Histomorphology of attrition in temporary teeth

Lezcano, Melisa R.*; Solis Arce, Elena P**.; Gili, Maria A.***; Zamudio Maria E.****

Abstract

A research project was conducted at the School of Dentistry of the National University of the Northeast, Corrientes, Argentina. The histologic features of the enamel and dentin of temporary teeth under the physiological process of attrition were studied. For this study 25 temporary teeth were obtained from patients attending the Pediatric Dentistry Department for dental care. Samples were categorized and classified according to a modified version of Gerasimov's tooth wear scale. The teeth were processed using the technical wear approach for observation through a microscope. It was determined that 48% of cases showed grade I wear, 36% grade II wear, and 16% grade III wear. In cases where only the dentin was affected, the section of the enamel prisms was observed. When both the enamel and the dentin were affected, reaching grade II and grade III wear levels, cases of both sclerotic dentin and dead tracts were observed.

Keywords: dental wear, prisms, sclerotic dentin.

* Dentist, Research Trainee, Secretariat of Research in Science and Technology; Assistant Professor at the Histology and Embryology Department. Universidad Nacional del Nordeste. Argentina.

** Dentist, Research Trainee, Secretariat of Research in Science and Technology; Assistant Professor at the Biomaterials Department. Universidad Nacional del Nordeste. Argentina.

*** Dentist, Specialist in University Education and Management. Associate Professor at the Histology and Embryology Department. Universidad Nacional del Nordeste. Argentina.

**** Dentist, Masters Degree in Methodology and Research. Professor at the Biomaterials Department. Universidad Nacional del Nordeste. Argentina.

Received on: 14 Jun 14 - Accepted on: 25 Jun 15

Introduction:

Human beings experience two types of dentition, the deciduous one, which undergoes a process of physiological resorption, and the permanent one, which does not. The temporary or deciduous dentition consists of 20 teeth, with sets of incisors, canines and molars (Fig. 1). The primary dentition must be complete at approximately 3 years of age and remains "unchanged" for about 4 years. (1)

Fig. 1. Temporary dentition

Loss of enamel is the first consequence of wear resulting from attrition. Recent studies have found that the average value of enamel hardness in permanent teeth ranges between 3.1 and 4.7 gigapascals (GPa). The corresponding hardness of permanent tooth enamel in the Mohs scale is 5. The dentin of primary teeth is slightly less hard than that of permanent teeth. Tooth tissues exhibit several differences, and even though the process of odontogenesis is basically the same, formation times are shorter for the deciduous dentition (1-3). Despite the fact that these teeth last only 5 to 10 years, they undergo great changes during this brief period, of which attrition is one of the most notable characteristics.

The enamel of temporary teeth is structurally made up of the same tissues as permanent teeth, but with some differences and peculiarities. The enamel thickness of deciduous teeth is half of that of permanent teeth, and varies across the different areas of the crown. The hydroxyapatite crystals of tooth enamel are arranged in small groups, forming the prisms; the peripheral edges of immature prisms are partially surrounded by a non-crystalline section of this matrix called prism sheath (3). These prisms resemble drops of water, due to the long and fine shape of their tails. There are tiny areas of water content that make up 0.1% of healthy enamel, which grow in size and number as early enamel caries progresses (1, 2). Regarding dentin, it should be noted that the center areas of the crown and the root are harder in permanent teeth than in temporary teeth, whereas the rest of the dentin, in both kinds of teeth, shows no difference in hardness. Dentin is also less thick in primary teeth than in permanent teeth, which is related to the size of the pulp chambers. Tubules in the dentin areas close to the enamel are narrower, and this is where the changes that tend to obliterate them take place. As a consequence of the apposition of peritubular dentin, dentinal tubules become increasingly narrow throughout life. This is why defensive responses to lesions in the enamel or direct lesions in the dentin give rise to regressive disorders with dentin sclerosis phenomena, called dead tract dentin or translucent dentin. Attrition is the wear, or physiological and mechanical process, experienced by teeth when chewing, speaking or swallowing. It is normal, natural, and many times it is related to the age of the patient. It occurs on incisal and occlusal surfaces (which are constantly in contact) and on interproximal surfaces (when teeth are moved). This takes place without the mediation of any product, unlike other dental tissue loss processes, such as erosion or abrasion.

