Conservative Dentistry

Digital photometric analysis of skin lesions and wound surfaces

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Дигитален фотометричен анализ на кожни лезии и раневи повърхности

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Summary

Clinical analysis of skin lesions and postoperative wound surfaces in dentistry is an important part of the treatment process. At present, this is done manually, using measuring instruments and mathematical calculations. Digital photography is used mainly for documentation and monitoring of the healing process, but not for an objective assessment of its progress. The aim of the present study is to develop and test a digital method for determining by photograph the metric characteristics of skin wound surfaces – length, width, perimeter, area. The obtained results show that the method proposed by us is reliable, very precise and can be used for analysis of skin wound surfaces in the course of the treatment process.

Key words: *skin lesions, wounds, dental photography, photometric analysis*

Резюме

Клиничният анализ на кожните лезии и постоперативни раневи повърхности в денталната медицина е важна част от лечебния процес. Към настоящия момент това се извършва ръчно, с помощта на измервателни уреди и математически калкулации. Дигиталната фотография се използва основно за документация и проследяване във времето на оздравителния процес, но не и за обективна оценка на неговия ход. Целта на настоящото проучване е да се разработи и апробира дигитален метод за определяне по фотоснимка на метрични характеристики на кожни раневи повърхности – дължина, ширина, периметър, площ. Получените резултати показват, че предложения от нас метод е достоверен, много прецизен и може да служи за анализ на кожни раневи повърхности в хода на оздравителния процес.

Ключови думи: *кожни лезии, рани, дентална фотография, фотометричен анализ*

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Introduction

Clinical analysis and evaluation of skin lesions and postoperative wound surfaces in various surgical interventions is a complex and difficult process that requires specific knowledge and follow-up over time. The information from this monitoring of the pre- and postoperative period is an important part of the treatment process, on which depends the choice of treatment methods and treatment plan, as well as the evaluation of the results of the performed interventions. The follow-up of clinical cases is carried out not only by registering the topography of the lesions and wound surfaces, but also by analyzing the linear and color characteristics. They provide valuable information on the course of the postoperative period [1].

The healing process of lesions and wound surfaces is associated with a cascade of reparative processes. They occur immediately after tissue damage and end with complete tissue reorganization. This process can last from 21 days to 18 months [1].

Therefore, it is important to follow the postoperative period and the course of the healing process by specific assessment of various criteria such as: location, stage, presence of necrosis, exudate and pain, color, characteristics of the edges and adjacent tissues, volume characteristics (shape, length, width, depth), induration, tunneling, undermining, odor [2].

The analysis of the metric characteristics of the size of the wound over time is one of the main ways to monitor and predict the period for the onset of the healing process. There are various methods for measuring wound surfaces [3, 4, 5, 6]. They are time consuming and include manual measurements and mathematical calculations, which creates preconditions for errors.

The application of modern digital technologies could facilitate the process of analysis and evaluation of wound surfaces. Digital analyses are characterized by very high accuracy, which allows much more accurate prediction of the course of the healing process. The development of a method by which one can determine the metric characteristics of the wound surfaces from a photograph would support not only the scientific but also the clinical activity [7]. This has been discussed by several organizations that have opinions on this issue – NPUAP, Wound Ostomy, Continence Society, American Professional Wound Care Association [8, 9, 10, 11].

Aim

To develop and test a digital method for determining by photograph the metric characteristics of skin wound surfaces – length, width, perimeter, area.

Material and methods

Material:

For the realization of the aim a highly specialized photographic technique is used:

1. DSLR: Nikon D600
2. Lenses: Nikon AF-S VR 105 mm f/2.8G IF-ED Micro lens
3. Flash: Nissin macro ring flash

Photographs of 30 cases of patients with cutaneous wound surfaces were used.

Criteria for inclusion in the study:

– Area of localization – scalp and neck;

– Areas without previous operative intervention;

– Wound defects obtained after the removal of a pathological skin lesion

Methods:

Specialized photographic equipment and software were used to perform digital photographic analysis for medical purposes. Photographs are taken by following the rules of image isometry. The camera lens should be perpendicular to the captured surface. There is a measuring line in the photo. All photos are color-calibrated by specifically adjusting the camera's white balance to the color temperature of the light source being used (5500K when using a ring flash). Wound surfaces were analyzed manually using a line.

Photo documentation is done on day 1, day 7, day 21 and day 60. Digital photometric analysis of the wound surfaces was performed on the photo-

