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A PREVIOUSLY UNDESCRIBED DEMONSTRABLE PATHOLOGIC CONDITION IN EXPOSED CEMENTUM AND THE UNDERLYING DENTINE*

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NO DESCRIPTION or mention of the condition to which attention is directed herein has been found in any of a considerable number of textbooks consulted,[1-31] embracing dental pathology, dental histology, or periodontal disease. Neither has it been found in the periodical dental literature which I have read.

This condition is not recognized in ground sections prepared in the usual way. Neither is it recognized in sections of decalcified teeth embedded in celloidin or in paraffin. This is because the condition is entirely changed (if not actually removed) by the alcohol employed for dehydration in the embedding processes and in the technique for staining and mounting such sections. A somewhat unusual (although extremely simple) technique is required for recognition and demonstration of this condition. Therefore it is referred to in the title of this article as a "demonstrable" condition.

The condition is found only in exposed cementum and in the dentine which lies beneath such exposed cementum. By exposed cementum, as used in this paper, is meant cementum from which the soft tissues which were formerly attached to it have been destroyed or removed in the course of the disease process —periodontoclasia. It is that part of the cementum to which there are no longer any living tissue cells or fibers attached. The surface is bare and exposed to the contents of the gingival crevice or to the contents of the oral cavity. At any place around such a tooth specimen this exposed cementum extends from the cementoenamel junction apexward to the outer border of the epithelial attachment.

The location of the outer border of the epithelial attachment is accurately indicated by the zone of disintegrating epithelial attachment cuticle (zdeac).[32] The extent of the exposed cementum on a given tooth often varies considerably at different locations, depending upon the distance apexward to which the periodontoclasia lesion has advanced. There is also great variation in the extent of exposed cementum on different tooth specimens.

This variation can be better understood and appreciated by studying suitable specimens by the method previously described for demonstrating the zdeac[32] or by referring to drawings indicating the location of the cementoenamel junction, the zdeac, and the periodontal fibers on a number of selected tooth specimens.[33]

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Technique and Methods

Extracted tooth specimens preserved in formalin, upon which there appears to be exposed cementum, are selected. This can be recognized better by first staining the specimen with crystal violet and brushing it, as in demonstrating the zdeac.[32] The zdeac accurately indicates the location of the apexward border of the exposed cementum.

Often there is more or less calculus on exposed cementum. This may be disregarded for the present purpose or, if heavy, it may be removed by scaling.

For decalcification I use routinely 10 per cent (by volume) HCl, 5 per cent formalin, in water. Specimens are placed in the acid and this is stirred or gently agitated several times a day in order to secure more uniform decalcification. Changing the acid several times, at intervals, gives the same result. The specimen may be suspended by a waxed string in the upper half of the acid solution contained in a wide-mouthed bottle. More rapid and more uniform decalcification for special purposes may be secured in this way, but it is not necessary for routine work.

Within twenty-four hours the decalcification has progressed through the cementum and deep enough into the dentine to permit satisfactory cutting of sections for our present purpose. However, several days may be required for complete decalcification of the deeper parts of the dentine. The size of the tooth influences the time required for complete decalcification of the deeper part of the specimen.

A little practice and care enable one to cut sections by hand that are thin enough and are quite satisfactory for demonstrating and studying this condition. The modified Rochester Pean forceps No. 522¼ previously described[32] are most satisfactory for holding and manipulating the specimen.

A "Little's pocket-case operating knife," Style C, smooth handle (J. Sklar Mfg. Co.), is most suitable for cutting sections. The blade should be ground and whetted thin and kept very sharp.

With the specimen held in the field of the dissecting microscope (Magnification about ×10 to ×15), a very thin section is secured by making two parallel cuts into the specimen at the selected area. If the blade is carried just a little deeper for the second cut than the first, the thickness of the slice can be controlled a little better. The section is freed by an undercut from the side, carried deep enough into the specimen to free the part wanted.

The section is transferred to a droplet of 50 per cent glycerin on a slide, covered with a quarter-size cover glass, and is now ready for examination. Tinting the section before mounting, with a very weak solution of crystal violet or other stain, helps to differentiate the cementum and dentine. The same result is secured by adding a little of the stain to the water in which the specimen is washed and kept before cutting.

