

PERIODONTICS

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INFLUENCE OF PERIODONTAL DISEASE ON THE DENTAL PULP

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INTRODUCTION

ALTHOUGH there have been many studies relating pulpal changes to local factors, such as operative procedures, sterilizing agents, filling materials, and pulp-capping materials, and a number relating pulpal changes to systemic disturbances, such as vitamin deficiencies, endocrinopathies, and developmental disturbances, few have attempted to study the relationship between the periodontium and the pulp. Because the nerves and blood vessels which supply the pulp must first pass through periodontal tissues, there arises the question of whether changes in the periodontium exert any influence on the histophysiologic condition of the pulp.

The primary purpose of this investigation was to study the influence of periodontal disease on the dental pulp.

REVIEW OF LITERATURE

Classification of Periodontal Diseases.—The etiology and pathogenesis of periodontal diseases have been studied extensively, but much remains to be known. There are differences of opinion among researchers as to the causative agents of periodontal disturbances. There is little uniformity in nomenclature or classification. Orban¹ suggested the following classification of periodontal diseases:

1. Inflammatory
 - A. Gingivitis
 - B. Periodontitis
2. Regressive
 - A. Gingivosis
 - B. Periodontosis
 - C. Periodontal atrophy
 - D. Periodontal traumatism
3. Productive

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Influence of Periodontal Disease on the Dental Pulp.—Cahn² maintained that the close proximity of the periodontal and pulpal tissues in the region of the apical foramen exposes the pulp to contamination and infection from diseased periodontal tissue. "The spread of infection by continuity of tissue is a fact too universally acknowledged to be disputed." An infective process arising in a periodontal pocket can spread along the periodontium to the apex, resulting in pulp involvement. The changes that Cahn reported in the pulps of periodontally diseased teeth included interstitial calcifications, round-cell infiltration, fibrosis, and fatty and hyaline degeneration. He stated that most of these teeth yielded positive bacterial cultures. His report gives no indication of the severity of the periodontal disease, and it is therefore impossible to correlate the reported pulpal changes with the severity of the disease.

Henrici and Hartzell³ studied the pulps of forty-four vital teeth in various states of health. They cracked each tooth open with bone-cutting forceps and dropped it into Zenker's fixative solution. The pulps were then stripped out and embedded in paraffin. The pulpal changes fell into two classes: (1) inflammatory cellular infiltrations and (2) secondary or degenerative changes, including fibrosis, calcifications, and fat accumulations. "The fatty changes which we observed are not fatty degenerations or infiltrations, but deposits of fatty tissue of an adult type in areas of the pulp tissue . . . and the tissue presenting the areolar appearance of fat tissue as it occurs in other parts of the body. We have found no description of this condition and cannot explain it."

Bauchwitz⁴ studied the pulps of twenty-five human teeth which had been loosened by periodontosis and found that they looked much different from the pulps of normal teeth. He grouped the examined teeth according to changes found in the pulps. The following stages could be observed:

1. Widening of arteries, hyperemia of capillaries, beginning compression of the veins; cell nuclei normal; no atrophy of the connective tissue.
2. Widened, slackened arteries; compressed, filled veins; beginning destruction of capillaries; beginning reticular changes; disappearance of cell nuclei.
3. Connective tissue completely degenerated; advanced reticular changes; nuclei disappeared, capillaries completely collapsed; venous congestion with disintegrated, discolored thrombi.

Bauchwitz⁴ re-emphasized what he claimed to have proved in his previous experiments, namely, that diffusion did take place from the periodontium into the contents of the root canal. Since he did not precisely describe the status of the periodontiums of these teeth, it is impossible to determine whether any relationship existed between the changes in the pulps and the severity of periodontal disease.

Brammer⁵ maintained that reticular atrophy in the dental pulp may be caused by (1) external stimuli (fillings, abrasion, fracture of alveolar process, cysts and tumors in vicinity of roots) and (2) collateral hyperemia, which takes place in advanced periodontal disease. The changes noted in the pulp chamber were vacuoles, small areas of bleeding, and, infrequently, denticles. In the root

canals were found interstitial calcifications and an increase in fibrous elements. In all cases an increase in the size of blood vessels was noticeable. Brammer was of the opinion that atrophic changes begin either in the odontoblastic layer or around the small blood vessels.

