

THE ASSOCIATION BETWEEN DECIDUOUS DENTIN SCLEROSIS
AND CALCIUM HYDROXIDE METHYL CELLULOSE
BASE MATERIAL

by
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INTRODUCTION

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One of the problems in operative dentistry for children is, of course, the preservation of the health of the pulp. Deciduous teeth, although similar to the permanent teeth, are smaller in size and have minor variations in anatomy. Kronfeld¹ stated that the dentin of deciduous teeth is structurally identical, except that it is thinner, than that of the permanent teeth in keeping with the smaller size of the deciduous teeth. Schour and Massler² state that the thickness of the enamel and dentin is approximately one-half of that found in the permanent teeth. They also note that the crowns of the deciduous teeth are more bulbous and sharply constricted cervically.

Cavity preparations in the deciduous teeth, particularly in primary molars, are more apt to come closer to the pulp than those in permanent teeth since the occlusal dentin is thinner than that of permanent teeth. The constriction at the cervix also calls for special care in the instrumentation of proximal preparations in order to avoid the large bulbous pulp chamber. Therefore, close approximation, minute as well as actual pulp exposure, require the use of a nonirritating base material for pulp protection.

Oxyphosphate of zinc cement base material leaves much to be desired because when it is reshaped particularly in proximal preparations, it more often than not may be dislodged. The free acid of the cement may also irritate the pulp if inadvertently placed in contact with it. In order to fulfill the need for a truly protective, workable material more suited to cavity preparation in

deciduous teeth, a calcium hydroxide methyl cellulose base can be used. The main disadvantage of this base is that the material does not set as hard as the oxyphosphate of zinc cement. It forms a fragile crust at its surface. However, when used in a thin layer, there is adequate support for most alloy restorations.

After using this calcium hydroxide methyl cellulose base material for some time, it was discovered that the recall radiographs showed a film-translucency "white area" in the dentin approximating the base material. The occurrence and location of these areas of film translucency suggests that dentin sclerosis was taking place in response to the irritating effect of the operative procedures. These casual observations suggested, moreover that dentin sclerosis occurred much more frequently as a response to a calcium hydroxide methyl cellulose base material in deciduous teeth than to any other type of base filling material used.

Therefore, in view of these preliminary observations this thesis was designed to determine if any association between dentin sclerosis in deciduous teeth and a calcium hydroxide methyl cellulose base material occurs. The techniques which were used in the study to evaluate dentin sclerosis were visual examination of the clinical bitewing radiographs for sub-cavity translucent areas, densitometric measurements of these dentin film images of translucency, and microscopic examination through the sub-cavity areas of histologic sections of deciduous teeth with and without a calcium hydroxide base material.

REVIEW OF THE LITERATURE

REVIEW OF THE LITERATURE

Dentin possesses a protective mechanism, a response to caries, abrasion and cavity preparation, namely, sclerotic dentin. Dentin sclerosis has been regarded as a response to irritation, and acts as a mechanism for the protection of the adjacent pulp tissues. Beust³ emphasizes the importance of this protective mechanism by stating that dental caries resistance of a tooth increases in proportion to the amount of its sclerosis.

John Hunter⁴ noted in 1839 that as a result of abrasion and in the face of possible exposure of the pulp, the bottom part of the cavity is filled with a new material. John Tomes⁵ first described a similar area as a barrier of hypercalcified dentin, which he called "translucent dentin". He suggested in 1848 that it retarded the progress of carious lesions and prevented fluid contamination of the pulp. Fish⁶ later described this hypercalcified dentin as a calcific scar.

Bodecker⁷, 8, Krenfeld⁹, Mummery¹⁰, Vissotzky¹¹, Beust^{12, 3, 13, 14}, Bodecker and Applebaum¹⁵, Fish^{16, 6}, Lefkowitz¹⁷, Weider and Mohamed¹⁸, referred to this material as sclerotic dentin and attributed its formation to the stimuli of caries, age, attrition, abrasion and operative procedures. All investigators generally agree that the dentin is capable of reacting to stimuli and injuries from without by formation of sclerosis¹⁹.

The nature of the reaction which culminates in sclerotic dentin is controversial. Beust¹² notes that sclerosis is a "normal biologic process" in response to a stimuli regarded as a biologic irritation.

Its occurrence and progress is partly governed by age, diet, resistance of the individual, environment of the tooth, localized irritations and the rate of contraction of the pulp cavity resulting from dentin deposits. Beust¹³, also believed that in addition to direct outside stimulus, dentin sclerosis is induced by the reduction of the size of the pulp cavity through a normal secondary dentin deposit. This is in itself a factor in the transformation of countless dentinal fibrils into sclerosed tissue. The reduction of the pulp cavity causes functional elimination of the mother cells, which continues until in extreme cases, all of the fibrils and even the pulp itself becomes transformed by depositions. Theoretically, this would be the fate of any tooth, provided the span of life sufficed for the transformation

Beust¹⁴ believes that sclerotic dentin caused by irritation results in the obliteration of the dentinal tubules. Through this obliteration process, the permeable, sieve-like structure of the dentin is converted into a tissue which, according to Miller²⁰, exhibits increased resistance to acids and refuses the ingress of ordinary staining reagents. He found that young unaffected dentin will stain while sclerosed dentin will not.

Fish¹⁶ states that the circulation of lymph in the dentin of the dog was discovered by Fritch in 1914. Fish demonstrated that particules of Indian ink could be forced into the dentinal tubules, between the fibril and the wall of the tubule. He also found by experimenting with extracted teeth with a carious lesions, that when methyl blue is introduced into the pulp chamber and moistened with

normal saline, the dye did not reach the periphery of the lesion, but entered the uninjured tubules of the normal dentin quite freely. However, where the tubules are open in the mouth at the peripheral ends by the lesion, they are closed from the pulp by a calcific barrier, so that there is no exchange of fluids between the pulp and the lesion.

The original view of Sir John Tomes, that sclerotic dentin was due to hypercalcification of the dentin has been disputed by Charles Tomes¹⁰, who attributed this to decalcification. This confusion probably arose because one worker examined a true sclerotic dentin zone, and the other worker, the decalcified closely adjacent carious dentin which occupies the same relative position under these lesions. Fish⁶ confirmed John Tomes' view that sclerosis is hypercalcification.

The interpretations of the physiologic phenomena resulting in sclerotic dentin are controversial. One school regards this phenomenon as a filling of the tubules by calcific deposits, another as a zone of decalcification, which results in swelling of the tubule walls, while a third regards the cause as a fatty degeneration of the dentinal fibril.

Bodecker²¹ explained the changes which occur in the dentin between the pulp and the carious lesion, by stating that these areas or "dead tracts" were tubules blocked by fatty metamorphosis of the dentinal fibril. He claimed that secondary dentin is laid down in the pulp chamber between the odontoblasts and the primary dentin, as

a result of abrasion and dental caries. This cuts off innumerable dentinal fibrils from their vital connection with the odontoblasts. As a result of this severance of the dentinal fibrils, they receive little or no nourishment from the pulp, and undergo a fatty metamorphosis.

Fatty metamorphosis of the dentinal fibrils has been demonstrated by Weber²², Hatton²³, Euler and Meyer²⁴, and others. The reports unanimously show the presence of traces of lipid in the dentinal tubules affected by dental decay and abrasion. Bodecker²¹ proposes that the lipid content of the enamel and dentin may be responsible for making these tissues impermeable and so reduce dental caries.

Some properties of the sclerotic dentin have been investigated. Cape and Kitchen²⁵ noted that sclerotic dentin had a peculiar luminous birefringence which may be attributed to two conditions: 1. removal of the inorganic substances from the particular area; and, 2. a marked increase of the birefringence of the organic material. They suggested that this increase in birefringence may function as a part of a defense mechanism against caries. Quantitative chemical analysis of sclerotic dentin have been made by Kimmelsteil and Langmak²⁶ who report little difference in the calcium content of sclerotic root tip dentin and other dentin of the same tooth. Cohn²⁷ reported a greater water content of sclerotic dentin beneath caries. Proell and Schubert²⁸ found an increased hardness in transparent areas which resulted from artificial exposure of dentin in dogs teeth. Richter²⁹ states that the trans-

parent zones (presumably under caries) is harder than normal dentin and also noted that the next hardest dentin was to be found in the crown directly under the enamel. Hodge³⁰ noted the average micro hardness of transparent dentin to be 20% less than that of normal coronal dentin in the same tooth.

The Rochester group composed of Van Huysen, Hodge, Warren, Bale and Wilsey did an exhaustive study of the Roentgen-ray absorption of tooth slabs. One of the first papers published by this group contains a description of a densitometric method for the precise quantitative measurement of the Roentgen-ray absorption of the dentin in one mm. thick plane-parallel tooth slabs. They note that Roentgen-ray absorption of a given portion of a tooth slab can be determined with an error of less than 5%.

In another study of the dentin in three tooth slabs, in which densitometric measurements are made Van Huysen³² pointed out; 1. normal unchanged dentin is almost constant in its absorption of Roentgen radiation and is nearly equivalent to the absorption of an equal thickness of pure aluminum; 2. normal and abnormal areas of dentin in the same tooth have different total Roentgen-ray absorption; and 3. certain areas of dentin between a carious surface and a pulp chamber give increases in Roentgen-ray absorption of 10 - 25% compared to normal dentin. Van Huysen³³ et al used a standard ionization chamber method in addition to the densitometric method for measuring Roentgen-ray absorption dentin in six tooth slabs from a series of seventy-three teeth with Roentgen and Grenz rays.

Their data indicated; 1. different teeth may have different absorption values for a given thickness of normal dentin, and 2. areas affected by dentinal caries have increases of Roengten-ray absorption of from 5 to 40%.

Van Huysen³⁴ reports from a study of five tooth slabs that transparent dentin absorbs 2 to 3% more Roengten radiation than unmodified dentin. Roengten-ray absorption measurements are also shown to be not always correlated with the intensity of staining. In a further study³⁵ relative to dentin changes due to attrition, Roengten-ray absorption measurements were made upon the coronal dentin from one young tooth and upon selected areas of several other tooth slabs taken from teeth showing varying degrees of attrition. The results are as follows: 1. The young tooth showed a constancy of Roengten-ray absorption throughout the crown dentin; and, 2. In teeth showing attrition, the attrition cone in the dentin between the abraded incisal edge and the pulp chamber showed a marked increase in Roengten-ray absorption, compared to the normal coronal dentin in the same tooth. These Roengten-ray absorption studies show that dentin sclerosis is hypercalcification.

Most of the dentin changes in response to caries have been treated as hypercalcifications. A few individuals have indicated that these so called sclerosed areas represent recalcification of the carious dentin. As early as 1846 Dwinelle³⁶ advocated, "what was then considered a new and very unorthodox method of leaving decomposed bone immediately over the nerve, when its removal would

expose it, then proceed to fill it as usual. Since 1845 I have frequently removed gold stoppings from teeth which were filled upon softened bone, from one to seven years before and have found the former softened parts as hard and insensible as the surrounding bone." Inglis³⁷ in 1900 brings this topic to light again by stating that "Recalcification would indicate that such softened dentin can have its meshes sufficiently refilled with inorganic material in an arrangement sufficiently orderly to approximately restore its original rigidity." References in the literature as to the recalcification of carious dentin are rather sporadic and for the most part are assumptions based on inaccurate observation.

Sowden³⁸ in 1956 restored 4,000 teeth with deep carious lesions. After removing the gross amount, but not all of the caries, calcium hydroxide was placed in the base of the cavity followed by an amalgam restoration. He observed what he called, "a recalcification" of the carious dentin beginning pulpally and progressing occlusally. In all probability this recalcification of the carious dentin is not actually a recalcification process in the true sense of the word, but sclerotic dentin being formed in a response on the part of the injured dentin to dental caries.

The use of calcium hydroxide first appeared in the dental literature in 1936 when Hermann^{39, 40} introduced calcium hydroxide in the form of a paste as a biologic wound dressing in pulpotomies. The paste known as Calxyl contained calcium hydroxide, sodium chloride, potassium chloride, calcium chloride, and sodium bicarbonate as well as other substances. For the first time reports of the

formation of true dentin in a form of a bridge walling off the pulp tissue appeared in the literature. Experiments using "Calyxl" were evaluated on a histopathological and roentgenological as well as a clinical basis. As a result of these investigations Hermann⁴⁰, Hess⁴¹, Zander and Arnold⁴², and Teuscher and Zander⁴³ revealed that the pulp wound was covered with a superficial calcified scar, beneath which was a layer of predentin and calcified dentin, lined by newly formed odontoblasts.

An explanation of the reaction of the pulp to calcium hydroxide was given by Zander⁴⁴. He notes the following, "The inorganic content of dentin is primarily a hydrated tricalcium phosphate and as such should follow the laws of mass action in relation to the solubility product. The blood is normally saturated or supersaturated with calcium or phosphate ions and hence any increase in calcium or phosphate ions would cause a precipitation or laying down of calcium salts. A material which contains either calcium or phosphate in combination, which would be easily ionized when brought in contact with the surface of the pulp, should react in this manner. This probably is the action of calcium hydroxide."

Much attention, mostly clinical in nature, has been given to calcium hydroxide mixtures as a pulp capping material. Rosenstein⁴⁵ reported the results of 1232 pulp capped primary teeth, and claimed a 91% success with each of a variety of materials used, showing no statistical difference between them. He concluded that the choice of capping material is not so important as other factors in diagnosis and treatment. Chatterton⁴⁶ advocated a technique of pulp

carriage, (a modified pulpotomy), at the sight of the exposure. The wound is covered with a paste of calcium hydroxide and distilled water. He reported on 377 posterior teeth so treated with a 72% success.

There is almost universal pessimism on the published works of vital pulp therapy.⁴⁷ Via⁴⁸ claimed only a 31% success while Shoemaker⁴⁹ wrote as follows: "An operation which is successful in 39% of the cases is undoubtedly better than an extraction. It appears, however, that the profession has been, and is advocating pulpotomy with more optimism and less proof than is justified."

