PERSPECTIVES FOR APPLYING THE ADDITIONAL STUDY METHODS FOR DIAGNOSTICS OPTIMIZATION OF POSTOPERATIVE HYPERTROPHIC SCARS OF THE HEAD AND NECK

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ABSTRACT

Introduction: The issue of improving the quality of diagnosis, prevention and treatment of patients with pathological scarring of the head and neck is being actively developed throughout the world. Currently, the scientific interest is attracted to the study of skin using non-invasive methods, such as RGB-visualization of digital images and ultrasound examination.

The aim of the research is to improve diagnostics of hypertrophic scars of the head and neck through the establishment of structural features of scar-modified tissues using RGB-system and ultrasound examination.

Materials and methods of the research. In this study, 60 patients with hypertrophic scars of the head and neck were examined, with the period of development of scar tissue from 3 to 12 months. Under our supervision, there were patients in whom the type of scar was previously confirmed not only clinically but also morphologically. The data was taken from the symmetrical intact area of the skin as a normal value.

Results and discussion: At present, computer digital image research is widely used in histological, cytological, pathologic and immunological studies, which led us to consider the use of digital analysis of images as the initial stage of primary diagnosis in various types of postoperative scarred facial tissues. Computer imaging is still the only source for obtaining visualized qualitative and quantitative information and preserving it in digital form. Based on the optical analysis of the obtained images, it can be concluded that hypertrophic scars are well visualized and are different from intact skin. We created a standardized table of numerical values for distribution of color components in the RGB system. Analyzing the data as for the numerical differences in terms of echogenicity of hypertrophic scars, we found that the echogenicity changes in the area of medial and lateral edges of the scar had significant differences.

Conclusions: A comprehensive examination of patients with hypertrophic scarring of the head and neck, which implies the mandatory use of such effective non-invasive diagnostic methods as RGB-visualization and ultrasound examination, enables us to differentiate the type of scar tissue and assess the dynamics of its changes. The described comprehensive approach to examination of patients with scarring will provide the optimal choice of methods for treatment and achieving the maximum therapeutic effect.

KEY WORDS: hypertrophic scarring of the head and neck, non-invasive diagnostic methods, RGB-visualization, ultrasound examination.

Introduction. The problem of improving the quality of diagnosis, prevention and treatment of patients with pathological scarring of the head and neck continues to be actively developed in the modern dental surgery. The need for in-depth study of these important issues is first of all due to the fact that even in developed countries, approximately 55% of cases of postoperative skin lesions healing resolve with rough scarring [1,2]. It should be noted that of fundamental importance is not only the fact and the extent of a certain functional or aesthetic defect in scar tissue changes, but also the degree of their negative influence on the process of physical, psychological and social adaptation of the patient, which brings this problem closer to medical and social spheres [3,4].

The development of algorithms for treatment and rehabilitation of such patients is difficult due to the uncertainty of the criteria for differential diagnosis of various types of scarring. Despite significant pathogenetic and morphological differences in scarring, some of their variants often have clinically similar features, which leads to a significant number of diagnostic errors. In its turn, the treatment without taking into account the clinical and morphological structure of scarring leads, as a rule, to a lack of reliable therapeutic effect, relapses and increased growth of scar tissue [5]. Therefore, effective treatment of patients with scarring of the skin is possible only through the development is differentially-diagnostic criteria for determining their various types.

Currently, the scientific interest is drawn to the study of skin using non-invasive methods, such as RGB-visualization of digital images and ultrasound examination [6,7]. Positive results of the use of these methods for studying skin changes in some diseases offer a wide range of opportunities for their application and determining the morphological structure of scar tissue.

The aim of the research is to improve diagnostics of hypertrophic scars of the head and neck through the establishment of structural features of scar-modified tissues using RGB-system and ultrasound examination.

Materials and methods of the research. In this study, 60 patients with hypertrophic scars of the head and neck were examined, with the period of development of scar tissue from 3 to 12 months. Under our supervision, there were patients in whom the type of scar was previously confirmed not only clinically but also morphologically. The data was taken from the symmetrical intact area of the skin as a normal value.

Clinical examination of patients was complemented by visualization of digital images using the RGB system. It is known that with a large digital increase on the monitor screen, a grid is visualized that consists of three basic colors, which in the computer technique are measured by numbers in the range from zero to two hundred and fifty-five, where zero is the absence of this color, two hundred and fifty-five is maximum of its presence. Hence, the maximum clean red value is defined as R/255 – G/0 – B/0. By analogy, green and blue colors are determined. This is the simplest color rendering model, called the RGB system. An additional analysis of the structure of scar tissue was carried out by ultrasound using Nemio MX SSA 590A (Toshiba) device with a pulsed ultrasonic wave reference.

