Acta Medica Okayama

Volume 51, *Issue* 2 1997 *Article* 7

APRIL 1997

New evaluation method for postoperative scar redness

Koki Nakamura* Hiroyuki Irie†

Shunji Sano‡

*Okayama University,

†Okayama University,

‡Okayama University,

New evaluation method for postoperative scar redness*

Koki Nakamura, Hiroyuki Irie, and Shunji Sano

Abstract

Even after successful operations, ugly postoperative skin scars are often distressing to patients and their parents. To judge the success of surgical methods and postoperative treatment, postoperative scars should be evaluated using a quantitative system. Height and width are easily measured, but scar redness is not. We have developed a simple and effective method for evaluating scar redness. According to the color definitions employed in computer graphics, each color can be expressed as RGB (red, green or blue) coordinates (r, g, b): 0 ≦ r, g, b ≦ 10. The degree of scar redness is defined by the following formula: redness score (RS) = $(r_1 - r_0)^2 + (g_1 - g_0)^2 + (b_1 - b_0)^2$. Here, ($R_1$, g_1, b_1) = coordinates of the scar color and (r_0, g_0, b_0) = coordinates of the surrounding skin color. RS was evaluated in 59 children (35 males, 24 females; ages 1 month to 12 years old) who had scar redness after congenital cardiac surgery. For each patient, scar color and surrounding skin color was identified on the color sample table. Scar redness was also evaluated by the conventional grading method: 1 = mild, 2 = moderate and 3 = severe. The RS of the colored scars ranged from 4 to 100 (38 ± 27). By the conventional grading method, 44 scars were grade 1, 15 grade 2 and none grade 3. RS was significantly higher among grade 2 than grade 1 patients, 52 ± 25 and 33 ± 27, respectively ($P < 0.05$). Given its subjectivity, the conventional grading method yields variable data; surrounding skin color, moreover, is not considered. Our new evaluation method using RS effectively and accurately defines scar and skin colors, and allows quantitative studies of these factors.

KEYWORDS: redness score, scar, redness, quantification, evaluation

---

*PMID: 9142347 [PubMed - indexed for MEDLINE]

ACTA MED OKAYAMA 1997; 51(2): 101-104

New Evaluation Method for Postoperative Scar Redness

Koki NAKAMURA*, Hiroyuki IRIE and Shunji SANO

Department of Cardiovascular Surgery, Okayama University Medical School, Okayama 700, Japan

Even after successful operations, ugly postoperative skin scars are often distressing to patients and their parents. To judge the success of surgical methods and postoperative treatment, postoperative scars should be evaluated using a quantitative system. Height and width are easily measured, but scar redness is not. We have developed a simple and effective method for evaluating scar redness. According to the color definitions employed in computer graphics, each color can be expressed as RGB (red, green or blue) coordinates (r, g, b): $0 \leqq r, g, b \leqq 10$. The degree of scar redness is defined by the following formula: redness score (RS) $= (r_1 - r_0)^2 + (g_1 - g_0)^2 + (b_1 - b_0)^2$. Here, (r_1, g_1, b_1) = coordinates of the scar color and (r_0, g_0, b_0) = coordinates of the surrounding skin color. RS was evaluated in 59 children (35 males, 24 females; ages 1 month to 12 years old) who had scar redness after congenital cardiac surgery. For each patient, scar color and surrounding skin color was identified on the color sample table. Scar redness was also evaluated by the conventional grading method: 1 = mild, 2 = moderate and 3 = severe. The RS of the colored scars ranged from 4 to 100 (38 ± 27). By the conventional grading method, 44 scars were grade 1, 15 grade 2 and none grade 3. RS was significantly higher among grade 2 than grade 1 patients, 52 ± 25 and 33 ± 27, respectively ($P < 0.05$). Given its subjectivity, the conventional grading method yields variable data; surrounding skin color, moreover, is not considered. Our new evaluation method using RS effectively and accurately defines scar and skin colors, and allows quantitative studies of these factors.