A mixture of calcium hydroxide and zinc oxide suspended in a chloroform solution of polystyrene was found to be an effective cavity liner by Zander et al.⁵⁰ They evaluated a number of experimental cavity liners through information gained by histological methods. The liners were also tested for permeability to phosphoric acid through the use of a radioactive phosphorus as a tracer. Controlled histologic and clinical tests also showed that this liner will protect the pulp from the irritating properties of silicate, zinc silicate, and zinc phosphate cements.

The literature quoted above suggests that dentin is in all probability a vital tissue, and under certain conditions will react to stimuli. These changes have been observed in histologic, Roentgen-ray absorption, and clinical radiographic studies. It has been demonstrated throughout the years that primary dentin, attacked by caries, or stimulated by operative procedure, will protect itself by sclerosis or hypercalcification. A recent author has gone so

far as to claim that calcium hydroxide will stimulate the recalcification of carious dentin. Therefore, it is logical that a study should be made concerning one of these much discussed factors, namely, the association between the presence of calcium hydroxide methyl cellulose used as a base material, and the appearance of sclerosis of the dentin approximating the base.

STATEMENT OF PROBLEM

STATEMENT OF PROBLEM

This study is being undertaken to illustrate the frequency of association of dentin sclerosis in deciduous teeth and calcium hydroxide methyl cellulose used as a filling base material. The dentin sclerosis will be determined by observing differences in the translucency of film images of dentin between the pulp and cavity bases. The intensity of the dentin sclerosis, will be measured by instrumental and visual film densitometry determination of these areas. Histologic examination of some of the deciduous teeth with and without a calcium hydroxide base will also be made.

METHOD AND MATERIALS

METHOD AND MATERIAL

The method and material section of this thesis is separated into four parts, as follows:

1. Clinical Operative Procedures

A description of the cavity preparation, base filling materials and radiographs used.

2. Visual Densitometric Evaluation (Sclerotic Index)

The estimation of the occurrence and intensity of dentin sclerosis by inspection of bitewing radiographs.

3. Instrumental Densitometric Evaluation

Instrumental densitometric measurements of projected bitewing x-ray film images of dentin sclerosis.

4. Histologic Evaluation

Microscopic examination of deciduous teeth with and without calcium hydroxide methyl cellulose base.

CLINICAL PROCEDURE

The operative procedures for this study were performed on seventy-five children in the deciduous and mixed dentition stage. These patients were selected at random from a Pedodontic practice. A total of 351 deciduous teeth were observed in two groups as follows:

Group A (control teeth) consisted of 160 deciduous teeth restored with amalgam.

Group B (test teeth) consisted of 191 deciduous teeth restored using a calcium hydroxide methyl cellulose base material beneath the amalgam filling.

The test and most of the control teeth were found in the mouths of 62 children. It was necessary to select an additional 13 patients containing control teeth only, to equalize the number of control and test teeth.

All operative dentistry was performed under a rubber dam, using the Young's rubber dam frame as illustrated in figure 1. A few of the cavities were simple occlusal preparations although the majority were of the compound type usually with the occlusal and one or more of the proximal surfaces involved. Preparations were made at an engine speed of from 8 to 10,000 revolutions per minute with a direct continuous air blast into the cavity acting as a coolant. Carbide burrs and diamond stones were utilized.

The cavity preparations in the deciduous teeth used in the control group a were generally not quite as deep as those in the test group b. However, in the deeper cavities of the test group

where a base was indicated, a zinc oxyphosphate cement was used. One should be aware of the fact that indications for a base material in a cavity preparation for deciduous teeth is usually a matter of clinical judgement. A difference as small as a fraction of a millimeter in depth would indicate or contraindicate the use of a base material for most practitioners.

The deciduous teeth in the test group b (those containing a calcium hydroxide base material) are generally deep cavities where one would ordinarily use a cement base. The base material used in the test group consisted of a mixture of calcium hydroxide (powder No. 40 Lime Slaked) and 1% methyl cellulose solution.* These previously prepared powder and liquid are mixed on a glass slab to a creamy consistency immediately before placement as a base for the restoration. See figure 2. This base was placed as a thin layer in the indicated area of the cavity floor and seated with a pledget of cotton. The excess material is removed from the margins and walls of the cavity with an explorer. In all instances restorations were completed with an alloy filling material.

As a part of the routine office procedure, bitewing radiographs are made for diagnosis before any operative procedures are begun. Bitewing films were also obtained at each recall period. Although it is desirable to recall patients at six month intervals,

*The methyl cellulose solution was prepared using one-half gram Cellothyl tablets (Warner-Chilcott Laboratories dissolved in distilled water to make a 1% solution.

it was found that the recalls on the cases used in this study were made at intervals of from 4 to 10 months between examinations.

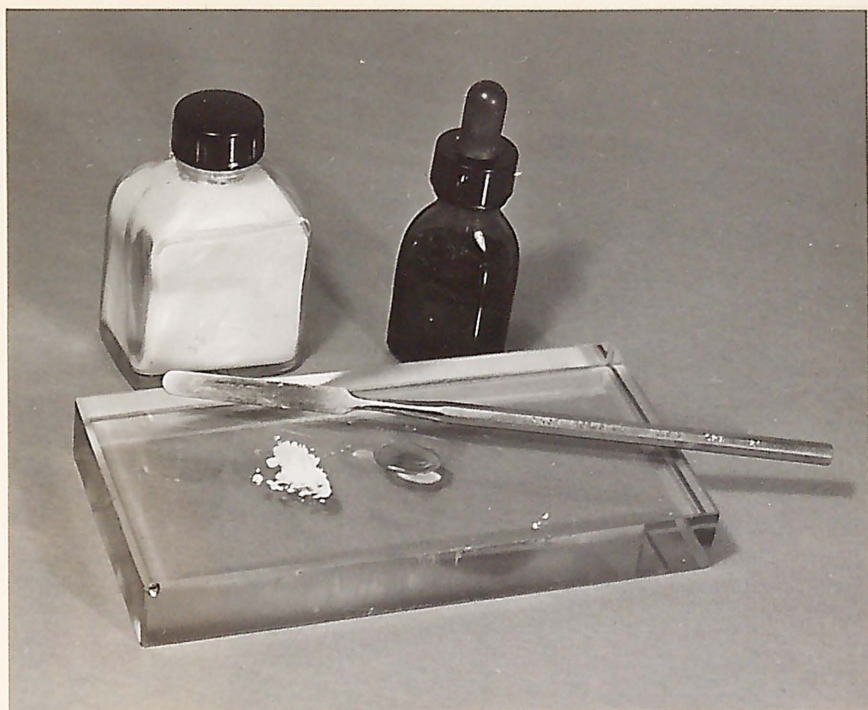
Figure 1: Clinical Preparation

The rubber dam attached to the Loung's frame is placed in preparation for the operative dentistry.



Figure 2: Materials for Base

The calcium hydroxide and 1% methyl cellulose solution is shown ready for mixing to a creamy consistency on the glass slab.



METHOD AND MATERIAL

VISUAL DENSITOMETRIC EVALUATION

SCLEROTIC INDEX

VISUAL DENSITOMETRIC EVALUATION

SCLEROTIC INDEX

The material for this portion of the study consisted of periodic bitewing radiographs. These radiographs covered 351 deciduous teeth in 75 patients that were observed over a period of from 4 to 28 months. Radiographs were taken before operative procedures and at recall intervals ranging from 4 to 10 months between examinations, after the completion of the restoration. The radiographs were examined visually in a semidarkened room using a clinical x-ray viewer. The viewer was masked so that each individual x-ray film fitted into a window of light the size of the film, in order that only the light transmitted through the film was observed.

The radiographs were examined visually for indications of sclerotic dentin. This sclerotic dentin is defined as an area of increased radiopacity and appears in the dentin film image as an area of relative translucency (white area) close to the cavity floor and sometimes extending toward the pulp. These "white areas" were noted visually and were found to vary in intensity from tooth to tooth. Therefore, it was possible to classify these variations in dentin sclerosis (sclerotic indices) on the basis of localized areas of film translucency. The arbitrary visual classification of dentin sclerosis is illustrated in figure 3. This shows a bitewing radiograph and outline diagram of the same beneath it. The radiograph and drawing illustrate areas of normal dentin at (a) which is used for comparison of increased radiographic density of the sclerotic dentin areas at (d).

Sclerotic index 1 is an evaluation of a slight increase in radiographic translucency which indicates a slight dentin sclerosis or a slight increased localized calcification. It is noted at the axial pulpal wall of the maxillary left first deciduous molar as (d^1).

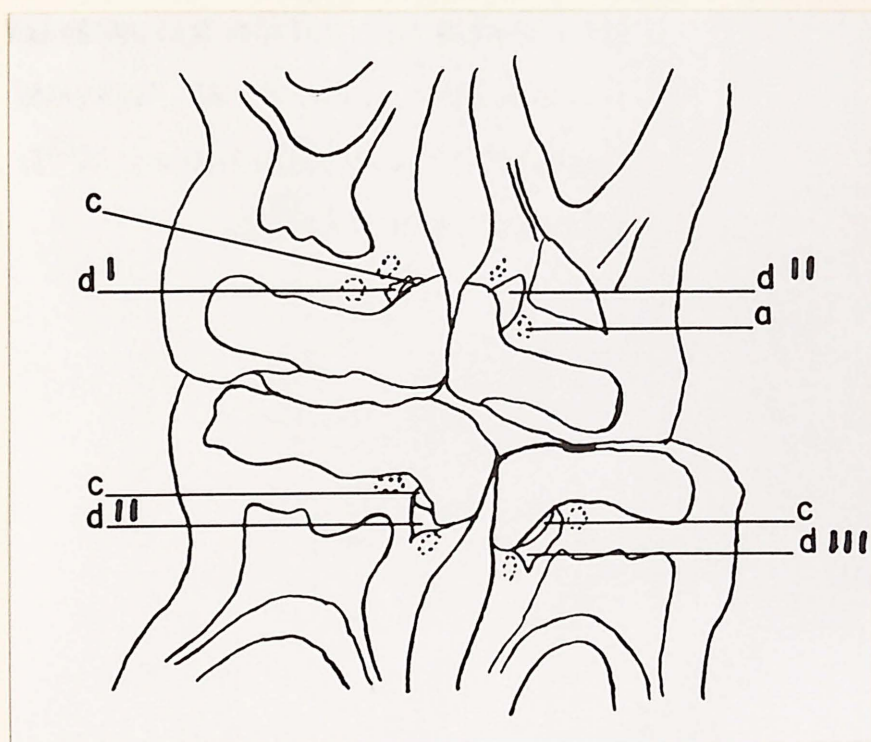
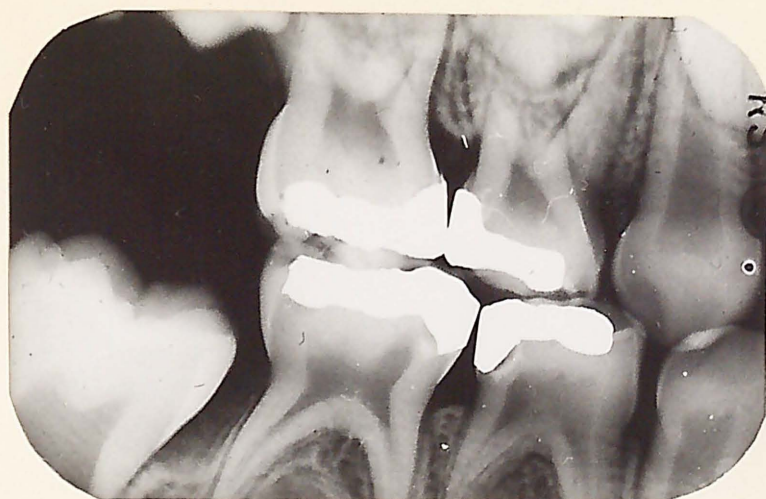
Sclerotic index 2 is an evaluation of a moderate increase in radiographic translucency which indicates a moderate dentin sclerosis, or moderate increased localized calcification. This is noted at the axial pulpal walls of both the maxillary left first deciduous molar and mandibular left second deciduous molar as (d^{11}).

Sclerotic index 3 is an evaluation of an extreme increase in radiographic translucency indicating a maximum amount of dentin sclerosis or maximum increased localized calcification. This is noted at the axial pulpal wall of the mandibular left first deciduous molar as (d^{111}).

The visual estimations of the sclerotic indices of the different teeth are arranged in table 1 in columns 6, 8 and 10.

Figure 3: Visual Densitometric Sclerotic Index

The postoperative radiograph and diagram show areas of normal dentin at (a); sclerotic dentin (d); calcium hydroxide methyl cellulose base material (c); Sclerotic Index 1 (d^I); Sclerotic Index 2 (d^{II}); and Sclerotic Index 3 (d^{III}).



METHODS AND MATERIAL

INSTRUMENTAL DENSITOMETRIC EVALUATION

INSTRUMENTAL DENSITOMETRIC EVALUATION

This procedure is an attempt to more accurately evaluate the calcium hydroxide methyl cellulose base material and its effect on dentin sclerosis. An attempt is made to correlate the Visual Sclerotic Index method with an instrumental x-ray film measurement. This was accomplished by measuring the x-ray film density of dentin sclerosis with a densitometer, of twenty sets of radiographs. These radiographs were selected to show a comparable number of control teeth and teeth with sclerotic indices of 1, 2 and 3. Each radiograph was placed in an Elwood Photographic Enlarger with a constant power source and fixed enlarging distance, thus enabling the radiographs to be magnified five times the original size. (see figure 4) The film shadow density of the dentin was measured with an Elwood Crystal Densitometer in a darkened room. The opening over the crystal was masked to admit light through a 1 mm diameter opening. (see figure 5) Measurements of the sclerosed area and the immediately adjacent surrounding normal dentin were taken from the projected radiographic film images. These measurements of normal dentin were within approximately a radius of 5 mm of the sclerosed area in the enlarged radiographic images. These areas were selected in order to obtain readings in a tooth, a portion of which is approximately the same thickness as that of the sclerosed area.

