Enamel defects of the primary dentition and osteopenia of prematurity

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Introduction

Enamel formation (amelogenesis) in the human dentition begins *in utero*. The process has been investigated widely in the primary dentition in animals, and to a much lesser extent in humans. Studies have confirmed that amelogenesis occurs in distinct stages.[1] Each of these stages may be affected by extreme systemic physiological changes with hypoplasia, hypomineralization, or opacities of enamel. Mineralization begins at 15–21 weeks in intrauterine life in the incisor teeth, at 19–22 weeks in the canines, and at 16–22 weeks in the molars. Major disturbances before, or in the early period after birth may be reflected in the enamel of the primary dentition. Skeletal mineralization *in utero* is maximal in the last trimester. Of the 30 g of calcium typically present in the term infant's skeleton, 25 g will be laid down in this trimester. Calcium is deposited chiefly as hydroxyapatite. The higher rate of calcium accretion during this period of calcium deposition in the skeleton, and part of the period of enamel calcification of the primary teeth overlap. Following premature birth the infant is unable to match the intrauterine accretion rate of calcium, which predominantly resides in the skeleton. Indeed calcium intakes often only average 75 mg/kg/day, compared with the *in utero* accretion rate of 120–150 mg/kg/day. The level of skeletal mineralization can be assessed using photon absorptiometry at a single peripheral skeletal site.[2] This technique has demonstrated that infants of fewer than 32 weeks gestation at birth have gross reductions in bone mineral content (BMC) upon reaching full-term when compared with those born full-term.[3] Reductions in BMC have been found to be approximately 40–50% when related to age. Enamel defects in primary teeth have been described in preterm infants and have been linked to disorders of calcium metabolism, particularly to premature neonatal hypocalcemia, Vitamin D dependency rickets, or hypoparathyroidism.[4, 5] A study of 106 children born prematurely found enamel hypoplasia in 37%, chiefly in the maxillary incisors.[6] Seow et al.[7] showed that in very-low-birth-weight (< 1500 g) prematurely born children, the prevalence of enamel hypoplasia was 62.3%, and 27.3% in low birth weight (1500–2500 g) children, compared with 12.8% in controls. No one factor could be related to the primary tooth enamel hypoplasia, but laryngoscopy and orotracheal intubation also may contribute to developmental defects of the upper anterior primary teeth.[8–11] Early hypocalcemia is a poor guide to neonatal calcium homeostasis, since it is almost universal in preterm infants and is also temporary in nature. The question arose as to whether enamel defects — namely defects in dietary mineral supply — are related to osteopenia of prematurity, and whether a measure of the degree of osteopenia could be used to predict enamel defects. The purpose of this present study was to examine the relationship between enamel defects in the primary dentition and BMC in premature infants.

Materials and Methods

One hundred premature Caucasian babies cared for at the Clarendon Wing of the Leeds General Infirmary since 1984, who also underwent an estimation of BMC at 40 weeks, served as the study population.

Babies who were of 35 weeks gestation or less at birth had individual records of growth, nutrition, and mineral intakes in the newborn period. Forty nine children were available for examination, including 28 babies (the premature group) born between 25–35 weeks gestation and 21 babies (the control group) born at 38–40 weeks gestation. They were recalled for dental examinations at 2 years and 6 months from the time when they would have reached 40 weeks, or 3 years 3 months from the date of conception. Dental examination was performed under routine clinical conditions by one examiner. Ten per cent of the children were reexamined at a later appointment to test the reliability of the method and the reproducibility of the examiner. Teeth were examined wet with a dental mirror and probe under overhead dental light for teeth present, and hypoplastic and hypomineralized areas. Enamel hypoplasia was defined as a quantitative defect of the enamel surface, whereas enamel hypomineralization was defined as the presence of an area of enamel exhibiting a distinct white opalescence with no detectable structural defect using a method derived from that of Curzon and Spector.[12] The hypoplasia and hypomineralization were recorded using a coded system to allow for more than one defect occurring on the same tooth. Data recorded from the dental examination were analyzed with respect to the term BMC measurement. BMC investigations were performed within five days of the postconception age of 40 weeks in the preterm infants and within three days of

birth in the full-term infants. The bone mineral calcium measurement was made by measuring the bone mineral content of the midshaft of the radius using a photon absorptiometer. This gave an ash weight/unit length estimation with a standard error of 2.99 mg/cm.2

Results

Twenty-eight premature infants (14 female and 14 male) and a control group of 21 who were born at full-term (seven female and 14 male) were examined. The mean age at the time of dental examination was 33.5 months (± 2 months SD) for the premature group, and 31.5 months (± 1.5 months SD) for the control group. In the premature group, 24 of the 28 children examined had been intubated during the period immediately after birth, compared with only one control.