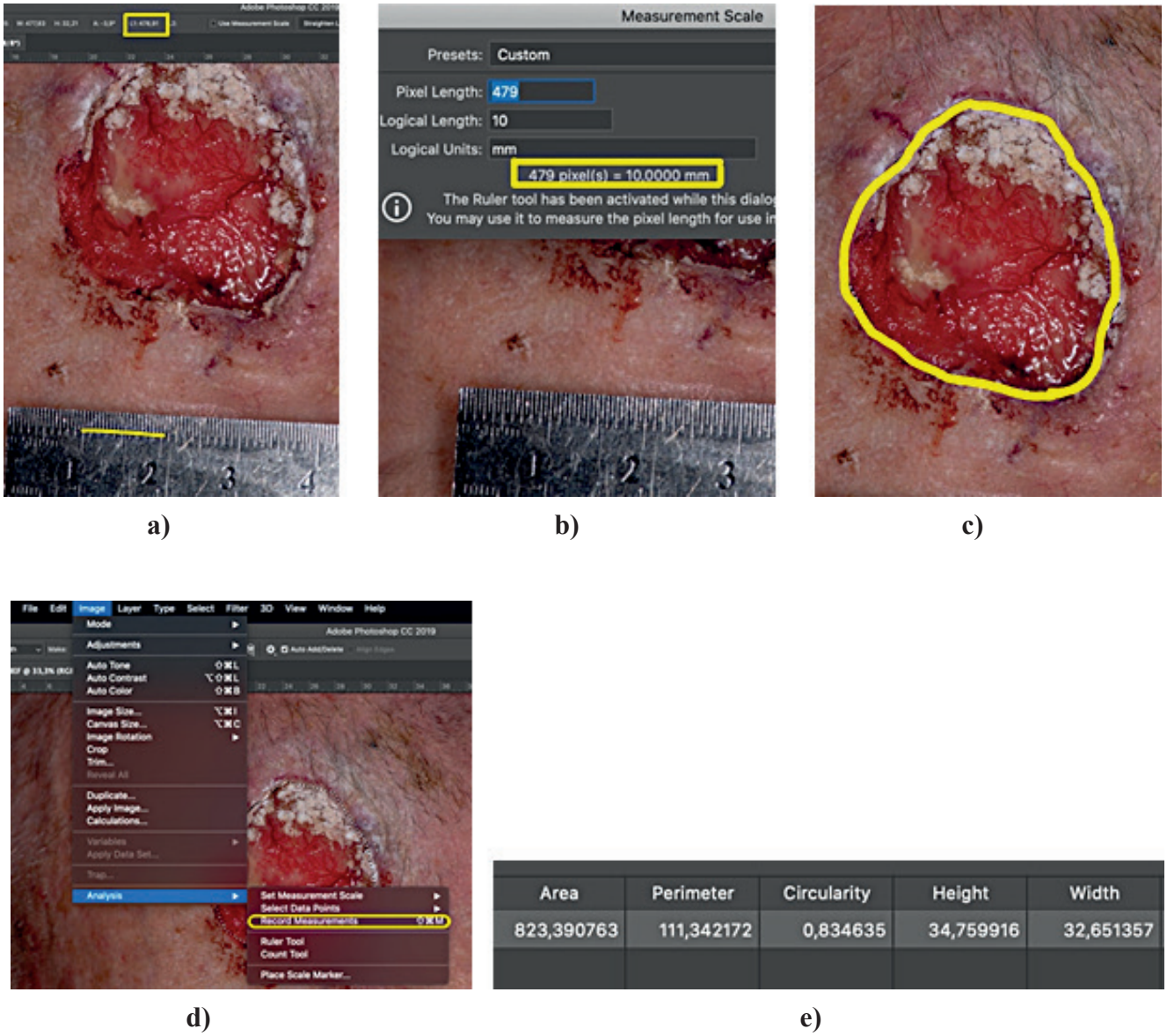
graphs using the Adobe Photoshop program. Manual and digital measurements were compared to verify the accuracy of the new digital methodologies.

Determining the linear characteristics of a photograph:

In the photo is marked one centimeter of the measuring line present in the frame. It is then checked by the software how many pixels are contained in one centimeter (the marked area) (Fig. 1 a). Then an individual measurement scale is set (Fig. 1 b). This is done by recording the number of pixels that correspond to 10 mm. Then the boundaries of the wound surface are marked with the pen tool (Fig. 1 c). The measurements are then recorded using the measuring instruments (Fig. 1 d). Different results are displayed on the screen. Length and width; area and perimeter are recorded (Fig. 1 e). The calculations are obtained automatically and are accurate to 0.01 mm.

The same characteristics are measured manually by the classical methods (with a measuring line – measurement of sections and calculations). The results of the two methods are compared – the tested new digital method and the classical method.

The obtained results were statistically processed using IBM Statistics SPSS v.19 software.



a) **b)** **c)**

d) **e)**

Figure 1. *Method for determining the linear characteristics of skin wound surfaces: a) determination of the number of pixels in 1 cm; b) setting a measurement scale; c) marking the boundaries of the wound surface; d) recording the measurement; e) results obtained*

Results

From the conducted researches we received the following results, which are presented in two tables below.

Table № 1 shows the measurements for length and width of the skin wound surfaces in all periods of examination by digital and manual measurement.

It can be seen that there is no statistically significant difference between the results obtained for the perimeter of the skin wound surface ($p > 0.05$) during all periods of the study. In terms of area, a significant difference was observed only in the study on the first day ($p < 0.05$). During the other periods there are no statistical differences in the results obtained by the two methods of measurement – digital and manual.

The results show that there is no statistically significant difference between the results obtained for measuring the length and width of the skin wound surface ($p > 0.05$) during all periods of the study by both methods (digital and manual).