This material is well adapted to the freezing microtome technique. For this purpose a small slice is cut from the specimen to include the tissue of interest and then sectioned. Sections less than 10 microns thick can be cut in this way. They hold together well in subsequent manipulations.

Fig. 1. Fig. 2.

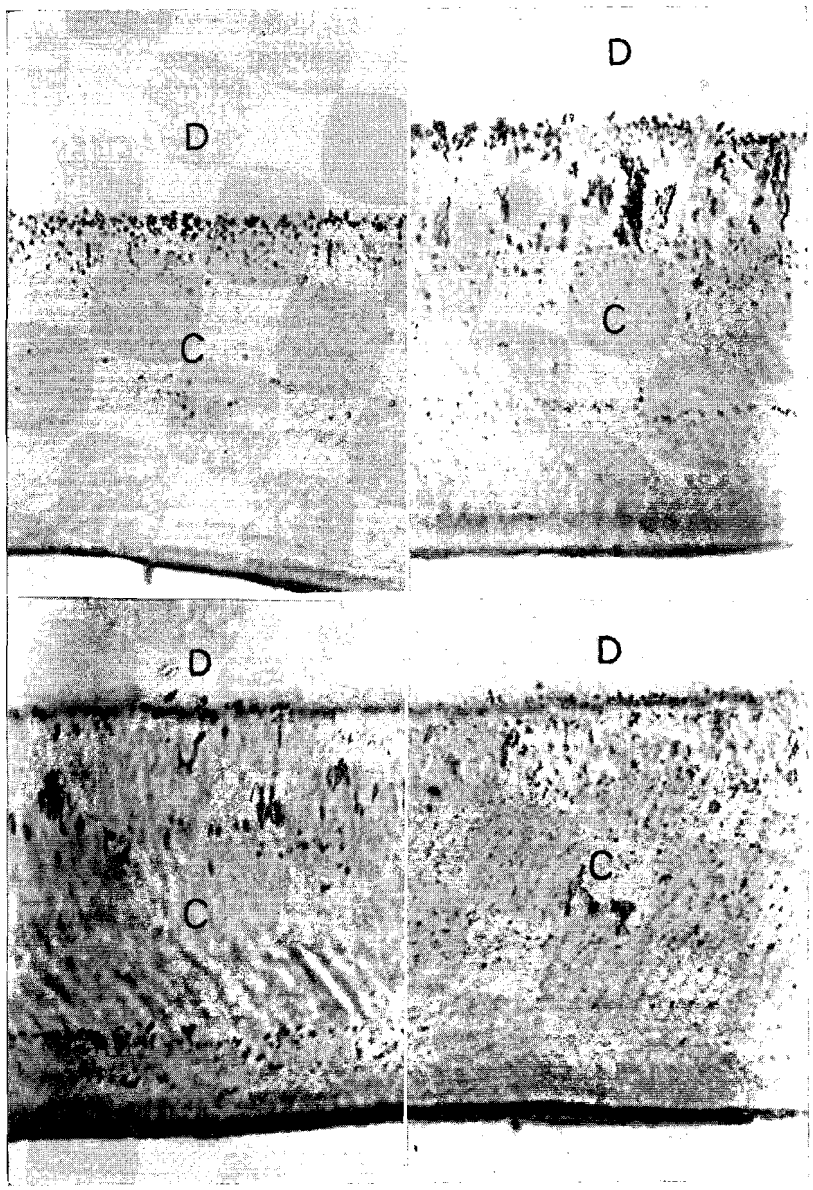


Fig. 3. Fig. 4.

Fig. 1.—Very thick cementum with only a few scattered granules in middle part; heavy granules along cementodentinal junction, becoming less abundant in cementum outward from junction. (×360.)*

Fig. 2.—Thick cementum; granules scattered throughout but heaviest along cementodentinal junction and along the course of incremental lines; very large elongated clump in primary cementum tending to follow course of Sharpey's fibers. (×360.)