In addition to comparing the sclerotic dentin beneath calcium hydroxide base material (test teeth) with normal dentin in the same tooth, measurements were also made in control teeth without

a calcium hydroxide base. In determining the density of dentin areas for the control teeth, readings were taken within a radius of 5 mm in a part of the enlarged film image of the tooth similar to the sclerosed areas mentioned above.

Figure 6 illustrates the clinical bitewing radiograph and diagram of the same beneath it, indicating the areas that were measured densitometrically. Three density measurements were made in each area with the Elwood Densitometer and averages determined for the normal dentin area (a) and the sclerotic dentin area (d). The space occupied by the calcium hydroxide methyl cellulose base material appears radiographically as a relative dark area (c). The densitometer values for each tooth are found in table 5, columns 5, 6, 7, and 8.

Figure 4: Instrumental Densitometric Equipment

The equipment used is from the left,
a constant voltage transformer, Elwood
Photographic Enlarger and Elwood Den-
sitometer with crystal carrier.



Figure 5: Densitometric Measuring Device

The Elwood Densitometer and crystal carrier showing the 1 mm. masked opening.

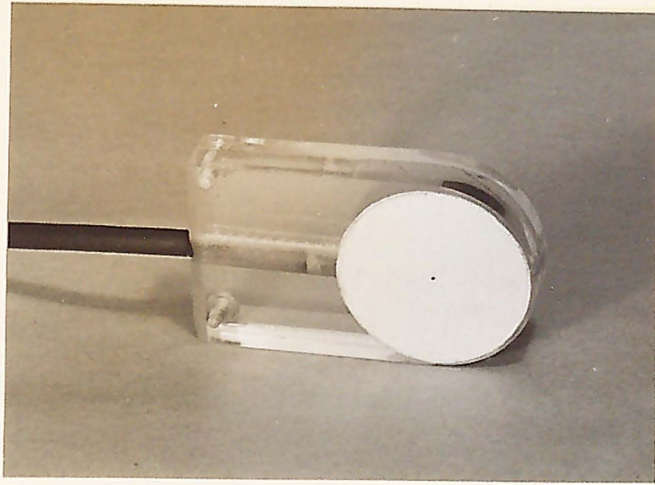
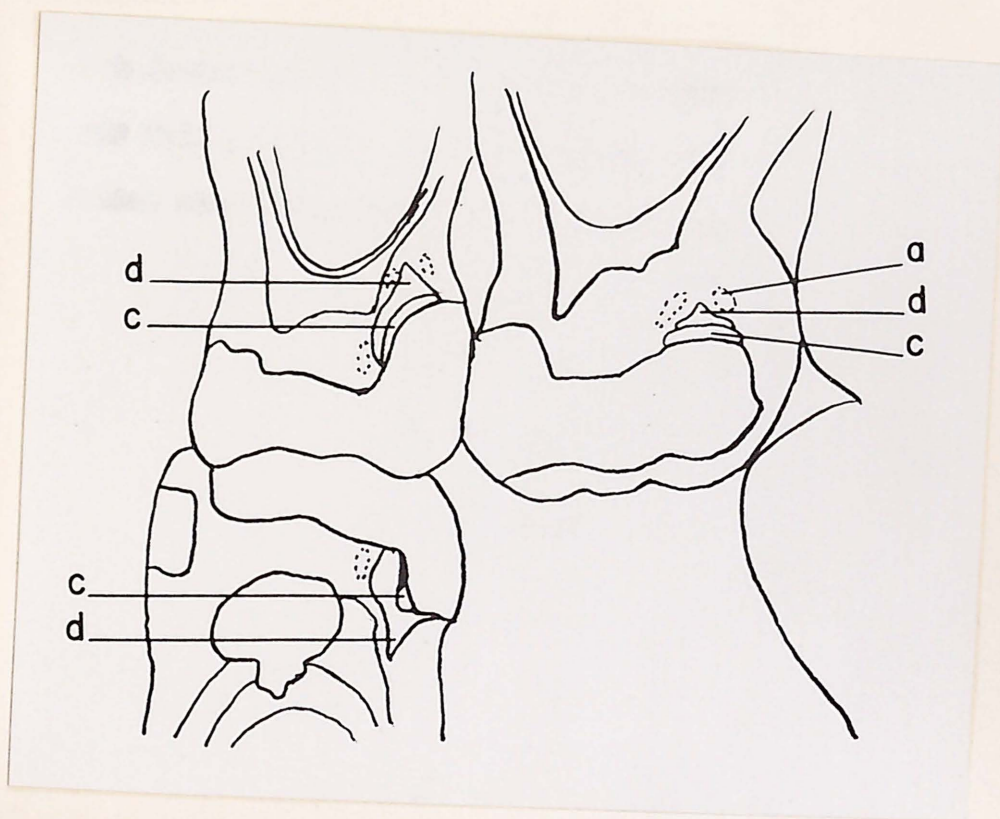


Figure 6: Areas of Instrumental Densitometric Measurements

The postoperative radiographs and appropriate diagrams to illustrate densitometrically measured areas of (a) normal dentin; and, (d) sclerotic dentin, with the area of the calcium hydroxide base material, (c).



METHOD AND MATERIAL

HISTOLOGIC EVALUATION

HISTOLOGIC EVALUATION

Twenty of the deciduous teeth used in this study were extracted for histologic evaluation. The teeth removed for this purpose were some of those whose x-rays were used in both the control and test groups. These teeth were removed just prior to normal exfoliation or in clinical situations where space maintenance could be easily accomplished. The teeth were stored in 10% formulin fixative immediately upon removal.

Ground sections of these teeth were prepared along planes, longitudinal and horizontal to the occlusal surfaces of the crowns of the tooth, and sections were cut to show dentin between the cavity bases and the tooth pulps, these are the areas where dentin sclerosis is most likely to occur. In order to establish a flat plane in the section it was necessary to use radiographs to show the relative position of the sclerosed area more clearly. The tooth enamel was removed with diamond stones and discs and the crown was shaped into a block of dentin. A radiograph was made of this block to further localize the sclerotic dentin area for preparation of the section to be studied. (see figure 12) Upon completion of the dentin block and its radiograph, the block was further reduced to a ground histologic section using levigated alumina slurry in water, as the grinding compound, on a flat plate slab. The sections were ground so that they contained an area of sclerosed dentin between the cavity surface and the pulp chamber. (see figure 12) These sections ranged from 20 to 60 microns in thickness. Upon reaching the appropriate thickness the sections

were polished on an arkansas stone using water as the wetting agent. This polishing action removed the slurry particles used for grinding. In one section (D. H. E7) no grinding compound was used. The section was prepared using a flat grinding stone and polished on a wet arkansas stone.

The cut sections were prepared by decalcifying the teeth in 5% formic acid. The decalcified sections were made using paraffin imbedding and stained with hematoxylin and eosin. The decalcified teeth were oriented in the paraffin block so that the plane of section showed the pulp tissue and the area of sclerosis. The post extraction radiographs were used to help with the orientation. Sections were made in both the horizontal and longitudinal planes, in reference to the occlusal surface of a tooth. In one case (D. S. 41 E.) it was possible to make both a ground and decalcified section in the same plane through the area of sclerosis to be studied.

The teeth studied histologically were arranged in five groups as follows:

1. Normal Control: Three teeth were sectioned in which there was no evidence of dental caries, therefore, no operative dentistry was necessary. One type of section was made from each tooth. A ground horizontal, ground longitudinal and decalcified longitudinal section were examined.
2. Alloy Control: Four teeth were sectioned in which caries were noted. The extent of this caries was such that it was not necessary to place base material beneath the restoration. One ground section was made from each tooth. Two ground horizontal and two

ground longitudinal sections were studied.

3. Zinc Oxide and Eugenol Base: Two teeth were sectioned that were restored with an alloy restoration beneath which was placed a zinc oxide and eugenol base material. Both teeth were studied in ground longitudinal section.

4. Calcium Hydroxide Base: Ten teeth were sectioned that were restored with an alloy restoration beneath which was placed a calcium hydroxide methyl cellulose base. One section was made from each tooth except in one case where both a ground and decalcified section was made from the same tooth. There were four ground longitudinal, three ground horizontal and four decalcified longitudinal sections studied.

5. Calcium Hydroxide Base Failure: One tooth was sectioned that was restored with an alloy restoration beneath which was placed a calcium hydroxide base. The tooth was extracted due to evidence of a periapical abscess. This tooth was studied in ground longitudinal section.

DATA

DATA

The data of this report on sclerotic dentin and its association with calcium hydroxide methyl cellulose cavity base has been separated into three parts, as follows:

1. Visual Densitometric Evaluation (Sclerotic Index)

The estimation of the occurrence and intensity of dentin sclerosis by inspection of bitewing radiographs.

2. Instrumental Densitometric Evaluation

Instrumental densitometric measurements of projected bitewing x-ray film images of dentin sclerosis.

3. Histologic Evaluation

Microscopic examination of deciduous teeth with and without calcium hydroxide methyl cellulose base.

VISUAL SCLEROTIC INDEX DATA

VISUAL SCLEROTIC INDEX DATA

Table 1 contains the data derived from the comparison of bitewing radiographs of deciduous teeth without a calcium hydroxide base material (control teeth) and those with a calcium hydroxide methyl cellulose base material (test teeth). The data are arranged in columns from left to right. In the first three columns are placed the patient number, age, and the tooth upon which the restoration was completed. The fourth column contains the base material utilized beneath the alloy restoration, and is indicated as follows: (C) calcium hydroxide methyl cellulose base material; (CP) calcium hydroxide methyl cellulose base material followed by a zinc oxyphosphate cement base; (*) no base material (control tooth); (ZNO) zinc oxide and eugenol used as a base material; (ZNO-C) calcium hydroxide methyl cellulose followed by zinc oxide and eugenol as a base material. The fifth, seventh and ninth columns indicate the sclerotic index, which is an arbitrary visual classification of radiographic evidence of sclerotic dentin density as follows:

Sclerotic Index 1, slight dentin sclerosis

Sclerotic Index 2, moderate dentin sclerosis

Sclerotic Index 3, extreme dentin sclerosis

N , no radiographic evidence of dentin sclerosis

N.E., no radiographic evidence of dentin sclerosis

in a tooth containing a calcium hydroxide

base material

The sixth, eighth and tenth columns indicate the time intervals (in months) between the date when the operative dentistry was

completed and the date of the respective follow-up radiographs.

Table 1 is lengthy although the data shows observations on radiographs of 351 deciduous teeth in 75 children during a time interval of from 4 to 28 months. In the control group a, 160 deciduous teeth increased without a calcium hydroxide methyl cellulose base material. In test group b, 191 deciduous teeth were studied in which a calcium hydroxide methyl cellulose base material was used. The teeth ranged in time intervals as follows: 99 teeth observed over 20 months, 109 teeth observed between 12 and 20 months, 96 teeth observed between 6 and 12 months, 45 teeth observed between 3 and 6 months, and 2 teeth less than three months.

Table 2 summarizes the visual densitometric data tabulated in table 1 as follows: The first column on the left indicates group a, the control teeth and group b, the test teeth. The second column shows the number of teeth in each group. In the third, fourth, fifth and sixth columns are the number of teeth classified as no sclerosis and the respective sclerotic indices 1, 2, and 3.

Of the 160 deciduous teeth which were restored with an alloy restoration without a calcium hydroxide methyl cellulose base material (control teeth group a), one tooth exhibited radiographic evidence of sclerotic dentin beneath the alloy restoration. (see figure 7)

Of the 191 deciduous teeth in which a calcium hydroxide methyl cellulose base was used (test teeth group b), 14 teeth did not show radiographic evidence of sclerotic dentin. This indicated that 93% of the deciduous teeth having a calcium hydroxide methyl

cellulose base placed beneath an alloy restoration demonstrated sclerotic dentin radiographically. The range of sclerotic indices for the 191 test teeth are as follows: Fourteen, or 7% of the test teeth, indicated no evidence of dentin sclerosis. Forty-two, or 22% of the test teeth, indicated a sclerotic index of 1. Seventy-two or 38% of the test teeth indicated a sclerotic index of 2. Sixty-three, or 33% of the test teeth indicated a sclerotic index of 3.

VISUAL DENSITOMETRIC DATA

Table 1 shows the patients number, age, tooth designation, Time Interval, Visual Sclerotic Index and base material used.

