THE COLOR OF GINGIVAE STUDIED
BY VISUAL COLOR MATCHING

Part II. Kind, Location, and Personal Difference
in Color of Gingiva

BY

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ABSTRACT

A replica of natural gingival color can be fabricated in a prosthesis. A precise record of
 gingival color helps to follow-up oral and systemic diseases.

A healthy gingival color according to the "Periodontal Workshop Committee I" is 'pink'
but no indication is given for color variations by age or position. For more precise definition,
therefore, gingival color was examined in the maxillary and mandibular anterior regions by
visual color matching using standard color chips after Munsell’s system. Gingival color was
measured in 60 subjects, in 18 locations around the anterior teeth.
1. The gingival color varies in Hue from 10 RP to 2.5 YR, being mainly between 2.5 R
and 5 R; in Value from 4 to 8, maximum between 6 and 7.5; and in Chroma from 1.5 to 7,
mainly from 4 to 5.

2. No difference in gingival color is recognized between the male and female, or between
left and right sides of the jaw.

3. Gingival color varies with the position of papillary, marginal, and attached gingivae, and
the parts corresponding to different teeth have different colors.

4. The gingival color of young persons, differs markedly from that of older people. In
all the parts, red Hue is more tinged with purple in the old than in the young; Value is higher
in the young; and Chroma is higher in the old.

INTRODUCTION

Knowledge of gingival color is essential for matching with prosthetic constructions; its
changes may indicate the diagnosis, or the course and prognosis of oral and sometimes
systemic diseases, or elicit therapeutic results. The "Periodontal Workshop Committee"1)
defines healthy gingival color as 'pink'. This terminology, however, is colloquial and too vague for scientific use. Based
on colorimetry, gingival color has been studied by Sekiya2), Ishikawa3), Baumgartner4), Kaneko5), and others. However, color
should be more precisely specified for different regions in the mouth, and for individuals differing in age, habit, and nationality.

In the present experiment, gingival color of the maxillary and the mandibular anterior regions was studied by visual color
matching with standard color chips. The experimental results were totaled according to each element of color in the Mun-
sell's system, viz., Hue, Value, and Chroma. Examinations were made on the characteristics of individual small regions of gingiva,
such as the papillary, marginal, and attached gingivae adjacent to the central incisors, lateral incisors, and cuspid teeth; transitional changes due to age were also examined.

MATERIALS AND METHODS
The subjects were 60 Japanese males and females who came for treatment to our university hospital. They were from 18 to 62 years old, and their gingivae in the maxillary and the mandibular anterior regions were considered to be clinically healthy, according to the specifications of the “Periodontal Workshop Committee I”\(^1\), as given below:

1. Color—pink
2. Texture—stippled (to varying degree)
3. Architecture—knife-like gingival margins and well-formed papillae
4. Consistency—firm
5. Gingival sulcus—of shallow depth free of any exudate

From these specifications, No. 1 “Color—pink” was omitted, since observation of color characteristics is the object of the present experiment.

Experimental areas: Small regions of papillary, marginal, and attached gingivae adjacent to each of the central incisors, lateral incisors, and cuspid teeth (Fig. 1).

Experimental method: By visual color matching with standard color chips, con-
duced on Hue, Value, and Chroma of Munsell's system (Fig. 2). The standard color chips were produced by the Japan Color Research Institute. The size of each chip was about 8×11 mm, with its handle angled at 45° (Fig. 3). There are 225 chips of color ranging from 5 RP to 10 R in Hue, from 3.5 to 8.0 in Value, and from 1.5 to 8 in Chroma (Fig. 4). For those colors which could not be matched by any of the color chips, the results were totaled by the nearest color measure. A few cases which deviated widely from the standard color chips for mucosa were examined by the standard color chips for the skin, also produced by the Japan Color Research Institute. Color comparison was made under daylight from a clear sky through a window facing north, this source being generally accepted as the one nearest to the specified achromatic light C.

Least perceptible color difference in actual situation was 0.36 Lab.6)

RESULTS AND DISCUSSION

1. Difference between male and female

The difference in gingival color between male and female was examined in 10 sub-
jects each. The distribution range, mean, and variance among the two sexes were compared and no remarkable difference was recognized at the 5% level of significance. Matsui7) also did not recognize any significant difference among the males and females of 30 years of age and over, but Kaneko8) did without distinction of age.

2. Difference between the left and right region

No significant difference in Hue, Value, and Chroma was recognized. This indicated that either the right or the left sample could be equally examined.

