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Neonatal line on fetus and infant teeth☆
An indicator of live birth and mode of delivery

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ABSTRACT

Background: The neonatal line (NL) is an important issue in forensic odontology. It is the sign of a developmental birth defect, which is caused by the effect of metabolic stress on tooth structures when the fetus passes to extrauterine life.
Aims: The aim of this research is to determine the existence and thickness of NL in teeth, as it is a legal necessity to indicate the signs of viability at birth in a forensic examination of a fetus or infant case.
Study design and subjects: This research was conducted on 48 lower left and right lateral teeth, which were taken from 24 autopsy cases (46% female and 54% male). Left lateral teeth were sectioned in a vertical plane and right lateral teeth were sectioned in a horizontal plane. The NL thickness was measured with a scanning electron microscope (SEM). These cases comprised three conditions as: 70.3% normal birth, 16.7% caesarean sections, and 12.5% still birth cases under the legal and ethical permission.
Outcome measures: The mean NL thickness of normal birth cases was higher than caesarean cases as 7.7 μm and 2.5 μm, respectively.
Results and conclusions: The results showed a statistical significance between all birth conditions. NL does not exist in still birth cases ($p < 0.001$). Not only is the presence of NL a sign of live birth, but also its thickness is an indicator of the delivery mode where NL thickness of normal birth was found thicker than the caesarean cases.

1. Introduction

A forensic odontologist can find reliable identification evidence from the size, structure, and tissues of human teeth concerning the gender and age [1–4]. In particular, enamel tissue, which encompasses the dental tissues, is the hardest and the most resistant tissue of the human body [5,6]. Therefore dental structures are important in forensic dental identification, which resists post-mortem alterations [7]. The tooth development of primary dentition starts in the uterus with the mineralization of the incisor teeth, which begins between the 13th–17th weeks and ends with the root apex closure of molars at approximately three years after birth [8–14]. During this development, the enamel and dentin are structured by the enamel and dentin forming cells in a circadian growth rhythm of constant speed starting to form the enamel matrix in utero [14–17]. The formation of these structures is blocked by metabolic stresses in birth trauma and band-type deformation landmarks occur as an incremental enamel line, which is called the neonatal line (NL) when the fetus is passing from intrauterine to extrauterine life. As the NL forms, an irregular staircase type of degeneration is denoted, which occurs between the interruption and restart of ameloblastic secretion to form the enamel matrix, by the ending of the secretion of the ameloblasts, which shortly thereafter starts to produce the enamel matrix again, where the size and direction of the pre- and post-natal enamel prisms change [18]. It is stated that in 90% of all primary teeth, a distinctive line may be seen corresponding to the time of birth [19].

The NL is located between the pre- and the post-natal enamel in every primary tooth and the first permanent molars, which shows enamel and dentin development and preserves the time of birth in the enamel. The presence of NL extends from the enamel–dentin junction in the cervical third of the deciduous teeth toward the enamel surface. It is claimed that this mineralization defect is created due to the changes

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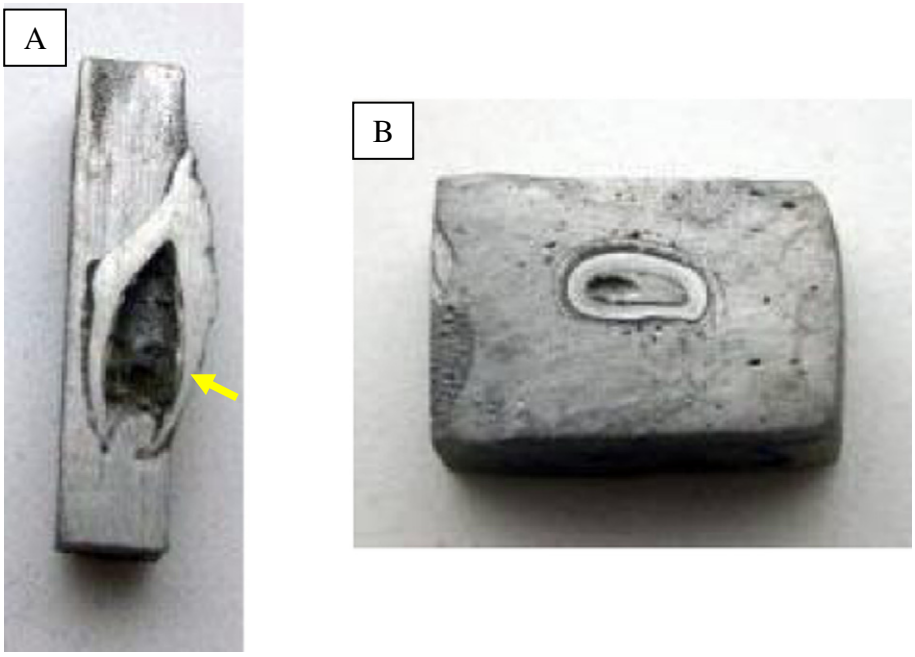