C - calcium hydroxide methyl cellulose

CP - calcium hydroxide followed by a zinc
oxyphosphate cement

ZNO - Zinc oxide and eugenol

ZNO-C - calcium hydroxide followed by zinc
oxide and eugenol

* - No base (control)

*P - Zinc oxyphosphate cement

N - No sclerosis (control)

N.E. - No sclerosis (test)

TABLE 1
VISUAL DENSITOMETRIC DATA

SCLEROTIC INDEX

Postoperative X-ray Examination

Patient Number	Age Years	Tooth	Base Mat.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.
1	5	[D	C	2	7	2	14	3	22
		[E	C	2	7	2	14	2	22
		[D	C	1	7	1	13	1	21
		[E	CP	3	7	3	13	3	21
		[D	*			N	6	N	14
		[D	*					N	7
2	6	[D	C	1	10	2	16	2	23
		[C	C	2	11	3	16	*	24
		[E	CP	3	12	3	17	3	24
		[D	C	2	9	2	14	2	22
		[E	C	1	9	1	14	1	22
		[E	C	2	9	2	15	2	22
3	5	[D	*	N	9	N	15	N	22
		[D	C	2	9	2	15	2	26
		[E	C	2	9	2	15	2	26
		[D	C	2	8	2	14	2	26
		[E	C	2	8	2	14	2	26
		[D	*	N	8	N	13	N	25
4	6	[E	C	1	8	1	13	1	25
		[D	C	1	7	1	13	1	25
		[E	C	2	7	2	13	2	25
		[D	C	3	6	3	9	3	12
		[D	C	1	4	1	7	1	11
		[E	C	N.E.	4	N.E.	7	1	11
5	4	[D	C	1	4	1	7	1	10
		[E	C	1	4	1	7	1	10
		[D	*	N	7	N	15	N	22
		[E	*	N	7	N	15	N	22
		[E	C	1	7	1	15	1	21
		[D	*			2		N	7
6	4	[D	C			1	4	2	7
		[E	C			3	4	1	7
		[E	CP			3	5	3	7
		[D	C			3	5	3	7

TABLE 1 CONTINUED

Postoperative X-ray Examination

Patient Number	Age Years	Tooth	Base Mat.	Scir. Index	X-ray Int.	Scir. Index	X-ray Int.	Scir. Index	X-ray Int.
7	6	[E	CP			3	9	3	14
		D]	*			N	9	N	13
		E]	CP			3	9	3	13
8	8	E]	C			1	6	1	11
9	6	[E	C			1	10	1	19
		D]	C					1	9
		E]	*					N	9
10	9	[D	C	N.E.	6	N.E.	11	N.E.	18
		[E	C	3	6	3	11	3	18
		[D	*	N	6	N	11	N	18
		D]	*	N	5	N	11	N	17
		E]	C	1	5	1	11	1	17
11	3	[E	CP	2	2	2	8	2	13
		E]	C	2	1	3	8	3	12
		D]	C	3	1	3	8	3	12
		[D	*	N	0	N	7	N	12
		[E	*	N	0	N	7	N	12
		D]	*	N	0	N	7	N	12
		E]	*	N	0	N	7	N	12
12	5	[E	*	N	7	N	13	N	20
		D]	C	2	7	2	13	2	20
		E]	C	1	7	1	13	1	20
		[D	*	N	6	N	12	N	19
		[E	C	1	6	2	12	2	19
		E]	C	3	6	3	12	3	19
13	4	[D	C					2	10
		D]	C					1	9
		[E	C					2	9
		[D	C					1	9
14	6	E]	C					2	7
		D]	C					2	7
		[E	*					N	6
		[D	C					2	6

TABLE 1 CONTINUED

Postoperative X-ray Examination

Patient Number	Age Years	Tooth	Base Mat.	Scir. Index	X-ray Int.	Scir. Index	X-ray Int.	Scir. Index	X-ray Int.
15	8	[D	*			N	4	N	10
		[E	C			1	3	1	9
		D]	*			N	2	N	9
		D]	C			1	2	2	8
		E]	C			1	2	2	8
16	6	E]	C					3	14
17	6	[E	CP					2	6
		[E	C					2	5
		D]	C					1	5
		D]	C					1	5
		[E	*					N	5
		D]	C					1	5
18	5	E]	C					1	5
		[E	C					1	8
		[D	C					2	8
		D]	C					2	7
		E]	C					2	7
		D]	C					2	7
19	7	E]	C					2	7
		[D	ZNO-C					3	16
		[E	ZNO-C					2	16
		[E	CP					3	15
		D]	C					2	15
		D]	CP					2	14
20	3	E]	CP					2	14
		[E	*					N	6
		[D	*					N	8
		D]	C					1	8
		D]	*					N	7
		E]	CP					3	7
21	5	[E	CP					3	7
		[E	C			2	8	2	15
		D]	*			N	7	N	15
		E]	*P			N	7	N	15
		[E	C			1	7	1	15

TABLE 1 CONTINUED

Postoperative X-Ray Examination

Patient Number	Age Years	Tooth	Base Met.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.
22	3	D]	C	N.E.	10	1	19	2	26
		E]	*	N	10	N	19	N	26
		[E	*	N	10	N	19	N	26
		D]	C	2	9	2	16	2	25
		[D	*	N	7	N	16	N	23
23	6	[E	C					2	8
		E]	CP					3	8
		[E	C					1	7
		D]	C					3	7
		E]	C					2	7
24	6	[D	*			N	11	N	15
		[E	CP			2	11	3	15
		D]	*			N	11	N	14
		E]	*			N	11	N	14
		[E	*P			2	11	2	14
		[D	C					1	4
		D]	*					N	3
25	7	D]	C					3	12
		E]	CP					3	12
26	5	[D	*			N	9	N	15
		[E	C			1	9	1	15
		D]	*			N	9	N	15
		[E	C			1	9	2	15
		D]	*			N	9	N	15
		[E	*			N	9	N	15
		D]	*			N	8	N	15
		E]	*			N	8	N	15
27	5	E]	C	2	6	2	12	2	26
		[D	*	N	5	N	11	N	23
		[E	*	N	5	N	11	N	23
		D]	*	N	4	N	10	N	22
28	7	[E	C					3	8
		E]	C					2	8
29	4	[D	C					N.E.	8
		[E	C					2	8
		E]	C					2	8

TABLE 1 CONTINUED

Postoperative X-ray Examination

Patient Number	Age Years	Tooth	Base Mat.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.
30	3	[D	*					N	10
		[E	*					N	10
		D]	C					N.E.	9
		E]	*					N	9
		E]	*					N	9
31	4	[D	C					3	9
		[E	C					3	9
		[D	C					2	8
		[E	C					1	8
		D]	*					N	8
		E]	C					2	8
		D]	*					N	7
32	4	E]	*P					N	14
		[D	C			N	7	3	13
		[E	C			3	8	3	13
		E]	C			1	7	1	13
		D]	C			N.E.	6	N.E.	13
		E]	*			N	6	N	13
33	6	D]	*			N	11	N	14
		E]	C			1	11	1	14
		[E	C			2	11	2	14
34	10	E]	C	3	7	3	14	3	17
		[E	C	1	7	1	14	1	17
35	6	[E	CP					2	9
		[D	*					N	8
		E]	*					N	8
36	3	D]	C			2	11	3	24
		[D	*			N	11	N	24
		E]	*			N	11	N	23
		[E	*			N	12	N	24
37	6	D]	ZNO-C			3	8	3	11
		[E	CP			2	7	3	10
		[E	CP			2	6	2	9
		[D	*			N	6	N	9
		D]	C			3	6	3	8
		E]	C			2	6	2	8

TABLE 1 CONTINUED

Patient Number	Age Years	Tooth	Base Mat.	Postoperative X-ray Examination					
				Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.
38	7	[D	*	N	8	N	14	N	23
		[E	C	2	8	2	14	2	23
		[E]	C	3	14	3	23	3	25
		[D	C	2	13	2	22	2	25
		[E]	CP	3	12	3	22	3	24
39	7	[D]	C	1	9	2	13	2	23
		[D	*	N	8	N	14	N	22
		[E	*	N	8	N	14	N	22
		[E	*	N	8	N	13	N	22
		[E	*					N	3
		[E]	*					N	7
40	8	[D]	C			N.E.	13	N.E.	20
		[D	C			N.E.	13	N.E.	19
		[D]	*			N	12	N	13
		[E]	C			N.E.	12	1	18
41	6	[D	*	N	10	N	16	N	26
		[E	*	N	10	N	16	N	26
		[D]	C	3	9	3	15	3	25
		[E	*p	N	8	N	15	N	25
		[E]	*	N	8	N	15	C	25
42	5	[E	C			1	10	2	18
		[D]	*			N	10	N	17
		[E]	C			2	10	2	17
		[D]	*			N	8	N	16
		[E]	C			1	8	2	16
43	4	[D	C			1	8	2	15
		[E	CP			3	8	3	15
		[D]	C			3	7	3	15
		[E]	C			3	7	3	15
		[E]	*			N	7	N	14
		[D	*					N	6
44	5	[E	*	N	5	N	11	N	18
		[E]	*	N	4	N	10	N	18
		[D]	C	N.E.	7	N.E.	13	2	21
		[E]	*	N	7	N	13	N	21
		[D	*	N	7	N	13	N	20
		[E	*	N	7	N	13	N	20

TABLE 1 CONTINUED

Postoperative X-ray Examination

Patient Number	Age Years	Tooth	Base Mat.	Scir. Index	X-ray Int.	Scir. Index	X-ray Int.	Scir. Index	X-ray Int.
45	7	C]	C	3	8	3	10	3	13
		D]	C	2	7	2	9	3	11
		E]	C	2	6	2	9	3	11
		[C	C	2	6	2	9	2	11
		[D	C	3	6	3	9	3	11
		[E	C	2	6	2	9	2	11
46	8	[D	C	3	8	3	14	3	16
		D]	C	1	6	2	12	2	14
47	4	[D	*	N	13	N	18	N	23
		[E	*	N	13	N	18	N	23
		D]	cp	N	12	N	17	N	23
		E]	C	1	12	1	17	1	23
		[D	C	3	12	3	17	3	22
		[E	C	3	12	3	16	3	22
		D]	C	3	11	3	16	3	22
		E]	C	3	11	3	16	3	22
48	6	E]	C					1	6
		[E	C					N.E.	6
		[D	C					1	6
49	6	D]	C					1	8
		E]	*					N	8
		[D	C					N.E.	8
		[E	*					N	8
		D]	*					N	8
		E]	C					N.E.	8
50	6	[E	C			2	5	2	8
		E]	C			1	5	1	8
		D]	C			3	5	3	8
		D]	*			N	4	N	7
		[E	CP			2	4	2	7
51	7	[D	*	N	7	N	14	N	26
		D]	*	N	7	N	14	N	26
		D]	C	N.E.	6	N.E.	13	N.E.	25
		E]	C	N.E.	6	N.E.	13	N.E.	25
		[E	*	N	6	N	13	N	25

TABLE 1 CONTINUED

Postoperative X-ray Examination

Patient Number	Age Years	Tooth	Base Mat.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.
52	6	[D	*P	N	10	N	16	N	28
		D]	CP	2	10	2	14	3	27
		[E	*			N	12	N	18
		D]	*	N	6	N	11	N	18
		E]	C	N.E.	6	N.E.	11	N.E.	18
53	8	D]	C			1	8	2	16
		E]	C			1	8	1	16
		E]	*			N	8	N	16
		[D	*					N	7
		[E	*					N	7
		D]	*					N	7
54	7	[D	C	1	8	1	16	1	22
		[E	C	1	8	2	16	2	22
		[D	*	N	7	N	15	N	21
		[E	CP	1	7	1	15	2	21
55	5	[D	*					N	12
		[E	C					3	12
		D]	*					N	12
		E]						3	12
56	5	[E	*	N	8	N	14	N	18
		[D	C	3	7	3	13	3	16
		[E	C	N.E.	7	N.E.	13	N.E.	19
		D]	C	1	5	1	11	1	17
		E]	C	1	5	1	11	1	17
57	6	E]	C					1	15
		D]	*					N	15
		[D	*	N	13	N	18	N	23
		[E	*	N	13	N	18	N	23
		D]	*P	N	12	N	17	N	23
		E]	C	N	12	N	17	2	23
		[D	C	3	12	3	17	3	22
58	6	[E	C	2	12	3	16	3	22
		D]	C	3	11	3	16	3	22
		E]	C	3	11	3	16	3	22

TABLE 1 CONTINUED

Patient Number	Age Years	Tooth	Base Mat.	Postoperative X-ray Examination					
				Scrl. Index	X-ray Int.	Scrl. Index	X-ray Int.	Scrl. Index	X-ray Int.
59	3 1/2	E]	C			3	8	3	14
		[D	*			N	7	N	13
		[E	C			3	7	3	13
		[E	C			1	8	2	13
		E]	C			3	6	3	12
60	8	D]	*	N	1	N	2	N	3
		E]	C	N.E.	1	1	2	1	3
		[E	*	N	1	N	2	N	3
		[D	C	1	1	1	2	2	3
		E]	*	N	1	N	2	N	3
		D]	*	N	1	N	2	N	3
61	8	[E	*	N	11	N	17	N	28
		E]	C					3	11
62	6	[E	CP	N.E.	1	2	2	2	3
		[D	*	N	1	N	2	N	3
		[D	C	1	1	2	2	2	3
		E]	C	N.E.	1	1	2	2	3
		D]	C	N.E.	1	N.E.	2	1	3
		E]	C	N.E.	1	2	2	2	3
		D]	C	N.E.	1	N.E.	2	N.E.	3
				2	4	2	5	2	6
				N	4	N	5	N	6
				1e	4	2	5	2	6
				2	4	2	5	2	6
				1	4	2	5	2	6
63	7	D]	*			N	21	N	27
		E]	*P			N	21	N	27
64	4	[D	*			N	10	N	17
		[E	*			N	10	N	17
		D]	*			N	10	N	17
		E]	*			N	10	N	17
65	7	[E	*					N	8
		[D	*					N	8

TABLE 1 CONTINUED

Postoperative X-ray Examination

Patient Number	Age Years	Tooth	Base Mat.	Scrl. Index	X-ray Int.	Scrl. Index	X-ray Int.	Scrl. Index	X-ray Int.
66	5	[D	*			N	9	N	16
		[E	*			N	9	N	16
		D]	*			N	9	N	16
		E]	*			N	9	N	16
67	5	D]	*					N	6
		E]	*					N	6
68	4	[E	*	N	6	N	13	N	20
		[E	*			N	7	N	13
69	4	[D	*	N	6	N	12	N	20
		[E	*	N	6	N	12	N	20
70	7	D]	*	N	8	N	15	N	21
		E]	*	N	8	N	15	N	21
		D]	*	N	8	N	15	N	21
		E]	*	N	8	N	15	N	21
		[D	*			N	7	N	13
		[E	*			N	7	N	13
71	8	[D	*	N	8	N	14	N	22
		[E	*	N	8	N	14	N	22
		E]	*	N	7	N	13	N	20
72	6 1/2	[D	*	N	7	N	13	N	21
		[E	*	N	7	N	13	N	21
		D]	*	N	6	N	13	N	21
		E]	*	N	6	N	13	N	21
73	4	[E	*			N	7	N	15
		[D	*			N	7	N	15
		D]	*			N	6	N	14
		E]	*			N	6	N	14
74	4	D]	*			N	5	N	14
		[D	*					N	7
		[E	*					N	7
		E]	*					N	4
		[D	*					N	4

TABLE 1 CONTINUED

Postoperative X-ray Examination

Patient Number	Age Years	Tooth	Base Mat.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.	Sclr. Index	X-ray Int.
75	5	[E	*	N	8	N	14	N	22
		E]	*	N	8	N	14	N	22
		D]	*	N	7	N	13	N	22
		E]	*p	N	7	N	13	N	22
		[E	*p	N	7	N	13	N	21
		D]	*					N	8
		[D	*					N	8
		[E	*					N	7

SUMMARY OF VISUAL DENSITOMETRIC DATA

Table 2 summarizes the Visual Densitometric data of Table 1 indicating the number of teeth in each group, classified in the different visual sclerotic indices.

