EFFECTS OF ACUTE FEBRILE DISEASES ON THE PERIODONTIUM OF RHESUS MONKEYS WITH REFERENCE TO POLIOMYELITIS

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A GREAT number of systemic diseases have been listed as contributing to, or even causing the occurrence of periodontal disease.[1, 4, 23] Acute febrile diseases have been considered to be important in the pathogenesis of periodontal disease, especially since Gottlieb[11, 12] described diffuse atrophy of the alveolar bone in a young man who died of influenza. Talbot[41] noted as early as 1899 an association between eruptive fever and impairment of the periodontal tissues. Acute febrile diseases have been mentioned as part of the complex of systemic diseases which might cause periodontal disease.[3, 5, 29] Patients frequently recall soreness of the teeth, gingival tenderness, and hemorrhage which have occurred during an attack of acute febrile disease. They therefore associate elevation of temperature as an initiating factor in periodontal disease.

No studies have been reported in which the gingival conditions were observed before, during, and after attacks of acute febrile disease. The theory of a relationship between this group of diseases and periodontal disease has therefore been built upon the history obtained from patients, clinical assumption, and mainly on a vague general concept of an influence of systemic disease on the metabolism and vitality of the periodontal tissues.[21, 38] Little is known of the nature of specific tissue vitality, tissue response, and tissue resistance related to systemic disease,[7] thus a general conclusion pertaining to the periodontium is of questionable value. Experimental investigations of the periodontal tissues during the course of acute febrile disease have not been reported previously.

The opportunity for an investigation of this problem was provided at the University of Michigan School of Public Health where work was done on experimentally-produced poliomyelitis in rhesus monkeys. This disease produced a high fever of a limited duration. In rhesus monkeys the morphology and physiology of the periodontium and the masticatory movements are essentially the same as in human beings. It has furthermore been established that the oral bacterial flora of rhesus monkeys is the same as the flora of the human mouth.[2] The monkeys were kept on a well-balanced human diet.

Nineteen rhesus monkeys were utilized as experimental animals and seven other healthy monkeys, exposed to the same environmental and dietary conditions, were used as controls. Only monkeys which at necropsy had no

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evidence of tuberculosis and were comparatively free of animal parasites were included in this report. The pre-experimental gingival condition varied from normal to severe gingivitis. Color photographs and gingival biopsies were taken before the poliomyelitis virus inoculation. The temperature of each animal was recorded daily, and at the same time their mouths were inspected. The monkeys lived from five to sixteen days following the virus inoculation and had high temperatures for from one to ten days (Table I).

TABLE I

MONKEYS WITH POLIOMYELITIS*

MONKEY NO.	AGE (YEARS)	CLINICAL DIAGNOSIS GINGIVA BEFORE THE EXPERIMENT	DAYS FROM POLIOMYELITIS INOCULATION TO DEATH	DAYS WITH FEVER TEMP. ABOVE 104° F.	MICROSCOPIC PERIODONTAL FINDINGS
1898	3½	Mild gingivitis	16	4	Mild chronic gingivitis
1989	2½	Normal	9	4	Normal gingiva
1988	3	Normal	12	4	Mild chronic gingivitis
1987	2½	Mild gingivitis	9	5	Mild chronic gingivitis
1986	2½	Normal	16	4	Normal gingiva
1985	2½	Normal	9	4	Mild chronic gingivitis
1984	2½	Mild gingivitis	16	4	Mild chronic gingivitis
1983	2	Mild gingivitis	7	3	Mild chronic gingivitis
1982	2	Mild gingivitis	7	2	Mild chronic gingivitis
1981	3	Mild gingivitis	7	1	Normal gingiva
1927	2	Mild gingivitis	14	10	Mild chronic gingivitis
1932	2	Mild gingivitis	10	9	Mild chronic gingivitis
1928	2	Normal	10	5	Very mild chronic gingivitis
1933	2	Gingivitis	6	2	Mild chronic gingivitis
1919	3½	Mild gingivitis	10	8	Mild chronic gingivitis
1916	2	Normal	10	8	Mild chronic gingivitis
1920	3	Mild ulcerating gingivitis	8	4	Mild erosive gingivitis
1912	2	Mild ulcerating gingivitis	5	2	Mild erosive gingivitis
1910	3½	Normal	5	4	Normal gingiva

*All dental roentgenograms were negative. No clinical nor histological periodontal changes during the disease.