Temporary teeth show increased attrition because they are less mineralized than perma-

nent teeth and their surface is more porous, which makes them less resistant to abrasion and attrition. Studies suggest that this type of problem is not only connected to stress, but that it also depends on other factors, such as age, sex, diet and harmful habits. Movement of the teeth and occlusion anomalies, or the clash between surfaces that are usually separated, are consequences of the loss of dental tissue due to the contact of teeth (2-5).

Bruxism is a common habit during the mixed dentition stage, and there are children who also develop bruxism patterns in the arches, which can even flatten their temporary teeth. Correct tooth wear, on the other hand, determines the correct growth of the maxillae, as well as the location of the permanent teeth in the dental arch and an adequate occlusion (4-8). The wear technique is used for microscopic observation and for studying the dental enamel. The structure of a tooth obtained with the wear technique that preserves the architecture of the tooth by not subjecting the tooth to decalcification was analyzed in particular. This technique includes the progressive and sequential wear of a tooth, in order to obtain thin sheets, measuring between 15 and 30 microns. This enables the light emitted by the optical microscope to go through. Changes caused by attrition in the hard tissue of temporary teeth, unlike those occurring in permanent teeth, are hardly ever mentioned in published papers or in the reviewed literature.

The general goal of the research was to identify the histologic and morphologic changes in enamel and dentin using the wear technique on temporary teeth with attrition. The specific goals established were to apply the wear technique to temporary teeth with attrition and to identify the histologic and morphologic changes in enamel and dentin.

Materials and methods

25 temporary teeth were obtained from 20 patients who came to the Pediatric Dentistry Department of the School of Dentistry, Universidad Nacional del Nordeste located in the capital of Corrientes, Argentina, for dental care. The patients considered were children aged between 4 and 12, of both sexes, whose clinical records were prepared, including their family history and diet chart, and the odontogram was filled in. The tooth was photographed before extraction and the written informed consent of a parent or guardian was requested. The sample was processed and identified with the following information: patient identification, date, material obtained, method used to obtain it, clinical data. Samples were fixed using physiological saline solution in order to prevent dessication and loss of properties. The following details were recorded before processing the samples: tooth organ, affected surface of the tooth and extent of attrition measured in millimeters. Most of the teeth obtained were from the anterior sets of teeth, which was deemed normal, taking into account that the age of the patients that come for dental care to the Pediatric Dentistry Department ranges between 4 and 7 years of age. This is consistent with the exfoliation period of these organs, unlike the other groups of teeth. The degree of attrition of each tooth and group of teeth was determined, with attrition being defined as the physiological tooth wear resulting from the contact between teeth during mastication. The teeth were classified according to a modified Gerasimov's tooth wear scale, as agreed by the work group, in which degrees 1, 5 and 6 of the original scale were not taken into account because they were deemed to be irrelevant for this research, since grade 1 is for absence of wear, grade 5 for a fully exposed crown and 6 for absence of dental crown

(completely worn off). Due to the above, the Gerasimov scale used in this study was modified taking into account the observed tooth wear, and ranges between grade I and III, as shown in Fig. 2.

Grade I	Enamel wear
Grade II	There are isolated spots of exposed dentin
Grade III	Concave surfaces of the exposed dentin are observed

Fig. 2. Modified Gerasimov's tooth wear scale

The teeth were hemisected to obtain two histologic specimens from each sample. The hemisection was made using a disc with carborundum at a low speed, starting at the periphery of the teeth (Fig. 3). The hemisected teeth were worn down to thin sheets, measuring between 15 and 30 microns, using Arkansas stones. The sheets were then placed on slides and covered with coverslips.

Fig. 3. Tooth hemisection procedure

The histologic specimens obtained were classified according to the scale mentioned above, and analyzed using an optical microscope at different magnifications: 10x, 20x and 40x (Figs. 4-8).

