Occurrence and appearance of cementum hypoplasias in localized and generalized juvenile periodontitis

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The occurrence and appearance of cementum hypoplasias have been studied on teeth affected by juvenile periodontitis. Scanning electron microscopy showed the presence of cementum hypoplasias on the root surface of all extracted first molars and one incisor from nine patients with localized juvenile periodontitis and on most extracted teeth from two patients with generalized juvenile periodontitis. No hypoplasias were found on the extracted third molars. The alveolar bone loss in these patients seemed to be correlated to the frequency and extension of the hypoplastic areas in the associated teeth. The distribution of the teeth affected by localized juvenile periodontitis showed a symmetric distribution in the jaws. The patients with generalized juvenile periodontitis showed considerable deposits of dental calculus and wide areas of root resorption. The disturbance of cementum formation may have been caused by hereditary systemic factors, which subside with increasing age of the patient. The clinical appearance of juvenile periodontitis may therefore be influenced by the age at onset, the duration, and the frequency of such systemic factors, giving rise to a localized form and a more generalized form. One such factor may be a varying degree of hypophosphatasia. □ *Dental cementum; excessive growth; periodontology*

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Juvenile periodontitis is a periodontal disease appearing in both a localized and a generalized form (1). It has an early onset in life and can, if not treated, progress rapidly (2–5). Patients suffering from this disease have been shown to have defects in their immune system (6–8). In several studies, specific bacteria have also been associated with this disease (9–16).

The localized form of periodontitis affects mainly the periodontal tissues of the first molar (1). Neither the immunodeficiencies nor the specific bacteria can explain the characteristic distribution of this disease among the teeth. It was therefore of interest that morphological studies of four molars extracted because of advanced juvenile periodontitis showed hypoplasias in their cementum (17). This finding was in support of Gottlieb's (18) idea that periodontitis was associated with 'cementopathia'. More recently this suggestion received further support from a long-term study of early-onset periodontitis in which the patients had various degrees of hypophosphatasia, a condition known to cause cementum aplasia (19, 20). Page & Baab (21) have suggested that several cases in previously published reports of early exfoliation of deciduous teeth and juvenile, prepubertal, and rapidly progressive periodontitis are in fact due to hypophosphatasia and the associated abnormalities in cementum formation.

The purpose of the present study was to analyze the occurrence and appearance of cementum hypoplasia on several extracted teeth from patients with juvenile periodontitis.

Materials and methods

In 11 young patients 25 teeth were extracted (Tables 1 and 2). Severe periodontitis and/ or difficulties in maintaining oral hygiene were the reasons for the extractions. All patients fulfilled the criteria of juvenile periodontitis used by Saxén (22). Bone loss was

Table 1. Clinical findings

	Data from earliest available radiographs		Data from latest radiographs		
Patient/sex	Age of the patients (years)	Teeth with bone loss (FDI nomenclature)	Age of the patients (years)	Teeth with bone loss (FDI nomenclature)	Diagnosis
K.G./F	12	36	16	16, 26, 36, 46	LJP
J.M./M	14	16, 26, 36, 37, 32, 31, 41, 42, 45, 46	14	16, 26, 36, 37, 32, 31, 41, 42, 45, 46	LJP
M.S./M*	14	16, 15, 14, 24, 25, 26, 37, 36, 34, 44, 46	22	All teeth	LJP
H.M./F	17	16, 26, 36, 46	19	16, 11, 21, 26, 36, 46	LJP
A.K./M	17	17, 16, 26, 27, 37, 36, 46	23	17, 16, 15, 13, 12, 25, 26, 27, 37, 36, 35, 32, 31, 41, 42, 43, 44, 46, 47, 48	LJP
C.N./F	18	17, 16, 14, 24, 26, 27, 37, 36, 35, 45, 46, 47	24	All teeth	LJP
C.K./F	18	11, 21, 46	18	11, 21, 46	LJP
M.K./F	18	16, 26, 36, 46, 47	22	16, 26, 36, 35, 34, 32 31, 41, 42, 46, 47	LJP
T.E./M	18	46	24	36, 45, 46	LJP
M.B./F	13	16, 15, 24, 25, 26 36, 46	19	All teeth	GJP
K.K./M	17	17, 16, 15, 14, 24, 25, 26, 27, 37, 36, 35, 34, 44, 45, 46, 47	23	All teeth	GJP