When the animals reached a moribund stage they were sacrificed and a necropsy was performed. Gross findings were recorded, photographs and dental roentgenograms taken, and models of their teeth were made. Specimens for microscopic study were taken from jaws, teeth, temporomandibular joints, mesial end of one tibia, and from the following visceral organs: lung, peribronchial and mesenteric lymph nodes, stomach, liver, kidney, spleen, adrenals, and pancreas. Hematoxylin and eosin stains of sections were utilized for examination of all of the tissues. Heidenhain's modification of Mallory's connective tissue stain was used to study sections of jaws and joints to determine the presence of changes in collagen fibers. Such chances, if present, would possibly be helpful in an attempt to explain eventual lowered periodontal resistance as the result of disease with acute high fever. The seven control animals were sacrificed and examined in the same way as the experimental animals.

FINDINGS AND INTERPRETATIONS

The case reports are summarized in Table I. Visceral changes typical of high fever were observed in all of the experimental animals: acute passive congestion of the lungs and spleen, degenerative fatty infiltration of the liver (verified by fat stain), cloudy swelling of the kidneys, catarrhal gastritis and colitis, and edema of peribronchial and mesenteric lymph nodes were present. Spinal cord sections showed evidence of poliomyelitis.

Gingival changes could not be observed clinically during the experimental period, nor did histopathologic examination of specimens, taken before and at the ultimate stage of the disease, show structural changes in the periodontium. A slight increase of materia alba on the teeth was observed in the terminal stage in a few animals. An additional number of monkeys with

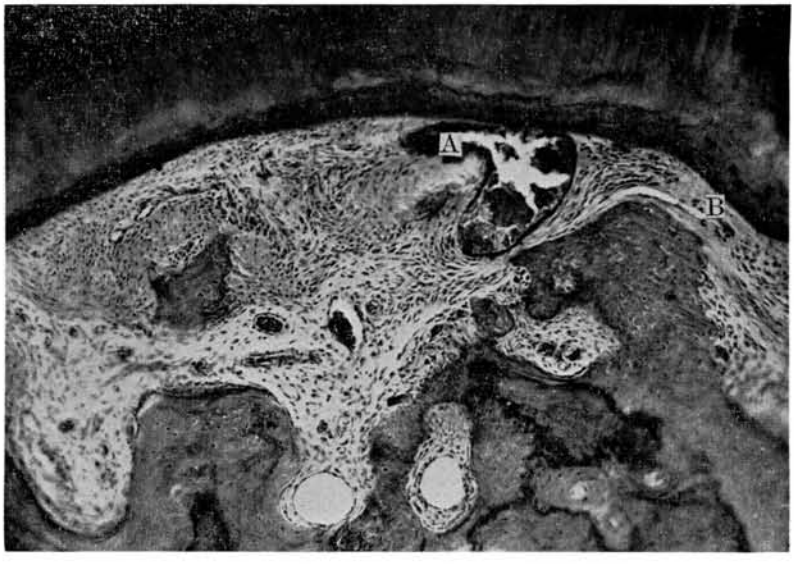
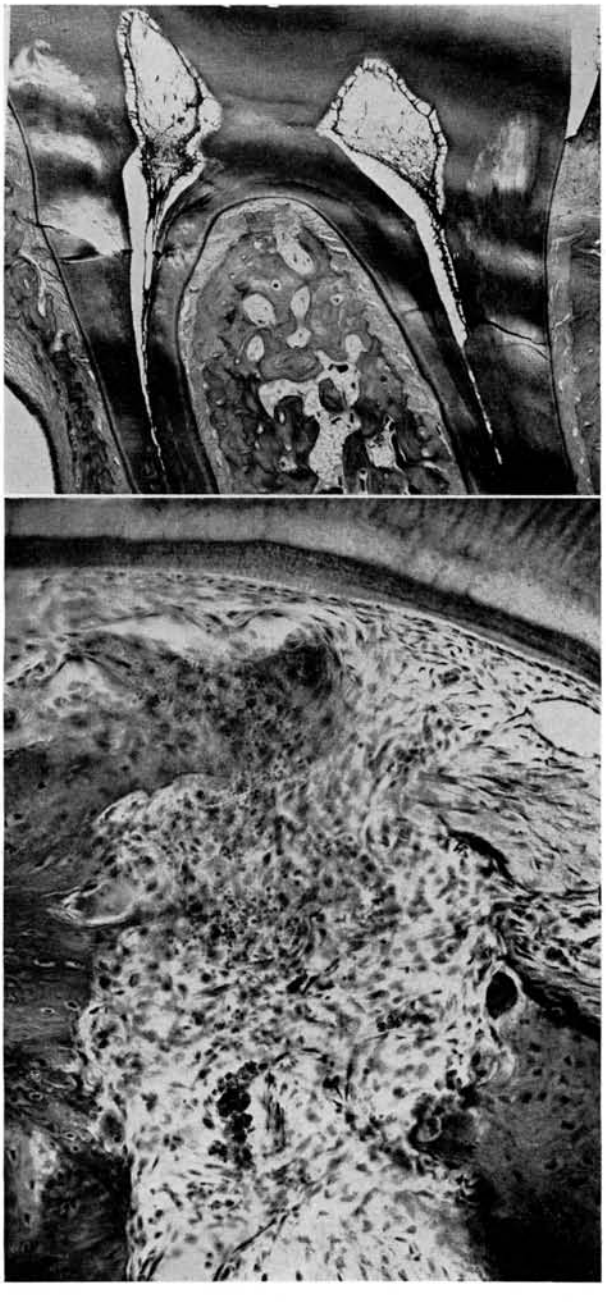