Fig. 3.—Thick cementum from specimen stained before cutting. Note distribution of granules, particularly the streak in the secondary cementum and the wide area beneath, in which there are no granules. (×360.)

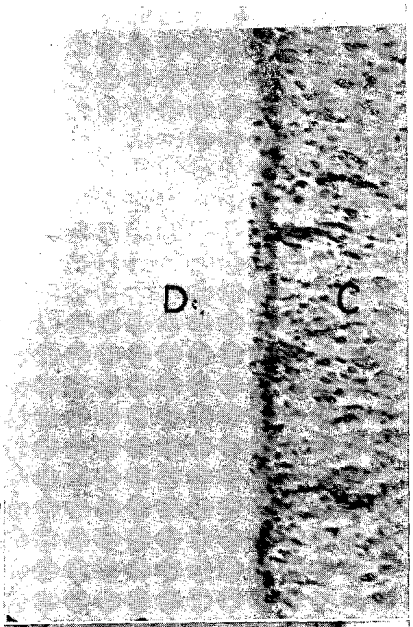
Fig. 4.—Thick cementum with granules distributed throughout deeper two-thirds of its thickness; a few projecting into the dentine. (×360.)

*Key to illustrations:

D, Dentine.
C, Cementum.
Zdeac, Zone of disintegrating epithelial attachment cuticle.
eac, Epithelial attachment cuticle.
BF, Bacterial film.
Ca, Calculus

Fig. 5.

Fig. 6.



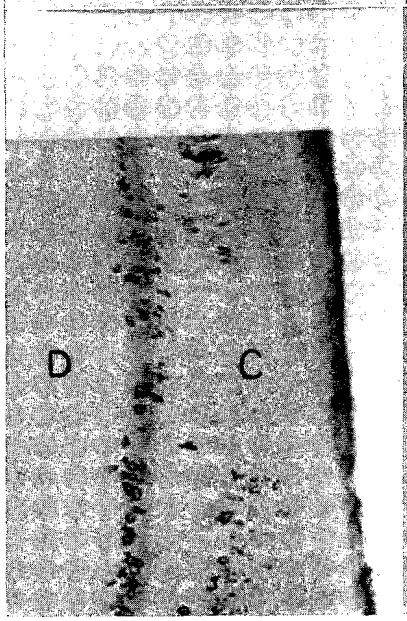


Fig. 7.

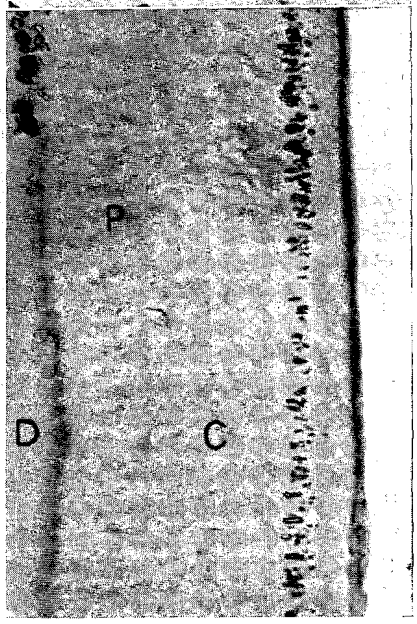


Fig. 8.

Fig. 5.—Thick cementum; small granules along and just beneath cementodentinal junction; large elongated clumps in primary cementum tending to follow course of Sharpey's fibers; a few granules and clumps in secondary cementum; heavy bacterial film retained on surface. (×360.)