* This patient had been orthodontically treated.

seen in the earliest available radiographs from before 19 years of age in all patients. Alveolar bone destruction at that time exceeded 2 mm in more than one site, and the sites were not associated with faulty restorations. The 11 patients were divided in 2 groups in accordance with Baer (1). One group consisted of nine patients with bone loss first seen around the first molars and occasionally also around the central incisors. This group was designated localized juvenile periodontitis (LJP) (Table 1). The second group consisted of two patients who had a general primary bone loss not associated with any specific group of teeth. This group was designated generalized juvenile periodontitis (GJP) (Table 1).

Ten first molars from each of 10 patients with adult periodontitis and 5 first molars from 5 young patients with no signs of periodontal bone loss were studied as control material. The latter five first molars were obtained as autopsy material.

Immediately after extraction, all teeth (except one from Patient M.S.) were immersed in a 10% solution of sodium hypochlorite for 24 h to render the root surface anorganic. The teeth were mounted in such a manner that the root surface facing the alveolar bone destruction could be examined. Some teeth were split, to enable examination of both the mesial and the distal side of the root. The mounted teeth were then dehydrated, critical-point-dried (23), and sputter-coated with gold (24). The whole extension of the root surface from the apical part to the cervical region was examined with the scanning electron microscope (SEM). The borderline between the cementum surrounded by connective tissue and the cementum exposed to the oral environment was observed by means of the radiographs. In one of the patients with LJP both upper first molars were extracted. One of these was fixed in 10% neutral buffered solution of formalin. It was then decalcified and embed-

Table 2. Histological findings

Patients/ diagnosis	Extracted tooth/teeth	Teeth showing cementum hypoplasia, root resorption, or intact cementum surface		
		Cementum hypoplasia	Root resorption	Intact cementum surface
K.G./LJP	36	36		
J.M./LJP	46	46		
M.S./LJP	16, 26, 38, 31	16*, 26, 31	16*, 26, 31	38
H.M./LJP	16	16		
A.K./LJP	17, 28, 46, 48	17, 46		28, 48
C.N./LJP	16, 18	16		18
C.K./LJP	48			48
M.K./LJP	26	26		
T.E./LJP	46	46		
M.B./GJP	18, 38		18, 38	
K.K./GJP	16, 17, 26, 27, 38, 36, 47	16, 17, 36	16, 17, 26, 27 38, 36, 47	

* This tooth was examined in the light microscope. The defects in the root surface could not be classified with certainty as hypoplasias or resorption cavities.

ded in paraffin, and longitudinal serial sections were prepared.

Results

Clinically, there were some marked differences between the LJP and GJP groups at the time of extraction. The two patients in the GJP group had supragingival plaque, sub- and supra-gingival calculus, and moderate to intense gingivitis, whereas the LJP group had a minimum of visible plaque, little calculus, only slight to moderate gingivitis, but always bleeding on probing to the bottom of the pocket. The radiographs also showed differences between the two groups. In the GJP group there was bone loss on almost all teeth. It consisted predominantly of horizontal bone destruction and some vertical bone loss (Fig. 1). The radiographs also showed that the GJP group had large amounts of subgingival calculus. The LJP group initially showed symmetrical vertical bone loss around one or more of the first molars (Fig. 2). However, radiographs taken at a later occasion showed that in some patients other teeth also became involved, with time. The progression of bone destruction was always more rapid around the first molars. After the first molars, incisors and second molars were most frequently affected by bone loss. The premolars and canines in the LJP group were the groups of teeth with least bone loss.