Key words: redness score, scar, redness, quantification, evaluation

Only a quantitative method enables one to evaluate postoperative skin scarring objectively for future improvements in surgical technique or postoperative management. While height, width and length are easily measured, it is difficult to quantify scar redness. Use of the conventional grading scale yields subjectively variable data without consideration of surrounding skin color. There have been no reports of evaluation methods which do not employ measuring devices. To this end, we have developed a simple and effective method for scar redness evaluation.

Subjects and Methods

Color sample table and redness score. According to computer graphic color definitions, every color can be expressed as RGB (red, green or blue) coordinates (r, g, b): $0 \leqq r, g, b \leqq 10$. A color sample table was made, which included 18 skin color samples (Fig. 1, Table 1). The degree of scar redness was defined as the sum of the squared differences between redness coordinates (r_1, g_1, b_1) and surrounding skin color coordinates (r_0, g_0, b_0): Redness score (RS) $= (r_1 - r_0)^2 + (g_1 - g_0)^2 + (b_1 - b_0)^2$ (Fig. 2-a, b).

Subjects. Our subjects were 59 children (35 males and 24 females, ages 1 month to 12 years old; 3.3 ± 3.0 y.o.) with postoperative scar redness 3 months after congenital cardiac surgery. Among these patients, 45 received median, 10 posterolateral and 4 submammary skin incisions. Cyanosis was seen in 27 patients (46 %) pre-operatively and in 13 patients (22 %) postoperatively.

Methods. For each patient, scar color and surrounding skin color were identified on the color sample table and RS was calculated. The degree of redness was also evaluated using the conventional 3-grade scale: 1 = mild, 2 = moderate and 3 = severe. Area, height and stiffness of the scar were not considered in this study.

* To whom correspondence should be addressed.

