ULTRAVIOLET ABSORPTION OF HUMAN TEETH
AS REVEALED BY MICROPHOTOMETRY

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Thin-slices of human teeth were applied for the determination of ultra-
 violet absorption by using a microspectrophotometer (Zeiss UMSP type 1). The
tooth tissue shows a non-specific ultraviolet absorption in a wide range
of wave-length from 240 nm to 300 nm. The profile of spectra was different
from that of nucleoprotein. The absorption spectrum in dentine was similar
to that in cementum, but differ from that in enamel. The A_{260} and A_{280} show
two or three times higher in dentine or enamel than those in cementum,
respectively. A major part of ultraviolet absorbing substance in teeth seems
to be extracted with a 5% of perchloric acid solution. A relative ultraviolet
absorption value (A_{260} or A_{280} per unit area) distributed in different quantity
relating to the tooth structure, whereas the value showed much higher in
enamel than in dentine and lowest in cementum.

Hartles et al. (1953) observed ultraviolet absorptions of teeth, revealing a
maximum absorption at 270 nm and a minimum one at 240 nm, and postulated
that the absorption was due to pyrimidine derivatives contained in teeth. Hoerman
and Mancewicz (1964) reported the presence of tryptophane in teeth. On the other
hand, Pincus (1953) found a decrease of the absorption following the progress of
caries. From these reports ultraviolet absorbing substance seems to relate to tooth
tissues. However, regional difference on the distribution of ultraviolet-absorbing
substance in tooth tissues, such as enamel, dentine and cementum, has not yet been
studied by microspectrophotometry. Then the authors attempt to determine an
individual difference in various areas of tooth tissues and to show some optical
properties linked with the tooth structure.

MATERIALS AND METHODS

Human permanent teeth (incisors, canines and premolares) were used for the
present examination. For preparing specimens to measure ultraviolet absorption,
teeth were fixed with acetone-ethanol mixture 1 : 1 (v/v), at 4°C, and stored prior
to measurement. The tooth was rinsed in water and ground slowly on a rough
whetstone and then on a fine agate-whetstone by dropwise supply of water untill
the slice reached 50–80 µ in thickness. Thereby, the tooth was ground sagitally
in the bucco-lingual direction without any thermal rise. The prepared sections
were mounted in non-fluorescent glycerol, and air bubbles were removed from inter-
spaces of specimens in vacuo. The coverslip was sealed with a manicure liquid.

For preparing extracts from various layers of the tooth, such as enamel, dentine
and cementum, each layer was pulverized by using a moter-driven dental equipment
and a 0.2 g of the powder was extracted with 2 ml of a 5% perchloric acid (PCA)
for 4 hours at room temperature.

Thin-ground slices were measured by wave-length scanning and area scanning
under a microspectrophotometer (Zeiss UMSP type 1, Germany). Various tissue
areas illustrated in Fig. 1 were adopted to scan from 300 nm to 240 nm. For area
scanning a measureing spot was set in 5 μ in diameter on the specimen level. To
facilitate the comparison of regional difference, absorption at 260 nm (A₂₆₀) and
that at 280 nm (A₂₈₀) per unit area (a round area of 5 μ in diameter) were also
measured in various areas of tooth tissues.

RESULTS

1. Ultraviolet absorption of various tissues in the tooth

Absorption curves were obtained by wave-length scanning. The curve of
dentine looks similar to that of cementum, while that of enamel markedly differs.
Moreover, absorption curves in dentine and cementum indicated a sudden decrease
from 240 nm to 250 nm and an additional slight decrease from 290 nm to 300 nm
(Fig. 2). To facilitate of comparing regional difference of absorption spectra between
dentine and enamel, a relative absorption value, $\frac{A\lambda}{A_{260}}$ (%), in which $\lambda$ ranges from 240 nm to 350 nm, seems useful (Fig. 3, 4). Thus corrected curves of dentine (Fig. 3) show a remarkable decrease (80%–40%) from 280 nm to 290 nm, ranging less than 20% when $\lambda$ is beyond 300 nm. The curves of the enamel, however, look different from those in dentine, showing a gradual decrease following increase of $\lambda$ from 250 nm to 350 nm, and the value ranges about 50% at 350 nm (Fig. 4). Relative absorption spectra of 5% PCA extracts of enamel differ from those of dentine and cementum, and little difference was found between spectra at the tissue level (a) and the extract level (b). The relative absorption in the extract from dentine was higher than that of the tissue level at higher wave length than 300 nm. There found little difference between relative absorptions at the tissue level (a) and the extract level (b) of enamel.