In the SEM there was no consistent dif-

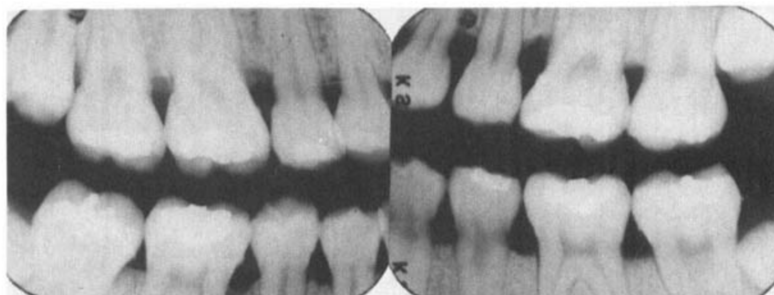

Fig. 1. Radiograph of the premolar and molar areas of one of the patients (M.B., 18 years old) with generalized juvenile periodontitis. The loss of alveolar bone is evident in all proximal areas. Subgingival calculus can be seen on some teeth.

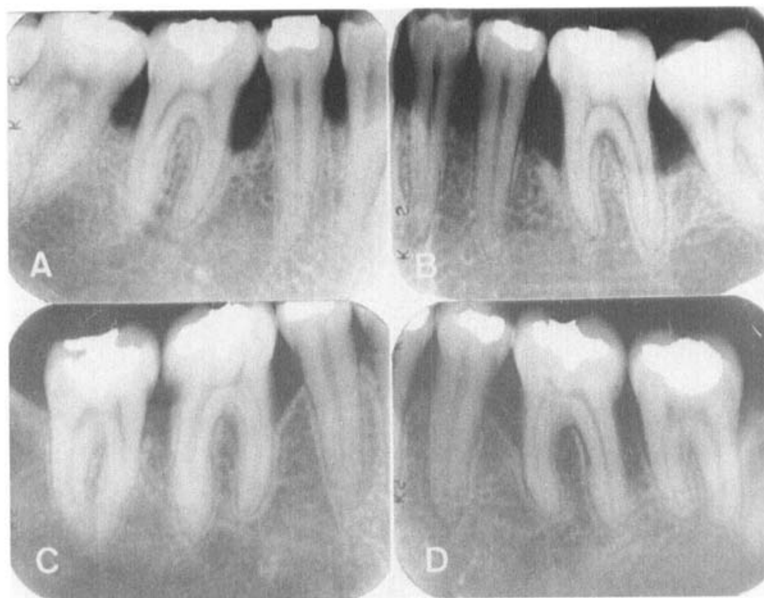

Fig. 2. Radiograph of the mandibular premolar and molar areas of one of the patients (M.S.) with localized juvenile periodontitis. When the patient was 17 years old (A and B) the alveolar bone loss was seen around the first molars, and there was no compact bone in the vertical bone destructions. The patient was then treated by means of periodontal surgery, including root-planing. 2C and D are radiographs taken when the patient was 22 years old. Distinct compact bone is now present in most of the proximal areas but no gain in bone height.

ference between cementum exposed to the oral environment and the cementum surrounded by connective tissue. However, in some teeth in both the LJP and the GJP group calculus formation was observed in the cervical region. There were large areas of cementum hypoplasia on the root surface of teeth with LJP. These hypoplasias occurred along the whole root surface, including surfaces still surrounded by alveolar bone at the time of extraction. Most hypoplasias were found on surfaces that showed extensive bone loss on the radiographs. Generally, the teeth showing the most advanced bone loss at a young patient age also showed the highest frequency of hypoplasias. They also seemed to be larger than in the other teeth. The hypoplasias had a rough surface (Figs. 3 and 4) and were different from the roundish resorption lacu-