Fig. 1. Longitudinal (A) and transverse (B) ground sections of samples.

in nutrition and the environment of the newborn during the delivery process [18,20–23]. NL l]ocations can be investigated by scanning electron microscopy (SEM), X-ray micro analysis (XRMA), light microscopy, and micro-radiography [18]. The NL can be examined in vertical or horizontal tooth sections. This line appears as a ring in the horizontal plane and therefore it is called the Neonatal Ring (NR).

The aim of this research is to determine the existence of any developmental birth defects in fetus or infant teeth, and if such a sign of disturbance exists, then to examine its scope, format, size, and interpretation. As in the forensic examination of a fetus or infant case, it is required to determine whether the body was alive at the time of birth and if not, then it is legally necessary to determine the signs of viability even the body breathes once [24–26].

2. Materials and methods

This research was conducted as a pilot study in three centers: the Council of Forensic Medicine, the Ministry of Justice, University of Ankara, Department of Forensic Medicine, Forensic Odontology Unit, and University of Kirikkale, KUBTAL Electron Microscope Laboratory with legal and ethical permission (The Council of Forensic Medicine, number and date: B.03.1.ATK.0.01.00.08/237, May 30, 2006) and the Ethics Committee of the University of Ankara, Turkey: number and date: 103-2692, December 4, 2006).

In this research 48 lower lateral teeth were studied, which were taken from 24 fetuses and infant autopsy cases (46% female and 54% male). The numbers 72 and 82 (*according to FDI notation*) were taken from each case for vertical and horizontal sections, respectively, to determine and to compare the thickness of NL and NR. Each tooth pair was kept in different tubes containing 10% formaldehyde solution, marked with the case numbers and the specific delivery conditions [including 70.8% normal birth (n = 17 cases), 16.7% caesarean sections (n = 4 cases), and 12.5% still birth cases (n = 3)]. Samples were then embedded in acrylic blocks (*methyl methacrylate, which is an organic compound with the formula* $CH_2{=}C(CH_3)COOCH_3$) and prepared for SEM investigation according to the following procedures:

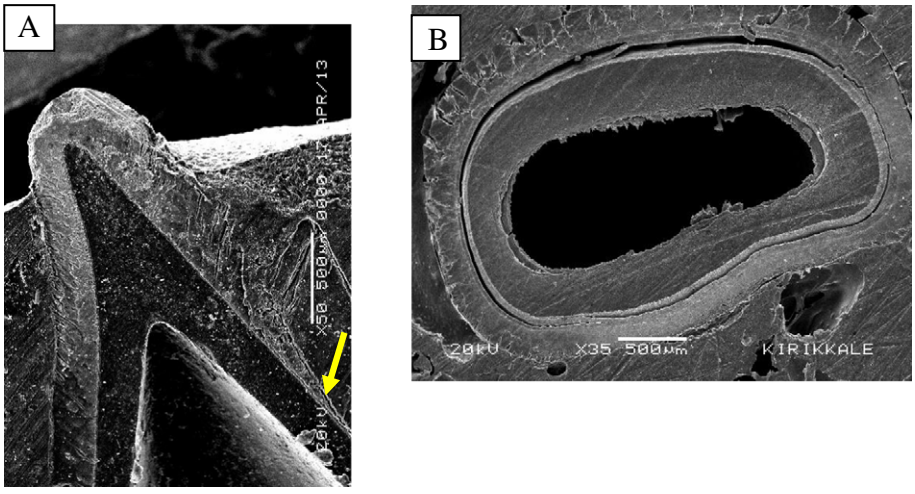

Fig. 2. The SEM images of a longitudinal sample (A) ×50 magnification and a transvers ground section of sample (B) ×35 magnification.