Fig. 4. 20x microscope image of enamel in a tooth with grade I wear

Fig. 5. 20x microscope image of dentin in a tooth with grade I wear

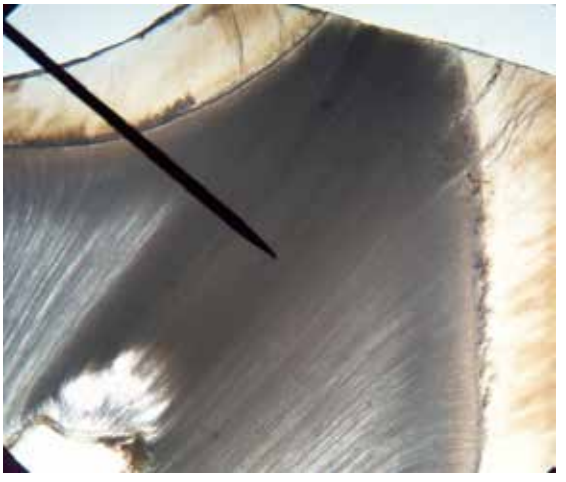

Fig. 6. 20x microscope image of dentin in a tooth with grade II wear

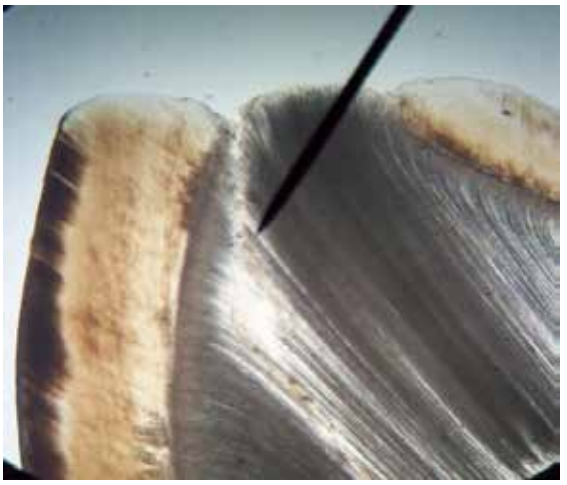

Fig. 7. 20x microscope image of enamel and dentin in a tooth with grade III wear

Fig. 8. 40x microscope image of enamel and dentin in a tooth with grade III wear

Results

48% of the teeth analyzed showed grade I occlusal/incisal wear, 36% showed grade II wear and the remaining 16% showed grade III wear, according to the modified Gerasimov's scale (Fig. 9). The wear on the proximal surfaces of all groups of teeth was classified as grade I.

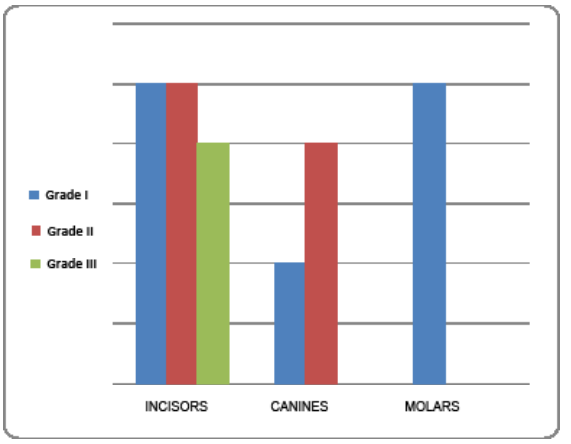

Fig. 9. Tooth wear distribution (occlusal/incisal) according to the modified Gerasimov's scale

