurde, sind (Hautsflächerprozentsatz).

Resumen

Se presenta aqui un sistema para la evaluación de las lesiones de acné por medio de un análisis morfométrico computarizado. Ese procedimiento permite (también con referencia al tratamiento) una evaluacíon cuantitativa eficaz también en caso de un gran número de lesiones y la evaluacíon del tamaño de lesiones individuales y de la área que ocupan con referencia también a la área de epidérmis que se ha elegido como muestra (area %).

Introduction

The course of acne and its response to therapy is usually evaluated by means of clinical observation and measurement. Clinical evaluation can be accomplished either by specific lesion counting or global evaluation: in both cases the judgement is subjective and therefore it does not allow exact quantification.

The evaluation of individual lesions requires that specific lesions in specific sites be counted so that minimum and maximum numbers be established: too few lesions would make it impossible to judge improvement, too many would make counting difficult (8).

Kligman and Plewig (2) suggested a method to simplify counting by means of grade assignment (ex. grade 1 = less than 10 comedones, grade 2 = 10-25 comedones, etc.). Comparison among groups with the same acne-grade is easier (ex. in relation to treatment) but lesions must be partly counted anyway. There are some advantages in limiting the number of lesions to be counted by using masks with gaps on correctly pre-determined face areas.

In *global evaluation*, individual lesions are not counted and the grading is based on some numerical scale, such as the Pillsbury 4-grade scale (6) or the Cook. 9-grade scale (1) which requires compa-
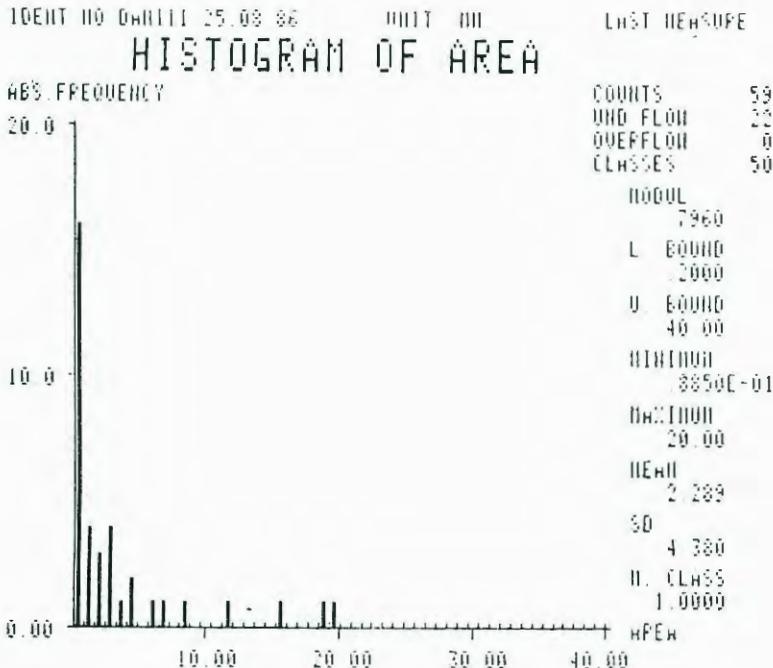

Graph 1: Pre-treatment.

ring the patient to a set of 5 standard photographic reproductions of acne. This method, adapted to office use (9), has been recently employed (3) evaluate to the effectiveness of two different antibiotic treatments (7).

Even if the global evaluation method is easier than counting specific lesions, it is less precise. In both cases the margins of error after successive visits or different observations could not be reduced sufficiently. Since 1985 (4, 5) we have been checking the possibility of using computerized morphometric analysis in evaluation of acne lesions.

Material and methods

35 mm color slides of skin areas containing acne lesions were taken through macro objective Pentax 50 mm, f 1:4 lens. These photographs were then scanned by means of a high geometric linearity TV-camera (d < 0,3% over the whole recording field of 512×512 pixels^2) connected to a computerized image analyzer Kontron Zeiss IBAS 2.

A suitable program, maintained the same for all the subjects was utilized. With this program the image was interactively elaborated by electronic filters and densito-
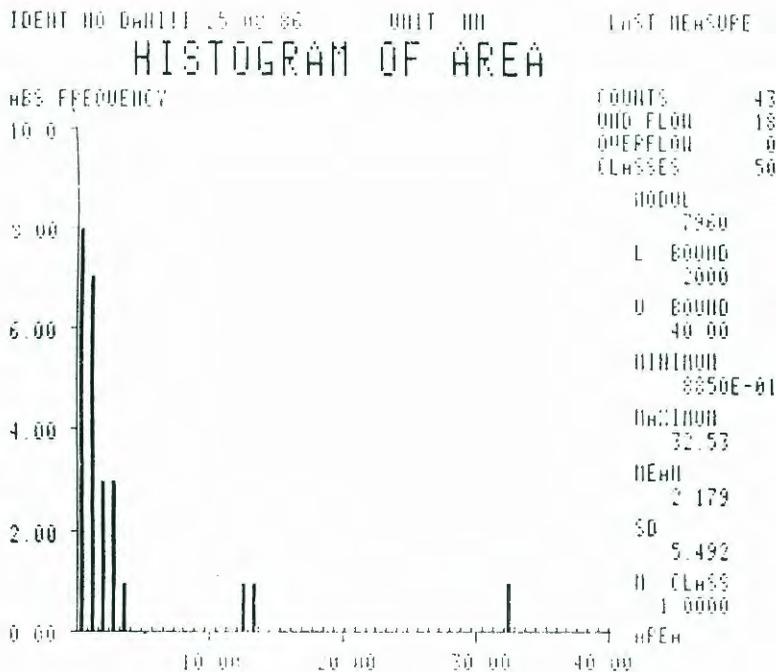
Graph. 2: Post-treatment.