Fig. 1.—Monkey No. 1919. First molar (orig. mag. ×100). Recent trauma. Hemorrhage (*A*) and necrosis (*B*). Evidence of resorption and repair in other areas.

severe poliomyelitis were examined to clarify this observation, but the increase in soft debris coating the teeth was not a constant finding and the difference in quantity was slight, and therefore a definite statement cannot be made as to the significance of this observation.

The self-cleansing of the teeth by mastication of food; the flow of saliva; and the movement of the tongue, lips, and cheeks is of utmost importance in maintaining the oral hygiene, and thereby the health, of the gingival tissues. In severe febrile diseases the salivation is decreased due to dehydration, the food intake is lowered (requiring less chewing action) and other movements of the jaws are markedly decreased—also the personal oral hygiene is often neglected in advanced stages of systemic disease. This would all be conducive to increased accumulation of materia alba on the teeth, causing a

A.



B.

Fig. 2.—*A*, Monkey No. 1910. First molar. Small area of trauma in bifurcation. *B*, High magnification (orig. mag. ×120) of *A*. Resorption of alveolar bone, degenerating red blood cells from previous hemorrhage. Young granulation tissue.

gingivitis or aggravating an existing periodontal disease. Upper respiratory disease with high temperature frequently causes nasal obstruction and mouth breathing, resulting in gingivitis and pulpal hyperemia. Maxillary sinusitis associated with upper respiratory infection causes "sore teeth." Increased nervous tension is often observed in the terminal stage of severe illness and is manifest by an increased tendency for clenching of the jaws (Karolyi effect). The traumatic injuries to the pulp and the periodontal membrane from this process will cause the traumatized tooth to feel sore. These local factors are discussed here because they offer a plausible explanation for the claimed relationship between febrile diseases and periodontal disturbances.