The enamel wear of teeth with Grade I wear was examined macroscopically on the occlusal/incisal surface, which showed microfractures that can be seen under white light. The areas of attrition appeared as polished and shiny surfaces when they only included enamel. The section of the enamel prisms of teeth with grade I wear was observed under the optical microscope at 20x magnification (Fig. 4). Dentin was translucent and yellowish, due to the deposit of peritubular dentin obliterating the dentinal tubules, all of which is consistent with sclerotic dentin (Fig. 5). In the cases where attrition only reached the enamel, the section of the adamantine prisms observed was consistent with tissue that does not respond to any stimuli. The presence of reactive or defensive dentin was observed. The microscopic examination of the teeth with grade II wear, according to the modified scale, showed discontinuities on the enamel on the areas closest to the outer tooth surface, and the peripheral areas of the dentin showed wear in small spots (Fig. 6). The teeth with grade III wear showed exposed dentin, and a central opaque yellow concavity surrounded by irregularly worn enamel which was visible to the naked eye. Sclerotic den-

tin was observed in the periphery, and dead or devitalized tract dentin was observed in the center of the teeth under the optical microscope at a 20x magnification (Fig. 7). At a higher magnification (40x), it can be seen that the dentinal tubules were empty, covered in germs and organic residue from the mouth (Fig. 8). They seemed dark due to the contamination with the wear technique material and the balm used to prepare the histologic specimen. Dead tract dentin was visible with 20x and 40x magnification due to the fact that the wear took place in a short period of time and there was no time for the odontoblasts to retract. However, some teeth showed both types of dentin.

Discussion

The significance of dental attrition in establishing an anatomically functional occlusion, in order for the teeth to be in correct occlusal relations (9) is recognized. The analysis of the results showed a correlation between the increase in the degree of attrition and the age of the patient. There are clear signs of attrition in the deciduous dentition stage, during which half and up to two thirds of the original height of the dental crown can be lost, after the normal exfoliation period has passed and it remains in the mouth. Tooth wear begins on the lateral surfaces of the crowns, not on the occlusal surfaces. The estimation of a person's age based on tooth wear is not conclusive, since there are sections that are worn down at different angles and rates. On the other hand, there are pathological processes associated to attrition, such as bruxism: continuous and excessive contact of the teeth due to parafunctions of the stomatognathic system. Bruxism is associated with changes in the sensory system (stress), although a clear direct cause is yet to be identified. Some studies suggest that wear could also be connected to the biochemistry of saliva, and the degree of hardness of the enamel (10).

The direct correlation between the amount of worn down dental tissue and the rate at which the tooth is worn down must be taken into account, as it is a sign of the fact that the maxillae are growing adequately and, therefore, that occlusion is evolving correctly. During the microscopic examination we found sclerotic or translucid dentin, which, according to some authors (4), is only produced in the presence of the odontoblast processes that secrete the matrix inside the lumen of the tubules (Fig. 7). The formation of sclerotic dentin is a defense mechanism for compensating the regional loss of surface dentin. Its quality and quantity are connected to the duration and intensity of the stimulus. Therefore, if it is formed quickly, the tubular pattern will be irregular and there can often be odontoblasts included. Exposure of the pulp and dentinal sensitivity are not common because loss of the tooth structure is slow, thus enabling the apposition of the secondary-reparative dentin (10). No variation was found in the direction of the dentinal tubules. The analysis of the dentin during noncarious processes has shown that the variability in the irregular or atubular dentin is not related to the type of harmful stimulus or to the destructive process of teeth, although a mild change in its path has been detected.

Conclusion

Attrition on the incisal edges and occlusal surfaces in temporary teeth is apparent during the exfoliation period. Moderate attrition is deemed to be an integral part of the functionality of teeth. This study enabled us to observe the changes or alterations experienced by the hard tissues of deciduous teeth during

the transition: a) enamel is worn down progressively without reaction to stimuli because it is an avascular and acellular tissue, b) dentin, which is a tissue that responds to stimuli, showed the formation of sclerotic dentin and dead tracts, depending on the location. In teeth which had passed the exfoliation period and had not been replaced, the wear and the lack of tissue was even more notable. The tooth wear technique was effective for carrying out the microscopic assessment of the specimen, because only the hard tissues were observed.

It is worth noting that the patient's diet history was recorded as part of this study, but the correlation between the diet and the type and degree of tooth wear was not analyzed (even though the influence of the diet on the wear pattern is well known). We also identify the need to replicate this study using histologic techniques that will make it possible to observe the organic tissues of the teeth.