3. Distribution of experimental results for gingival color

Fig. 5 shows the frequency distribution for Hue in the anterior regions of the maxilla and the mandible. The distribution range of either papillary, marginal, or attached gingivae varies from 10 RP to 2.5 YR, being especially high from 2.5 R to 5 R. Fig. 6 is a similar frequency distribution for Value. The distribution range of papillary and marginal gingivae varies from 4 to 8, and that of attached gingivae is from 4 to 7.5. For all three regions the maximum range is from 6.5 to 7.5 Fig. 7 is a frequency distri-
bution for Chroma. The distribution range of papillary and marginal gingivae varies from 3 to 7, and that of attached gingivae is from 1.5 to 7. For all three regions, the maximum range is from 4 to 5.

4. Regional variations in gingival color

Table 1 shows the mean and standard deviation for the color of papillary, marginal, and attached gingivae in the anterior regions of the maxilla and the mandible. The measurements are graphed in Fig. 8 according to Munsell's system.

Hue forms a V-shaped curve in both the maxilla and the mandible. Hue of the papillary gingivae is nearly the same in both jaws, whereas that of the attached gingivae differs markedly. Hue of the marginal gingivae is the lowest in both jaws. Hue of the attached gingivae in the maxilla is similar to that of the marginal gingivae, whereas that in the mandible resembles the Hue of the papillary gingivae. In general, Hue measures are lower in the maxilla than in the mandible, the maxillary Hue deviat-
Fig. 7. Frequency distribution of Chroma
P denotes papillary, M marginal, and A attached gingivae.

Fig. 8. The graph for measurements in Table 1, L denotes mandible and U denotes maxilla. P denotes papillary, M marginal, and A attached gingivae.

Table 1. Mean and standard deviation SD of gingival color. P denotes papillary, M marginal, and A attached gingivae

<table>
<thead>
<tr>
<th></th>
<th>Hue (red)</th>
<th>Value</th>
<th>Chroma</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>SD</td>
<td>mean</td>
</tr>
<tr>
<td>Maxilla</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>4.61R</td>
<td>3.42</td>
<td>6.36</td>
</tr>
<tr>
<td>M</td>
<td>4.17R</td>
<td>3.34</td>
<td>6.38</td>
</tr>
<tr>
<td>A</td>
<td>4.23R</td>
<td>3.38</td>
<td>6.43</td>
</tr>
<tr>
<td>Mandible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>4.71R</td>
<td>3.39</td>
<td>6.36</td>
</tr>
<tr>
<td>M</td>
<td>4.39R</td>
<td>3.33</td>
<td>6.34</td>
</tr>
<tr>
<td>A</td>
<td>4.80R</td>
<td>3.57</td>
<td>6.32</td>
</tr>
</tbody>
</table>

The Value of the papillary gingivae is identical for both jaws, but that of the marginal and attached gingivae is higher in the upper than in the lower jaw. In the maxilla, the Value increases in the order of papillary, marginal, and attached gingivae. In the mandible, the Value decreases in that same order. The Value has, therefore, no common measure for similar regions in the two jaws.

Chroma for both jaws decreases in the order of papillary, marginal, and attached gingivae. Chroma of all three regions is higher in the maxilla than the corresponding measures in the mandible. On the contrary, Kaneko reported that the Chroma as well as the Value is higher in the mandible than in the maxilla, and that Hue measures around 5 R. Also in contrast, he reported that the Value of the marginal and attached
Table 2. Regional variations of mean and standard deviation SD of gingival color

<table>
<thead>
<tr>
<th></th>
<th>Hue mean</th>
<th>Hue SD</th>
<th>Value mean</th>
<th>Value SD</th>
<th>Chroma mean</th>
<th>Chroma SD</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>P</td>
<td>4.35R</td>
<td>3.35</td>
<td>6.52</td>
<td>1.08</td>
<td>4.90</td>
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<tr>
<td></td>
<td>M</td>
<td>3.92R</td>
<td>3.37</td>
<td>6.53</td>
<td>1.09</td>
<td>4.82</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>3.82R</td>
<td>3.07</td>
<td>6.58</td>
<td>0.96</td>
<td>4.69</td>
</tr>
<tr>
<td>2</td>
<td>P</td>
<td>4.38R</td>
<td>3.25</td>
<td>6.39</td>
<td>1.94</td>
<td>4.90</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>3.75R</td>
<td>3.01</td>
<td>6.33</td>
<td>1.16</td>
<td>4.82</td>
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<tr>
<td></td>
<td>A</td>
<td>4.71R</td>
<td>3.51</td>
<td>6.33</td>
<td>1.06</td>
<td>4.79</td>
</tr>
<tr>
<td>3</td>
<td>P</td>
<td>5.13R</td>
<td>3.64</td>
<td>6.10</td>
<td>1.05</td>
<td>4.88</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>4.83R</td>
<td>3.62</td>
<td>6.28</td>
<td>1.12</td>
<td>4.95</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>4.17R</td>
<td>3.53</td>
<td>6.38</td>
<td>0.99</td>
<td>4.69</td>
</tr>
</tbody>
</table>