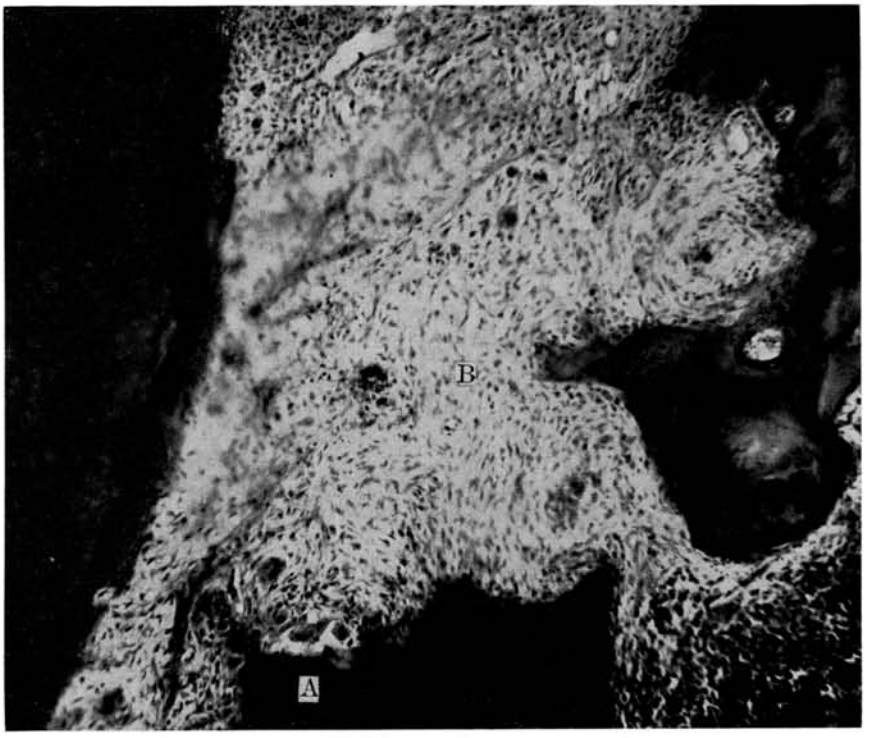
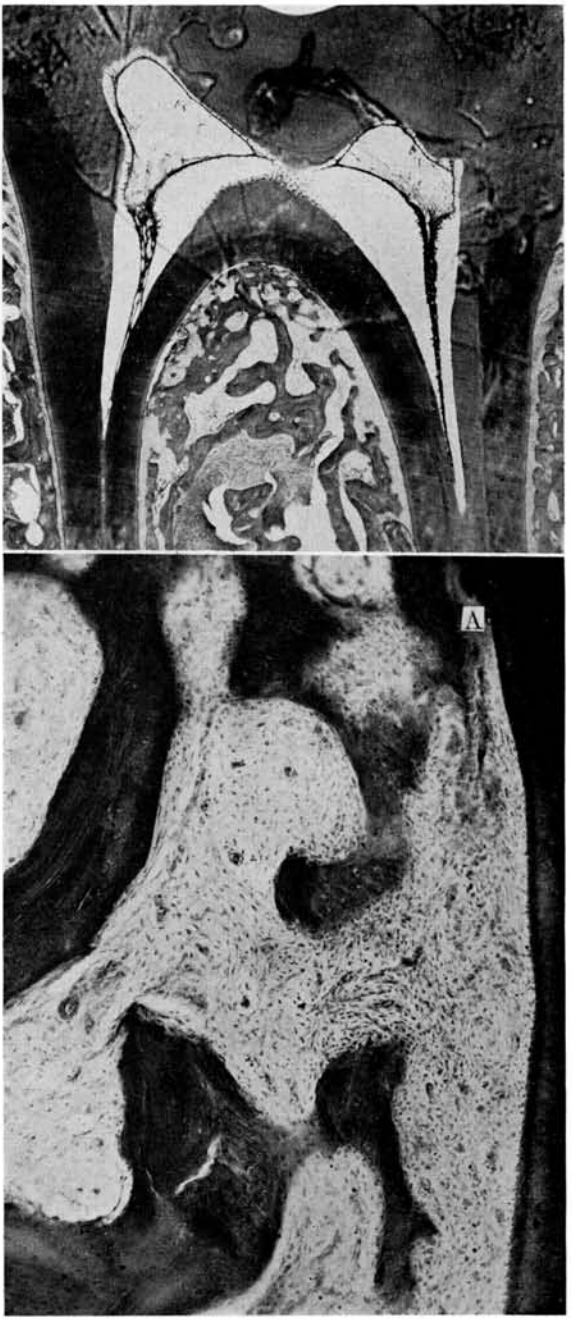


Fig. 3.—Control monkey. First molar (orig. mag. ×120). Resorption of alveolar bone (*A*). Replacement of lost bone and periodontal membrane by vascular loose connective tissue without functional orientation (*B*). Histologically resembling periodontosis.