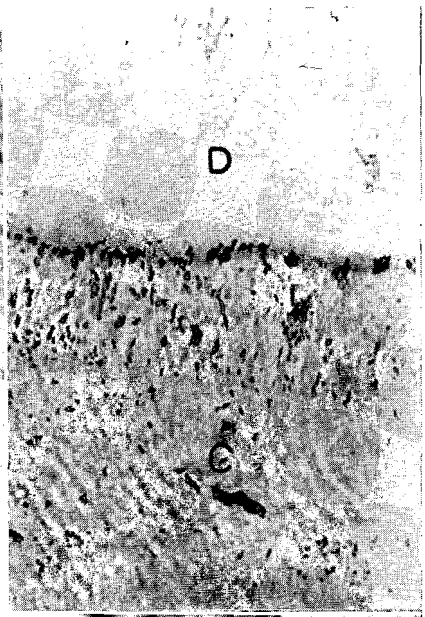
Fig. 6.—Field takes in deeper half of cementum, Tomes granular layer of dentine, and tubular dentine deeper in. Note heaviest distribution of granules along cementodentinal junction, a few extending into outer part of Tomes layer; dentinal fibrils and their branches in the deeper part in dentine. (×360.)

Fig. 7.—Large, coarse granules distributed along the cementodentinal junction; others about midway the thickness of cementum; at other places the cementum is entirely free of granules. (×360.)

Fig. 8.—Thickened cementum, primary portion (P) about one-fourth entire thickness. Note streak of granules running parallel to, and near, surface; a few very coarse granules in dentine just at or beneath cementodentinal junction at top part of picture but none from there downward; wide area entirely free of granules. (×360.)

Fig. 9.

Fig. 10.



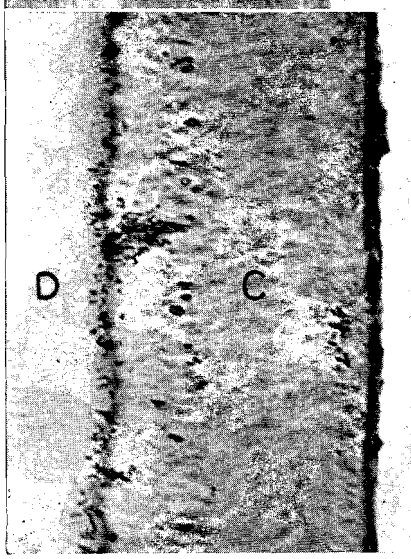


Fig. 11.

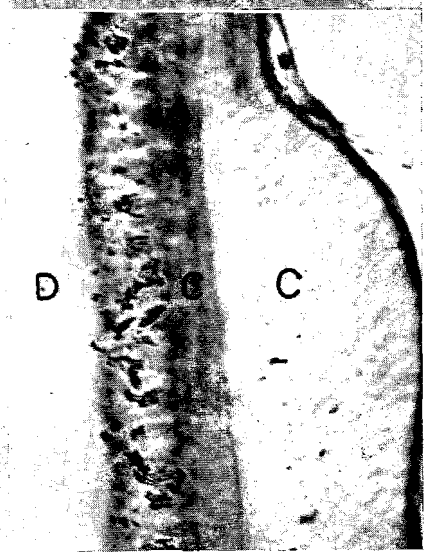


Fig. 12.

Fig. 9.—Very thick cementum with scattered large clumps of granules in deeper half; entirely different size and appearance of the much more numerous granules in the outer half. (×360.)

Fig. 10.—Granules and large clumps along cementodentinal junction; granules in the cementum diminishing as we go away from the junction; dentinal fibrils extend well into the Tomes granular layer, probably indicating that they are vital notwithstanding the heavy pathologic granules and very much thickened cementum overlying it. (×360.)

Fig. 11.—Many granules distributed along outer surface of Tomes layer and some in cementum at cementodentinal junction; scattered coarse granules or clumps at junction of middle and deeper third of cementum; small collection in outer third at one place; large collection or clump near middle of picture. (×360.)

Fig. 12.—Hump of very much thickened cementum; heavy granules and clumps in primary cementum and only a few scattered ones in the secondary part. Was the secondary cementum laid down upon primary cementum that previously had been exposed? (×360.)

Still thinner sections of this material can be made by embedding it in the water-soluble Carbowax according to the technique of Carsten[34] as modified by Blank,[35] with the exception that the use of alcohol for fixing the sections to the slide must be avoided. I have found this method especially useful when it is desirable to retain some part of the bacterial film or the (now) decalcified calculus attached to the cementum. Such sections are adaptable for staining on the slide by any desirable method which does not require the use of alcohol.