TABLE 2
SUMMARY OF VISUAL DENSITOMETRIC DATA

	No. of Teeth	No Sclerosis	Index 1	Index 2	Index 3
Group A (control teeth)	160	159		1	
Group B (test teeth)	191	14	42	72	63

**Figure 7: Evidence of Radiographic Sclerosis In A
Control Tooth**

A Sclerotic Index of 2 has been given to
the mesial pulp horn area of the mandibu-
lar left second deciduous molar. A zinc
oxyphosphate cement base was used.



INSTRUMENTAL DENSITOMETRIC DATA

INSTRUMENTAL DENSITOMETRIC DATA

Table 3 contains the data derived from the film image density measurements of the radiographs covering 115 deciduous teeth with the Elwood Crystal Densitometer. These data are a comparison between sclerotic indices as a measurement of dentin sclerosis and the instrumental densitometric measurement of the same areas. In the first two columns are the patient's number and age. The third column indicates the base material used beneath the alloy restoration as follows: (C) calcium hydroxide methyl cellulose; (P) zinc oxyphosphate cement; (CP) calcium hydroxide methyl cellulose followed by a zinc oxyphosphate cement base; (*) control tooth, no base material; (*P) control tooth with a zinc oxyphosphate base. The fourth column indicates the tooth upon which the operative dentistry was completed. The fifth, a triple column, the data of instrumental densitometric measurements and the percentage change of these measurements in the control teeth, designated as group a, without a calcium hydroxide methyl cellulose base. The sixth, seventh and eighth columns show respectively comparisons between the three sclerotic indices and the instrumental densitometric measurements with the percentage change of these two measurements. The visual sclerotic index and the densitometric measurements were obtained from the same tooth film images.

As a subheading of each of the fifth, sixth and seventh, and eighth columns one notes the following: Normal Dentin (Nor. Den.), the average densitometric readings in the unchanged dentin film area; Sclerotic Dentin (Sclr. Den.), the average densitometric readings in the sclerotic index area,; Percentage Change (% Chng.), the percentage

change between the unchanged (Nor. Den.) dentin and the sclerotic dentin (ScIr. Den.) densitometric average readings. This indicates the percentage of increased calcification of the sclerotic dentin area over the unchanged dentin area in the same tooth.

Table 4 is a summary of table 3 denoting a comparison between sclerotic indices and instrumental densitometric measurement arranged according to the absence or presence of a calcium hydroxide base. In the first column headed by cavity base, are found those teeth in the control group a without, and test group b with a calcium hydroxide base material. The second column visual sclerotic index, indicates the arbitrary classification of radiographic evidence of sclerosis as 0, 1, 2, 3. The third column, No. of teeth, is the number of teeth measured with visual sclerotic index and the Elwood Densitometer in each group. The third column shows the range of percentage change noted between the average instrumental density reading in the unchanged and sclerotic dentin areas in the same tooth, and the fourth column indicating the mean percentage change for each index.

The control group, in which no calcium hydroxide base was used, contained 29 teeth. These teeth showed no evidence of sclerosis: therefore, no sclerotic index when the clinical x-rays were examined. However, when these x-rays were measured with the densitometer, the percentage change was observed between dentin of the tooth and that approximating the cavity base where sclerosed dentin occurred when calcium hydroxide bases were used. These percent changes ranged between 0 and 20%. Of this group 22 teeth were at

0%, 5 teeth ranged from 3% to 8%, 1 at 14% and 1 at 20%, with a mean percentage change of 2%.

The test group b data is summarized in the lower part of the table. There were 86 teeth in this group which contained a calcium hydroxide methyl cellulose base. These teeth showed evidence of sclerosis when the clinical x-rays were examined and were arbitrarily classified as to sclerotic indices.

Under the classification Index 1, x-ray films of 25 teeth were measured with the densitometer. The percentage change between unchanged areas and areas of sclerosis ranged from 9 to 25%. Of this group 8 teeth ranged from 0 to 10%, 13 teeth ranged from 11 to 18%, and 4 teeth ranged from 20 to 25%, with a mean percentage change of 13%. Thirty-one teeth classified as Sclerotic Index 2 were measured densitometrically with the percentage change ranging from 15% to 50%. Of this group 1 tooth measured 15%, 6 teeth ranged from 25% to 31%, 18 teeth ranged from 33% to 43% and 6 teeth indicated a 50%, with a mean percentage change of 38%. There were 30 teeth under the classification of Sclerotic Index 3 that were measured densitometrically with the percentage change ranging from 50% to 125%. Of this group 7 teeth ranged from 50% to 52%, 13 teeth ranged from 55% to 78%, 3 teeth ranged between 80% to 83%, 4 teeth at a 100%, and 2 teeth between 112% and 125%, with a mean percentage change of 70%.

This data indicated that visual estimations and densitometric measurements of unchanged and sclerotic dentin can be correlated as follows:

Control: Increase of calcification of sclerotic dentin
ranged from 0% to 20%, with a mean of 2%.

Sclerotic Index 1: Increase of calcification of sclerotic
dentin ranged from 0% to 25%, with a mean of 13%.

Sclerotic Index 2: Increase of calcification of sclerotic
dentin ranged from 15% to 50%, with a mean of 38%.

Sclerotic Index 3: Increase of calcification of sclerotic
dentin ranged from 50% to 125%, with a mean of 70%.

INSTRUMENTAL DENSITOMETRIC DATA

Table 3 shows the patient's number, age, tooth which was measured and base material utilized beneath the restoration.

(C) calcium hydroxide methyl cellulose

(P) zinc oxyphosphate

(CP) calcium hydroxide methyl cellulose

followed by a zinc oxyphosphate cement

(*) no base

(Nor. Den.) average densitometric readings
in normal dentin

(Sclr. Den.) average densitometric readings
in sclerotic dentin

(% Chng.) percentage change between the average
densitometric readings for normal and
sclerotic dentin.

TABLE 3
INSTRUMENTAL DENSITOMETRIC DATA

Pat. No.	Age Yrs	Base	Tooth	Control			Index 1			Index 2			Index 3		
				Nor Den	Sclr Den	% Chng	Nor Den	Sclr Den	% Chng	Nor Den	Sclr Den	% Chng	Nor Den	Sclr Den	% Chng
1	5	C	[D							10	16	40			
		C	[E										12	22	83
		C	[D				12	14	17						
		CP	[E										14	26	100
		*	[D	14	16	14									
		*	[D	18	18	0									
2	6	C	[E							14	20	43			
		CP	[E										14	22	57
		C	[D							8	11	37			
		C	[E				12	15	25						
		C	[E							14	18	28			
		*	[D	16	16	0									
3	5	C	[D							8	12	50			
		C	[E							12	18	50			
		C	[D							6	9	50			
		C	[E							10	14	50			
		*	[D	10	12	20									
		C	[E				14	17	21						
		C	[D				6	7	17						
		C	[E							12	17	42			
4	6	C	[D										4	8	100
		C	[D				10	12	20						
		C	[E				14	16	14						
		C	[D				6	7	17						
		C	[E				16	18	12						
6	4	C	[D							14	20	23			
		C	[E				17	20	18						
		CP	[E										16	26	62
		C	[D										10	18	80
7	6	CP	[E										8	12	50
		*	[D	10	10	0									
		CP	[E				15	16	7						

TABLE 3 CONTINUED

Pat. No.	Age Yrs	Base	Tooth	Control			Index 1			Index 2			Index 3		
				Nor Den	Scir Den	% Chng	Nor Den	Scir Den	% Chng	Nor Den	Scir Den	% Chng	Nor Den	Scir Den	% Chng
11	3	CP	[E							14	20	43			
		C	E]										16	24	50
		C	D]										12	20	67
		*	[D	17	17	0									
		*	[E	22	22	0									
		*	D]	16	16	0									
		*	E]	22	22	0									
12	5	*	[E	8	8	0									
		C	D]							6	8	33			
		C	E]				8	8	0						
		*	[D	9	9	0									
		C	[E				7	8	14						
		C	D]										8	12	50
		C	E]										8	12	50
13	4	C	[D							10	14	40			
		C	D]				9	11	22						
		C	[E							18	25	39			
		C	[D				15	16	7						
17	6	CP	[E							14	20	43			
		C	E]							19	26	31			
		C	D]				12	14	17						
		C	D]				16	18	12						
		*	[E	26	26	0									
		C	[D				12	14	17						
		C	E]				25	28	8						
18	5	C	[E				12	13	8						
		C	[D							9	12	33			
		C	D]							6	8	33			
		C	E]							12	16	33			
		C	D]							8	12	50			
		C	E]							12	16	33			
25	7	C	D]										10	18	80
		CP	E]										20	30	50
31	4	C	[D										8	17	112
		C	[D										12	20	67
		C	[D							12	16	33			
		C	[E				16	17	6						

TABLE 3 CONTINUED

Pat. No.	Age	Base	Tooth	Control			Index 1			Index 2			Index 3		
				Nor Den	Sclr Den	% Chng	Nor Den	Sclr Den	% Chng	Nor Den	Sclr Den	% Chng	Nor Den	Sclr Den	% Chng
31	4	*	D]	12	12	0									
		C	E]							14	18	28			
		*	D]	17	17	0									
		*	E]	22	22	0									
32	4	*P	[E	31	32	3									
		C	[D										18	30	67
		C	[E										24	38	58
		C	E]				30	31	3						
		C	D]	20	21	5									
		*	E]	32	32	0									
43	4	C	[D				9	10	11						
		CP	[E										12	20	67
		C	[E	19	19	0									
		C	D]										6	10	67
		C	E]										10	16	60
		*	E]	19	19	0									
45	7	C	C]							13	15	15			
		C	D]										18	28	55
		C	E]										21	32	52
		C	[C							8	10	50			
		C	[D										12	19	58
		C	[E							20	28	40			
47	4	*	[D	12	12	0									
		*	[E	12	12	0									
		*P	D]	17	18										
		C	E]							17	24	41			
		crown C	[D												
		C	E]										10	22	125
		C	D]										9	16	78
		C	[E										9	18	100
59	3	C	E]										20	32	60
		*	[D	13	13	0									
		C	[E										20	31	55
		C	[E				22	24	10						
		C	E]										23	35	52

COMPARISON OF VISUAL SCLEROTIC INDEX
WITH INSTRUMENTAL DENSITOMETRIC DATA

Table 4 is a summary of table 5 containing a comparison between sclerotic indices and densitometric measurements arranged according to the absence or presence of a calcium hydroxide base material.

TABLE 4

COMPARISON OF VISUAL SCLEROTIC INDEX
WITH INSTRUMENTAL DENSITOMETRIC DATA

Cavity Base	Sclr. Ind.	No. of Teeth	Densitometric % Change Increased Sclerosis	Mean % Change
Group A (no calcium hydroxide)	0	22	0	2
		5	3-7	
		1	14	
		1	20	
Group B (with calcium hydroxide)	1	8	0-10	13
		13	11-18	
		4	20-25	
	2	1	15	38
		6	25-31	
		18	33-43	
		6	50	
	3	7	50-52	70
		13	55-78	
		3	80-83	
		4	100	
		2	112-125	

HISTOLOGIC EVALUATION DATA

HISTOLOGIC EVALUATION DATA

The data obtained from visual inspection and densitometrically from radiographs of deciduous teeth with a calcium hydroxide base material show increased density of the dentin or dentin sclerosis in the areas between the base material and the pulp. Since this is a microscopic observation and it is known that tissue changes take place only on a microscopic level, it was important that representative histologic sections of these same teeth be examined. Dentin in unaffected teeth was compared microscopically with dentin which is found beneath alloy restorations with and without zinc oxide eugenol bases and calcium hydroxide base material. This histologic sections were taken from teeth whose densitometric measurements are found in sections one and two of this thesis.

The teeth studied histologically were arranged in five groups as follows:

1. Normal Control: Three teeth were sectioned in which there was no evidence of dental caries, therefore, no operative dentistry was necessary. One type of section was made from each tooth. A ground horizontal, ground longitudinal and decalcified longitudinal section were examined.
2. Alloy Control: Four teeth were sectioned in which caries were noted. The extent of this caries was such that it was not necessary to place base material beneath the restoration. One ground section was made from each tooth. Two ground horizontal and two ground longitudinal sections were studied.
3. Zinc Oxide and Eugenol Base: Two teeth were sectioned

that were restored with an alloy restoration beneath which was placed a zinc oxide and eugenol base material. Both teeth were studied in ground longitudinal section.

4. Calcium Hydroxide Base: Ten teeth were sectioned that were restored with an alloy restoration beneath which was placed a calcium hydroxide methyl cellulose base. One section was made from each tooth except in one case where both a ground and decalcified section was made from the same tooth. There were four ground longitudinal, three ground horizontal and four decalcified longitudinal sections studied.

5. Calcium Hydroxide Base Failure: One tooth was sectioned that was restored with an alloy restoration beneath which was placed a calcium hydroxide base. The tooth was extracted due to evidence of a periapical abscess. This tooth was studied in ground longitudinal section.

