Attrition: aging of tooth shape, interdental spacing and its meanings

Alberto **CONSOLARO***
Leda **FRANCISCHONE****
Renata Bianco **CONSOLARO*****

Abstract

Attrition may explain some of the alterations that occur after months or years of rehabilitation treatment, since it causes changes in shape and mesiodistal and occlusal-apical size of dental crowns, changing their position and relationship with dental implants. Dental attrition may: 1) represent a sign of occlusal maladjustment; 2) suggest the existence of parafunctional habits such as clenching and bruxism; 3) reduce the circumference of the dental arch because the proximal dental contact points turn into wear facets over the years; 4) age the mouth due to some morphological details that vary with age, namely: absence of serration caused by smoothing of the incisal edge until the dentin appears and a dark yellow line can be seen between the buccal and the incisal enamel of incisors and canines; 5) worsen aging caused by dental crowding; 6) aggravate aging by causing loss of facial vertical dimension; 7) be associated with diastemata between osseointegrated implants and natural teeth a few years after rehabilitation treatment is finished.

Keywords: Tooth wear. Demastication.

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Contact address:

Alberto Consolaro
consolaro@uol.com.br

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* Full professor, Department of Pathology, School of Dentistry — University of São Paulo/Bauru and Postgraduate Department, School of Dentistry — University of São Paulo/Ribeirão Preto.
** PhD in Oral Pathology, School of Dentistry — USP/Bauru.
*** Professor, FAI.

» The patient displayed in this article previously approved the use of her facial and intraoral photographs.

The beginning

Maintenance of healthy teeth and oral rehabilitation that reproduce teeth functional and esthetic patterns increase patient's requirements as they tend to have more detailed questions about teeth positioning, color, size and shape.

Some names and concepts such as attrition, abrasion, abfraction and erosion seem to be similar, which explains the confusion set among them. This may hinder one to take preventive measures in case of rehabilitation treatment with or without dental osseointegrated implants.

Attrition may explain some of the alterations that occur after months or years of rehabilitation treatment, since it causes changes in shape and mesiodistal and occlusal-apical size of dental crowns, changing their position as well as their relationship with the dental implants. Diastemata between natural teeth and adjacent implants as well as anterior mandibular crowding are among those alterations.

"Tribology" is the science that studies wear, friction, lubrication and corrosion in Materials Engineering, especially in Metallurgy. The concepts of Tribology for attrition, abrasion and erosion are not equivalent to those applied in Dentistry. In Metallurgy, for instance, abrasive wear is known as "erosion", whereas wear caused by chemical or electrochemical action is known as "corrosion". In Dentistry, the widespread use and sedimentation of concepts for more than a century hinder changes and adaptations in the concepts employed by Tribology. Thus, the concepts employed in this article for wear and loss of mineralized dental tissue cannot be extended to materials, especially metals.

In previous articles,[3,4,6-11] we described the concept, history, pathophysiology, clinical characteristics and therapeutic implications of "mineralized dental tissue lesions induced by physical and chemical agents" so as to contribute to sediment more precise and specific concepts about each one of these alterations. In this article, some paragraphs are literally the same as those found in the aforementioned articles. However, other parts are specifically geared towards dental implant practice.

In oral rehabilitation, what does attrition represent to planning, treatment and post-treatment performed with osseointegrated implants? To answer this question, it is necessary to review some concepts of dental attrition.

Attrition: the concept

"Attrition" is the name given to mineralized dental tissue wear caused by contact between teeth without the interference of any physical factor, but food (Figs 1 to 8). It can occur in permanent or deciduous teeth. Attrition results in the formation of wear facets that have a well-polished appearance (Fig 1).

Attrition may occur naturally, as a result of mastication and other physiological contact between teeth. It may result in facets in the incisal edge of anterior teeth (Figs 2 to 6) and in occlusal facets of posterior teeth. Normal loss of enamel, in a period between six months and one year, ranges from 20 to 38 μm, in other words, from 0.02 to 0.038 mm.[17,20]

A type of attrition commonly found in proximal crown surfaces — which highly interests implant dentists — is caused by constant friction between both surfaces of the enamel, promoted by intrusive movement of teeth in the alveolus, especially during mastication. This constant friction alters the contact points in the proximal surfaces, which results in the formation of facets or contact areas between adjacent teeth. With age, throughout the extension of the dental arch, from third molar to third molar, proximal attrition may lead to a