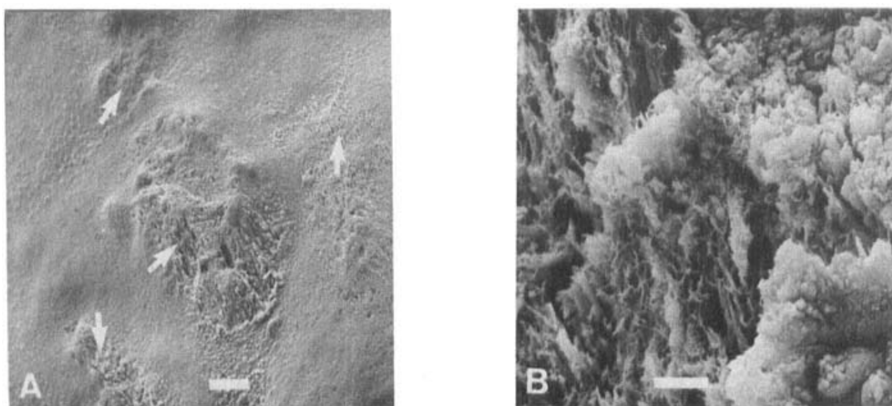

Fig. 3. SEM of the cementum surface of a tooth with juvenile periodontitis. In the low magnification (A) numerous hypoplastic areas (arrows) can be seen (bar = 100 μm). Detail of a hypoplastic area (B) shows that it has an uneven surface with numerous projections (bar = 10 μm).

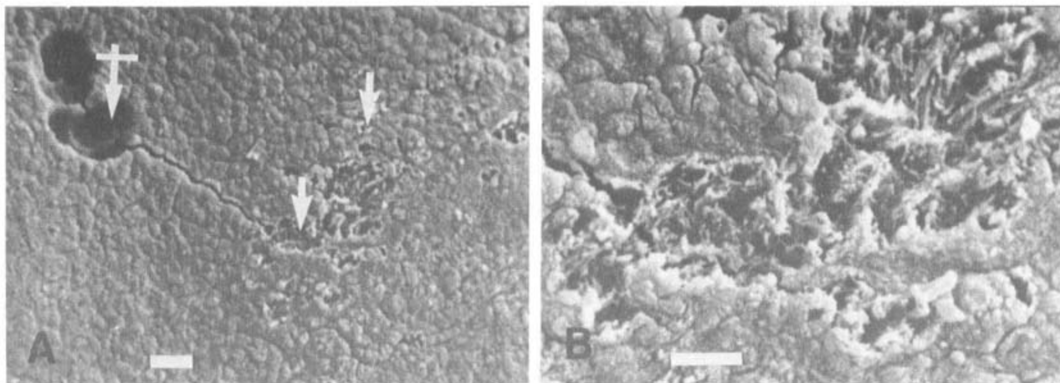

Fig. 4. SEM of the cementum surface of a tooth with localized juvenile periodontitis. The low magnification (A) shows the widespread distribution of the hypoplastic areas (arrows) and a neighboring resorption lacuna (crossed arrow) (bar = 100 µm). A detail of the hypoplastic area is shown in B (bar = 50 µm).

nae found on the teeth from one patient, which had been orthodontically treated. No cementum hypoplasias were found on the extracted third molars.

In the light microscopic examination of the paraffin sections it was not possible with certainty to separate a hypoplastic area from a resorption lacuna. They were all filled with a loose connective tissue and fibroblasts. No resorbing cells were noted in the defects, and no reparative cementum had been deposited. The defects had various depths. Some of them extended into the dentin (Fig. 5).

Some, but not all, teeth in the GJP group showed cementum hypoplasias of various severities. Numerous resorption lacunae were also observed in all teeth (Fig. 6, Table 2). Dental calculus was found both sub- and supra-gingivally. The cementum surface around the calculus deposits and the hypoplasias had a mosaic-like pattern, with grooves and minute holes covering the entire root surface. It was similar to that of the healthy control material (Fig. 7). The dental calculus in the patients with GJP was similar to that in the control teeth extracted because of periodontitis.