Description of the Condition

The condition consists of the presence of what appear, by transmitted light, to be highly refractile granules colored varying shades of brown. They vary in size from very fine to coarse and may appear to be separate or in clumps. The clumps appear to be made up of a number of particles. Some of these clumps are very large in some specimens. Often there are large clumps among many other separate granules in the same region.

The distribution of these "pathologic granules" varies in different tooth specimens and at different locations in the same specimen. It is strictly limited to the exposed cementum and the underlying dentine. Therefore it is found only from the cementoenamel junction apexward to the zdeac. On stained hand-cut sections one can often recognize and identify the zdeac (Figs. 18 and 19) and see the distribution of the granules in relation to this landmark. The granules become less and less abundant as the level of the outer edge of the zone is approached. Some few can usually be found beneath the zone (Figs. 18, 19, and 20). These scattered most apexward granules at or beneath the zdeac may be found distributed and more abundant in different levels in the cementum of different specimens. Sometimes the very last, most apexward granules are in the underlying dentine. (Fig. 20.)

There is the greatest variation in the distribution of these "pathologic granules" in the cementum of different tooth specimens and at different locations around a given tooth. Often there is much variation in the distribution and other characteristics of the granules at different places along a given longitudinal section. (Figs. 2, 3, 5, 6, 7, 8, 9, and 12.)

At one place or on a given specimen the granules may be found mostly in the outer half of the thickness of the cementum (Figs. 3, 8, and 9) or they may be mostly in the deeper half (Figs. 1, 2, 5, 6, 10, and 12). In general the heaviest collection is in the deeper layer at the cementodentinal junction. In some specimens there is a corresponding heavy collection in the outermost part of dentine. (Figs. 11, 13, 14, and 15.) In such case the cementodentinal junction appears, under low magnification, as a heavy dark brown line (Fig. 22).

In other specimens the granules in the deeper part of the cementum tend to project outward from the cementodentinal junction into the cementum (Figs. 2, 5, and 6) for some distance. In still other specimens the granules may be more abundant in the dentine at and beneath the cementodentinal junction (Figs. 11 and 13). In some instances they extend far into the dentine (Figs. 14, 15, and 16).

Fig. 13. Fig. 14.