One of the most important and extremely varying local factors is the change in performance and efficiency of the personal oral hygiene during a period of severe disease. The exclusion of this factor in experimental animals increases the significance of the findings pertaining to systemic factors as a possible cause of periodontal disease.[44]

Various stages of traumatism were observed in jaw sections from monkeys in the experimental and control groups (Figs. 1, 2*A* and *B*, and 3). A common location for these traumatic lesions was the inter-radicular space of the first molars, indicating an axial force. The lesions, conformed histologi-

A.



B.

Fig. 4.—*A*, Monkey No. 1916. First molar. Evidence of extensive inter-radicular trauma. Hemorrhage. Calcific deposits, resorption of bone, and fibrosis of marrow spaces. Widening of the periodontal spaces. Widening of periodontal space in the cervical region. *B*, High magnification of *A* (orig. mag. ×100). Recent trauma (*A*). The rest of the picture shows healing stage of traumatism, resembling periodontosis.

cally to the description in the literature of traumatic periodontal injuries.[8, 14-16, 27, 28, 32-34, 37, 39, 40] Thrombosis, hemorrhage, degeneration, necrosis, bone and root resorption, calcific deposits, and hyalin changes constituted the early manifestations[6, 22] (Figs. 1, 2*B*, 4*A*).

The healing stage of traumatic lesions in numerous areas showed features which resembled the commonly accepted picture of "diffuse atrophy of the alveolar bone" or periodontosis.[9, 10, 13, 17, 24, 31, 35, 42, 43, 45] A widespread resorption of alveolar bone, sometimes extending into the supporting bone, was observed (Figs. 3 and 4*A*). Fragments of degenerating periodontal fibers were seen in loosely arranged vascular granulation tissue which extended into the adjacent marrow spaces (Figs. 3, 4*B*, and 5). No difference in susceptibility to these lesions was noted in comparing experimental and control animals. A section of a human tooth showing the same type of traumatic periodontal changes is included for comparison (Fig. 6).

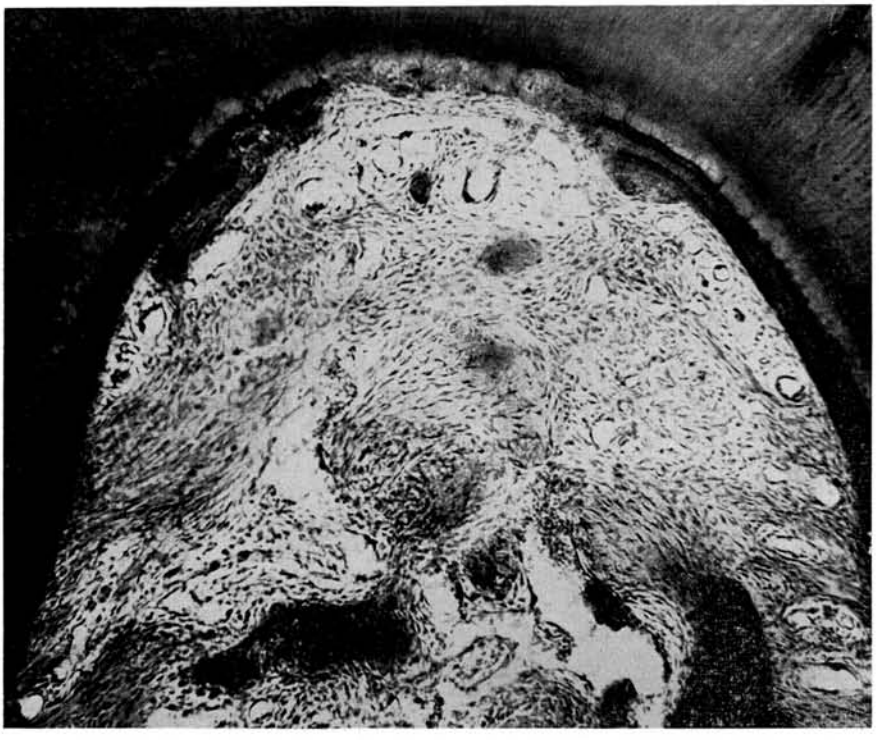


Fig. 5.—Tuberculous monkey. First molar (orig. mag. ×120). Repair following traumatic injury. Remains of old fibers in loosely arranged vascular granulation tissue.