Table № 2 shows the measurements for perimeter and area of skin wound surfaces in all periods of examination by digital and manual measurement.

Discussion

Digital technologies are becoming increasingly important in dental medicine, especially dental photography. The introduction of digital methods for photographic analysis in medicine will support the process of creating various scientific developments in the field of all specialties [12, 13].

The results of our research clearly show that our proposed digital photometric method for determining the linear characteristics of skin wound surfaces is accurate and reliable. The statistically significant difference in determining the area of the wounds on the first day of the study is due to the greater accuracy of the digital measurement compared to the manual (and its corresponding mathematical calculation). This is also associated with the high resolution of the photograph, which provides the ability to calculate the linear characteristics with an accuracy of 0.01 mm, which is impossible with manual measurement.

Digital photometric analysis of skin lesions and wound surfaces is more accurate and provides more

Table 1. *Mean values of length and width of skin wound surfaces during the different periods of examination, measured digitally and manually*

Measured value / Way of measurement	Length (cm)				Width (cm)			
	Day 1	Day 7	Day 21	Day 60	Day 1	Day 7	Day 21	Day 60
Digitally (a)	5,13 ± 0,88	4,22 ± 0,33	2,08±0,21	0 ± 0	3,24 ± 0,67	1,93 ± 0,23	0,65 ± 0,12	0 ± 0
Manually (b)	5 ± 1	4,2 ± 0,4	2 ± 0,25	0 ± 0	3 ± 0,9	2 ± 0,32	0,6 ± 0,2	0 ± 0
t-test	$t_{(a,b)}$=3,60 $p_{(a,b)}$=0,11	$t_{(a,b)}$=0,01 $p_{(a,b)}$=0,99	$t_{(a,b)}$=0,01 $p_{(a,b)}$=0,99	$t_{(a,b)}$=0 $p_{(a,b)}$=0	$t_{(a,b)}$=0,34 $p_{(a,b)}$= 0,89	$t_{(a,b)}$=1,15 $p_{(a,b)}$=0,69	$t_{(a,b)}$=1,35 $p_{(a,b)}$=0,60	$t_{(a,b)}$=0 $p_{(a,b)}$=0

Table 2. *Mean values of perimeter and area of skin wound surfaces during the different periods of examination, measured digitally and manually*

Measured value / Way of measurement	Perimeter (cm)				Area (cm^2)			
	Day 1	Day 7	Day 21	Day 60	Day 1	Day 7	Day 21	Day 60
Digitally (a)	16,74 ± 1,62	12,3± 0,68	5,46± 0,44	0	16,62 ±1,32	8,14±0,43	1,35±0,24	0
Manually (b)	16 ± 2	12,4 ±0,82	5,2±0,52	0	15±1,8	8,4 ±0,67	1,2±0,41	0
t-test	$t_{(a,b)}$=0,32 $p_{(a,b)}$=0,75	$t_{(a,b)}$=0,86 $p_{(a,b)}$=0,97	$t_{(a,b)}$=1,35 $p_{(a,b)}$=0,60	$t_{(a,b)}$=0 $p_{(a,b)}$=0	$t_{(a,b)}$=2,05 $p_{(a,b)}$<0,05	$t_{(a,b)}$=1,94 $p_{(a,b)}$=0,36	$t_{(a,b)}$=0,84 $p_{(a,b)}$=0,40	$t_{(a,b)}$=0 $p_{(a,b)}$=0

accurate information about the course of the healing process. It is done much faster, as the mathematical calculations made in the classical method are obtained automatically. This provides the ability to process a wide range of cases without subjectivity and with absolute accuracy. Unlike the digital method, in manual measurement it is possible to make mistakes both in recording the linear characteristics and in the calculation of area and perimeter. Determining linear parameters requires excellent mathematical knowledge of complex calculations, which are normally beyond the competence of dentists. This takes valuable time that can be devoted to important clinical activities [14].

On the other hand, the implementation of digital photometric analysis requires the presence of specific and expensive equipment, additional training in dental photography and work with specific software, which is not necessary for manual measurement. However, many dentists have semi-professional or professional photographic equipment in their offices to document their cases. The digitalization of our profession is also related to the need for knowledge in the field of dental photography. They, in turn, can be used not only for routine activities such as recording the patient's before and after conditions, but also for more specific procedures, such as digital photometric analysis. Thus, in the presence of knowledge in the field of dental photography, dentists should be trained in a few more simple steps for software processing, which will avoid complex and time-consuming mathematical calculations. In this way, digital photometric analysis saves both time and effort, and on the other hand, the results obtained are much more accurate and error-free unlike with manual calculation [7].

We believe that the time devoted to such training (in dental photography and processing) is significantly less than the time devoted to manual calculation of linear and volumetric characteristics of wounds in everyday practice. For this reason, as well as the absolute accuracy and lack of subjectivity of digital methods, the latter are preferred in the analysis and monitoring of the healing process of skin lesions and postoperative wound surfaces.

Conlcusion

The new digital method for photometric analysis developed by us is not subjective and is much more accurate than the classical methods. Its application facilitates the assessment, analysis and monitoring of the healing process in various surgical interventions.

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