Brammer⁵ did not indicate how many teeth or patients he observed in his experiments, and he did not group the teeth according to severity of periodontal disease. Because of this, no correlation of periodontal disease with changes found in the pulps is possible.

Craney⁶ regarded periodontal disease not as a localized phenomenon but, rather, as a result of changes in the general state of health by which a local indisposition was created. He expressed the opinion that the hyperemia found in almost all cases of periodontal disease was caused by the inflammatory process in the alveolus and that this played a special role in the atrophy of the pulp. Twenty-five teeth used for his study were divided, according to the Sachs-Neumann (1920) classification, into three groups. In Group 1, about one third of the alveolar bone was resorbed. Craney examined seven teeth of this group, from four patients, and found partly degenerative, partly productive changes. Normal pulp tissue was found in the root canal. The pulp tissue, however, seemed to be looser; fibrils were more pronounced; the odontoblasts were increased in number, stained darker, and were arranged in multicellular layers (hyperplasia). Weil's zone was still noticeable in some areas. Inter- and intra-odontoblastic vacuoles were present. The fibers and fibrils seemed to come to the foreground of the picture and were more visible than the cellular elements. In Group 2, half of the alveolar bone was resorbed. There were nine teeth, from six patients, in this group. Odontoblasts were fairly well preserved; Weil's zone had almost completely disappeared. Denticles, interstitial calcifications, and secondary dentine were present; atrophy had progressed further, the cells were fewer, and the fibers were greater in size and number than in Group 1. An extraordinarily fine network of fibers could be seen in the pulp. In Group 3 were the most advanced cases. There were nine teeth, from six patients, in this group. The odontoblastic layer was interrupted by vacuoles. Formation of denticles and predominance of fibers indicated a degenerative-atrophic process in the pulp. The formation of secondary dentine was of special importance as far as the configuration of the pulp was concerned. External stimuli of chemical, toxic, or infectious nature seemed to have caused the pulp to increase its defensive activity. Craney concluded that, although it could be stated that the changes in the pulp are in no way responsible for the development of periodontal disease, "we have to admit the reverse—some influence of pyorrhea on the pulp. This influence, however, is not a constant or regular one."

Sauerwein⁷ attempted to determine to what degree a relationship exists between dystrophic and dystrophic-inflammatory periodontal conditions and degenerative changes in the pulp. He collected 154 teeth extracted because of periodontal involvement. To eliminate the influence of age on the pulp, the teeth were collected from patients not more than 50 years of age. Sauerwein states that 15 per cent of the pulps contained interodontoblastic vacuoles, indicating atrophy of the odontoblasts; 39 per cent showed reticular degeneration, espe-

cially in the pulp chamber; and 46 per cent showed advanced reticular degeneration which reached partly into the root canal. He was of the opinion that the reticular degeneration of the pulp was not necessarily a sequel of periodontal disease. It could be caused also by obstruction of the nutritional channels by denticles or pseudocysts, as well as by such exogenous irritants as thermal stimuli acting on the unprotected necks of the teeth or toxins from periodontal pockets or interdental spaces. He stated further that, on the basis of a considerable amount of material, it had been proved that the state of the pulp could be completely independent of the kind and extent of the periodontal disease. His illustrations showed that the pulp did not necessarily reflect the severity of the periodontal disease and that the reticular degeneration and atrophy of the pulp were not necessarily among the regular findings in cases of periodontosis.

This review shows that the influence of periodontal disease on the dental pulp was approached from different angles by different investigators. None of the investigations was conducted according to the rules of controlled experiment. The diseased teeth were collected and examined histologically, and the findings were recorded. One does not know whether the changes were limited to the diseased teeth or whether they could be observed also in other teeth, not periodontally involved, from the same patient.

It was hoped that an investigation conducted under better-controlled conditions could throw additional light on the influence of periodontal disease on the pulp.

