Color of Gingival Tissues of Blacks and Whites

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Value, chroma, and hue of attached gingiva of blacks and whites were measured clinically with Munsell color tabs. The color of nonmottled gingiva of blacks and whites was similar. The color of gingiva pigmented by melanin in blacks was similar in hue, but lower in value and chroma than nonmottled gingiva.

Quantitative information on the color of healthy gingival tissues would be useful for the development of more natural-appearing denture resins for blacks and whites.

Wright[1] has reviewed three methods of measuring skin color that include visual comparison with comprehensive color charts and wheels, spectral reflectance with use of a spectrophotometer, and comparison with colored filters by colorimetry. Application of the latter two techniques for scientific measurement of skin color have not been used for measuring the color of the gingiva because of the inaccessibility of the mouth to suitable instruments. The Munsell color system and its potential use in dentistry have been reviewed in detail by Sproull.[2-4]

The purpose of this investigation was to measure the color of uniformly pigmented, attached gingiva of black and white patients and the color of gingiva pigmented by melanin in black patients under clinical conditions by use of the Munsell color system.*

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* Munsell Color, Baltimore, Md.

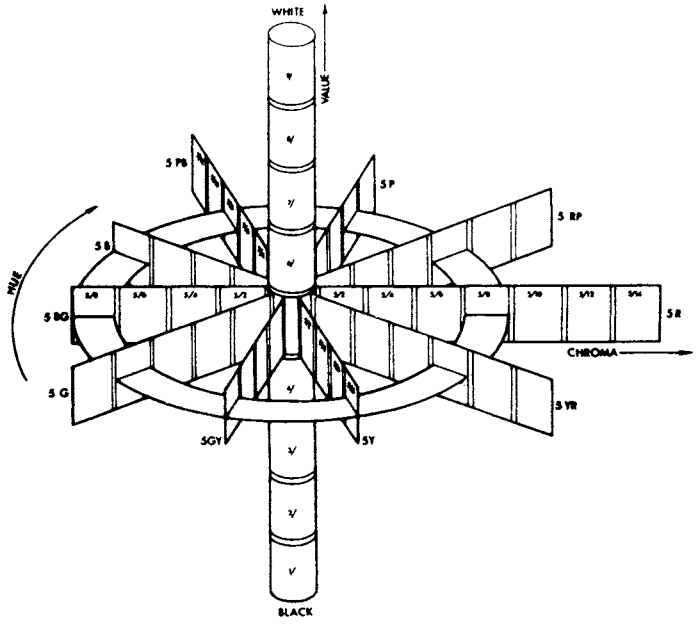

FIG 1.—Munsell scales of hue, value, and chroma in color space (reprinted with permission of Munsell Color, Baltimore, Md).

Materials and Methods

Each of three investigators was instructed in the Munsell color system (Fig. 1) with the use of color samples† and tested for color vision anomalies and color aptitude with the use of a hue test.‡ Finally, comparisons of observers and of light sources were made with use of a color rule.§

The color of a selected area of the attached gingiva in dentulous patients was matched with color tabs (glossy finish).# The patient's lips were retracted and a set of tabs was held adjacent to the area to be measured. Value was determined first by selection of a tab that most nearly corresponded with the lightness or darkness of the gingiva. For example, value was designated as 5/ on a scale from 0/ (black) to 10/ (white). Then chroma was determined by use of tabs that were close to the value of the gingiva but were of increasing saturation of color. For example, chroma was designated as /4 on a scale from /0 (neutral gray) to /14 (high saturation of color). The hue of the gingiva then was matched with tabs corresponding to the value and chroma already measured. Hue was measured on a scale from 2.5 to 10 in increments of 2.5 for each of the ten color families. The red-purple hue was designated as RP, the red hue as R, and the yellow-red hue as YR. For example, an observation could be recorded as 7.5R 5/4 to indicate hue of 7.5 R, a value of 5/, and a chroma of/4. Each patient was examined under the fluorescent light present in the clinic and under simulated daylight from a portable source/ with a correlated color temperature of 6,000 K. If disagreement in color match existed between the investigators, then a concensus color match was agreed on by them and recorded with the initial matches.

Color difference (I) between colors measured under fluorescent light and simulated daylight was determined with the use of an equation derived by Nickerson,[5] $I = C/5)(2\Delta H) + 6\Delta V + 3\Delta C$, where C is the average chroma, ΔH is the difference in hue, ΔV is the difference in value, and ΔC is the difference in chroma between the two observations. ΔH, ΔV, and ΔC were always taken as positive. Mean values of I were compared statistically with Scheffe intervals[6] computed from the analysis of variance.[7]

A total of 200 patients that included 100 blacks and 100 whites were studied. The color of uniformly pigmented or nonmottled, attached gingiva between the central and lateral maxillary incisors was measured for each of these patients. In addition, the color of mottled

† Student Set (11 charts), Munsell Color, Baltimore, Md.

‡ Farnsworth-Munsell 100 Hue Test, Munsell Color, Baltimore, Md.

§ Davidson and Hemmendinger Color Rule, Munsell Color, Baltimore, Md.