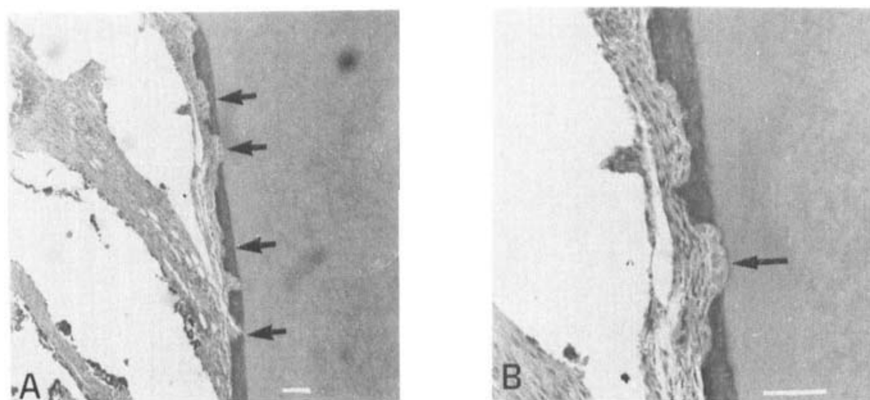

Fig. 5. Light photomicrograph of cementum and adjacent dentin of an extracted tooth with localized juvenile periodontitis which has been orthodontically treated. The defects (arrows) penetrate to various depth: some of them reach all the way into the dentin, whereas others are limited to the cementum. There is no sign of cementum repair or of resorbing cells in the defects. (Bars = 100 µm.)

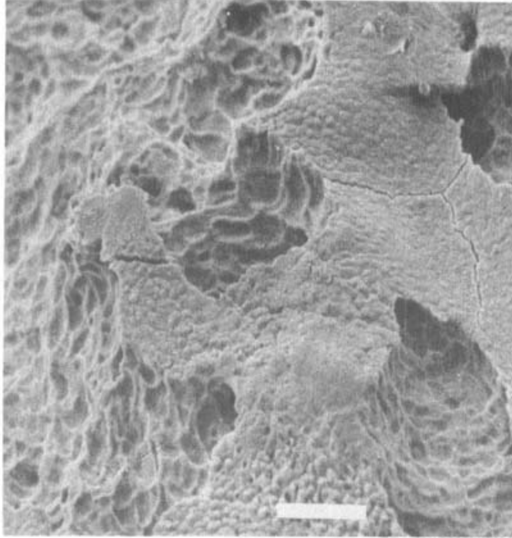

Fig. 6. SEM of a tooth with generalized juvenile periodontitis. The cementum surface shows numerous resorption lacunae. Note the difference between the resorption lacunae and the hypoplastic areas in Fig. 3. (Bar = 100 μm.)

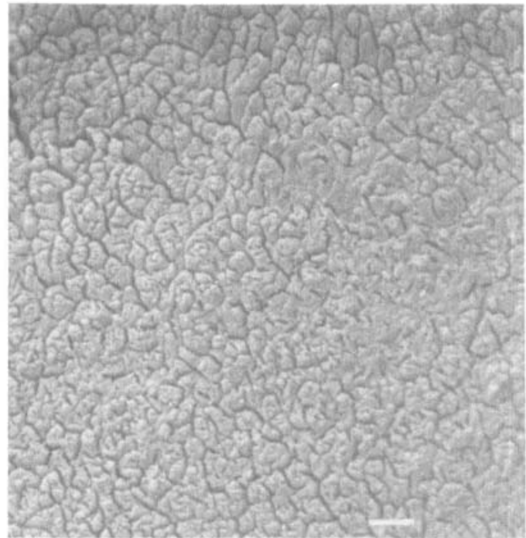

Fig. 7. SEM of a tooth with localized juvenile periodontitis. The cementum surface has mosaic-like pattern with grooves and holes. It has the same appearance as was seen in the control teeth from young patients. (Bar = 20 μm.)

