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Research Article

Histological Comparison of Amelodentinal Junction and Striae of Retzius in Donated Secondary and Primary Teeth

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Abstract

Adults have secondary teeth and children primary teeth. Covered by enamel, their crowns have dentin below that gives them volume. The embryological difference of these tissues creates a clearly defined amelodentinal junction [ADJ]. In secondary teeth, the enamel shows lower mineralization stages called striae of Retzius, which should also be visible in primary teeth. Our objectives were to compare the histological aspect of ADJ, its relationship with dentine structures and the striae of Retzius in both dentitions.

Material and Methods: Seven secondary and seven primary teeth were used [n = 14]. A cutting line was drawn on the enamel, then a groove was made with a metal disc to the dentin and the piece was separated by a quick blow with a sharp-edged tool. With an abrasion technique, a translucent sheet was obtained that was adhered to the slide. Using an optical microscope at lower magnification, the ADJ was classified in complete and non-complete. At higher magnification, in the non-complete part the cause was analyzed. The number of lines was classified in one and/or several and the thickness in thin and thick.

Statistical Analysis: Fisher's exact test and Chi-squared exact test 5%.

Results: In secondary teeth, the junction was 100% complete, crossed by dentinal structures that did not modify their vision; in primary teeth, only 14% were complete, showing the same grouped structures covering some sections. In secondary teeth, 71% had several lines, 57% thin, 14.5% thick and 28.5% not visible; in primary teeth, 57% had only one [p = 0.296]; lines with values of 43%, 43% and 14% respectively [p = 0.4654].

Conclusion: In secondary teeth, the ADJ was complete and dentinal structures did not hide it, in primary teeth they were grouped partly covering the ADJ. In secondary teeth, given the greater volume of the crown, there were several short periods of lower mineralization that produced more striae of Retzius, while in primary teeth there were shorter and longer periods producing thin and thick lines that modified their histological appearance.

Keywords: Incremental Lines; Embryological Origin; Mineralization; Human Dentition Secondary; Primary Teeth

Abbreviations

ADJ: Amelodentinal Juntion; NNL: Neonatal Line; OM: Optical Microscope

Introduction

In young people and adults we find permanent, secondary or permanent teeth. The crown of these teeth is formed by enamel, tissue of ectodermal origin, which covers it. Below, dentin, of mesodermal origin, gives it volume. Observed under an optical microscope [OM], these two tissues have different aspects, while the enamel shows several shades of brown, the dentine is lighter with grayish tones. These tissues are separated by a well-defined dentinoenamel junction [ADJ], a quality attributed to their different embryological origin. This can be observed in a single or in several layers and it is located where, during dentinogenesis and amelogenesis, the interdigitation of the hydroxyapatite crystals of both tissues occurs causing the strong anchoring of the enamel to the dentin [1]. In the ADJ we find dentinal structures that end in the enamel, they are dentinal penetrating canaliculi, dentinal spindles and Linderer tufts [2]. The first are dentinal tubules that cross the boundary. Their path in the enamel is short and their space would be occupied by an odontoblastic process whose length ends before arriving and the canaliculus crosses it empty; abound in cusps, incisal edges and lateral faces [2]. Adamantine spindles, short irregular tubes extending from the ADJ to the inner third of the enamel, numerous on cusps and incisal edges, are believed to act as receptors for sensory stimuli [1]. They are produced by the entrapment of the cytoplasmic prolongation of the odontoblast during the first stage of amelogenesis and its subsequent mineralization [1-3]. The Linderer tufts are structures similar to an external arborization with a common end united at the ADJ [2-3]. They are produced by contractions of the prisms during mineralization whose pods are widened by water loss [1-3]. Under an optical microscope, in the cusp area other structures are observed, similar to brownish spherical caps, which run from an ADJ to the opposite side of the same cusp. On the other hand, in the free and proximal faces of the teeth these structures are arranged as ascending arches located between the ADJ and the outer edge of the enamel. Both structures represent periods of minor amelogenesis and are referred to as striae of Retzius [2-3].

In the oral cavity of children, from 6 months to 3 years old, we find dental pieces called primary, temporary or deciduous. For a long time they were incorrectly considered expendable, but they play an important role in chewing and preserving the space for secondary teeth eruption [4]. Their hard tissues do not differ in embryological origin or in the name of their structures from the permanent ones, but they differ in size and color [4]. The permanent ones have greater volume and their enamel shows a yellowish color due to a more calcified dentine, on the other hand the primary ones are small and their color is bluish white due to lower calcification [1-3]. This fact was corroborated by an investigation, where the chemical composition of enamel in primary and permanent human teeth was compared and a greater difference was found in the proportion of calcium in the latter [5]. Due to their resemblance to the secondary ones, the ADJ and the dentinal structures should be similar to those described in secondary teeth.