Munsell Book of Color, Munsell Color, Baltimore, Md.

/ Ney-Lite, J. M. Ney Co., Bloomfield, Ct.

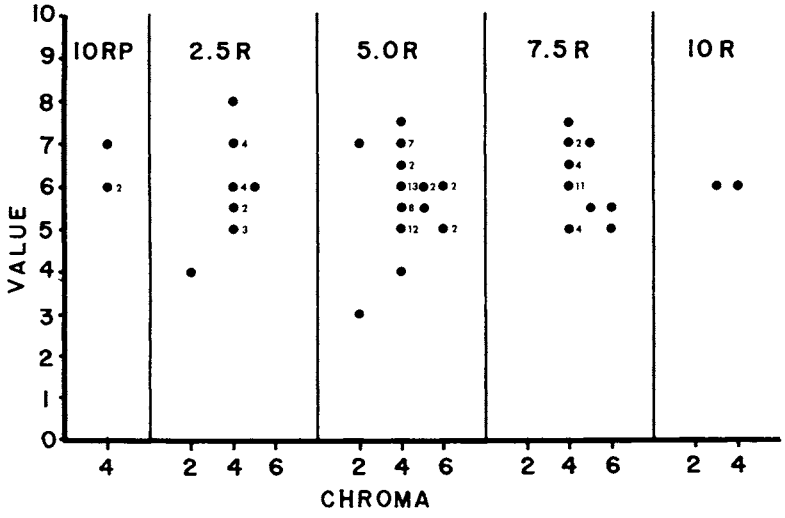

FIG 2.—Value, chroma, and hue of nonmottled areas of attached gingiva of 100 black patients measured under fluorescent light. Numbers adjacent to data points represent sample size of each point.

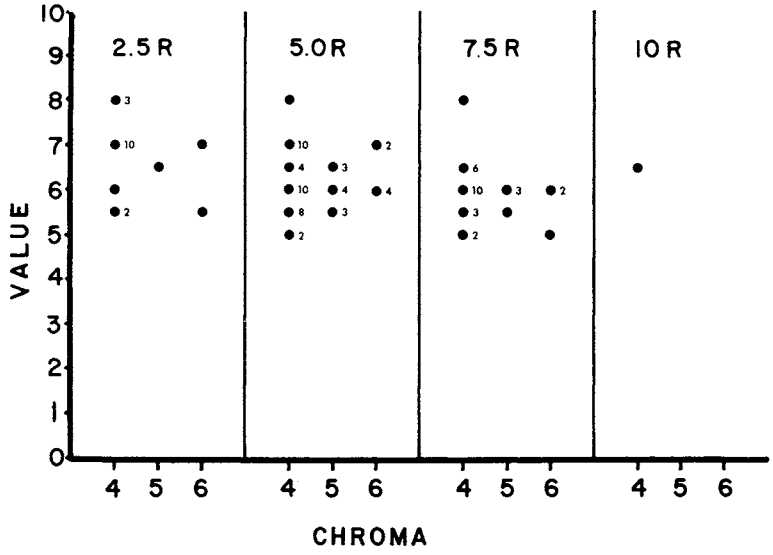

FIG 3.—Value, chroma, and hue of attached gingiva of 100 white patients measured under fluorescent light. Numbers adjacent to data points represent sample size of each point.

gingiva (pigmented by melanin) was measured for 61 of the black patients. The general oral health and oral habits of each patient were observed and recorded on an oral diagnosis form. The form and density of the gingival tissues were observed and the position of epithelial attachment and sulcus depth were also recorded. Patients with pathosis of the gingival tissues were excluded from the study.

The informed consent of all human subjects who participated in the experimental investigation reported or described in this article was obtained after the nature of the procedures and possible discomforts and risks had been fully explained.

Results

The value, chroma, and hue of uniformly pigmented (nonmottled), attached gingival tissues of 100 black patients measured under fluorescent light are shown in Figure 2. A value between 5/ and 7/ was observed for 94% of black patients. Of the black patients, 25% had a value of 5/ or lower. In 84% of the observations, chroma was equal to /4. Hue ranged from 10RP to 10R, but 79% of the observations were from 5R to 7.5R.

The value, chroma, and hue of uniformly pigmented, attached gingival tissues of 100 white patients measured under fluorescent light are shown in Figure 3. A value between 5/ and 7/ was observed for 95% of the white patients, but only 5% had a value of 5/ or lower. In 74% of the observations, chroma was equal to /4. Hue ranged from 2.5R to 10R, but 80% of the observations were from 5R to 7.5R.

The value, chroma, and hue of mottled gingiva pigmented by melanin of 61 black patients measured under fluorescent light are shown in Figure 4. A value between 3/ and 4/ was observed for 90% of the patients. In 87% of the observations, chroma was equal to /1 or /2. Hue ranged from 2.5R to 2.5Y, but 70% of the observations were from 5R to 7R.