Gingival is higher in both jaws than that of the papillary gingivae. The three regions were said to be similar in Chroma. Ishikawa et al. reported that the color of marginal gingivae resembled that of the alveolar gingivae in 51.3%, and contrasted in 48.7% of his cases.

5. Comparison between corresponding regions of gingivae belonging to different teeth

Designation of papillary gingiva in this report is indicated according to the number of teeth: Papillary gingiva 1, for example, refers to the one between the two upper central incisors, papillary gingiva 2 refers to that between the upper central and the lateral incisors, and papillary gingiva 3 refers to that between the upper lateral and the cuspid. The same is true for the mandibular papillary gingiva.

Fig. 9 and the Table 2 show that Hue of papillary and marginal gingivae around the upper central incisor resembles the corresponding measures around the upper lateral incisor, both measures being significantly high around the upper cuspid. Hue of the attached gingivae is varied among the three regions belonging to the different teeth, being highest around the upper lateral incisor. Similar comparison is found in the mandible for all three regions.

Fig. 10 and Table 2 show that in the maxilla, the Value of the papillary, marginal, and attached gingivae resembles closely around the central and lateral incisors, differing only by 0.06. Around the upper cuspid the difference is 0.28. It is apparent that the Value of all the three regions around the upper central incisor is higher than the corresponding Value around the upper lateral incisor and the cuspid. In the mandible, difference in the Value among the three regions around the central incisor and the cuspid is 0.08 to 0.09. As in the maxilla, all three measures around the central incisor are higher than those around the cuspid.

Fig. 11 and Table 2 show that Chroma of the three regions varies least around the upper cuspid (0.12) and greatest around the upper incisor (0.21). Chroma of the papillary gingivae is the least variable around all three teeth in both jaws. Chroma of the marginal gingivae in the maxilla, around the central and lateral incisors are identical, that of the cuspid being the highest. In the mandible, this is highest around the lateral incisor. Chroma of the attached gingivae in the maxilla is lowest around the central incisor and highest around the cus-
Fig. 9. Comparison of Hue between corresponding regions of gingivae belonging to different teeth.

P denotes papillary, M marginal, and A attached gingivae.

1 denotes upper central incisors, 2 upper lateral incisors, and 3 upper cuspids.

1 denotes lower central incisors, 2 lower lateral incisors, and 3 lower cuspids.

Fig. 10. Comparison of Value between corresponding regions of gingivae belonging to different teeth.

P denotes papillary, M marginal, and A attached gingivae.

1 denotes upper central incisors, 2 upper lateral incisors, and 3 upper cuspids.

1 denotes lower central incisors, 2 lower lateral incisors, and 3 lower cuspids.

pid whereas in the mandible, this is lowest around the cuspids and highest around the lateral incisor.

6. Variation in gingival color by age

The subjects were divided into three age groups of 20 each. Group 'young' signifies those under 30 years, 'middle' for those from 30 to 49, and 'old' for those from 50 and above. Figures 12, 13, and 14 are graphs for Hue, Value, and Chroma, respectively, plotted against the young, middle, and old age groups.
Fig. 11. Comparison of Chroma between corresponding regions of gingivae belonging to different teeth
P denotes papillary, M marginal, and A attached gingivae.
1 denotes upper central incisors, 2 upper lateral incisors, and 3 upper cuspids.
1 denotes lower central incisors, 2 lower lateral incisors, and 3 lower cuspids.

Fig. 12. Age variation of red Hue (R) in the three regions
P denotes papillary, M marginal, and A attached gingivae.
L = lower jaw, U = upper jaw, Y = young group under 30 years,
M = middle group from 30 to 49, and O = old group from 50 years and above.

In Fig. 12 for Hue, red becomes tinged with yellow upwards, and tinged with purple downwards along the ordinate. In both jaws, Hue of the papillary gingivae in the young group is nearly identical to that in the middle age group, whereas in the old group, the papillary gingivae become more tinged with purple.