Fig. 2. Ultraviolet absorption curves observed in various tooth areas; $E_2$ showing an intermediate area of enamel, $D$ showing a deep area of dentine, and $C$ showing a cementum area.

Fig. 3. Comparison of relative absorption values ($A/A_{260}$, %) of dentine between the tissue (a) and its extract with a 5% PCA (b). Least difference is shown between them.
2. Regional difference of absorptions in various tooth tissues

To compare regional difference of absorptions among different tissue areas (Fig. 1), absorbance in an unit area is adopted as a relative absorption, whereas optical densities at 260 nm or 280 nm are measured in a round spot of 5 μ in diameter. In determining both $A_{260}$ and $A_{280}$ per unit area, enamel shows much higher absorption ($A$: beyond 1.0) than dentine ($A$: around 0.8), but cementum shows...
lowest (A: 0.2–0.6). Further, regional difference is found in each area as shown in Fig. 5. The $A_{260}$ or $A_{280}$ is 1.0–1.3 in $E_1$ as well as in both $E_2$ and $E_3$ of Fig. 5b. The absorbance in the surface of dentine (SD) adjacent to enamel is similar (A: 1.0) or lower (A: 0.7) to that in $E_1$ or $E_2$, and lower (A: around 0.8) in that of predentine (PD). Cellular cementum (CC) shows a lesser absorption (A: below 0.5) as in cementum (C). In most of tissue areas, the $A_{260}$ resembles the $A_{280}$ in quantity.

**DISCUSSION**

Hartles et al. (1953, 1955) studied ultraviolet absorption spectra of tooth extracts and showed that the spectra resembled those of nucleoprotein. There was found an absorption maximum at 270 nm and a small inflection was observed from 240 nm to 270 nm. Further, they reported that thymidine was rich in cementum and poor in dentine. From the present findings, however, ultraviolet absorption at less than 300 nm does not resemble the typical pattern of nucleoprotein. The absorption spectrum of cementum is similar to that of dentine being different from enamel. The $A_{260}$ and $A_{280}$ in dentine or enamel are two or three times higher than those of cementum, respectively. Ultraviolet absorption spectra of extract from enamel, dentine and cementum with a 5% PCA solution appear a similar shape to those in the tissue level. From these findings a major part of absorbing substance of tooth tissues seems due to a 5% PCA soluble material. Although the present authors observed tissue fluorescence on a 5% PCA extract prepared by the same way, the fluorescence intensity was not correlated with ultraviolet absorption of the extract (in the separate paper by Horibe et al., 1974).

Both relative absorption ($A_{260}$ and $A_{280}$ per unit area) were ranged as the order of $E$, $D$, and $C$. The absorption was highest in enamel, moderate in predentine, and lowest in cellular cementum. The predentine is known to be in highly proliferating activity and the cellular cementum contains a considerable number of cells. These findings, therefore, may indicate a high absorbance is not due to cell population in tooth tissues. Moreover, the enamel contained less nucleoprotein, where found a higher ultraviolet absorption. On the basis of data, most of the ultraviolet absorption may be derived from complexed components in tooth other than nucleoprotein nature, and a major part of the components seems to be easily removed to an acid soluble fraction from the tooth. So that, some of components seem to be linked with the mineral phase of teeth, to which some of fluorescent component is corresponding as reported by Glasser and Fonda (1938) and Onikubo (1957).

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**REFERENCES**