It has been suggested by Häupl and others[18-20, 25, 30] that the histopathologic findings which Gottlieb, Orban, Weinmann and others[12, 13, 17, 31, 35, 38] have described as being pathognomonic of periodontosis are manifestations of occlusal trauma. In my investigation of the periodontium of rhesus monkeys these traumatic changes resembling degeneration have been observed in monkeys suffering from severe tuberculosis (Fig. 5) and alloxan diabetes, as well as in

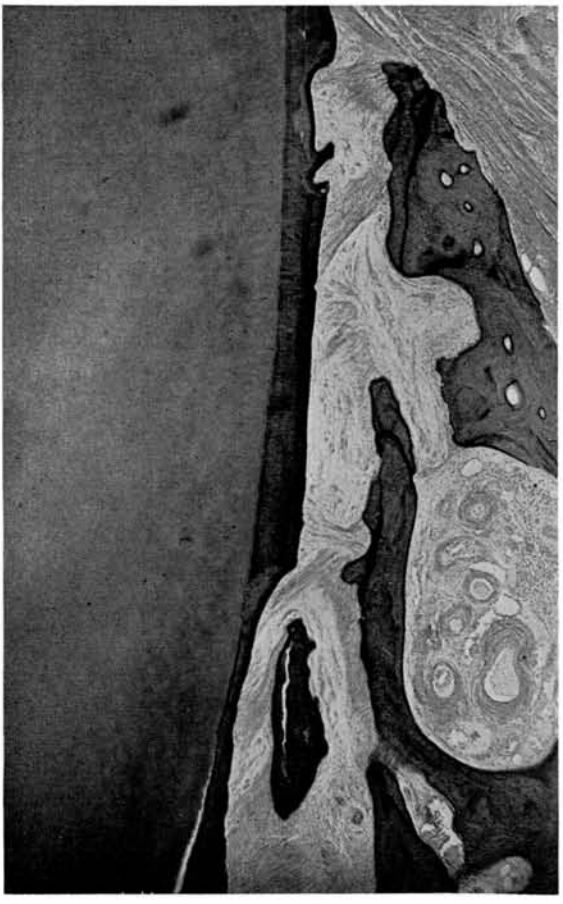


Fig. 6.—Human lateral lower incisor (orig. mag. ×65). Severe traumatic occlusion with cemental tears. Only small remaining bundles of periodontal fibers. Most of the periodontal space filled with loose unorganized connective tissue extending into the adjacent marrow spaces. Well-developed alveolar crest fibers.

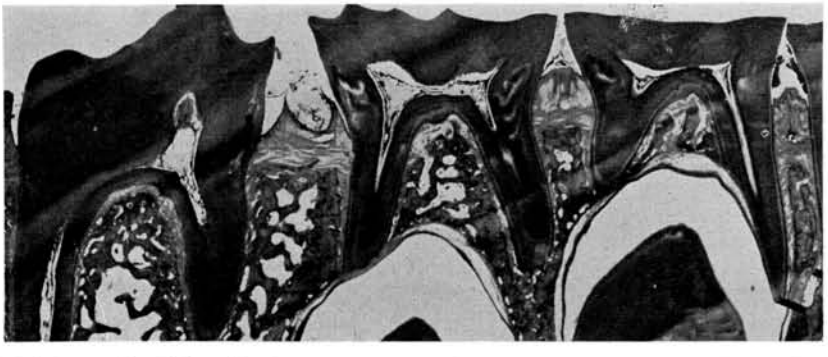


Fig. 7.—Monkey No. 1910. Various stages of root resorption. Inter-radicular and cervical evidence of traumatism. Gingivitis between the deciduous teeth.

the control animals. If the changes had not been observed simultaneously in the experimental and in the control animals there would have been a possibility of falsely interpreting the periodontal changes as due to the systemic diseases.