Hue of the marginal gingivae in the maxilla becomes more tinged with purple from the young to old age. In the mandible, this is about the same in groups of middle and old ages, having more purple tinge than in the young. Hue of the at-
attached gingivae in both jaws becomes significantly purple from the young to old.

In Fig. 13 for the Value, the measures of the papillary gingivae in the maxilla for the young group differ little from those for the middle age group, that of the old age group being much lower. In the mandible, the Value increases from the young to the middle age and drops low in the old age. Similar tendency applies to the Value of the marginal gingivae in both jaws.

The Value of the attached gingivae in the maxilla is identical for the young and middle age groups, but much lower in the

Fig. 13. Age variation of Value in the three regions
P denotes papillary, M marginal, and A attached gingivae.
L = lower jaw, U = upper jaw, Y = young group under 30 years,
M = middle group from 30 to 49, and O = old group from 50 years and above

Fig. 14. Age variation of Chroma in the three regions
P denotes papillary, M marginal, and A attached gingivae,
L = lower jaw, U = upper jaw, Y = young group under 30 years,
M = middle group from 30 to 49, and O = old group from 50 years and above
Table 3. Age variations of mean and standard deviation of gingival color.

P denotes papillary, M marginal, and A attached gingivae.

<table>
<thead>
<tr>
<th></th>
<th>Hue</th>
<th>Value</th>
<th>Chroma</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean SD</td>
<td>mean SD</td>
<td>mean SD</td>
</tr>
<tr>
<td>MAXILLA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>young</td>
<td>P 4.79R 3.24</td>
<td>6.40 1.00</td>
<td>4.85 1.08</td>
</tr>
<tr>
<td></td>
<td>M 4.34R 3.18</td>
<td>6.43 1.40</td>
<td>4.85 1.15</td>
</tr>
<tr>
<td></td>
<td>A 4.96R 3.62</td>
<td>6.45 1.01</td>
<td>4.66 1.44</td>
</tr>
<tr>
<td>middle</td>
<td>P 4.84R 3.37</td>
<td>6.39 1.05</td>
<td>4.83 1.12</td>
</tr>
<tr>
<td></td>
<td>M 4.21R 3.40</td>
<td>6.44 1.15</td>
<td>4.80 1.16</td>
</tr>
<tr>
<td></td>
<td>A 4.42R 3.41</td>
<td>6.45 0.95</td>
<td>4.66 1.50</td>
</tr>
<tr>
<td>old</td>
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<td>6.29 1.11</td>
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<tr>
<td></td>
<td>M 3.96R 3.37</td>
<td>6.28 1.15</td>
<td>4.93 1.13</td>
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<td></td>
<td>A 3.75R 3.43</td>
<td>6.41 1.05</td>
<td>5.00 1.61</td>
</tr>
<tr>
<td>MANDIBLE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>young</td>
<td>P 4.93R 3.20</td>
<td>6.35 0.99</td>
<td>4.85 1.07</td>
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<td></td>
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<td>6.34 1.00</td>
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<td></td>
<td>A 5.45R 3.69</td>
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</tr>
<tr>
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<td>P 4.96R 3.39</td>
<td>6.42 1.06</td>
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<td></td>
<td>M 4.17R 3.23</td>
<td>6.41 1.10</td>
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<td></td>
<td>M 4.25R 3.49</td>
<td>6.28 1.13</td>
<td>4.78 1.06</td>
</tr>
<tr>
<td></td>
<td>A 4.04R 3.50</td>
<td>6.31 1.03</td>
<td>4.94 1.58</td>
</tr>
</tbody>
</table>

Apparent color variation by age does not follow a definite pattern. The measures for the middle age group may either resemble those of the young or the old group (Figs. 12, 13, and 14, and Table 3). However, it may be generalized that with increase in age, Hue becomes more purplish, the Value becomes less, and Chroma becomes high. These findings in color variation agree with Matsui’s report on the mandible.

Color of the gingiva is a variable feature among different individuals and varying regions of the mucosa. The color of a clinically normal gingiva may be modified by pigmentation, vascularity, thickness of the mucosa, and the degree of keratinization. Therefore, gingival color in any one individual or in one region cannot be permanent, and its tone is subject to modification.