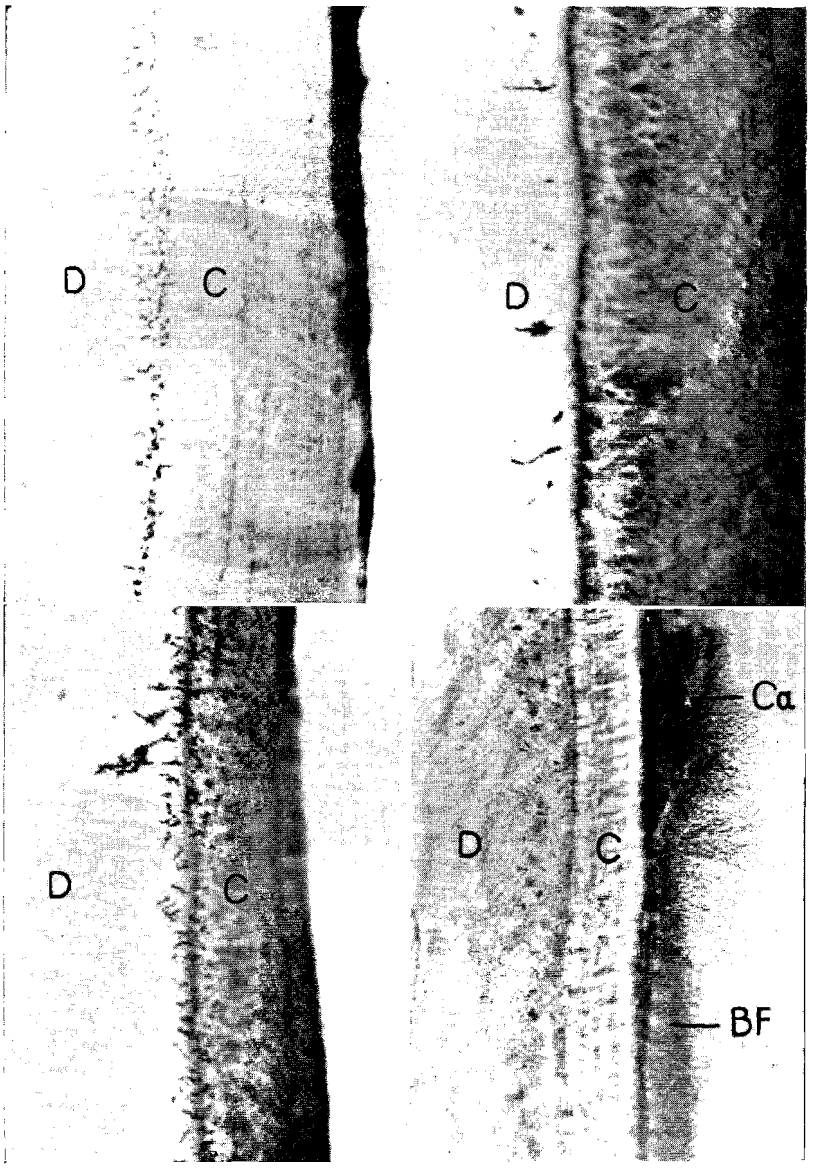


Fig. 15. Fig. 16.

Fig. 13.—Abundant granules in dentine beneath cementodentinal junction; cementum practically free of granules; outer surface heavily stained before section was cut. (×360.)

Fig. 14.—Stained preparation; cementum showing only a few granules in it but the granules and clumps extending deep into the dentine stand out sharply. (×360.)

Fig. 15.—Stained preparation; thin cementum with numerous granules showing in it and many clumps extending deep into Tomes layer; one extra large clump especially noticeable. (×360.)

Fig. 16.—Granules distributed in Tomes layer beneath exposed cementum; heavy bacterial film on surface of cementum or on calculus in upper part of picture. (×189.)

The "pathologic granules" in the dentine are largely in the Tomes granular layer, since they are more abundant just beneath the cementodentinal junction. However, the thickness of Tomes granular layer of dentine varies considerably and the inner side merges into the deeper tubular dentine (Fig. 16). There is no sharp differentiation between these two portions of dentine. In fact dentinal tubules, their branches, and the branches of fibrils can be seen to pass into, and some all the way through, the Tomes granular layer.[36] (Figs. 6, 10, and 17.)

In some specimens the granules in the dentine tend to conform to the course of the smaller tubules and their branches (Figs. 15 and 16). Sometimes they appear as a string of separate spherical or oval bodies, perhaps within the tubule itself. However, in the same region there may be other larger granules or clumps in the dentinal matrix without any apparent relation to tubules.

By incident light at about a 45° to 50° angle, with dark background, the granules appear as brilliant white (Fig. 23). Under low magnification of a specimen with heavy granulation the appearance is that of a shining white line or streak in the section, the remainder of which is dark and not so distinct.

The condition is rapidly changed or cleared by alcohol. In sections less than 10 microns thick the granules are cleared in absolute alcohol, so they are no longer visible, within one or two minutes. Thicker sections and very coarse (or large clumps of) granules may require a little more time for complete clearing.

One can observe the disappearance of the granules in alcohol under the microscope. Another good way is to note the location of the granules in a frozen section, then treat it with alcohol, remount and return to the same field in which granules were previously observed. In either case the refractile "colored" granules have disappeared, but there are no holes or spaces left in their place. On the other hand, the exact location formerly occupied by the granule now looks like the other matrix material.

I have employed still another method for studying the relation of these granules to the matrix material. A favorable specimen is selected with heavy granules, especially along the cementodentinal junction. With a very sharp knife the cementum is shaved away to about the junction level. Now the surface is scraped so as to remove the matrix material mostly in small particles. This is mounted in glycerin on a slide under a cover glass. It is helpful to stain it before mounting, with some dilute stain (fuchsin) which lightly stains matrix material.