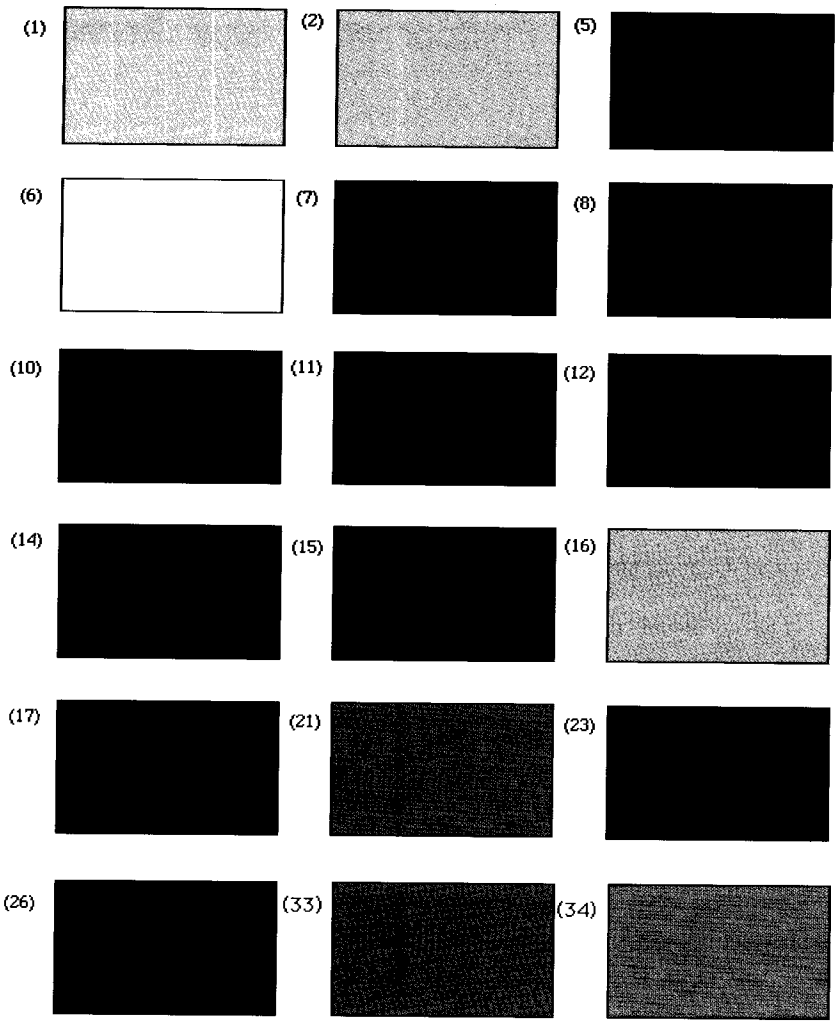

Fig. 1 Color sample table.
Eighteen color samples were made using computer graphics. After observing the actual scar color, the sample which most closely matched the scar color was chosen.

Table 1 Color sample coordinates and frequency of matching to actual colors

No.	Coordinates (R, G, B)	Match to skin color	Match to scar color	No.	Coordinates (R, G, B)	Match to skin color	Match to scar color
1	(10, 8, 4)	38	0	14	(6, 2, 6)	0	8
2	(10, 8, 6)	13	0	15	(10, 0, 10)	0	2
5	(10, 6, 6)	0	12	16	(10, 6, 4)	3	1
6	(10, 10, 8)	0	0	17	(8, 2, 6)	0	0
7	(10, 2, 4)	0	15	21	(8, 6, 4)	4	0
8	(4, 0, 4)	0	3	23	(8, 4, 2)	0	0
10	(10, 0, 4)	0	7	26	(8, 0, 2)	0	0
11	(10, 4, 4)	0	8	33	(10, 6, 2)	1	0
12	(6, 0, 4)	0	3	34	(8, 6, 0)	0	0

R, G, B: Red, green or blue.