During the research, quantitative indicators were measured at the following points: T1 – the area of intact skin around the scar, T2 – the area of the medial edge of the scar, T3 – the area of the lateral edge of the scar, T4 – the middle area of the scar. Furthermore, the study of the ultrasound pattern was additionally carried out at the following points: L1 – the border between the epidermis and the scar tissue, L2 – the border between the scar tissue and the hypodermis, L3 – the border between the medial edge of the scar and intact derma, L4 – the border between the lateral edge of the scar and intact derma. In addition, for the purpose of objectification of the data we introduced 2 coefficients: L1/2 – the index showing the nature of the change in the echogenicity parameters in the central and peripheral tissues of the scar in its middle zone; L3/4 – the index showing the nature of echogenicity changes in the medial and distal edges of the scar.

Results and discussion. Today, computer digital image research is widely used in histological, cytological, pathologic and immunological studies, which led us to consider the use of digital analysis of images as the initial stage of primary diagnosis in various types of postoperative scarred facial tissues.

Computer imaging is still the only source for obtaining visualized qualitative and quantitative information and preserving it in digital form. It is important that the camera matrix turns the shade of the image into a microscopic grid, each cell of which (pixel) is assigned digital data. When transferring information to a computer, the physician gets the opportunity to digitally increase the image by hundreds of times with minimal loss of quality and obtaining quantitative and qualitative characteristics of pixels with subsequent mathematical treatment.

Under ideal lighting conditions (IC), imaging was performed in macro mode at a distance of 40 cm, with the flash off and without optical magnification. Under satisfactory lighting conditions (SC), imaging took place at a distance of 80-90 cm, without flash, with minimal use of optical magnification. Under poor lighting conditions (PC), imaging was carried out at a distance of 110-120 cm, with the flash turned on and with the maximum possible optical magnification.

In optical analysis of the obtained photos on the computer monitor, it can be concluded that hypertrophic scars are well visualized and are different from intact skin. Analyzing the data, we have created a standardized table of numerical values for distribution of color components in the RGB system (Table 1).

Table 1

Distribution of intervals in digital values of colored components in the RGB system when visualizing scars and intact skin

Quality of lighting		T. 1	Hypertrophic scar		
			T. 2	T. 3	T. 4
IC	R	182±3	188±2	185±2	187±2
	G	128±2	140±3	130±3	132±3
	B	111±2	124±3	112±3	113±3

SC	R	179±4	184±2	180±2	181±2
	G	126±3	135±3	126±3	128±3
	B	108±6	116±5	111±5	112±5
PC	R	176±5	182 ±5	179 ±5	180 ±5
	G	124±4	130±5	125 ±5	126 ±5
	B	101±3	109±2	107±3	108±3

Note:

IC – ideal lighting conditions;

SC – satisfactory lighting conditions;

PC – poor lighting conditions.

Analyzing the data from the table, one can conclude that the discrepancy between the values of different color spectra in the RGB system at T1 varies under different lighting conditions with the greatest spread of confidence intervals under satisfactory light conditions. All indicators of intensity in spectral radiation tend to decrease. Hence, the indicator of red color tends to decrease by an average of 4 units, just as in the indicator of the green spectrum.

The average values of the reduction in the intensity of the blue color equals to 10 units. Thus, the spectral color characteristic of intact skin depending on the conditions of illumination is influenced by the blue color spectrum.

At the stage of digital imaging of hypertrophic scar tissues, we found out that the intensity of the reduction parameter in the reliable intervals of digital values of the red component in the RGB system on average equals 6, which is reliably lower in the dynamics of changes in the green spectrum, which was on average 10 units, the largest differences T2 were observed in the blue spectrum, which was on average 15 units. When studying the dynamics of changes in the components of T3, it should be noted that the digital values of red color intensity decreased by 6 units, green and blue – by 5 units. In T4, the following values were obtained: the reliability of reduction in the indicator of red color was 7, green – 6, and blue – 5 units.

Thus, the conducted quantitative digital color analysis proved that hypertrophic scars differ from intact skin in the digital components of the spectrum, and also differ in confidence intervals of the range and change in the digital color indices at different areas of the scar.

At the initial stage of ultrasound examination, we studied the echogenic structure of intact skin. In all cases, from the point of view of echogenic qualities, the following layers can be distinguished: the upper layer; the middle layer, which is represented by the dermis limited above by the border of the epidermal tissues, the lower layer of the hypodermis, the lower layer, which is represented by the subcutaneous fatty tissue, which is limited above by the reticular layer of the dermis.