References

1. Escobar Muñoz F. Odontología Pediátrica. 2nd ed. Caracas: Amolca, 2004. p57-68, p411-431.
2. Bernier J. Tratamiento de las Enfermedades Orales. Buenos Aires: Editorial Libreros, 1962. Chapter 8. p185-189
3. Machado Martinez M, Hernández Rodríguez JM, Grau Avalos R. Estudio clínico de la atrición dentaria en la oclusión temporal [Internet] Rev. Cubana Ortod. 1997; 12(1): 6-16. Cited: 2015 Jun 16. Available from: http://bvs.sld.cu/revistas/ord/vol12_1_97/ord02197.htm
4. Bhaskar SN. Patología Bucal. 2nd ed. Buenos Aires: El Ateneo, 1997. Chapter 5. p107-115
5. Dawson PE. Evaluación y Diagnóstico de los Problemas Oclusales. Barcelona: Mundi, Salvat, 1997 Chapter 1. p17-27
6. Ash Major M, Nelson Stanley J. Anatomía, Fisiología y Oclusión Dental. 8ed. Editorial Elsevier, 2004. Chapter 1. p8
7. Boj JR, Catalá M, García-Ballesta C, Mendoza A, Planells P. Odontopediatría: la evolución del niño al adulto joven. 4th ed. Madrid: Ripano, 2011. p27-56
8. Mateini M, Moles A. Ciencia y Restauración: método de Investigación. Madrid: Nerea, 2001.
9. Cawson, RA, Odell EW. Pulpitis, periodontitis apical: resorción e hipercementosis. In: Fundamentos de Medicina y Patología Oral. 8th ed. Barcelona: Elsevier, 2009.
10. Acuña Ramos CP. Clasificación de la caries. In: Odontopediatría Cariologia; Bogotá D.C. – Cited: 2013 Apr 23. Colombia. Available from: http://www.virtual.unal.edu.co/cursos/odontologia/2005197/capitulos/cap2/265.html.
11. Goldberg M, Lasfargues JJ. Pulpo-dentinal complex revisited. J Dent. 1995; 23(1):15-20.
12. Latorre C, Pallenzona M, Armas A, Guiza E. Desgaste dental y factores de riesgo asociados. Rev. CES Odontología 2010; 23(1): 29-36.
13. Rodríguez-Flórez C. Asimetría del Desgaste Oclusal Bilateral en Dentición Permanente y su Relación con la Paleodieta en una Sociedad Prehispánica de Tradición Cultural Sonso en Colombia. Rev. Fac. Odontol. Univ. Antioq. 2009; 21(1): 65-74.
14. Cuenca Salas E, Baca García P. Odontología preventiva y comunitaria. Principios, métodos y aplicaciones. 3rd ed. Barcelona: Masson, 2005.
15. Gómez de Ferraris ME, Campos Muñoz A. Histología, Embriología e Ingeniería

tisular bucodental. 3rd ed. Mexico: Panamericana, 2009
16. Lynch M., Raphael S., Mellor L., Spare P., Inwood M. Métodos de laboratorio. 2nd ed. Mexico: Interamericana, 1972.
17. Orban B. Histología y Embriología bucal. 4th ed. Mexico: Editorial La Prensa Médica Mexicana, 1980.
18. Regezi, JA, Sciubba JJ. Patología bucal. 3rd ed. Editorial Mc Graw-Hill Interamericana, 2000.
19. Sapp PJ, Eversole LR, Wysocki GP. Patología oral y maxilofacial contemporánea. 2nd ed. Madrid: Elsevier, 2005.
20. Shafer WG, Hine MK, Levy BM. Tratado de patología bucal. 4th ed. Mexico: Interamericana, 1987.
21. Nelson SJ, Ash MM. Wheeler anatomía, fisiología y oclusión dental. 8th ed. Amsterdam: Elsevier/Saunders, 2004.

Melisa Raquel Lezcano: mlezcano@odn.unne.edu