Microscopic study of enamel defects in deciduous teeth of infants of diabetic mothers

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Ground sections of deciduous teeth from infants of diabetic mothers were examined in polarized light and by microradiography. Widened neonatal lines and subsurface lesions were the main findings in the enamel. Three teeth showed enamel hypoplasia in connection with the neonatal line. The widening of the neonatal line and the hypoplasias are related to the more frequent and more pronounced neonatal hypocalcemia occurring among infants of diabetic mothers. □ *Hypocalcemia; mineralization disturbances; neonatal line*

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Dental hard tissues may reflect developmental disturbances of prenatal or postnatal origin. In some groups of children enamel hypoplasias are commoner than in other groups (1–3). Premature infants of diabetic mothers are known to have more changes in the dental hard tissues than normal, healthy children. In a recent paper, dealing with tooth development in low-birth-weight infants, the possible role of altered calcium metabolism in developmental disturbances in teeth was discussed (4).

Infants of diabetic mothers (IDM) are more immature than their gestational age would indicate, and their calcium phosphate homeostasis is impaired in the same manner as in premature infants with a marked tendency to develop hypocalcemia and hyperphosphatemia (5).

The purpose of this investigation was therefore to study the histological appearance of the enamel of deciduous teeth from infants of diabetic mothers.

Materials

Deciduous teeth from 30 infants of diabetic mothers were collected, comprising 16 central upper incisors, 4 laterals, 3 lower central incisors, and 7 lower laterals. The gestational ages ranged from 33 to 40 weeks, with a mean value of 38 ± 2 ($\pm$SD) weeks. Birth weight varied from 2050 to 4520 g, with a mean of 3392 ± 597 ($\pm$SD) g. (For further information see Refs. 3, 6.)

Methods

From each tooth a mid-sagittal planoparallel section 70–80 μm thick was prepared. Contact microradiographs were prepared, using Kodak spectrographic plates 069 in a Machlett tube AEG 50 with nickel-filtered copper radiation, excited at 20 kV and 20 mA at a target distance of 8.6 cm.

The sections were examined in a Zeiss Universal Polarising microscope, using 'POL Z' strain-free objectives. The examinations were carried out after drying in air and after water imbibition for 24 h.

Results

In polarized light, when examined dry in air, a neonatal line was present in 93% of all specimens. The line appeared as a marked, positively birefringent band of unusual width (Fig. 1). The enamel exhibited a pore volume

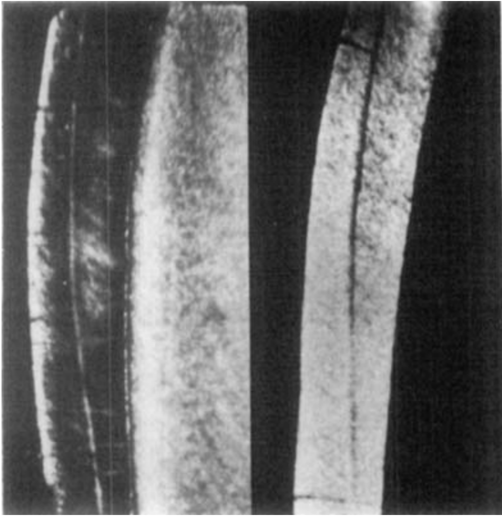

Fig. 1 (Left). Ground section of a deciduous incisor, examined in polarized light dry in air, showing a neonatal line.

Fig. 2 (Right). Microradiogram of the same section demonstrates the hypomineralized nature of the neonatal line.

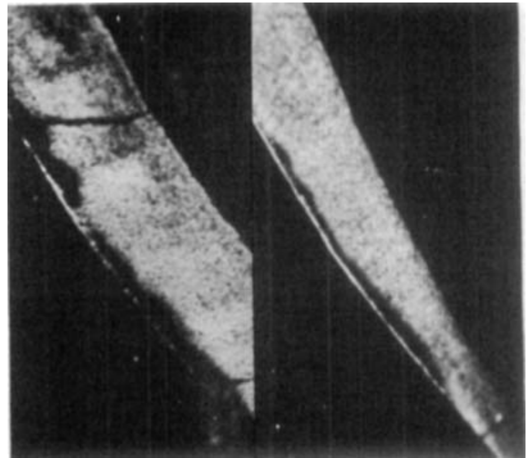

Fig. 3 (Left). Microphotograph of a ground section through a deciduous incisor, examined in polarized light dry in air. A distinct positively birefringent lesion is located in the postnatal enamel.

Fig. 4 (Right). Microradiogram of a similar tooth shows a hypomineralized subsurface lesion deep to a well-mineralized surface.

along the neonatal line of 5% or more (7), as the line most often remained positively birefringent after water imbibition. In the microradiographs the neonatal line was seen as a hypomineralized, well-defined band (Fig. 2).

The prenatal enamel, when examined dry in air in polarized light, appeared either pseudoisotropic or positively birefringent, and the postnatal enamel was negatively birefringent. Since the prenatal enamel appeared negatively birefringent after imbibition in water, the degree of porosity in the zone varied from 1% to 5% (7). This was not reflected in the microradiograph, since the overall degree of mineralization did not differ within the enamel.