METHODS AND MATERIALS

This study consists of two parts.

Part I, Survey Series.—One hundred six caries-free teeth were collected from twenty-six patients, 19 to 70 years of age, diagnosed on the basis of clinical examination as having severe periodontosis.

TABLE I. RELATION OF PULPAL CHANGES TO THE SEVERITY OF PERIODONTAL DISEASE

PERIODONTAL DISEASE GROUP	AMOUNT OF ROOT EXPOSED	NUMBER OF TEETH	PULPAL CHANGE			
			MILD	MODERATE	SEVERE	VERY SEVERE
I	0 to $\frac{1}{4}$	37	7	26	4	—
II	$\frac{1}{4}$ to $\frac{1}{2}$	46	21	21	3	1
III	$\frac{1}{2}$ to $\frac{3}{4}$	14	4	8	1	1
IV	$\frac{3}{4}$ to 1	9	3	4	—	2
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The teeth were classified on the basis of bone loss and root exposure, as seen in roentgenograms (Table I). Those in which one fourth or less of the root was exposed were placed in Group I. Those with one fourth to one half of the root exposed were put into Group II. Teeth with one half to three fourths of the root exposed composed Group III. Group IV consisted of teeth in which three fourths or more of the root was exposed.

The extracted teeth were fixed in 10 per cent neutral formalin, decalcified in ethylenediaminetetraacetic acid (EDTA), and embedded in celloidin. Sec-

TABLE II. RELATION OF PULPAL PICTURE TO PERIODONTIUM IN TEETH FROM SAME PATIENT
(SURVEY SERIES)

PA- TIENT	RACE	SEX	AGE	NUMBER OF TEETH	PERIODONTAL DISEASE GROUP					PULPAL CHANGES			
					I	II	III	IV		MILD	MOD- ERATE	SEVERE	VERY SEVERE
1	Negro	F	19	2				2		1	1		
2	Negro	M	29	4	1		3			1 2			1
3	Negro	F	33	7	2		3	1		2 3 1 1			
4	Negro	M	33	2				2		1	1		
5	Negro	M	34	10	3		3	2		1	2 3 1 2		1
6	White	M	35	2	2						2		
7	White	M	42	6	3		3				3 2	1	
8	White	F	43	3			1	2		1			2
9	White	M	43	9	4		4	1		1 2	3 2 1		
10	Negro	F	43	6	2		4			2	2 2		
11	White	M	45	6	2		4			1 4	1		
12	Negro	M	46	8	4		3	1			4 3 1		
13	Negro	F	50	2	1					1 1			
14	Negro	M	51	11	1		10			6	1 4		
15	White	M	53	1	1						1		
16	Negro	F	61	5			3	2			3 2		
17	Negro	M	61	6	1		2	3			1 2	2 1	
18	Negro	M	62	9	9						5	4	
19	White	M	64	3	1		2			1	1		
20	Negro	M	69	3			3			2	1		
21	White	M	70	1			1				1		

tions were made at 12 microns and stained with hematoxylin and eosin or Mallory's triple connective tissue stain. They were then examined histologically.

Part II, Paired Control Series.—The control series consisted of twenty-two teeth from four patients, 39 to 50 years of age (Table II). Patients selected for this series had some teeth which were periodontally involved and somewhat fewer homologous teeth on the other side of the arch, or on the same side but in the opposite jaw, with a periodontium which was clinically and radiographically normal. The teeth selected were free of caries and unfilled. The teeth were x-rayed, then extracted, and placed in 10 per cent neutral formalin. After fixation, they were decalcified in a solution containing equal volumes of 50 per cent formic acid and 20 per cent sodium citrate and embedded in celloidin. They were sectioned at 12 microns and stained with hematoxylin and eosin and with Mallory's triple connective tissue stain, and the sections were examined histologically.

FINDINGS

Classification of Pulpal Changes.—The morphologic changes observed in the pulps were classified as mild, moderate, severe, and very severe. None of the teeth examined showed a normal pulp.