The gingival epithelium contains melanin granules, whose color may vary from light brown to black. Pigmentation of the gingiva occurs frequently among Negroes, Orientals, and Indians, and is also seen in the whites of Mediterranean ancestry. Melanin pigmentation was recognized in 5% of all age groups among both sexes of the Japanese subjects, and manifested by individual and regional variations. It varied from faint to intense, and distributed either regularly or irregularly. Pigmentation is physiological and should not be confused with changes that accompany periodontal disease.

The relationship between gingival color and capillaries has been reported by Nakamura and Hiratsuka. According to them, the Value and Chroma are not much affected by difference in the diameter, form, or number of capillary loops in the gingiva, whereas Hue is said to be slightly modified. In males, the capillary loops are few in number and larger in diameter, whereas in
females they are smaller and more numerous. It appears therefore, that the net amount of blood flow is little or no different between the two sexes.

Gingival epithelium may have parakeratosis, keratosis, or akeratosis in various proportions among different regions and individuals.

Even in the gingiva which appears normal to the naked eye inspection, round cellular infiltrations are often recognized, particularly in the free margin. Capillar-ectasia, and abnormal arrangement and distribution of capillary loops could develop with advance in age. This inflammatory character, being not visible to the naked eye, could have possibly been present in the experimental subjects of the old group. The color of gingiva, however, could not have been substantially altered by this process and, therefore, any slight modification that might have resulted is considered negligible. The composition of paradentium being essentially the same in all ages and among both sexes, is unlikely to cause any variation in gingival color. Any variation of color recognized in the present experiment is considered to be the net outcome of modifications due to pigmentation, vascularization, thickness of the mucosa, and the degree of keratinization.

Over and above these color of the gingiva is thus subject to modifications by external factors such as ultraviolet rays, tooth brushing, smoking, etc.

Conclusion

1. In 60 male and female subjects 18 regions of gingivae around the neighborhood of maxillary and mandibular anterior teeth were examined by matching with 225 kinds of standard color chips. The frequency distributions and means of experimental results are shown in Figs. 5, 6 and 7 and in Table 1.

2. Sex difference in gingival color was examined in 10 each of male and female subjects. The distribution range, mean, and variance among the two sexes revealed no remarkable difference at the 5% level of significance.

3. Difference of gingival color between the left and right regions was examined in 10 subjects and no substantial difference was recognized for Hue, Value, and Chroma at the 5% level of significance.

4. Regional variations of gingival color are as follows: Hue in the maxilla has the R(red) measure of Munsell’s system highest in the papillary gingivae, second in the attached gingivae, and least in the marginal gingivae. In the mandible, R(red) measure of gingival Hue falls in the order of attached gingivae, papillary gingivae, and marginal gingivae. Hue of all three regions in the maxilla is more tinged with purple than the corresponding ones in the mandible. The Value in the maxilla measures highest in the attached gingivae, second in the marginal gingivae, and lowest in the papillary gingivae. In the mandible, the Value falls in the order of papillary gingivae, marginal gingivae, and attached gingivae. The Value is identical in the papillary gingivae of both jaws, whereas Value of the marginal and attached gingivae is higher in the maxilla than in the mandible. Chroma in both jaws falls in the order of papillary gingivae, marginal gingivae, and attached gingivae. Chroma of all regions in the maxilla is higher than the corresponding measures in the mandible.

5. Comparison between gingivae of similar regions neighboring different anterior teeth shows that in both jaws, the tinge of purple in red Hue is highest around central incisors, second around lateral incisors, and least around cuspids. In both jaws the Value
falls in the order of regions around central incisors, lateral incisors, and cuspids. Chroma in the maxilla in highest in gingivae around cuspids teeth, and in the mandible in the gingivae around lateral incisors. The difference around other teeth is not remarkable.

6 The gingival color of the young group differs markedly from that of the old group. In all the regions, red Hue becomes more tinged with purple in the old than in the young; Value is higher in the young and Chroma is higher in the old age group.

Acknowledgement

Much of this work was suggested by Prof. T. Hayashi, to whom I owe thanks for his constant guidance in the course of the work. This was presented at 39th Meeting of the Japan Stomatological Society, Tokyo, November, 1974.

References


Erratum

On pages 258 and 259 of Vol. 22, 1975, issue in the article “The color of gingiva studied by visual color matching” by Ibusuki, M., (1) the 18th line of the right of page 258 should read: “No. 1 and No. 8”, (2) the fifth line from the bottom of the left of page 259 should read: “... as did K and P, the...”, and (3) the 14th and 15th lines of the right of same page should read: “... in group II who had not a training...”.