In such a preparation granules can be found which appear entirely free from any matrix material. Others are attached to, or partly embedded in, recognizable matrix material. Finally alcohol may be run under the cover glass from one side while it is drawn off with filter paper from the other side. Clearing of a granule or granules can be seen under the microscope, leaving in their place what now appears to be the same kind of matrix material as that which was not affected.

Particles which formerly appeared to consist of granules in or attached to matrix material now are cleared and resemble the previously unaffected matrix

Fig. 17.

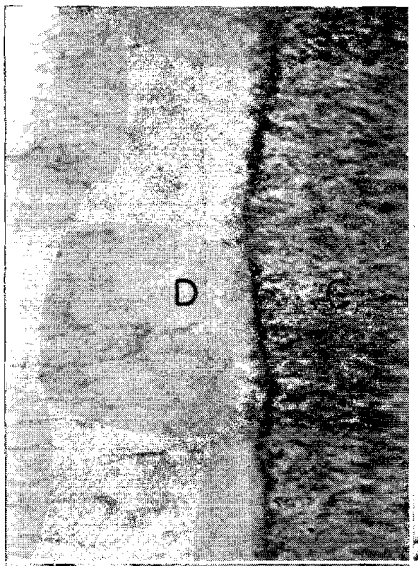
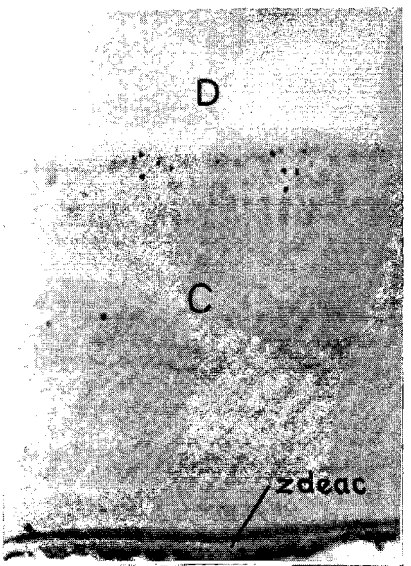


Fig. 18.



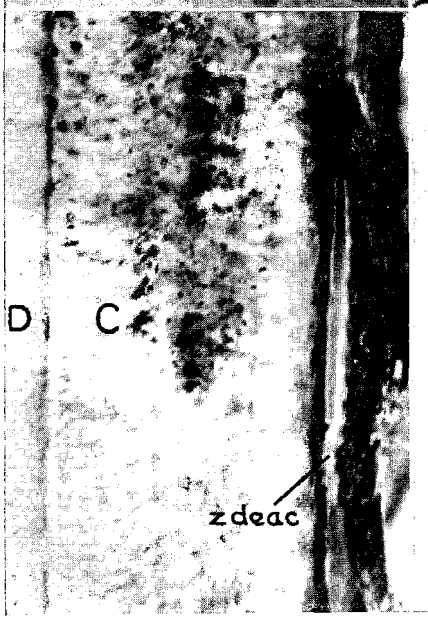


Fig. 19.

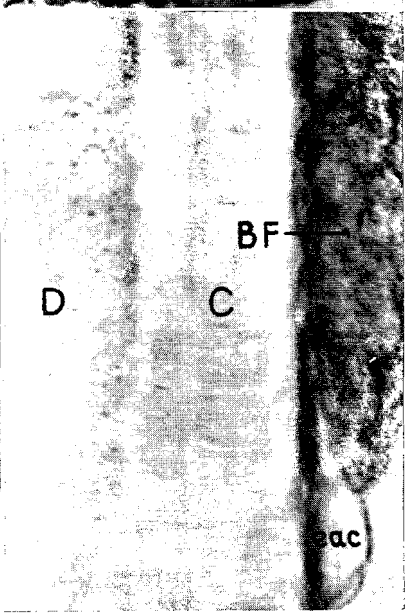


Fig. 20.

Fig. 17.—Heavily stained section showing a few of last granules in deeper part of cementum which was located just beneath the zdeac; no granules in most apexward part (upper one-fourth of picture) of cementum; vital dentinal fibrils extending into Tomes layer. (×360.)

Fig. 18.—The last few granules directly beneath the zdeac at the surface but none farther apexward (top of picture). (×360.)