Birth weights of the premature children ranged from 725 to 2760 g with a mean of 1410.9 (± 456.2 SD), and for the control children ranged from 2650 to 4600 g with a mean of 3467.5 (± 543.5 SD). Bone mineral counts for the premature children ranged from 65.0 to 218.6 mg/cm ash weight with a mean of 118.4 (± 41.2 SD) and in the control children ranged from 181.0–235.8 mg/cm with a mean of 200.1 (± 14.3 SD). A linear correlation test showed r = 0.830 (t = 8.80 with 35 df). A highly significant result ($P < 0.001$) was found in the relationship between birth weight and BMC. Results are shown in the Table.

Table. Birth weights, bone calcium concentration, percentage completed eruption, mean arch width, caries prevalence, hypoplasia and hypomineralization in premature and control group babies.

	Premature (N = 28)	*Control (N = 21)*
Birth Weight (g)		
Mean	1410.9	3467.5
SD	456.2	543.5
Range	725 – 2760	2650 – 4600
Bone Calcium (mg/cm Ash weight)		
Mean	118.4	200.1
SD	41.2	14.3
Range	65.0 – 218.6	181.0 – 235.8
Completed Eruption (%) at 30 months	50	67
Mean Arch Width (mm)	25.0	27.5
Caries (#) (dmft)	2 (4; 11)	1 (2)
Hypoplasia (#)	21*	0*
Hypomineralization (N)	14†	2†

* Statistically significant difference at $P < 0.001$.

† Statistically significant difference at $P = 0.0036$.

A comparison of eruption completion (the percentage of children with complete primary dentition at examination) found 50% of the premature children, as compared with 67% of the controls, had complete eruption which was not significant (Chi-square/Yates correction = 0.51 [1df]). Fisher's Exact test was performed on the data for enamel defects. Hypoplasia occurred in 75% of the premature children compared with none of the controls ($P < 0.001$). Fifty per cent of premature children had hypomineralization compared to 9% of controls ($P = 0.036$). The relationships between BMC and enamel defects were tested using Spearman Rank Correlation Tests. The relationship between BMC and hypoplasia severity (taken as the number of teeth involved) was significant at $P < 0.01$ (rs = –0.43 with 36 df), and that between BMC and hypomineralization severity also was significant ($P < 0.01$ level, rs = –0.49 with 36 df).

Discussion

The values for BMC levels varied widely among the premature babies, and were significantly lower for the control group, and BMC values of the controls showed a much narrower range. This variation has been shown previously with respect to serum calcium levels in the first week of life,[6] and confirms the difficulty of interpreting the significance of these measurements when diagnosing and treating premature babies. The premature children showed a delay in the complete eruption of their primary dentitions. This may be due to the general delay in development of premature babies. Delayed eruption of the primary teeth has been reported previously,[13, 14] and it was found that when ages were corrected for the weeks of prematurity, there was no difference in ages when the primary dentition was complete. However, in the present study, which also has allowed for the weeks of prematurity, a distinct delay was detected in the premature group.

Hypoplasia and hypomineralization were recorded separately to determine if they occurred at the same site or at different sites on the tooth surface and to investigate the timing, type, and severity of the insult. Both of these conditions occurred significantly more frequently on the enamel of teeth in the premature children. As confirmed by several authors[9, 15] the hypoplastic defects found in this study were more common on the incisal edges of the upper anteriors, suggesting that these teeth may have been in the very early stages of mineralization.

Several authors[7, 11, 16] have suggested that laryngoscopy and/or the position of an endotracheal tube may provide enough pressure to disrupt the enamel structure since tooth germs are very close to the surface of a quite malleable alveolus. Twenty-four of the 28

(86%) babies in the premature group studied had been intubated immediately after birth (from minutes to 40 days). The defects recorded did not appear to favor the normal site of endotracheal tube placement and tended to be bilateral, so the pressure of the laryngoscope may be a more likely cause. Another possible explanation was that at the time of rapid development of this area of the tooth — after the removal of the protein — calcium and phosphates for mineralization were unavailable. Subsequent correction of the deficiency allowed the rest of the enamel to mineralize normally. The hypomineralized areas (opacities) occurred mainly on the buccal surfaces of the teeth and probably were caused at a later stage in enamel maturation. Systemic insult cannot be ruled out, but was questioned because most of the defects were not linear and thus had not occurred over the complete developing front of the enamel. The results showed marked differences between the two groups with regard to hypoplasia and hypomineralization. None of the control group of children showed any signs of hypoplasia of the primary dentition, but two had hypomineralization. When the relationships between BMC and hypomineralization and BMC and hypoplasia were investigated, it was found that both relationships were significant. The severity of the hypoplasia and hypomineralization in the premature group did not correspond exactly to the bone mineral content measurements. Further investigation should be completed with more subjects, grouping the babies into gestational age and bone mineral measurement.

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