



# Neonatal Line as a Tool to Investigate Neonaticide Cases - A Review of its Genesis and Structure



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## Introduction

The death of a child is always a distressing event. When the child is a much wanted infant who dies close to birth, the loss is particularly poignant. There are, however, situations in which it is clear that the infant has died at the hands of an adult, usually the mother. In this case, the death is termed neonaticide, the killing of a newborn, as defined in the seminal paper by Resnick. The expression is usually applied when the death occurs within 24 hours of birth, although this definition can be flexible. It is this flexibility that sometimes causes disagreement over the status of the issue amongst forensic practitioners, and the subsequent difficulty of determining incidences and reasons for death and comparisons across cultures [1].

The brutal act of neonaticide, especially targeted against newborn female babies is a common practice in India. Most cases of neonaticide are not known to the outside world, and those cases which are brought before the law remain unproven due to lack of proper evidences. Forensic examination of the skeletonized remains belonging to the infants in the perinatal period is an enduring challenge in forensic medicine. The prime objective of forensic investigation in infanticide is to provide evidence against the claim of stillbirth. Distinguishing live birth from stillbirth would be a sturdy evidence to prove a case of "infanticide".

In many situations, the soft tissue components are decomposed and are not suitable for assessment of the details however the examination of developing tooth germs may provide a reliable answer pertaining to the fetal age, the possibility of a separate existence, and even the period of survival after birth [2].

## Genesis of Neonatal Line

Embryonal tooth enamel development starts in about the 10th week of pregnancy. In a circadian rhythm, appositional layers of organic enamel matrix are formed. Mineralization of the matrix, where hydroxyapatite units form alongside, wavy running enamel prisms is initiated soon after matrix secretion giving mature enamel an onion like appearance. At birth a well discernible layer

called neonatal line [NNL] is formed. NNL was first named in 1936 by Schour who described it as a distinctive incremental line in the enamel and a corresponding incremental line in the dentin [3].

The timing of birth is preserved in the enamel and corresponds the neonatal line. It is a predictable consequence of the birth process and occupies a characteristic position. It marks the event of birth. It is found in all deciduous teeth as they start to form enamel matrix in utero, and usually but not always found in earliest enamel formed of first permanent molar [4] sometimes in a mesiobuccal cusp of the first permanent molar [5]. The neonatal line is said to be caused due to decreased plasma calcium in first 48 hours after birth or could be due to trauma associated with birth [4]. It extends obliquely from surface to dentino-enamel junction. It is less densely mineralized and is said to be at a constant level within the tooth and shifts cervically as gestation is prolonged [6].

NNL separates pre and postnatal enamel and dentin and varies in location in different tooth types [7]. The thickness of prenatal enamel gradually grows from preterm to post term and consequently the location of NNL changes [6]. NNL makes up one measure of prenatal and postnatal development of a child. The presence and characteristics of NNL are particularly important in forensic medicine, in alleged infanticide with decomposed human remains because NNL is an evidence of live birth [5].

## Factors affecting Neonatal Line

Schour [7] suggested that Neonatal lines are caused by metabolic changes resulting from the experience that the infant undergoes at birth and during its neonatal life. So far, factors affecting amelogenesis in the formation of NNL and the variation in width are unknown [5,6]. However, in a study by Hurnanen et al. [5] NNL width was inversely proportional to the duration of the delivery. Accordingly a prolonged delivery process might inhibit the development of NNL [5].

Eli et al. [8] reported a significant association between NNL width and the mode of delivery, that elective cesarean sections

represented narrowest lines, assisted vaginal (breech, forceps or vacuum delivery) the widest, whereas the widths of NNL in spontaneous vaginal deliveries were in-between.

Witzel et al. suggested that the disturbance in amelogenesis is dependent of the intensity and duration of the stress factors. They introduced a theory that under the influence of stress, secretory ameloblasts cross three levels of thresholds depending on the strength of the stress factor;

Level 1: Weak stress factor- reduced secretory activity but still forms prismatic enamel with shorter incremental spacing.

Level 2: Strong stress- aprismatic enamel is formed.

Level 3: Strongest stress – secretion of ameloblasts totally or temporarily ceases [9].

Therefore stress during delivery might be a factor influencing the ameloblasts and thereby resulting in variations in the width of NNL.

### Structure of Neonatal line

Under light microscope, NNL is visible as a dark, sharpish band against the surrounding lighter enamel. In microradiograph analyses, both Weber and Eisenmann and Sabel et al. showed hypo mineralization in NNL. Maturation of enamel in NNL may continue to occur after it has formed, ending as equally mineralized as the surrounding enamel [10]. This continuous maturation can partly explain why NNL is not seen with its total length [5]. The line is usually slightly wider in the middle third of the crown length because the secretion rate of ameloblasts is bigger in this area of the crown wall [5,11]. Diffuse line was explained by Weber and Eisenmann to result from oblique cutting [5]. The width of NNL is reportedly from few  $\mu\text{m}$  to 30 $\mu\text{m}$  [5,6,8].

### Identification of Neonatal Line

Decalcified sections- NNL cannot be identified. Under Light Microscope- NNL is seen as a distinct dark line closer to the outer surface of enamel and parallel to the outer surface. Under Polarized Microscope- NNL appears as a distinct positive birefringent band. Under SEM- NNL appears as an indistinct scalloped or non-scalloped white line [2].



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### Conclusion

Neonatal line can be used as an important tool in the investigation of neonaticide cases which claim to be still births, as NNL being the live birth indicator. However the main limitation of using neonatal line for the assessment of postnatal survival of infants is that most of the infanticides occur immediately after birth, but a couple of days of survival are necessary before the neonatal lines could be detected. Further research on neonatal line is needed to understand the underlying mechanisms to overcome the limitations.

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