Noteworthy is the fact that the top layer consists of two conventionally parallel strips that are represented above – by the dark, and below – by the light stripes. The light stripe characterizes the echogenic structure of the epidermis and on the ultrasound it is visualized with homogeneous structural components. This is an essential feature of the structure of the intact skin of the epidermis, which must be taken into account when comparing ultrasound images with similar studies in the epidermal layer of the scar tissue.

We also observed features of dermis visualization: in terms of ultrasonic waves distribution, in 93% of cases it had the structure with low echogenicity. On the scans, this layer had a rather homogeneous structure, which, according to the degree of "darkening" had somewhat higher rates than the upper layer of the epidermis. We have followed distinct upper and lower boundaries whereby the upper boundary is visualized as a denser consistency, due to the morphology of dermal and epidermal connections. The bottom layer is visualized as more spongy, which is probably due to the presence of deep membranes that slide with interspersed elements of fat lobules of epidermis.

The lower layer, which is represented by hypodermic fatty tissue with an upper boundary and the reticular layer of the dermis, had reduced hyperechoic structure. This layer had heterogeneous, loose structure, in which there were areas with hypo- and hyperechoic properties.

At the stage of ultrasound examination of hypertrophic scars, we have established the following features. The epidermal tissue of the scar had a reduced echogenic structure and was characterized by homogeneity close to the intact skin. However, in all cases, this tissue had a deep depressions of an average of 0.22 to 0.58 mm. Noteworthy is the fact that the connective tissue density was heterogeneous with different number of connective tissue components (collagen and elastic fibers) in different parts of the scar. It is necessary to observe that the depth of hypertrophic scars was significant and had quite divergent variable values from 1.6 to 4.3 mm. In this case, the structure of the scar itself was hypoechoic. In the vast majority of cases, ultrasound images of the scar tissue were characterized by distinct, limited contours whose thickness decrease along the periphery of the scar and reach the maximum values in its center. Thus, the hypertrophic scar has a clear boundary with intact skin and underlying tissues. Analyzing the data as for the numerical differences in terms of echogenicity of hypertrophic scars, it should be noted that the echogenicity changes in the area of medial and lateral edges of the scar had significant differences (Table 2).

Table **2**

Distribution of values in echogenicity indices of hypertrophic scarring in ultrasound examination

No.	T1	T2	T3	T4	L1	L2	L3	L4	L1/2	L3/4

1	86	77	78	61	57	98	63	60	0.60	1.05
2	90	82	79	62	56	95	60	55	0.60	1.09
3	82	71	73	61	72	102	75	74	0.70	1.01
4	88	79	81	60	51	85	51	50	0.60	1.02
5	89	80	83	61	69	94	72	75	0.73	0.96
6	85	76	77	62	62	90	61	62	0.70	0.98
7	84	74	74	61	53	88	59	59	0.60	1.00
8	92	81	80	67	71	102	74	79	0.70	0.94
9	80	71	72	54	73	102	80	81	0.71	0.99
10	79	72	68	51	61	90	65	66	0.67	0.98
11	83	74	73	57	54	87	66	62	0.62	1.06
12	92	81	79	62	72	90	72	74	0.80	0.97
13	89	78	81	58	50	82	52	55	0.60	0.95
14	78	68	66	56	52	85	60	61	0.61	0.98
15	94	82	84	64	77	107	81	84	0.71	0.96
Mean value	86.1	76.4	76.5	59.8	62.1	93.1	66.1	63.1	0.66	0.99

We obtained data on the reliable differences between the values of echogenicity at the edge of the scar-modified tissues with epidermis and hypodermis, which were 62.1 and 93.1, respectively. In our opinion, this gives evidence of irregular density in the tissue of hypertrophic scar in its surface and deep layers. By analyzing the indices in the areas between the medial and lateral edges of the scar and dermis, a significant reduction of these indices was established up to 66.1 and 63.1 respectively, which, in our opinion, may be indicative of heterogeneous density of connective tissue elements in different edges of hypertrophic scarring. The digital characteristics of the variational series in echogenicity indicators obtained at certain points may indicate a correlation between the scar density in different areas, the degree of its echogenicity at these points and its affiliation to a certain type of scar.

Thus, a comprehensive examination of patients with hypertrophic scarring of the head and neck, which implies the mandatory use of such effective non-invasive diagnostic methods as RGB-visualization and ultrasound examination, allows for differentiation of the type of scar tissue and assessing the dynamics of its changes. Such a comprehensive approach to examination of patients with scarring, in our opinion, will provide the optimal choice of methods for treatment and achieving the maximum therapeutic effect.