In the inner zone of the crown of primary teeth, adjacent to the ADJ, the enamel deposited during the intrauterine stage, called prenatal, is described and in the exterior, the postnatal is deposited. While the former is formed from maternal metabolism and is of higher quality, the latter depends on the quality of the child's diet. The boundary between the two is evidenced by a neonatal line [NNL] separating them. This line is similar to a prominent Retzius line and marks the moment of birth. In addition, it is claimed that lines and striae are uncommon in these teeth [1-3].

It was found that embryologically, the periodicity of striae of Retzius in temporary teeth ranged from 5 to 6 days and that this rhythm of amelogenesis did not differ from the incisor and molar on the same individual [6]. It has also been proven that the thickness of this line is sensitive to external factors during the gestation period. One of these factors would be the intake of spasmolytic drugs, which reduces the thickness of the line [7]. An Australian investigation determined that children whose mothers consumed alcohol during pregnancy had thicker NNL compared to children whose mothers abstained [8]. In addition, other external factors were not readily explainable, such as the fact that children born during summer and spring had a thinner NNL than children born in winter [7]. Escobar Muñoz described neonatal Retzius lines as an optical phenomenon when viewed with a light microscope. He attributes it to the hypoglycemia that occurs during the first few days after birth when the mother's metabolic intake is replaced by breastfeeding [9].

Our objectives were to analyze and compare the histological aspect of the ADJ, its relationship with dentin structures and the appearance of the striae of Retzius in both dentitions. Data were analyzed with Fisher's exact test and Chi-squared exact test with a significance level of 5%.

Material and Method

To carry out this basic research work we used fourteen teeth. Seven secondary incisors, canines and premolars, homologues to seven primary incisors, canines and molars of anonymous patients, donated by students of the Department of Anatomy, Histology and Embryology. Due to the way they were obtained, authorization by the Institute's Ethics Court was not required to proceed with the work. With a fine point marker, we drew a line in the middle of the vestibular face of each crown and continued in a lingual or palatine direction. With a fine grain metal disc at low speed, we made a groove along the line to the dentin. On it, we placed a cutter knife and split the tooth with a quick blow obtaining two approximately equal halves. One half was prepared with an abrasion technique, rubbing it on stones of coarse, medium and fine grain, always wet, until we obtained a translucent sheet (Figure 1), which was adhered to the slide with lacquer and prepared for observation under an optical microscope (Figure 2).

Figure 1: Abrasive element, marked tooth ready to groove.

Figure 2: Finished sample, ready for OM.

At lower magnification, the AD junction was classified as complete, when it was visible in all its length, and incomplete, when it presented visible and other non-visible sections. At higher magnification, in the non-visible section of the boundary, the cause that prevented its visualization was analyzed. In the thickness of the enamel, we observed the number of striae and classified them as one or several, and their thickness as fine or coarse.

Results

At lower magnification, in permanent teeth, the ADJ was well defined and 100% complete (Figure 3); in primary teeth, it showed the same characteristics only in 14%. The majority, represented by 86%, showed a well-defined boundary in part of their contour and in other relatively large sections, it was thickened and covered, therefore we considered it incomplete (Figure 4).

Figure 3: Secondary tooth with well-defined amelodentinal junction.

Figure 4: In primary, covered and incomplete contour.

At higher magnification the ADJ in 100% of secondary teeth was occasionally crossed by dentinal structures but was not hidden, as we see in (Figure 5 to 7) below.

Figure 5: Dentinal canaliculi.

Figure 6: Adamantine spindles.

Figure 7: Linderer tufts.

On the other hand, in primary teeth, where the ADJ was incomplete, we focused on the non-visible sector and in 100% we found the same dentin structures but occupying relatively large sections, partially hiding the boundary which was observed with difficulty, as demonstrated in the photographs of (Figure 8 to10) below.

Figure 8: Canaliculi and tufts.

Figure 9: Adamantine spindles.

Figure 10: Linderer tufts.

In permanent teeth the Retzius line as a single structure was observed in 29% and as several in 71%; primary showed a single one in 57%, coinciding with the description of the NNL and in 43% more than one, although there is no statistically significant evidence to believe there is a relationship between the type of tooth [Primary / Secondary] and the number of striae ks [p = 0.296]. The histological characteristics are observed in figure 11 and 12; and below, its statistical representation in graph 1.

Figure 11: Secondary tooth, Retzius line.

Figure 12: NLL and narrow Retzius line.

Graph 1: Number of retzius striae in primary and secondary teeth

In permanent teeth, the thickness of the Retzius lines was thin in 57%, thick in 14.5% and non-visible in 28.5%. In primary teeth, the values were 43%, 43% and 14% non-visible, respectively, although there is no statistically significant evidence to believe that the thickness of the striae is related to the type of tooth [p = 0.4654]; data in graph 2.

Graph 2: Thickness Of Retzius Striae In Primary And Secondary Teeth.