NORMAL CONTROL GROUP

NORMAL CONTROL GROUP

In the normal control group (teeth with no evidence of caries or operative dentistry) ground horizontal, ground longitudinal or decalcified longitudinal sections were made. The first representative section was prepared from the I'E of patient 71, a female 11 years of age, which is illustrated in Figure 8. This was a normal tooth with no evidence of caries. (Figure 8a) No evidence of sclerosis is noted on either the clinical or post extraction radiographs of the tooth. The first step in the preparation of the ground histologic section was to remove some of the tooth surfaces by grinding in order to prepare a rectangular block of crown dentin. Removing the crown enamel and some dentin in this manner, made it possible to obtain, for purposes of orientation, a clearer radiograph of the dentin area approximating the cavity floor or the area from which the ground histologic section is to be made. This radiograph is shown in Figure 8b and no evidence of sclerotic dentin is seen. The ground mesial distal longitudinal section was prepared from the dentin block, through the pulp chamber and the unchanged dentin of the cavity base. The dentin block radiograph was utilized for localizing the area.

Figure 8c, (approximately 5 x magnification), shows the pulp chamber with a mesial and distal pulp horn and two incomplete root canals. The mesial pulp horn is sharply pointed, while the distal pulp horn is truncated. There is no area of translucent secondary dentin in either pulp horn. In the dentin just peripheral to the pulp, there is evidence of slightly altered dentin

that has been deposited since the eruption of the tooth. Also visible in the coronal dentin subjacent to the enamel fissure one notes two conical "reaction zones" in the dentin. A small area of enamel with a fissure is attached to the occlusal surface. There is cementum attached in the bifurcation and some transparent secondary dentin is noted surrounding the tooth canal.

The representative horizontal ground section in the normal control group was made from the E7 of patient D. H., a male 12 years of age. Clinically this was a normal tooth with no caries involvement and relatively normal root resorption. Radiographic examination indicates no evidence of caries or sclerosis (see Figure 9a).

Histologically a horizontal ground section through the crown of the tooth at the level just occlusal to the pulp horns was studied. Under low power microscopic examination one notes a normal arrangement of dentinal tubules in horizontal view (see Figure 9b). Transmitted light shows areas of relatively more translucent dentin at the right in the section one can see the small opening of the mesial pulp horn. The central circular translucent area when examined carefully under higher magnification shows numerous dentinal tubules cut in cross section (Figure 9x). This represents the area of the tooth over the distal pulp horn. The peripheral translucent area visible in the illustration shows under higher magnification tubules cut longitudinally.

Figure 8: Normal Control Group (ground longitudinal section)

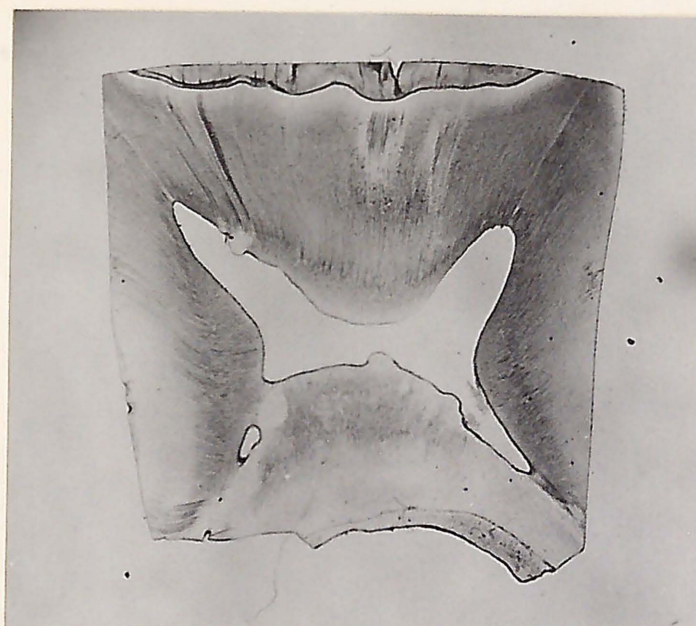
The section was made from the $\overline{1E}$ a female, 11 years of age. (a) indicates the pre-extraction radiographs, (b) dentin block radiograph and (c) a photograph of the section magnified 8 x.



a



b



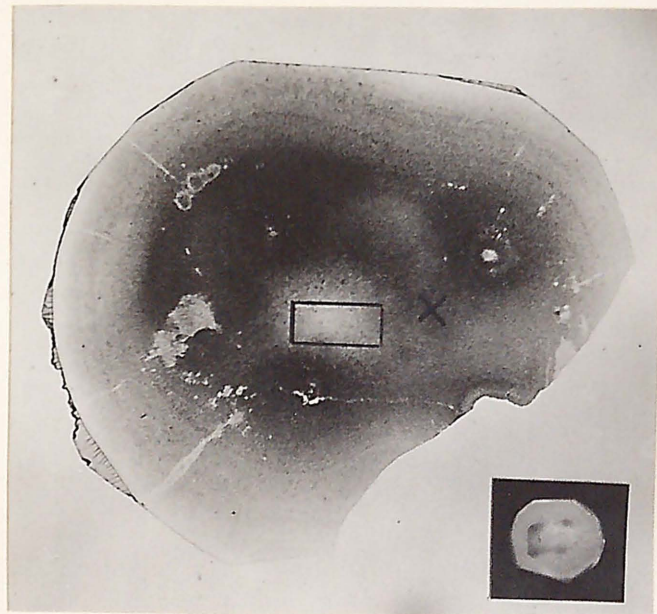
c

Figure 9: Normal Control Group (ground horizontal section)

The section was made from the E7, a male, 12 years of age. (a) indicates the pre-extraction radiograph, (b) a photograph of the section magnified 10 x with an insert radiograph of the dentin block, (x) the area described microscopically.



a



b

ZINC OXIDE AND EUGENOL BASE GROUP

ZINC OXIDE AND EUGENOL BASE GROUP

Two teeth in the zinc oxide and eugenol base group were examined microscopically. Both teeth were removed from a female, seven years of age. The first of these two teeth, (L.D. Figure 10), shows in the clinical radiograph that the tooth is involved with mesial occlusal distal caries of a medium depth (Figure 10a). The cavity was prepared in the usual manner and no pulp exposure was clinically evident. A zinc oxide and eugenol temporary restoration was placed. Seven days later a portion of the temporary restoration was removed allowing the remaining to act as base material. The cavity was completed with an alloy restoration. The tooth was extracted for study purposes near the time of normal exfoliation. This was twenty-three months after the restoration was initially inserted. (see Figures 10b and d which demonstrate the clinical postoperative radiographs)

The clinical bitewing radiographs showed no evidence of sclerosis when examined at ten, sixteen and twenty-two months after the restoration was completed. However, the radiograph of the dentin block, preliminary to making a ground section, showed a sclerotic index of 1 at the distal axial pulpal wall. (Figure 10c)

A ground mesial-distal longitudinal section through the pulp chamber of the crown of the tooth was studied, histologically. One notes in Figure 10e, which is magnified 10 x, that the mesial pulp horn is larger than the distal pulp horn which is open toward the occlusal surface. This was opened during grinding of the section. The dentin to the left of the distal pulp horn (Figure 10x) shows nothing significant at the magnification illustrated. However, at higher magnifications there is a layer of secondary dentin along the

margins of the pulp chamber. This section shows no evidence of histologic change in the exact corresponding area of sclerosis noted in the x-ray of the dentin block in Figure 10c. The second tooth in this group showed no dentin sclerosis radiographically and normal primary dentin histologically.

Figure 10: Zinc Oxide Eugenol Base Group (ground longitudinal section)

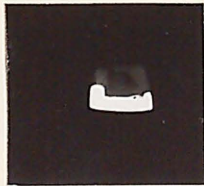
The section was made from the D₁ of a female, seven years of age. (a) indicates the preoperative radiograph, (b) radiograph of the extracted tooth. (Note there is no evidence of dentin sclerosis beneath the distal axial pulpal wall of the preparation.) The radiograph of the dentin block is at (c). One notes evidence of dentin sclerosis at the distal axial pulpal wall of the preparation. The irregular sclerotic dentin area observed radiographically and described microscopically is noted at (x) in the photograph (e) which is an illustration of the ground section magnified 10 x.



a



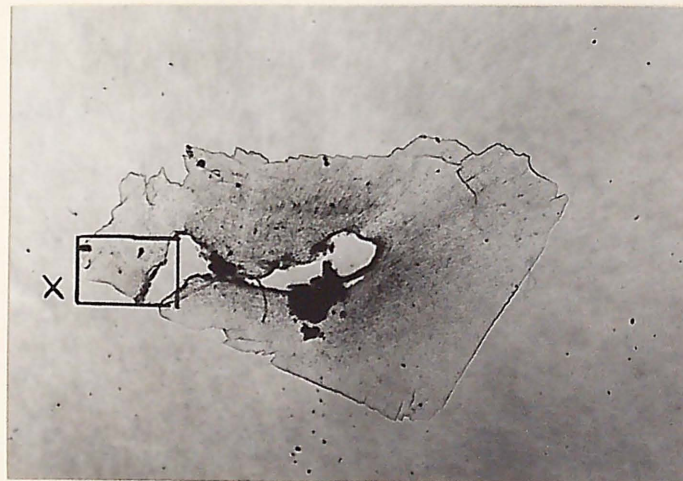
b



c



d



e

ALLOY CONTROL GROUP

ALLOY CONTROL GROUP

Four teeth in the alloy control group were examined histologically. A representative description of one of these sections, the I'E extracted from patient 61, a female, ten years of age, is as follows: (see Figure 11). Clinical examination indicates caries involvement of the mesial, occlusal, and distal surfaces. The cavity was prepared in the usual manner and restored with an MOD restoration, without the use of any base material. The tooth was extracted for study purposes, twenty-eight months after the restoration was completed. Periodic radiograph examination exhibited no evidence of sclerosis after eleven, seventeen and twenty-eight months. Figure 11a demonstrates the pre-extraction radiograph, (Figure 11b) the post-extraction radiograph and (Figure 11c) the radiograph of the dentin block.

A horizontal ground section through the crown of the tooth, at the level just occlusal to the pulp horns, was studied histologically. Figure 11d, a photograph of the section magnified 12 x indicates a patch of recurrent caries, yellow in color, at the distal surface. Under low power microscopic examination one finds an area of secondary dentin surrounding the distal pulp horn in which the dentinal tubules are cut in both cross and transverse section. There seems to be a reduction of the number of dentinal tubules surrounding the area overlying the pulp horns. (Figure 11dx)

The mesial-occlusal does not involve this area of secondary dentin that were observed in the four teeth in the alloy control group. No evidence of markedly irregular secondary dentin was observed. Radiographic examinations of all the teeth in this group

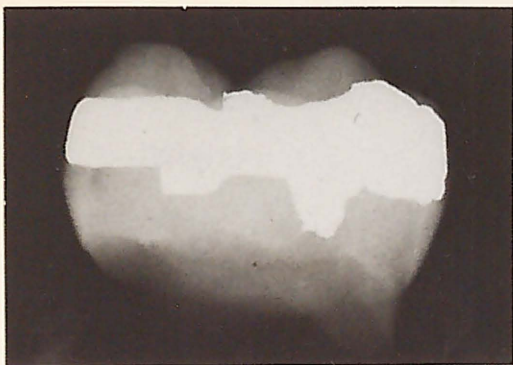
indicate no evidence of sclerotic dentin.

Figure 11: Alloy Control Group (ground horizontal)

The section was made from the E⁷ of a female, ten years of age. The pre-extraction radiograph, (a) post-extraction radiograph, (b) dentin block radiograph, (c) indicate no evidence of dentin sclerosis. Photograph (d) of the section studied magnified 12 x, within which area (x) is described microscopically. The teeth illustrated in Figures 11 and 12 were extracted from the same patient.



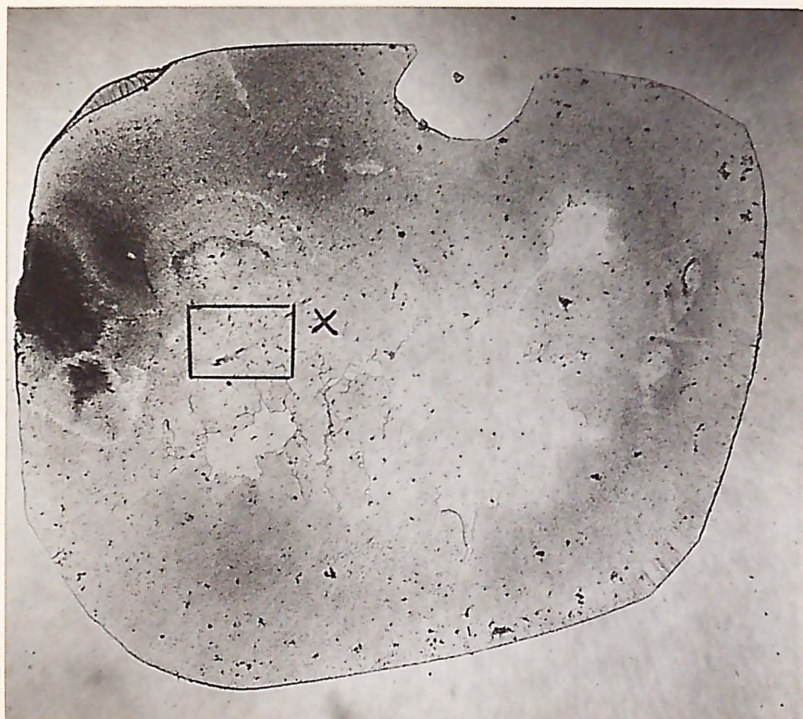
a



b



c



d

CALCIUM HYDROXIDE BASE GROUP

CALCIUM HYDROXIDE BASE GROUP

Ten teeth in the calcium hydroxide base group were examined in ground horizontal, ground longitudinal and decalcified longitudinal sections. The first section studied was the E7 obtained from patient 61, a female, ten years of age. (see Figure 12) The illustration for the alloy control group was obtained from the same patient. (see Figure 11) Clinical examination of the E7 notes mesial occlusal distal caries involvement that does not require a base material. All caries was removed and an MOD cavity preparation was completed with an alloy restoration. Seventeen months later the distal lingual cusp was noted to be fractured and involved cariously. (Figure 12a) A distal occlusal lingual preparation was completed and all caries was removed. No pulp exposure was noted although the cavity can be classified as a near exposure at the distal axial pulpal wall. A calcium hydroxide base material was placed at that point and the alloy restoration completed. The tooth was removed for study purposes eleven months after the last restoration, which was near the time of normal exfoliation.