Deciduous teeth in various stages of root resorption showed traumatic lesions both in the inter-radicular and cervical region (Figs. 7, 9*A*, 9*B*). As a group the deciduous teeth showed more advanced gingivitis than the permanent teeth (Fig. 7) and the extent of the gingival inflammation appeared to increase with decrease in the length of the remaining roots (Fig. 8). This observation indicated that the increase in traumatic periodontal damage in teeth with short remaining roots contributed to an increased gingival inflammation by disturbing the blood supply and tissue metabolism, thereby lowering the resistance to infection and other local irritants.

Fig. 8.—Extent of gingival inflammation increased with decreasing length of the remaining roots. Trauma has led to fracture of mesial root of first deciduous molar and periodontitis.

Special stains for collagen proved to be of limited value in the detail study of collagenous fibers because these stains are influenced by factors which cannot be satisfactorily standardized in jaw sections containing teeth. Several sections from experimental and control animals showed artifacts closely resembling the fragmentation and degeneration of collagen fibers which have been described as being characteristic of periodontal changes seen in systemic disease.[36] A large number of sections from each specimen should be stained before an evaluation is attempted.

CONCLUSIONS

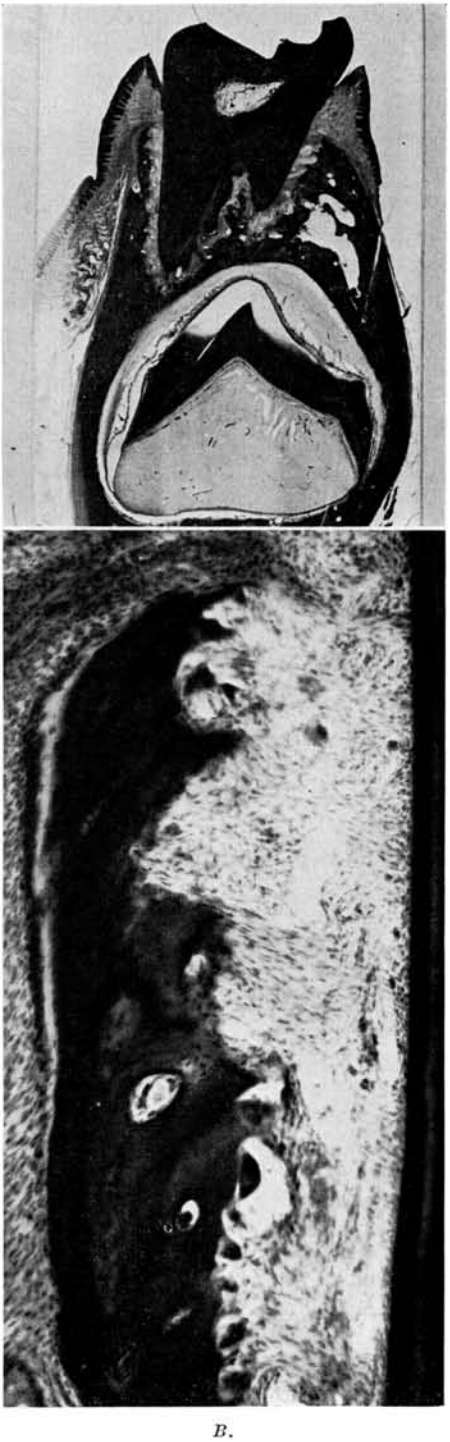
1. No changes attributable to poliomyelitis were observed in the periodontium of nineteen rhesus monkeys having the disease.

2. Special connective tissue stains did not reveal any structural changes in the collagenous fibers in joint or periodontal tissues of monkeys with severe poliomyelitis.

3. An association was noted between accumulation of debris on the teeth and gingivitis.

4. Gingivitis was observed more frequently and found to be more severe around deciduous than permanent teeth.

A.



B.

Fig. 9.—*A*, Monkey No. 1982. Active resorption of alveolar bone. *B*, High magnification (orig. mag. ×105) of *A*. Osteoclastic activity. Loosely arranged connective tissue constituting the periodontal membrane.

5. An inverse relationship was observed between the length of the root of the deciduous teeth and the degree of gingival inflammation.

6. The increase in incidence and severity of periodontal diseases which has been claimed to accompany febrile diseases is possibly due to increased local irritation, mainly because of poor oral hygiene, during the period of systemic illness.

7. The healing stage of certain traumatic lesions resembled the description of diffuse alveolar atrophy or periodontosis.

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