Mild changes: In the pulp chamber, the multicellular layer of odontoblasts was well preserved, with only occasional vacuoles between the cells. The intercellular ground substance was slightly condensed, with a slight increase in the number of fibrous elements in some pulps. The cells were normal in number and appearance; blood vessels were abnormally prominent; capillaries were abnormally numerous; and venules were abnormally large. Occasionally, small denticles were present (Fig. 1).

In the root canal, the odontoblasts were present in a layer two to three cells thick, although more numerous vacuoles were present than in the chamber. The odontoblasts were better preserved in the root canals than in the pulp chambers of many teeth. The pulp tissue was "compressed" slightly, with some increase in fibers.

Moderate changes: The odontoblasts were replaced in many areas by vacuoles (Fig. 2). There were cysts near and in the pulpal horns. In the root portion of the pulp, hyperemia was pronounced. The fibrous elements of the pulp were significantly increased in number (Fig. 3). The fine reticular network of ground substance was more pronounced, and the denticles were more numerous and larger. In the root canal, interstitial calcifications were present.

Severe changes: The odontoblasts in the pulp chamber were entirely replaced, in most cases, by vacuoles. The odontoblastic layer was intact in only an occasional specimen. In some areas reticular degeneration was evident. The cells were pyknotic. The ground substance, especially in the root portion, stained more intensely. Hyperemia was prominent. In the root canal, the pulp contained either vacuoles or

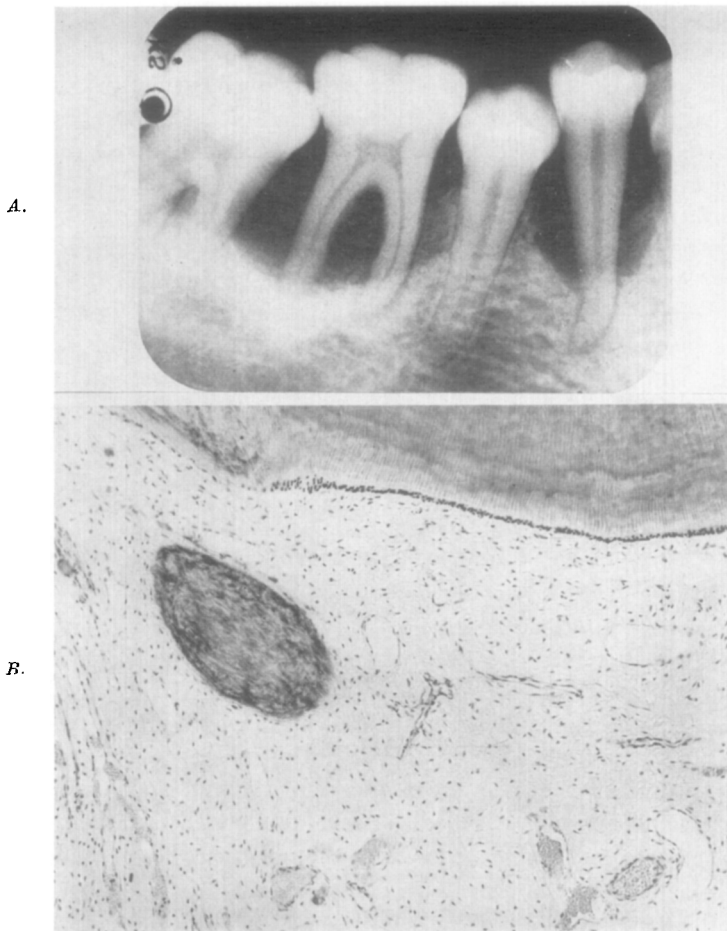


Fig. 1.—A, Roentgenogram of the lower right first molar of a 19-year-old female patient. Note that more than three-fourths of the roots are denuded of bone (Group IV). B, Photomicrograph of pulp of tooth shown above. Note calcification in an otherwise normal pulp. Pulpal changes were classified as very mild.

cysts and showed reticular degeneration or extensive interstitial calcification.

Very severe changes: In these specimens pulpal degeneration was complete; none of the structures were recognizable. In some instances, the entire pulpal chamber and parts of the root canal were filled with calcified masses.