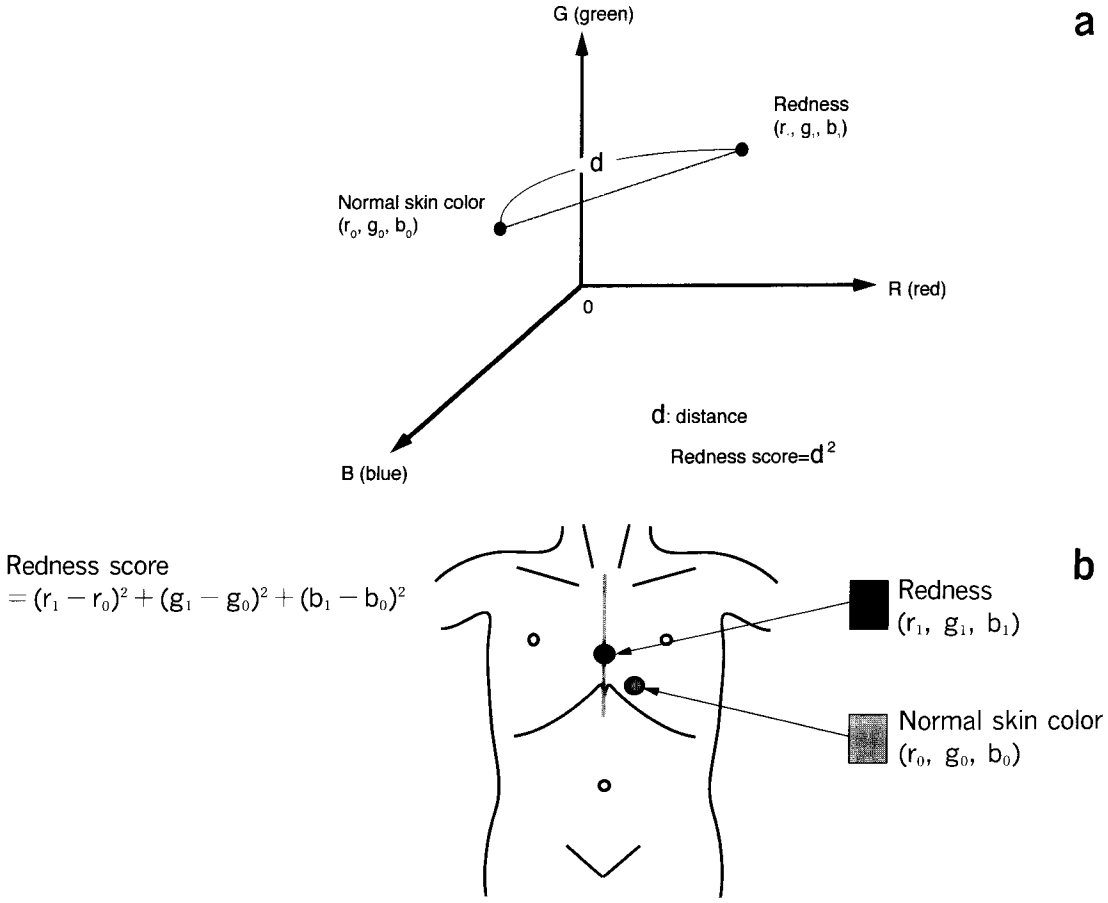

Fig. 2 Redness score (RS).
a: All colors were expressed as coordinates in the RGB (red, green or blue) system, which is a 3-dimensional plotting, as shown in Fig. 2. Each skin color and redness has coordinates. RS was defined as the square of the distance between the 2 points.
b: Redness and surrounding skin colors were matched to the color samples, respectively, after which redness score was calculated as shown in the figure.

Statistics. An unpaired Student's t-test was used for the comparative RS statistics between the grade 1 and grade 2 groups. The P-value, less than 0.05, was considered significant.

Results

Redness and surrounding skin color coordinates were $(9.9 \pm 0.5,\ 7.7 \pm 0.7,\ 4.4 \pm 0.9)$ and $(8.9 \pm 1.9,\ 2.6 \pm 2.2,\ 4.9 \pm 0.9)$, respectively. The RS of colored scars ranged from 4 to 100 (38 ± 27).

As normal skin colors, Nos. 1, 2, 16, 21 and 33

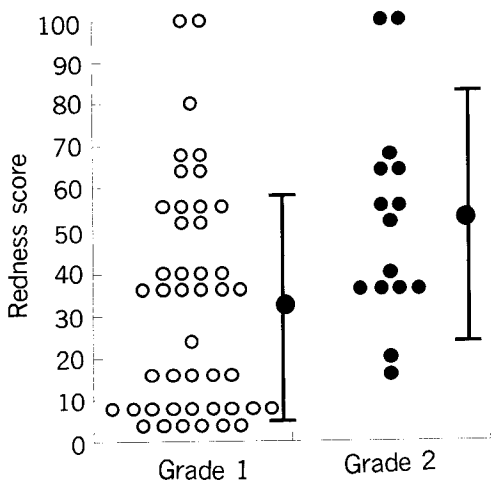

Fig. 3 (Right) Redness score *vs.* grading scale.
Redness score was significantly higher among grade 2 than grade I patients: 52 ± 25 and 33 ± 27, respectively ($P < 0.05$).

were matched. As scar colors, Nos. 5, 7, 8, 10, 11, 12, 14, 15 and 16 were matched. No. 16 was used as both a skin and a scar color. Nos. 6, 17, 23, 26 and 34 samples were not used (Table 1).

On the conventional grading scale, 44 scars were grade 1, 15 grade 2 and none grade 3. RS was 33 ± 27 for grade 1 and 52 ± 25 for grade 2 scars ($P < 0.05$; Fig. 3).

Discussion

To reduce ugly postoperative scarring, operation method and postoperative scars should be evaluated. In order to judge effectively, a quantitative method for scar evaluation is necessary. While scar height, width and length are easily measured, redness is not; evaluation of redness is, nonetheless, an important parameter, especially in treating keloid and/or hypertrophic scars. Until now, there has been no efficient and accurate method for scar evaluation available.