Discussion

Juvenile periodontitis is a rare disease. The incidence among a group of Finnish youngsters, 16 years of age, was 0.1% (22). About 100 teenagers in Stockholm have been diagnosed as having juvenile periodontitis, which indicates approximately the same low incidence as in Finland (L. Blomlöf, personal communication). Careful periodontal treatment including excision of deep pockets, root-planing, total plaque control, and, sometimes, use of antibiotics at an early stage of the disease can usually stop the progression of the bone loss and thus save the teeth (2–5, 14, 25). The finding of as many as 11 patients with juvenile periodontitis requiring extraction of one or more teeth occurred when periodontal care was being organized in the Stockholm area.

The symmetrical nature of juvenile periodontitis with regard to both alveolar bone loss and cementum hypoplasias indicates that there may be a systemic factor involved in the etiology of the disease. All the first and second molars and the one incisor extracted in patients with LJP and three out of six first and second molars extracted in patients with GJP showed cementum hypoplasias, whereas no hypoplasias could be found on the roots of the extracted third molars. The roots of the first and second molars and of the incisors are formed during the first 10 years of life, whereas the formation of the roots of the third molars does not begin until the 2nd decade of life. It seems reasonable to suggest that the disturbances are caused by some systemic factor that subsides with increasing age of the patients. Baab & Page (21) have suggested that some subclinical type of hypophosphatasia may cause cemental defects and thus be the main etiologic factor in early-onset periodontitis. The observations of the distribution of the cementum hypoplasias in this study may lend some support to their suggestion, since there are forms of hypophosphatasia which only affect teeth formed early in life (26). However, the finding of cementum hypoplasias, in contrast to a total lack of cementum, suggests that any disturbance of cementum formation during root development must have been intermittent rather than continuous.

Cementum hypoplasias were also found in patients with GJP, indicating that it may have the same etiology as LJP. The severity of hypophosphatasia may vary with time in the same patient. Such variations may have affected the cementum formation periodically. The appearance of juvenile periodontitis may therefore be influenced by the age at onset, the duration, and the frequency of the hypophosphatasia attacks, giving rise to a localized form (LJP) and a more generalized form (GJP).

It is possible that the different appearances of the two types of juvenile periodontitis may be due to different infecting agents. Spector et al. (27) have reported on a family manifesting both GJP and LJP. Patients with LJP often harbor significant numbers of *Actinobacillus actinomycetemcomitans* in their periodontal lesions (10, 28, 29). Patients with GJP, on the other hand, are reported to have *Bacteroides gingivalis* as a major component of their periodontal microflora (13, 16, 30).

However, there may be other factors involved in the pathogenesis of juvenile periodontitis. The cementum defects noted in the present study showed no sign of reparative cementum, suggesting a defect in the periodontal ligament or in the reparative process possibly associated with the defects of the immune system which have been demonstrated in patients with juvenile periodontitis (6, 21).

In the SEM the cementum hypoplasias were clearly distinguishable from resorption lacunae. So far we do not know of any report on increased susceptibility to root resorption of teeth affected by juvenile periodontitis. The resorption of cementum noted in one of the patients with LJP may have been caused by the orthodontic treatment of this patient. Orthodontically treated teeth often show root resorption (31, 32). The root resorption of the teeth in the patient with GJP may have been associated with the plaque deposits and the associated chronic inflammatory reaction.

This study confirms the previous observation of cementum hypoplasias in teeth affected by juvenile periodontitis. The question still remains how this is associated with the early and rapidly progressing periodontitis. The hypoplasias may facilitate bacterial penetration and thus explain the characteristic distribution pattern among the teeth. However there were also some teeth with no demonstrable cementum hypoplasias which were extracted because of advanced generalized juvenile periodontitis, and it seems reasonable to assume that this disease is the result of the combined effects of cementum hypoplasias and immunological defects. It is of interest to note that patients with the juvenile type of hypophosphatasia have been reported to show cementum aplasia as well as an increased sensitivity to infections (33). The latter observation may reflect some immune deficiency.

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