Secondary dentine was not included in the foregoing descriptions given, for it was not specifically associated with any of the changes described. It was present in various amounts in all groups.

Periodontal Disturbances and Pulpal Changes.—In the first survey series no relationship was observed between the amount of exposed root and the changes in the pulp (Table I). In each of the four periodontal disease groups there was practically a full array of pulpal changes, from mild to most severe, including complete pulpal degeneration and/or calcification.

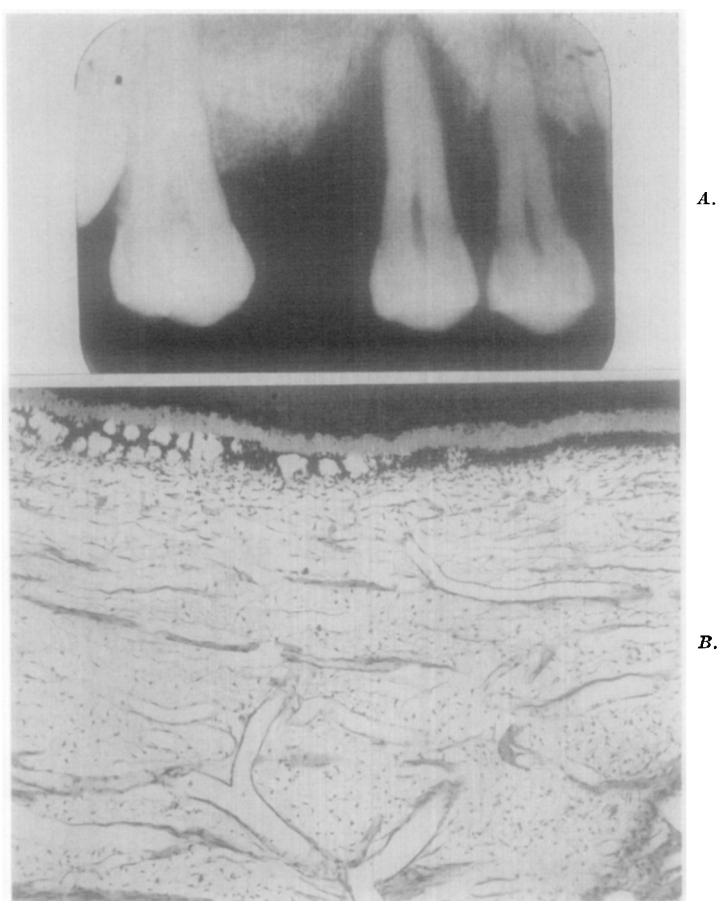


Fig. 2.—A, Roentgenogram of an upper right second premolar with practically no bony support (Group IV) in a patient 34 years of age. B, Photomicrograph of pulp of same tooth showing moderate amount of degenerative change.

When the teeth of the same patient were grouped together and examined, to correlate the degree of periodontal disturbance with the changes in their pulps (Table II), it was found that (1) there was no correlation between the severity of periodontal disease and the pulpal changes and (2) the pulps of the teeth, regardless of periodontal involvement, presented very similar pictures. Analysis of the paired control series confirmed both points mentioned above (Table III). In addition, Table III shows that in a given patient *the teeth with normal periodontium showed the same pulpal changes that were found in the periodontally involved teeth.*

This study indicates that morphologic changes in the pulp are not related to changes in its periodontium.

The finding of very similar pulpal changes in all the teeth of a given patient, even when the status of the periodontium differed and the states of attrition and eruption were different, suggests that changes in the pulp were more directly related to the systemic condition of the patient than to the local environment. Since none of these pulps was "normal" but showed various de-