Evaluation of scar redness using the conventional grading scale (grade 1 = mild, grade 2 = moderate and grade 3 = severe redness) is both subjective and imprecise. Surrounding skin color, moreover, is not considered.

Recently some devices, such as the colorimeter, have been developed which include redness as a factor in skin color quantification (1-6). These devices yield accurate, objective evaluations in the L*a*b* system, but they are very expensive and not immediately available for clinical application (1-6). In L*a*b* color space, equal distances are approximately equal to perceived color differences. L* represents psychometric lightness, and a* and b* are the psychometric chroma coordinates of red-green and yellow-blue, respectively. Using the RGB (red, green or blue) system, colors were quantified using a computer or Doppler color flow mapping (7, 8). RGB can be plotted easily on a three-axis graph. The resultant plot shows the difference between the color of the scar and the color of the surrounding skin as the distance between their two respective points on the graph (d). Redness score is then easily calculated by squaring this figure (*i.e.*, d^2). Therefore, we have developed a simple and effective new method (RS) using the RGB system to evaluate and quantify scar redness.

Using the conventional grading scale, all patients were classified as either grade 1 or 2. According to our results, grade-evaluation and RS corresponded. In contrast to the grading scale, however, RS is a continuous parameter which more precisely expresses redness.

In this study, skin color variations (five samples) and scar color variations (nine samples) were matched to determine the actual color (only the No. 16 color was used for both surrounding skin and scar colors). Five samples were never matched for the actual colors because the color of the scar tissue did not correspond to any of the colors on the color sample table. This means that the color sample table can still be improved. It is necessary to develop a color sample table in which colors are closer to the actual skin and scar colors. We must also consider how many samples are necessary in the color sample table.

In conclusion, RS was simple, effective and useful for evaluating scar redness. If the color sample patterns are closer to the actual scar and surrounding skin colors, an even more reliable evaluation method can be produced.

References

1. Takahashi Y, Nakazawa Y, Okazaki K and Yamamoto Y: Study on numerical expression of gastric mucosal color with a videoendoscope and an image processor. Dig Endosc (1995) **7**, 140-149.
2. Nose T and Tsurumi K: Pharmacological studies on cutaneous inflammation induced by ultraviolet irradiation (I): Quantification of erythema by reflectance colorimetry and correlation with cutaneous blood flow. Jpn J Pharmacol (1993) **62**, 245-256.
3. Agner T: Basal transepidermal water loss, skin thickness, skin blood flow and skin colour in relation to sodium-lauryl-sulphate-induced irritation in normal skin. Contact Dermatitis (1991) **25**, 108-114.
4. Queille-Roussel C, Poncet M and Schaefer H: Quantification of skin-colour changes induced by topical corticosteroid preparations using the Minolta Chroma Meter. Br J Dermatol (1991) **124**, 264 270.
5. Takiwaki H and Serup J: Variation in color and blood flow of the forearm skin during orthostatic maneuver. Skin Pharmacol (1994) **7**, 226 230.
6. Kelly RI, Pearse R, Bull RH, Leveque JL, De-Rigal J and Mortimer PS: The effects of aging on the cutaneous microvasculature. J Am Acad Dermatol (1995) **33**, 749-756.
7. Simpson IA, Valdes-Cruz LM, Yoganathan AP, Sung HW, Jimoh A and Sahn DJ: Spatial velocity distribution and acceleration in serial subvalve tunnel and valvular obstructions. J Am Coll Cardiol (1989) **13**, 241-248.
8. Kuyatt BL, Reidy CA, Hui KY and Jordan WH: Quantitation of smooth muscle proliferation in cultured aorta. Anal Quant Cytol Histol (1993) **15**, 83-87.

Received December 6, 1996; accepted January 16, 1997.