Fig. 19.—Hand-cut section: abundant pathologic granules in cementum terminating just beneath zdeac (not in sharp focus) at surface, separated from cementum; no granules farther apexward (lower part of picture). (×360.)

Fig. 20.—Granules mostly in dentine terminating at about the zdeac level; heavy bacterial film also terminating at zdeac level; loosened ribbon of epithelial attachment cuticle bulging outward at lower right hand corner of picture. (×360.)

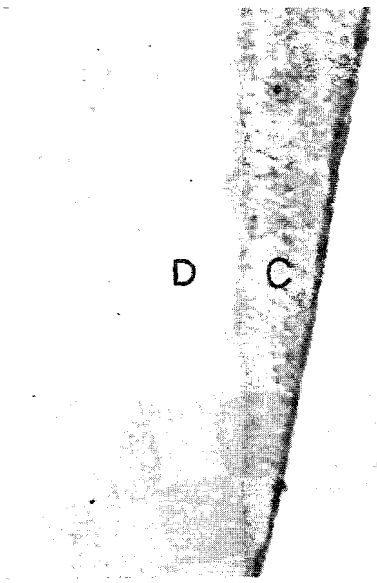


Fig. 21.

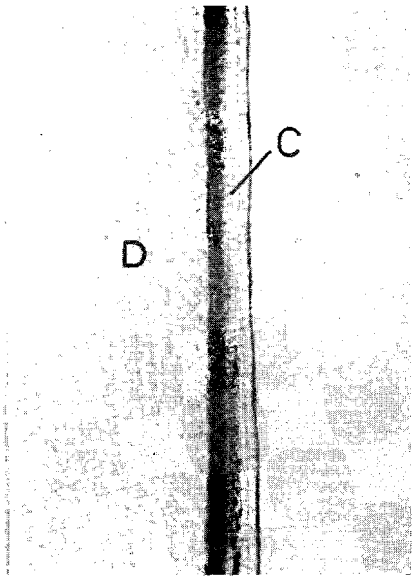


Fig. 22.

Fig. 21.—Cementum worn down by toothbrush abrasion; no pathologic granules in either the cementum or the underlying dentine; the one dot seen is an artifact. (×360.)

Fig. 22.—Hand-cut section showing heavy dark appearance produced by abundant dark brown granules in deeper part of cementum and along cementodentinal junction. (×72.)

Fig. 23.—Thin piece shaved from about level of cementodentinal junction, photographed by incident light, showing the pathologic granules bright white, which appear dark brown (black) by transmitted light. (×72.)

material. Thus far I have not been able to restore the refractile colored appearance to these "pathologic granules" after they have been cleared with alcohol. Neither have I been able to stain them differentially.

These "pathologic granules" are also cleared in very thin sections kept in water (+5 per cent formalin), within one to four weeks. The size of the granules and no doubt other factors influence the rate of clearing in water.

Practically all exposed cementum shows this striking condition. It is never found in cementum which has not been exposed by the disease process, periodontoclasia, and therefore, never apexward from the zdeae. For this reason I believe it is appropriate to call it a pathologic condition.

Sometimes an individual wears back his gum and cuts a considerable groove in the tooth at and below the cementoenamel junction, with a stiff toothbrush and abrasive dentifrices. I have never found the pathologic condition just described in such mechanically exposed cementum or the underlying dentin (Fig. 21).

Comment

What influence, if any, this condition may have upon any possible repair of periodontoclasia damage remains for future work to show. In view of the fact that the condition is not found in cementum exposed by toothbrush abrasion and subjected to frequent cleaning, it will be interesting to ascertain what, if any, influence daily effective cleaning will have upon cementum that is already affected.

Summary

Attention is directed to a previously undescribed pathologic condition which is limited to exposed cementum and the underlying dentine. Simple technical methods for its demonstration are given.

Parts of the matrix material in decalcified specimens appear, by transmitted light, as refractile brownish granules and, by incident light, as bright white granules. The appearance is quickly removed by alcohol.

The observation is made that this condition is not present in or beneath cementum which has been exposed by abrasion.

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