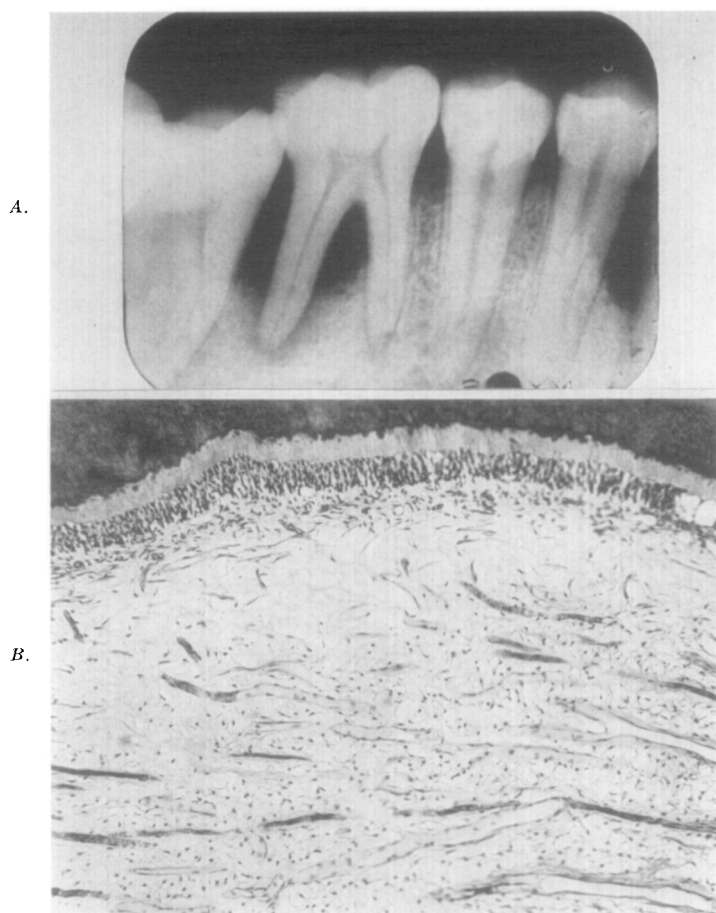


Fig. 3.—A, Same patient as in Fig. 2. Roentgenogram of lower right second premolar showing less than one-fourth bone loss from root. B, Photomicrograph of the pulp of this tooth, also showing moderate amount of degenerative change. Note similarity of pulp pictures in Figs. 2 and 3: zone of Weil absent; slight increase in fibrous elements; slight hyperemia; vacuoles in odontoblastic layer. All teeth in this patient showed essentially similar pulpal changes in spite of great differences in the severity of periodontal disease.

degrees of change, it is also suggested that the adult pulp might be affected by the systemic condition of the patient long after formation of the dentine is completed. Furthermore, the series of paired controls suggests that *the structural morphology of the pulpal tissue is peculiar to the individual person, no matter what the status of the periodontium*. In this series correlation with systemic conditions of the patient, as suggested by Glickman and Shklar,⁸ could not be made.

DISCUSSION

The results of this study indicate that there is no correlation between periodontal involvement of the teeth and their pulpal changes. This finding does not corroborate the opinions of Cahn,² Henrici and Hartzell,³ and Bauchwitz.⁴ The pulpal changes that Brammer⁵ found in periodontally involved teeth correspond

TABLE III. RELATION OF PULPAL PICTURE TO PERIODONTIUM IN TEETH FROM SAME PATIENT
(PAIRED CONTROL SERIES)

PA- TIENT	RACE	SEX	AGE	NUM- BER OF TEETH	PERIO- DONTIUM NORMAL	PERIODONTAL DISEASE GROUP				PULPAL CHANGE			
						I	II	III	IV	MILD	MOD- ERATE	SEVERE	VERY SEVERE
1	Negro	F	50	6	2	2	1		1				2
													2
													1
													1
2	Negro	F	39	7	2		1			1	1		
								2		1		2	
									2	1	1		
3	Negro	F	40	5	1		2			1			
								2		1			1
										2			
4	Negro	F	49	4	2		1			2		1	
									1	1			

rather closely to the pulpal changes observed in this study. Since Brammer failed to indicate the severity of periodontal disease, the influence of the periodontal disease on pulpal changes in his series cannot be assessed. The findings of Craney⁶ would agree with ours, but Craney concludes that "some influence of pyorrhea on the pulp must be admitted because of the proximity of pulpal and periodontal tissues in the apical region." He added that "this influence, however, is not a constant or regular one." Such an influence of periodontal disease on the pulp is not in agreement with findings of the present investigation.