Discussion

The origin of the ADJ is established during the first stages of morphogenesis with the basement membrane located between odontoblasts and ameloblasts before the start of the respective mechanisms of dentin and enamel mineralization. Then, the calcification of these tissues causes the anchoring and assembly of their hydroxyapatite crystals, indicating their presence in primary and permanent teeth as described in the research literature [1-3]. This connection is not rectilinear, rather it is formed by concavities or small pits that give it a scalloped appearance. We observed it as such in histological sections of the secondary teeth included in our work, coinciding with the literature [1-3].

Regarding the ADJ of the primary teeth in our study, its description agrees with the literature consulted in the places where it is visible [1-3]. But although it is distinguishable, its contour was not uniform, it showed some thickened sections, others hidden by grouped dentinal structures and we even found breaks and overlays not attributable to the technique for which there was no related research that would allow us to establish comparisons. We believe that external factors were added to the lower calcium content, common in these teeth, which modified the relationship between both tissues [5,6,9]. This could have permitted the advance of structures on the enamel that had hidden variable sections of the AD junction.

In regards to the striae on secondary teeth, they were arranged in an orderly manner, as Mahoney described in his quantitative study of the incremental lines retained in the enamel during the formation of the crown of the first permanent mandibular molar [10]. They were also numerous, in direct relation to the higher volume of the crown enamel and its thinness indicates that there were several periods of lower mineralization but they were short. On the other hand, in the primary teeth, the existence of a single large stria of Retzius was found, coinciding with the neonatal line described by Gomez de Ferraris [3] and Mahoney [6,10]. However, we did not discriminate between NNL and striae, although we think that the difference in their thickness could reduce hardness. In this concept we agree with Jaana Hurnanen, a researcher who studied the prevalence of NNL in deciduous teeth looking for a possible association with external factors that affect its thickness. He proposes that its width would have a strong impact on the microstructure of the enamel, making it weaker the wider it is [11].

It has been proven that the thickness of this line is affected by alcohol consumption. Mothers who consumed alcohol during pregnancy had children with NNL of a width greater than usual and weak and hypo mineralized teeth [8]. On the other hand, a smaller NNL appears as the result of a spasmolytic intake during pregnancy [7]. In our primary teeth, the thickness of the striae was divided equally into thin and thick. We did a qualitative assessment and we did not measure their width, but we have provided histological data. The matter is that these are periods of a lower degree of enamel calcification in both permanent and primary teeth and this fact reduces the chemical, physical and functional properties of the dental pieces, compromising the hardness and mechanical function of the teeth, as Durso and team would verify in analyzing the enamel microstructure in relation to the microhardness and chemical composition, finding that the average values of Vickers microhardness and calcium content of the enamel were higher in permanent teeth compared to temporary teeth [5]. Since our primary teeth already have lower calcium content, having wide striae could lead to a weak or hypo mineralized enamel in accordance with Durso and collaborators.

Hypo mineralized enamel presents a deficit in the formation of hydroxyapatite and although its volume is normal, its consistency is not as hard. Clinically, the striae of Retzius are prominent and the crown surface shows a chalk-white stain that may be small or generalized, it can affect one or all of the dental pieces, effects we did not observe on the surface of our primary crowns. It can be caused by genetic mutations, birth traumas, nutritional deficiencies, lack of vitamin D, infections, traumatisms [12], causes we did not investigate. However, this finding led us to study the matter in order to decide how to clinically approach the restoration of this type of enamel in patients, but the conclusions of researches did not add clarity to the problem [11-13].

We realize that since these donated dental pieces belonged to anonymous subjects, we lack information that could be considered useful. It is therefore possible that maternal factors unknown to us might have contributed to their histological aspect. Among them, an acute lack of calcium during pregnancy or an illness of one of the parents compromising the calcium metabolism or genetics of the child that could have affected the histological structure of the primary teeth studied [11-12]. These data were not included because it was not available to us, our contribution is histological.

Consequently, we suggest studying this topic further with a clinical orientation, expanding the information with maternal data and avoiding the study of teeth of anonymous origin to verify whether or not these results are repeated.

Conclusions

The dentinal boundary was complete, crossed by dentinal structures that did not change throughout its length, in permanent teeth.

In temporary teeth, it was incomplete and the boundary did not show the clearly defined aspect that characterizes it, because these structures crossed it in a grouped fashion, hiding part of its contour.

The permanent ones had a greater number of striae due to their greater volume and the succession of more than one short period of lower mineralization during the formation of their crown.

In permanent and primary teeth slender striae predominated, although one group showed shorter and longer periods of lower mineralization causing thin and thick striations that modified their histological appearance.

This topic should be researched further to corroborate our findings.

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Conflict of Interest

None Own resources.

Contribution of Authorship

Participation of all authors in the review and writing of the article.

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