metrically analyzed over 256 grey levels, in order to obtain a binary image suitable to the quantitative evaluation of the most significant morphometric parameters. After standardization of the primary subject image (directly taken from the color transparency), on a scale over 256 levels, the image itself was submitted to interactive elaboration in order to define the areas to analyze quantitatively. A measuring frame was placed over the image so as to de-limit a homogeneous area which avoids surfaces with different lightings. Amplitude and coordinates were memorized in the program, for a suc-

cessive and exact application on the same skin area after treament. In this image were accurately analyzed the frequency of distribution of the various grey levels, by defining inside the 0-256 range a threshold for the grey interval corresponding to the examined lesions.

If the illuminating conditions of the examined areas of the subject were the same before and after a treament we chose the same grey interval values, otherwise it was necessary to modify that value in order to obtain the best possible correspondance between the electronic image and the original color transparency.

Fig. 1: Pre-treatment (black and white from color transparencies).

In this way it was possible to descriminate the lesions inside the measuring frame. The grey levels of such an interval were converted to white (leve 255), obtaining a binary image suitable to quantitative evaluation of lesions acne. This evaluation was automatically performed after identification with pseudocolours.
Morphometric analysis of acne lesions in a patient before and after a treatment (systemic antibiotic therapy) was performed.

Results

All examples of the evaluation system are presented. Two color transparencies (before and after treatment; photo 1, 2) are submitted to TV-recording connected to the computerized image analyzer. After the normalization of the primary subject image an electronic measuring frame is superimposed (photo 3, 4) and the enlargement index is calculated.
The images are densitometrically analyzed and a binary image is obtained (photo 5, 6).
Evaluation of lesions is automatically performed:

1) a quantitative evaluation: before treatment the lesions are 59 and after treatment 43;

Fig. 2: Post-treatment.

2) a quantitative evaluation of each lesion area. The lesions are distributed according to their extension in 25 predetermined classes. If elements are below 0,2 mm² they are eliminated for calculation and graphs: a verification has shown that below said value a number of misleading elements can be included, such as scales, debris and ostia. Before treatment the average area is mm² 2.289 (graph 1). After treatment the average area is mm² 2.179 (graph 2).

3) An evaluation of the skin area covered by lesions in relation to the measuring frame area (area %) that before treatment is 12.14% and after treatment is 8.445%.

Discussion and conclusions

The evaluation methods of acne lesions and of their regression, in relation to treatment, which have been presented up to now allow, both in vivo or in photographic reproductions, the simple counting of a number of lesions, which is generally limited, and whose global evaluation is insufficiently precise.

The method presented here has allowed (in the same pre- and post-treatment sample area): a quantitative evaluation, effective even with a high number of lesions, a quantitative evaluation of individual lesion areas, and an evaluation of the lesions as a percentage of a chosen skin area. It is a method that minimizes subjectivity in the evaluation of the smallest differential quantitative modifications of selected parameters, induced by a therapy, in a single subject. Nonetheless there are some drawbacks: it is impossible to automatically distinguish elementary lesion types and the interactive determination of a densitometric threshold is required.
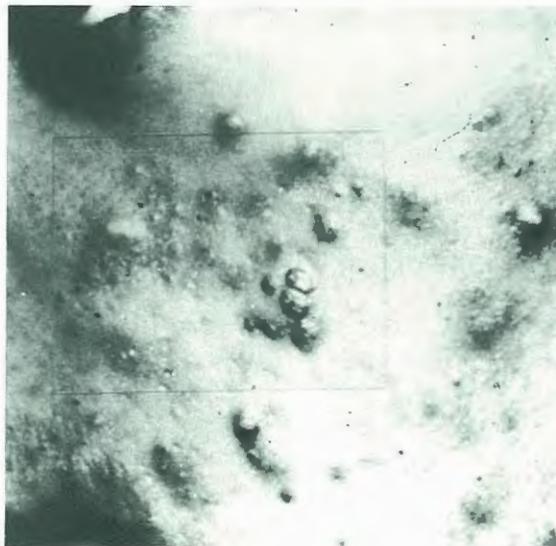

Fig. 3: Pre-treatment: «normalized electronic image with a superimposed measuring frame (electronic window).

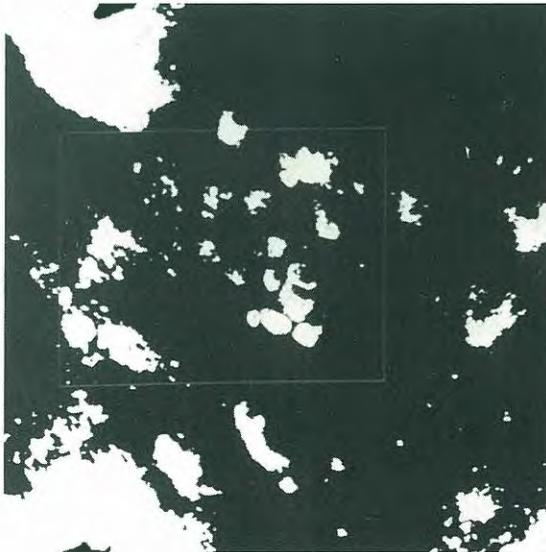Fig. 4: Post-treatment, «normalized» image with the same measuring frame.

Fig. 5: Pre-treatment: interactive determination of densitometric threshold (segmentation).

Fig. 6: Post-treament.

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