Enamel Hypoplasia as a Prerequisite to Rampant Caries

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Enamel hypoplasia (EHP)

• Developmental Enamel Defects (DED)
  – Various forms of enamel defects seen
    • Linear
    • Pitted
    • Opaque (most commonly called hypoplasia)

• Decreased and flawed mineralization, surface irregularities
  – Colonization/retentive sites for cariogenic bacteria
  – Less resistant to acid attack

• Position and extent of defect corresponds time of insult
Hypoplasia vs White Spot Lesion?

Early Childhood Caries
California Dental Association
MOVING FORWARD. TOGETHER.

Early childhood caries (ECC), also known as baby bottle tooth decay (BBTD) is a preventable, infectious disease caused by certain types of bacteria (bugs) that live in your mouth. Bacteria stick to the film on your teeth called plaque. The bacteria feed on what you eat, especially sugars (including fruit sugars) and cooked

White Spots – Early ECC
Moderate ECC
Advanced ECC

Early – Moderate – Advanced - New definitions?
Conditions preceding EHP

- Malnutrition
- Low birthweight
- Prematurity
- Maternal illness
- Smoking
- Drug abuse
- Liver disease
- Other systemic diseases
Contributing factors to subsequent caries

- High sugar intake
- Mutans streptococci
  - Early colonization of EHP
  - MS dominate biota
  - Source?
- Poor oral hygiene
- Incisor crowding
- Difficulty with early detection by HCW
SEM scan S-ECC incisor
Prevention of ECC begins with intervention in the pre-natal and perinatal periods. Women should be advised to optimize nutrition during the third trimester and the infant’s first year, when enamel is undergoing maturation. Enamel hypoplasia is common in children with low birthweight or systemic illness in the neonatal period. There is considerable presumptive evidence that malnutrition/undernutrition during the perinatal period causes hypoplasia. A consistent association exists between clinical hypoplasia and ECC. Cariogenic bacteria (specifically mutans streptococci) may be transmitted to the child; decreasing the mother’s/primary caregiver’s/sibling(s)’ mutans streptococci ...............
Evidence supporting perinatal events predate EHP

• 37 published studies in literature
• 3 studies
  – Li et al., 1994
  – Needleman et al., 1994
  – Seow, et al.,
Antecedents and correlates of hypoplastic enamel defects of primary incisors

Howard L. Needleman, DMD  Elizabeth Allred, MS  David Bellinger, MD
Alan Leviton, MD  Michael Rabinowitz, PhD  Kirsten Iverson

• Macroscopic examination of 455 primary incisors from children having perinatal histories
• Enamel defects reported in 77% of children from "underdeveloped" countries. This study – 18.5% prevalence
• Antecedents to hypoplasia:
  • Delayed pre-natal care past first trimester (p < 0.007)
  • Premature labor (p < 0.004)
  • Prematurity (p < 0.001)
  • Special care nursery (p < 0.005)
  • Greater prepregnancy weight of mothers (p < 0.001)
  • Measles infection (p < 0.0008)
  • Smoking (p < 0.008)
Case-Control Study of Early Childhood Caries in Australia

W.K. Seow\textsuperscript{a}  H. Clifford\textsuperscript{d}  D. Battistutta\textsuperscript{c}  A. Morawska\textsuperscript{b}  T. Holcombe\textsuperscript{e}

• Case-control study of 617 Australian children age <4 yo
• S-ECC group receiving restorative treatment under general anesthesia
• EHP significantly higher among Aboriginal population
• Correlation to low household income, mother education, employment status (p<0.001)
• Significant risk indicators:
  • Enamel hypoplasia (OR 4.2)
  • Presence of \textit{S. mutans} (OR 4.8)
  • Sweeten drinks/diet (OR 4.0)
  • Mother's anxiety (OR 5.1)
• 25 percent of this racial group lives at the poverty level.
• American Indian/Alaska Native infants are 3.7 times as likely as non-Hispanic white infants to have mothers who began prenatal care in the 3rd trimester or did not receive prenatal care at all.
• American Indian/Alaska Native adults were 2.3 times as likely as white adults to be diagnosed with diabetes.
• American Indian/Alaska Native adults were 1.6 times as likely as White adults to be obese.
S-ECC?
Enamel Hypoplasia (EHP)
- pits -

EHP_Beijing, 1996
Linear enamel hypoplasia on primary incisors

EHP + Caries

EHP_Beijing, 1996
Caries over EHP lesions pattern!

EHP_Beijing, 1996
Prenatal EHP
The marked EHP affecting the 2/3 of the enamel on these maxillary primary incisors is evidence of a severe metabolic disturbance occurred probably during the 2\textsuperscript{nd} and 3\textsuperscript{rd} trimesters of pregnancy.

Neonatal EHP
The wide band of EHP affecting the primary teeth in this case was associated with preterm birth and a weight of approximately 1.3 kg. LBW immature babies suffer considerable metabolic disturbance during the neonatal period and this is often reflected in defective amelogenesis.

Rapp R. & Winter GB, 1979
EHP first, then caries

Brazil_ 1999
Primary central incisor crown
Primary central incisor crown from child with S-ECC

Neonatal lines in enamel and dentine

Carious enamel

EDJ
Neonatal line in dentine only

Primary central incisor crown from normal child
CROWN FORMATION
ENAMEL CROWN STRUCTURE

Appositional stage

Striae of Retzius

Perikymata

Imbricational stage

Enamel horns

Dentine

Prisms

Dentine horns

Dentine horns

Cross-striations

ENAMEL INCREMENTAL DEVELOPMENT

ENAMEL CELLS SHOW CIRCADIAN OSCILLATION

![Graphs showing CRY1 and PER2 mRNA levels over a 24-hour period with standard deviations indicated.](image)
Enamel prism orientation and direction of growth

Striae of Retzius and the instantaneous forming front

Enamel cross striations

Daily cross striations prism orientation and direction of growth
ENAMEL STRIAE OF RETZIUS

Striae of Retzius
ENAMEL STRIAE OF RETZIUS AND HOMININ BODY SIZE


Modern Human

Range: 6-12 days

♀ avg: 9 days

♂ avg: 8 days
Relationship Between Striae of Retzius Repeat Interval and BMR (ml O2/h) Among Primates

$\text{Basal Metabolic Rate (log)}$

Striae of Retzius Repeat Interval

$\text{r = 0.90, p < 0.001}$

$\text{Callithrix pygmaea, Callithrix jacchus, Saginus oedipus}$

$\text{Erythrocebus patas, Hylobates lar}$

$\text{Pongo pygmaeus}$

$\text{Papio anubis}$

$\text{Alouatta palliata}$

$\text{Pan troglodytes}$

$\text{Homo sapiens sapiens}$

$\text{Aotus sp., Saimiri sciureus}$

$\text{Alouatta palliata}$

$\text{Homo sapiens sapiens}$
ENAMEL INCREMENTAL GROWTH RATE VARIABILITY
RELATIONSHIP BETWEEN STRIAE OF RETZIUS AND PERIKYMATA

PERIKYMATA (SEM)
PERIKYMATATA
(CSOM)
ENAMEL SURFACE TOPOGRAPHIES ARE HAVENS FOR MICROBES