The results of our study are in complete agreement with the findings of Sauerwein.⁷ His conclusions that "the state of the pulp could be completely independent of the kind and extent of the periodontal disease" and that "the pulp did not necessarily reflect truly the severity of the periodontal disease" coincide completely with our observations.

Etiological Factors in Pulpal Changes.—The dental pulp, like any other connective tissue of the human body, will react when stimulated. The type and result of this reaction depend upon the character, intensity, and duration of the stimulus. Caries, operative procedures, or medicaments placed in cavities will cause the pulp to react defensively. In our investigation, the changes observed in the pulps cannot be attributed to local irritants, since none were present. The selected teeth were unfilled and free of caries.

Age, per se, cannot be regarded as the causative factor in the pulpal changes observed.^{9, 10} Table II, arranged according to the chronologic age of the patients, does not indicate that any correlation exists between age and changes in the pulp. The changes found in the pulps of older patients are not further advanced or more severe than those seen in young patients.

It is generally accepted that pulpal changes may occur if more than half the thickness of the enamel is abraded. Since the teeth used in this study showed

minimal amounts of attrition, this factor cannot be regarded as the cause of the changes observed in the pulp.

Periodontal Disease and Pulpal Changes.—Periodontal disturbances can occur at any age, although they are more prevalent after the age of 45. Fig. 1 shows a roentgenogram of teeth in a 19-year-old patient. There was very extensive resorption of alveolar bone in the area of the lower right first molar (Group IV). In spite of this, the changes in the pulp were minimal. Were it not for calcifications, the pulp could be classified as normal.¹¹

This investigation disproved any influence of the periodontal disease on the pulpal tissue of the involved teeth, which has been claimed by some authors, and confirmed the theory that the pulpal changes are independent of the status of the periodontium. In addition, this study showed that the pulpal structures of teeth from the same patient are similar, regardless of the degree of severity of periodontal involvement. Even the teeth with normal periodontium, used in this study as controls, showed changes similar to those found in periodontally involved teeth. Here, however, it must be remembered that the teeth were placed into different periodontal groups on the basis of roentgenographic findings. The amount of resorption of alveolar bone was taken as a criterion of the severity of periodontal disease and as the factor which determined the periodontal group into which the particular tooth was to be placed. The periodontium was not available for histologic examination. It can be assumed that much more information could be gained if both periodontium and pulpal tissue were present on the same histologic slide.

SUMMARY AND CONCLUSIONS

The influence of periodontal disease on the pulp was studied in two groups of teeth.

Survey Series.—One hundred six periodontally involved teeth were collected from patients 19 to 70 years of age. The teeth were divided, for the purpose of analysis, into four groups according to the severity of periodontal disease. The severity of periodontal disease was determined by the amount of root exposed as shown in the radiographs. In Group I one fourth or less of the root was exposed; in Group II one fourth to one half of the root was exposed; in Group III one half to three fourths of the root was exposed, and in Group IV more than three fourths of the root was exposed. After routine histologic preparations, the teeth were sectioned labio- or buccolingually.

Paired Control Series.—Twenty-two teeth from four patients 39 to 50 years of age were collected. Seven of these teeth with normal periodontiums served as controls. Fifteen teeth with periodontal involvement were divided into four groups in the same way as the teeth of the survey series. All teeth were subjected to routine histologic preparation, sectioned labio- or buccolingually, and examined microscopically.

This analysis showed no relationship between severity of periodontal disease (as expressed by the amount of exposed root) and changes in the pulp. In each group of periodontally diseased teeth and in the control teeth, a full range

of pulpal changes, from mild to severe, was found. This analysis suggests that the status of the periodontium does not exert any great influence on the pulp.

It was found that the teeth from the *same patient* showing a wide variety of periodontal involvements had pulps that were *histologically same or similar*. The pulpal condition could vary from almost normal to one of advanced degeneration. These changes could not be related to age per se. It is suggested that the systemic condition of the patient may have a greater influence on the condition of the pulp than does the status of the periodontium or his chronologic age.

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