Under conditions of simulated daylight, observations of value greater than 7/ increased from 3 to 13% for nonmottled gingiva of black patients and from 5 to 27% for gingiva of white patients. For gingiva pigmented by melanin in black patients, observations of value greater than 4/ increase from 10 to 16% when determined under simulated daylight. There was no dramatic change in the distribution of observations of either chroma or hue when determined under simulated daylight for black or for white patients. The I's between measurements made under fluorescent light and under simulated daylight for white patients, black patients with nonmottled gingiva, and black patients with mottled gingiva were 3.6, 2.6, and 1.1, respectively. There was no statistical difference between the first two values of I, but both were different from $I = 0$ at the 95% level of

confidence (Scheffe interval was 1.6). The third value of I was different statistically from the first at the 95% level of confidence (Scheffe interval was 1.9) but not from the second value of I or from I = 0.

A total of 522 color matches was made in this study. Of these color matches, 380 were made by one of the investigators. There were 142 situations in which a patient was examined independently by two of the investigators. Of these independent observations, there was agreement between investigators in 92% of the color matches. Of the 11 disagreements that occurred, 5 were concerned about interpolation between a difference in value of 1 unit, 4 about interpolation between a difference in chroma of 2 units, and 2 about interpolation between a difference in hue of 2.5 units.

Discussion

The Munsell value, chroma, and hue of a specimen correlate well with an observer's perception of its value, chroma, and hue if the following three conditions are met: (1) the observer has normal color vision; (2) the observer is adapted to daylight, and (3) the observer views the specimen illuminated by International Commission on Illumination (CIE) Source C or D_{6500} on a middle gray-to-white background.[8] In this study the third condition was not met; so there is systematic error particularly in the measurements made under fluorescent light. Measurements made under simulated daylight approximate the requirements of condition 3 more closely.

In 141 of 261 instances, a color change was seen between fluorescent light and simulated daylight. Of these 141 instances, 75% were the result of an increase in value between 0.5 and 1 unit for measurements made under simulated daylight. The color changes observed between lighting conditions are attributed to the higher intensity of light available from the simulated daylight source, rather than from an effect of metamerism.[4]

The differences between value and chroma of uniformly pigmented, attached gingiva of blacks and whites were not dramatic compared with the differences between the pigmented and nonpigmented gingiva of blacks. Quantitative comparisons between blacks and whites are difficult to make because the Munsell color space is non-Euclidean and, therefore, conventional statistics do not apply to measurements made on different patients. If this limitation is recognized, however, means of value and chroma can be computed independently from each other. The means and standard deviations (in parenthesis) of Munsell value of uniformly pigmented, attached gingiva of blacks and whites were 5.9 (0.8) and 6.3 (0.7), respectively. The means and standard deviations of chroma for blacks and whites were 4.1 (0.6) and 4.4 (0.7), respectively. The means and

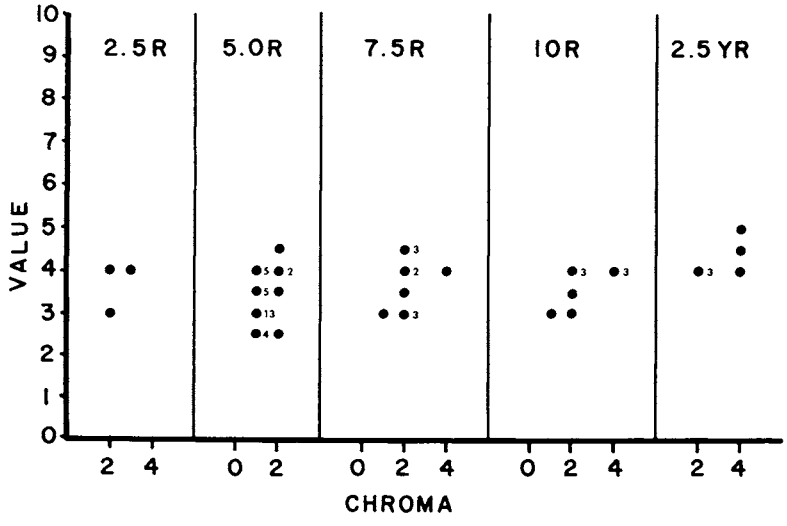

FIG 4.—Value, chroma, and hue of mottled areas of gingiva of 61 black patients measured under fluorescent light. Numbers adjacent to data points represent sample size of each point.

standard deviations of value and chroma of gingiva pigmented by melanin in blacks were 3.5 (0.6) and 1.8 (1.0), respectively.

Conclusions

Value, chroma, and hue of gingiva of 100 black and 100 white patients were measured clinically with Munsell color tabs under fluorescent light and under simulated daylight. The color of uniformly pigmented attached gingiva of both blacks and whites was described most often by a value between 5/ and 7/, a chroma of /4, and a range of hues from 2.5R to 7.5R when determined under fluorescent light. The color of gingiva pigmented by melanin in 61 black patients was lower in value (3/ to 4/) and chroma (/1 to /2) but had a similar range of hues compared with uniformly pigmented gingiva. The use of a simulated daylight source instead of a fluorescent light present in the clinic resulted in a modest change in color described by an I of no more than 3.6.

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