In a large proportion of the specimens (77%) a subsurface lesion was seen (Fig. 3). In polarized light, when examined dry in air, the subsurface defects were observed as positively birefringent lesions beneath a negatively birefringent surface zone. The lesions appeared narrow, and water imbibition did not alter their positively birefringent character but reduced their apparent depth. In the microradiographs the lesion was seen in 50% of all specimens as a hypomineralized zone beneath a well-mineralized surface (Fig. 4).

Teeth with hypoplasia

In three teeth macroscopically detectable enamel defects were found on both the buccal and lingual surfaces. In ground sections the bottoms of the hypoplasias were located corresponding to the neonatal line. In one case the hypoplasia was located in the middle third of the tooth, with postnatal enamel on both the cervical and incisal parts (Fig. 5). In the other two specimens no postnatal enamel was seen in the incisal parts (Fig. 6). The overall structure of the teeth with hypoplasia did not differ from that of the other teeth. The prism direction in the postnatal enamel along the cervical border and in the incisal border of the hypoplasia differed from that of the remaining enamel. Instead of running almost perpendicular to the tooth surface, the prisms along the wall bent so that they ran almost perpendicular to the enamel surface in the grooves.

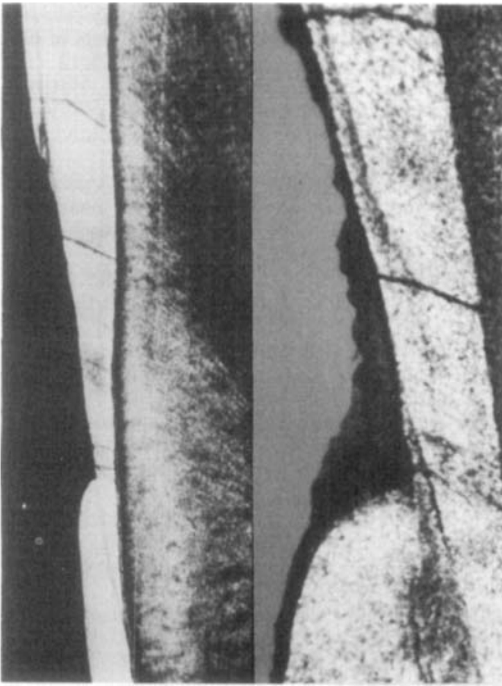

Fig. 5 (Left). Enamel hypoplasia in the buccal enamel in the middle third of the crown of a deciduous incisor examined in polarized light dry in air. The bottom of the hypoplasia is located corresponding to the neonatal line; postnatally formed enamel is seen in both the cervical and the incisal parts.

Fig. 6 (Right). Enamel hypoplasia in the buccal enamel of a deciduous incisor, examined in polarized light dry in air, with postnatal enamel only in the cervical part. The hypoplasia is located corresponding to the neonatal line. The dark material seen at the bottom of the lesion is a remnant of the embedding material.

Discussion

This study shows that deciduous enamel from infants of diabetic mothers displays widened neonatal lines and various structural changes in the postnatal enamel.

The neonatal line is a well-recognized landmark in the enamel of deciduous teeth. Different explanations have been given for the neonatal line (8). Infants of diabetic mothers have a higher incidence of hypocalcemia than infants born to nondiabetic mothers, even if gestational age and perinatal complications are taken into consideration (9). They also have lower serum calcium values and a greater decrease of calcium in plasma than normal infants (9, 10). All newborn infants show a more or less marked decrease in plasma calcium during the first 48 h of life (10). It is therefore reasonable to assume that the normal decrease in plasma calcium is responsible for a structural response in the enamel—that is, the neonatal line. Since infants of diabetic mothers have a more pronounced decrease in plasma calcium, the result would be a widened neonatal line.

Whereas the location and structural changes of two of the enamel hypoplasias in this material appeared very similar to what has been observed previously in teeth from premature low-birth-weight infants (4), the third hypoplasia appeared different. The causative trauma has obviously affected the secretory ameloblasts in the stage of outer enamel formation, but the cells in very late secretory stages have been able to complete enamel formation, since the neonatal line incisally to the hypoplasia is covered with a thin layer of enamel. Furthermore, it is of interest that, although the ameloblasts cease secretion corresponding to the hypoplasia, they obviously do not prevent the enamel already formed by these cells from maturing and acquiring a normal mineral content. However, the numbers of hypoplasias examined are too limited to permit any definite conclusions, and since the literature is scarce in this field, more hypoplasias in human deciduous enamel, caused by various factors, must be examined.

Enamel hypoplasia has been found in higher frequencies in vitamin D deficiency, vitamin-D-dependent rickets, hypoparathyroidism, and various disorders with neonatal hypocalcemia (11). Since infants of diabetic mothers develop neonatal hypocalcemia, and since the ameloblasts are sensitive to hypocalcemic states (11), it is likely that enamel hypoplasia and widened neonatal lines would occur with higher frequency among such infants than among normal infants.

In the postnatal enamel, in the cervical parts, the microradiograms showed a hypomineralized zone beneath a well-mineralized surface. Such subsurface defects have been described in specimens from normal

full-term infants and low-birth-weight infants (4). These lesions have also been found in late stages of normal development in deciduous incisors from fetuses and infants (12, 13). Postnatal enamel thus seems to be more vulnerable to disturbances in the mineralization. As in normal specimens, an arrest in very late stages of enamel maturation frequently occurs in the cervical deciduous enamel.

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