Radiographic examination eleven months after the distal restoration was completed indicated a large area of sclerotic dentin, with a sclerotic index of 3, in the area of the calcium hydroxide base material. The mesial occlusal restoration exhibits no evidence of sclerosis after being in place twenty-eight months. (Figure 12b) Figure 12c demonstrates the post-extraction radiograph and Figure 12d illustrates the radiograph of the dentin block.

Histologically a horizontal ground section through the crown of the tooth, at the level just occlusal to the pulp horns, was

studied. There is a small hole approximately 1 mm. in diameter distal lingual to the mesial cavity preparation which is the mesial pulp horn. See Figure 12e which is magnified 12 x the size of the section.

Microscopic low power examination notes that the mesial cavity preparation is in primary dentin with the dentin tubules in this area cut in cross and tangential section. There is evidence of secondary dentin formation immediately beneath the cavity preparation and surrounding the pulp horn hole. The secondary dentin noted in this area was fairly regular. This illustrated in (Figure 12f) a high power photomicrograph of the mesial area (12y). Distal to the mesial pulp horn hole one finds a large amount of secondary dentin. At the margins of the distal cavity, the area in which radiographically one notes extreme sclerosis, the dentinal tubules are seen mostly in cross section, however, some tangential sections are in the field. There is an extreme reduction in the number of dentinal tubules in this area in comparison to other areas of the section. This is noted as markedly irregular dentin. Figure 12g, which is a high power photomicrograph of the distal area (12x) demonstrates this.

Figure 13 is an illustration of a longitudinal ground section of a tooth in the calcium hydroxide base group. This E₁ was extracted from patient 38, a male, nine years of age. Clinical radiographic examination shows an extensive defective mesial alloy restoration with occlusal distal caries involvement. (see Figure 13a) All of the alloy and the caries beneath it was removed. The cavity was prepared as an MOD. There was no pulp exposure. A calcium hydroxide methyl cellulose base material was placed against the

mesial axial pulpal wall, following which the alloy restoration was superimposed in the usual manner. The tooth was extracted, for study purposes, twenty-five months after the restoration was placed. Figure 13b demonstrates the pre-extraction and (Figure 13c) illustrates the post-extraction radiograph. The area of section was determined from the dentin block radiograph (Figure 13d) and the plane of section illustrated in photograph (Figure 13e). Preoperative radiographic examination indicated a defective mesial restoration with occlusal and distal involvement (Figure 13a). The mesial surface seems to indicate a near exposure. The postoperative bitewing radiographic examinations at fourteen, twenty-three and twenty-five months notes an estimated sclerotic index of 3 between the mesial pulpal surface and the cavity floor (Figure 13b).

A ground buccal lingual longitudinal histologic section, approximately 10 microns in thickness, was studied. The section shows a circular 1 mm. hole in the buccal side and an intact pulpal wall on the lingual side. There is a patch of enamel over the lingual occlusal corner of the section. Figure 13f shows the section magnified about 12 x. Under low power one notes an occlusal cavity preparation in primary dentin. The intact pulpal wall on the lingual side is made up of secondary or irregular dentin. Some of the dentinal tubules in this area are in cross section and others in tangential section. There is a definite diminution of dentinal tubules in this area. (Figure 13x) One notes on the lingual margin of the circular space some slightly stained primary dentin. It is assumed that this area represents the sclerosis seen in the clinical radio-

graph at the base of the cavity. The yellow stain seen in the section is from the carious lesion

A decalcified section was studied in the same tooth and plane at the above, but through the pulp chamber. Microscopically one notes a pulp tissue that is free from pathology. Within the pulp tissue there are three or four true denticles.

Figure 12: Calcium Hydroxide Base Distally and No
Base Mesially (horizontal ground section)

The section was made from the E⁷, a female, ten years of age. The clinical radiograph noting distal lingual caries is at (a) A sclerotic index of 3 is noted beneath the distal occlusal replaced restoration eleven months after the restoration was placed, with a calcium hydroxide base. The post-extraction (c) and dentin block (d) radiographs clearly illustrate the dentin sclerosis at the distal. A 12 x magnification of the section (e) with (x) the distal sclerosed area is illustrated as a high power photomicrograph (g). The mesial alley control area (y) is illustrated in the high power photomicrograph (f).



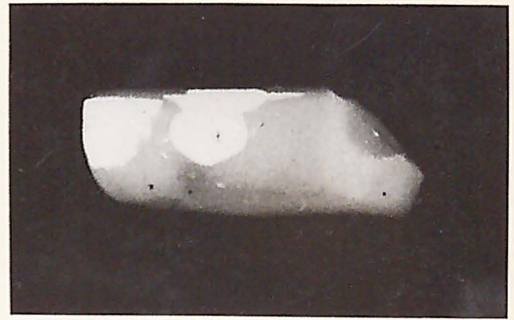
a



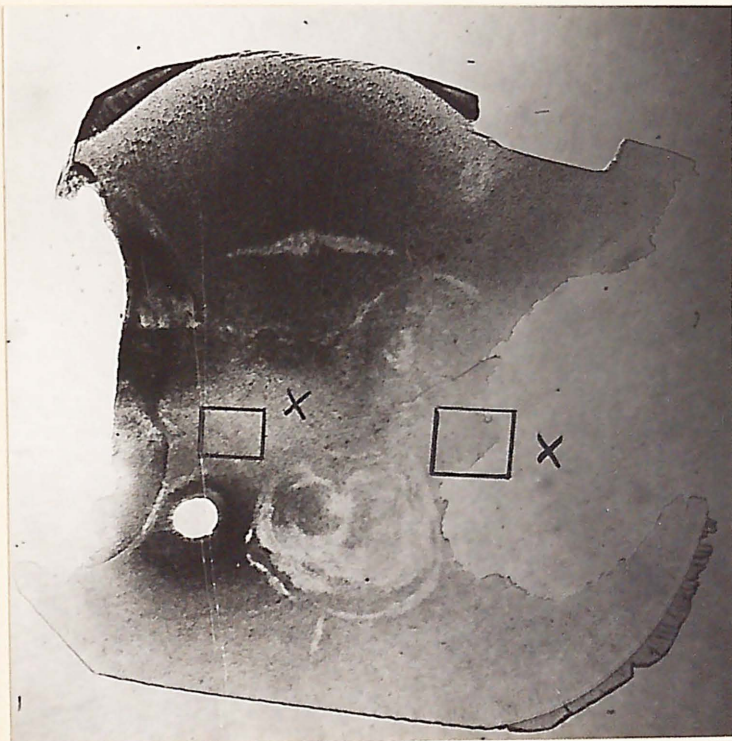
b



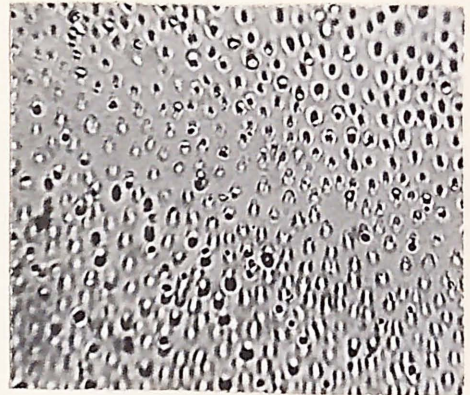
c



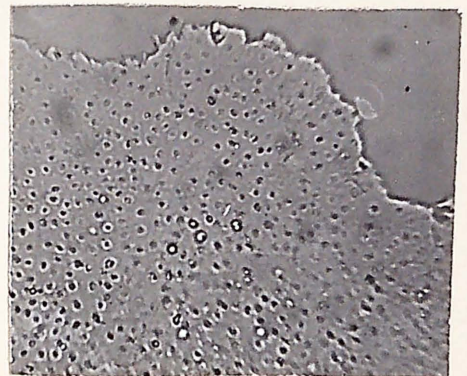
d



e



f



g

Figure 13: Calcium Hydroxide Base Group (ground and decalcified longitudinal sections)

The section was made from the E₁ of a male, nine years of age. The preoperative radiograph at (a) the postoperative radiograph at (b) which indicates a sclerotic index of 3 at the mesial axial pulpal wall. The postoperative radiograph (c) and dentin block (d) were used to localize the plane of section at (e). The photograph of the section (f) is magnified 9 x with (x) indicating the area of irregular sclerotic dentin described microscopically.



a



b



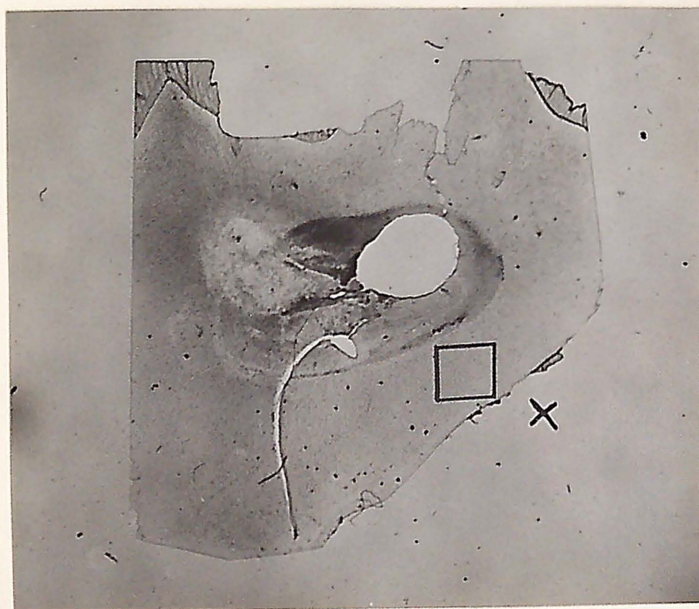
c



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e



f

CALCIUM HYDROXIDE BASE GROUP WITH NO SCLEROSIS

CALCIUM HYDROXIDE BASE GROUP WITH NO SCLEROSIS

Radiographic examination of all teeth in the calcium hydroxide base group indicated sclerotic indices of 2 or 3 except two teeth extracted from the same patient 40, D $\overline{1}$ and $\overline{1}$ D. A description of the section prepared from one of these, namely D $\overline{1}$, of a female, ten years of age, is illustrated in Figure 14. Clinical radiographic examination notes a distal occlusal caries involvement with a near exposure at the distal axial pulpal wall. (Figure 14a) The cavity was prepared and restored using a calcium hydroxide base material at the distal axial pulpal wall followed with an alloy restoration. The tooth was removed for study purposes near it's normal exfoliation date twenty-two months after the restoration was placed. Radiographic examination at thirteen and twenty months indicates no evidence of sclerotic dentin. (Figure 14b) No evidence of radiographic sclerosis is noted on the post-extraction radiograph of the tooth (Figure 14c) or on the radiograph of the dentin block. (Figure 14d)

A horizontal ground section through the crown of the tooth, at the level just occlusal to the pulp horns, was studied histologically. There is a small patch of enamel at the distal buccal margin of the cavity. Two round areas which are the mesial lingual and mesial buccal pulp horn can be found. See Figure 14e which illustrates the section magnified 12 x.

Microscopic low power examination of the pulp horn areas shows that the dentinal tubules are viewed both in cross and tangential section. The presence of secondary dentin is noted. Upon examination of the distal axial pulpal wall where calcium hydroxide base material was placed, one notes that the dentinal tubules are

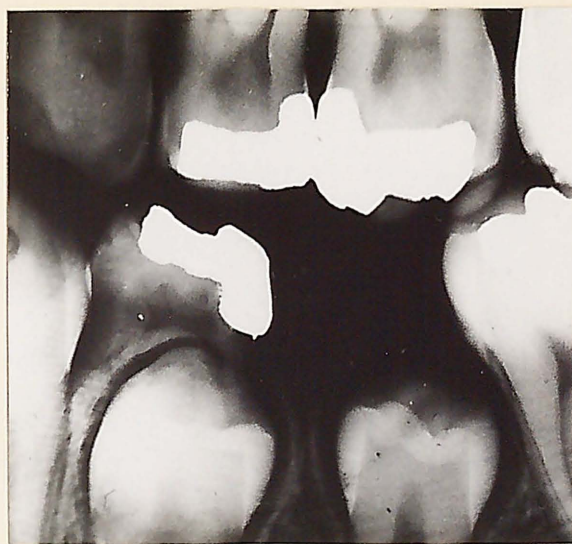
viewed in cross section and is immediately impressed with the reduction in the number of dentinal tubules in the field. Although this area did not appear radiographically as a sclerotic area.

**Figure 14: Calcium Hydroxide Base Group With No
Evidence Of Radiographic Sclerosis
(ground horizontal section)**

The section was made from the D7 of a female, ten years of age. The preoperative radiograph (a) the postoperative radiograph (b) post-extraction radiograph (c) and dentin block radiograph (d) indicate no radiographic evidence of dentin sclerosis at the distal axial pulpal wall where the calcium hydroxide base was placed. The photograph of the section (e) is magnified 12 x with (x) indicating the area of sclerotic dentin described microscopically.



a



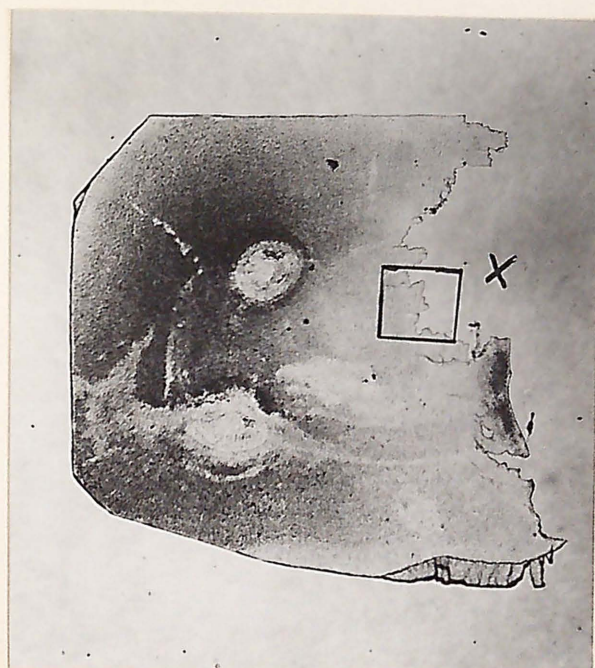
b



c



d



e

CALCIUM HYDROXIDE BASE GROUP FAILURE

CALCIUM HYDROXIDE BASE GROUP FAILURE

One tooth in which a calcium hydroxide base was used failed due to a periapical abscess. The tooth D¹ was extracted from patient 47, a male, seven years of age. Clinical radiographic examination notes a caries involvement of the mesial occlusal and distal surfaces with the distal caries providing a near exposure. (see Figure 15a) All the caries was removed in preparing an MOD cavity. A calcium hydroxide base was placed at the distal axial pulpal wall followed by an MOD alloy restoration. The tooth was symptom free, other than after thirty-one months was removed due to a periapical abscess. Radiographic examinations at eleven, sixteen and twenty-two months exhibited evidence of sclerosis which was estimated as a sclerotic index of 3. It was noted also that a pulp stone had formed in the distal pulp horn (Figure 15b). A dentin block was formed and radiographed (Figure 15c) in order to establish the plane of section through the sclerosed area.

A ground mesial distal longitudinal section of the crown through the pulp chamber of the tooth was studied histologically. The section shows the pulp chamber with a mesial and distal pulp horn. The mesial pulp horn is larger and, there is debris within it. Figure 15d is an 11 x magnification of the section. Low power examination reveals that the cavity preparation is principally within the primary dentin, however it cuts through areas of secondary dentin at one point in the occlusal and distal surfaces. There is an extensive amount of secondary dentin formation along the entire pulp chamber and into both root canals. The mesial pulp

horn opposite the mesial cavity preparation has a bulge of secondary dentin in which there is a definite reduction of dentinal tubules.

Upon examining the area which appears radiographically as sclerosis one notes that the dentin of the mesial pulpal axial wall appear highly irregular particularly as to the number of dentinal tubules present. (Figure 15dx) There are remnants of reaction zones along this margin. An attempt to correlate these reaction zones with the radiographic evidence of sclerosis noted in Figure 15b, was not successful.

In view of the preceding histological examination, the sclerotic dentin areas seen radiographically cannot be correlated with the histological picture. The histologic picture, in the area of the calcium hydroxide base, shows a markedly irregular secondary dentin, characterized by a definite diminution of dentinal tubules, with an increased amount of dentin matrix. These changes could have taken place as a result of age, caries or cavity preparation.

Figure 15: Calcium Hydroxide Base Group Failure
(ground longitudinal section)

The section was made from the D1 of a male, seven years of age. The preoperative radiograph (a) postoperative radiograph (b) and dentin block radiograph (c) was given a sclerotic index of 3 at the distal axial pulpal wall. The photograph of the section (d) is magnified 11 x with (x) indicating the area of irregular sclerotic dentin described microscopically.



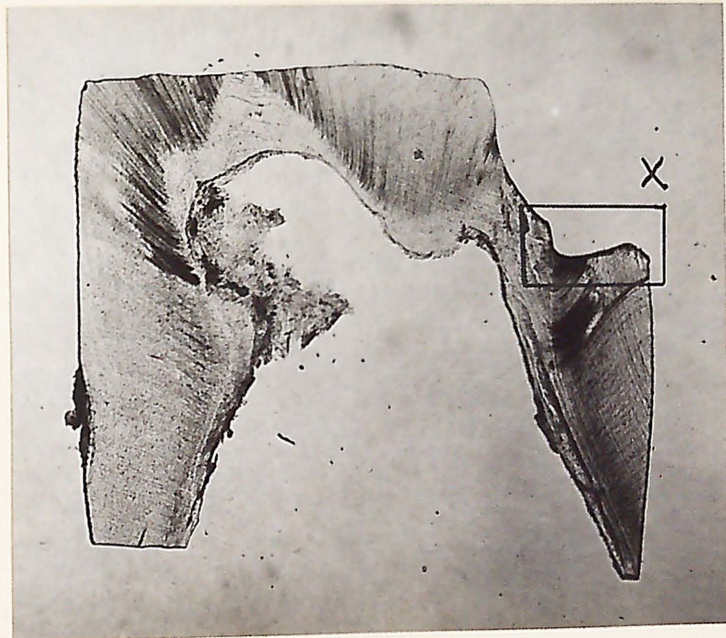
a



b



c



d

DISCUSSION

DISCUSSION

The data in the preceding sections show that a calcium hydroxide methyl cellulose base material will stimulate the production of sclerotic dentin in deciduous teeth. There was radiographic evidence of dentin sclerosis in 93% of the instances in which this material was applied to the base of cavities. Cavities in which no base material was utilized, exhibited no radiographic evidence of dentin sclerosis in 99% of the teeth examined.

A general indication of the range of intensity of the calcification of sclerotic dentin is presented. The Instrumental Densitometric data shows that dentin beneath the calcium hydroxide base material may represent increased dentin calcification as high as 125%. Without a base material there were only a few instances of sclerosis where the greatest intensity was only 20%. The data therefore shows sufficient evidence, considering all factors, to make one believe that a calcium hydroxide base material clinically effects and enhances the production of sclerotic dentin.

The sclerotic dentin areas seen radiographically beneath the calcium hydroxide methyl cellulose base material cannot be correlated with the histological sections of these teeth. Microscopic examination shows that this area of radiographic sclerosis is markedly irregular sclerotic dentin characterized by a definite diminution of dentinal tubules, with an increased amount of dentin matrix. These changes could have occurred as a result of age, caries, or cavity preparation.

From time to time there has appeared, in the dental literature, claims as to the recalcification of carious dentin. In this

study all carious dentin was removed previous to placing the calcium hydroxide base material. There is no doubt that the "white area" seen radiographically beneath the base material is an area of sclerosis of the existing dentin and not an area of recalcification of carious dentin.

The clinical phase of this study presented many variables which one was unable to adequately control. During the operative procedures it was not feasible to control the depth of the cavity due to the differences of extent of dental caries in each tooth. This problem evolved itself more prominently in selecting an adequate control for this study. One should realize that the control teeth cavity preparations are usually not as deep as those containing a calcium hydroxide base. The clinical decision of whether or not a base material should be used in a cavity, may depend on a difference in depth of as little as one half a millimeter. An ideal control would be a cavity preparations of the same depth, however, placing an alloy restoration without a base material where it was indicated, would not be good clinical dental practice. To somewhat overcome this situation cases were selected containing both control and test teeth. Differences in the depth of the cavity preparations between control and test teeth could introduce an appreciable error.

The arbitrary classification of Sclerotic Index 0, 1, 2 and 3 by viewing the radiographs, brings to ones attention the human error. During the classification there is no question as to the presence or absence of the radiographic evidence of sclerotic

dentin. However, the differences in density between Index 1 and Index 2 also between Index 2 and Index 3 could at times, be questioned. This human error is of importance only to the point to which the data is to be used. It is of primary interest to know whether or not calcium hydroxide base material effects the production of sclerotic dentin and also whether the material enhances this phenomenon. Therefore the fact that in this study, the presence of the calcium hydroxide base material is consistently associated with x-ray evidence of sclerotic dentin, about which there is no error.

The application of an accurate measuring device such as the Elwood Densitometer to measure clinical radiographs, leaves much to be desired. The errors over which there is no control are due to the technique used. No attempt was made to closely standardize the exposure time, focal distance, developing technique and angle of exposure. Actually under clinical operating conditions this would be an improbable task. Another factor of extreme importance in x-ray densitometry is the variable thickness of tooth structure the rays must penetrate. Since each deciduous tooth varies in thickness and the dimensions of all teeth differ, the comparison of one part of a tooth with another or with different teeth can only provide relative measurements.

This method of measurement was used because there was no other alternative. The method, however inaccurate, does give some indication of the degree of dentin sclerosis enhancement or resistance that a calcium hydroxide base would stimulate in dentin.

Plans have already been formulated to further investigate this problem more accurately in the laboratory, by utilizing microradiographic techniques of some of the sections in this study. It is hoped that we may gather information as to exactly where in the dentin this calcification takes place and to what degree.

The practical clinical application of this information is that a calcium hydroxide methyl cellulose base material should be used in deciduous teeth cavity preparations and in all probability permanent tooth preparations. Kronfeld¹ states that the dentin of deciduous teeth is structurally identical with that of the permanent teeth, except that it is thinner in keeping with the smaller size of the deciduous teeth. The production of sclerotic dentin and its enhancement by the use of a calcium hydroxide base material would be of value in protecting the pulp tissue from fluids (Fish¹⁶) and dental caries, (Beust³ and Bodecker²¹).

SUMMARY

SUMMARY

Seventy-five children in the early mixed dentition stage with operative dentistry completed on 351 deciduous teeth were observed from four to twenty-eight months with periodic bitewing radiographs taken at intervals of from four to ten months. These cases contained 191 deciduous teeth in which a calcium hydroxide methyl cellulose base material was used beneath the alloy restoration (test teeth) and 160 deciduous teeth in which no base material was utilized beneath the alloy restoration (control teeth). Radiographic examinations indicated that 93% of the (test teeth) containing a calcium hydroxide base material gave radiographic evidence of sclerosis beneath the area of the base material. One also notes that 99% of the deciduous teeth without a calcium hydroxide base material (control teeth) indicated no radiographic evidence of sclerosis.

A densitometric evaluation was made of the bitewing radiographs of 115 deciduous teeth utilizing the Elwood Densitometer. The results of this radiographic densitometric evaluation indicate a localized increase of dentin sclerosis ranging from 0% to 125% in teeth containing a calcium hydroxide methyl cellulose base material. Densitometric evaluation of deciduous teeth that did not have a calcium hydroxide methyl cellulose base material indicated an increase of dentin density immediately below the restoration that ranged from 0% to 20%.

Histologic examinations of both ground and decalcified sections were made of twenty teeth. The sections indicated that the sclerotic areas seen radiographically beneath the calcium hydroxide base material cannot be correlated with the histological picture.

CONCLUSIONS

CONCLUSIONS

1. Calcium hydroxide methyl cellulose base material stimulates and enhances the production of sclerotic dentin in deciduous teeth.
2. The sclerotic dentin areas seen radiographically, beneath the calcium hydroxide methyl cellulose base material, cannot be correlated with the histologic changes. These changes could have taken place as a result of age, caries, or cavity preparation.
3. It can be assumed that dentin sclerosis, which appears as a "white area" radiographically, is a hypercalcification of the existing primary dentin, and not a recalcification of carious dentin.
4. This study reemphasizes the fact that dentin sclerosis is a response to an external stimulus.

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ABSTRACT

THE ASSOCIATION BETWEEN DECIDUOUS
DENTIN SCLEROSIS AND CALCIUM
HYDROXIDE METHYL CELLULOSE BASE
MATERIAL

Arthur Irving Klein, D.D.S.

THE ASSOCIATION BETWEEN DECIDUOUS DENTIN SCLEROSIS
AND CALCIUM HYDROXIDE METHYL CELLULOSE BASE MATERIAL

Seventy five children in the early mixed dentition stage with operative dentistry completed on 351 deciduous teeth were observed from 4 to 28 months with periodic bitewing radiographs taken at intervals of from 4 to 10 months. These cases contained 191 deciduous teeth in which a calcium hydroxide methyl cellulose base material was placed beneath the alloy restorations (test teeth) and 160 deciduous teeth in which no base material was utilized beneath the alloy restorations (control teeth). In each instance all carious dentin was removed before the base material or restoration was completed.

A visual densitometric evaluation utilizing sclerotic index, which is an estimation of the occurrence and intensity of dentin sclerosis by inspection of bitewing radiographs. This evaluation indicates that 93% of the test teeth gave evidence of dentin sclerosis beneath the area of calcium hydroxide base material while 99% of the control teeth showed no radiograph evidence of dentin sclerosis.

An instrumental densitometric evaluation was made of the projected bitewing x-ray film images of 115 deciduous teeth utilizing the Elwood Densitometer. The results of this evaluation indicate a localized increase of dentin sclerosis, or dentin calcification, ranging from 0% to 125% in the test teeth, immediately beneath the calcium hydroxide base material. The control teeth showed an increased dentin density range of from 0% to 20% immediately beneath the alloy restoration.

Histologic examination, both ground and decalcified sections, were made of 20 deciduous teeth with and without calcium hydroxide methyl cellulose base material beneath their alloy restorations.

The sections indicated that the sclerotic areas seen radiographically beneath the calcium hydroxide base material cannot be correlated with the histologic picture. Microscopically this shows a markedly irregular secondary dentin characterized by a definite diminution of dentinal tubules, with an increased amount of dentin matrix. These changes could have taken place as a result of age, caries or cavity preparation.

From the results of this research it is apparent that a calcium hydroxide methyl cellulose base material is effective in the production of sclerotic dentin in deciduous teeth. There is no doubt that the "white area" seen radiographically is an area of sclerosis of the existing dentin and not an area of recalcification of carious dentin.