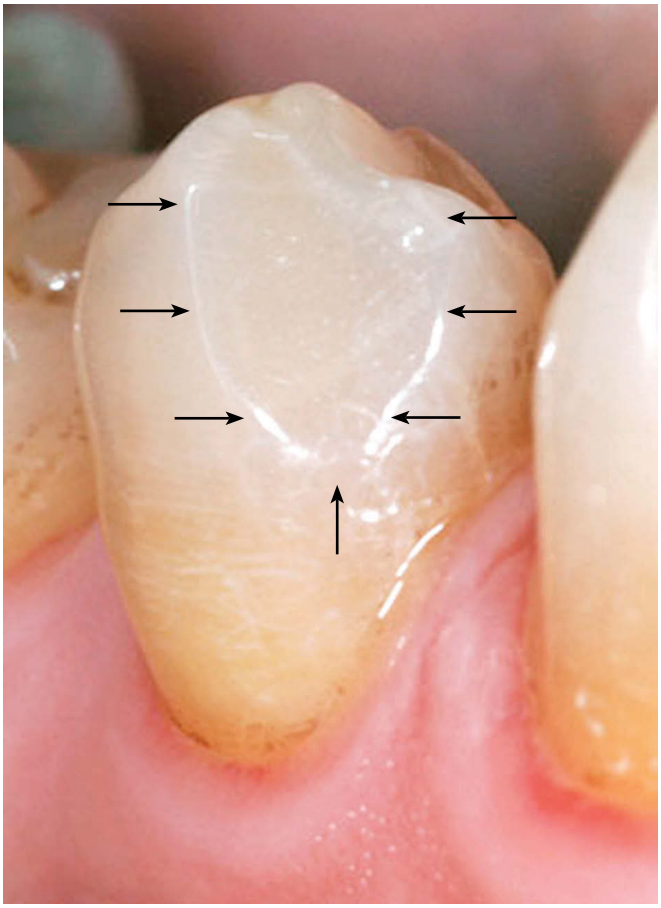

Figure 1 - The most classic manifestation of attrition: a wear facet.

Figure 2 - Attrition gradually alters the shape of the crown as well as its inciso-apical and mesiodistal size, thus, aging the dental arch. The tubercles of enamel (**A**) gradually give place to smoothed incisal edges (**B**) until the dentin is exposed and a dark yellow line can be seen between the buccal and the incisal enamel (**C** and **D**).

reduction not greater than 1 cm.[18] Those alterations pertain to aging and must be taken into account during esthetic and prosthetic restorations.

Intensified attrition was diagnosed in skulls dated from the beginning of civilization and in Egyptian mummies dated from 5 to 3000 BC. In primitive races, a loss of 1 mm was detected to occur every 5 years in the height of teeth. Eskimo tribes that subsist with a typical diet present more attrition in comparison to other tribes adapted to food of European origin. This fact denotes the influence of food over the level of severity of attrition.[18] Food that damages the dentin is more abrasive and not necessarily more consistent.

The presence of saliva alleviates wear, probably due to a potential lubricating action that occurs on the surfaces. Therefore, subjects with less or nearly none saliva present greater level of dental attrition. Another plausible explanation for such a fact is the plug effect of saliva over the acid and microbial components of diet, which potentially contribute to cause a more severe tooth wear.

The severity of attrition is not only related to age (Fig 2), eating and parafunctional habits (Figs 3, 4 and 5), but also to characteristics such as muscle strength, morphology of the face and lifestyle,[1,2,12,16,17] which are inherent to a particular individual. The level and morphology of attrition comprise the system of references used to determine age and other identifying characteristics[2,16,21] in Forensic Dentistry.

Tooth wear caused by attrition may be quicker and more severe when:

1) The enamel is hypoplastic, as in cases of dental fluorosis and hereditary amelogenesis imperfecta.
2) The dentin is dysplastic, as in cases of hereditary dentinogenesis imperfecta.
3) There are occlusal disorders that result in premature or inappropriate contact, with more constant and severe friction.
4) There are parafunctional habits, such as bruxism and/or clenching.
5) The patient has the habit of daily chewing tobacco or other related products.

Attrition and parafunctional habits

In normal conditions, attrition promotes mineralized dental tissue loss that ranges from discreet to mild, however, this condition is worsened in the presence of parafunctional habits (Figs 4 and 7). Attrition is part of the clinical presentation of patients with bruxism and dental clenching, and can lead to significant losses in the clinical crowns, considerable reduction in vertical dimension and potential changes in the facial profile and smile pattern of the patient.

The cause of severe attrition in only one or a few teeth must be found, since it is generally related to occlusal interferences (Fig 3) or local postural habits. Wear facets on the occlusal facets and incisal edges are one of the classic signs of occlusal trauma (Figs 1 and 6).

Some people around the world have the habit of chewing products made from tobacco, nutmeg, lime, seeds and other vegetables — the "betel" in India, for example — which increase the prevalence and severity of attrition. Tobacco is chewed, instead of smoked, by millions of adolescents and young adults and its use increases the prevalence and severity of dental attrition, even though additional studies are warranted to further investigate the topic.

Some researchers, whose studies focus on tooth wear, claim that severe attrition caused by solid and extremely abrasive food, as well as by the habit of chewing products such as betel and tobacco, also present char-

Figure 3 - Increase in tooth wear caused by attrition in the incisal edges cause them to be sharp and the enamel partially supportless, which result in microfractures that affect esthetics and may damage the oral mucosa. Proximal contact points turn into facets due to attrition between teeth caused by intra-alveolar movement during normal mastication.

acteristics of abrasion. The interposition of substances between worn teeth characterizes abrasion and not attrition. Tooth wear caused by the interposition of foreign matters between involved teeth during masticatory movements has a specific pathophysiology. For this reason, this condition is named demastication.

Classifying attrition

Even though attrition represents tooth wear promoted by occlusal and proximal contact between antagonist and adjacent teeth in the incisal edges, without involving the cervical region of the crown, it is often covered in classes and book chapters about non-carious cervical lesions.

Many books and articles published outside Brazil and translated into Brazilian Portuguese may contribute to establish confusion between the concepts used to talk about tooth wear.[18] In Germany and Scandinavian countries, for instance, the terms "attrition" and "abrasion" are used interchangeably. For this reason, attrition is classified as follows.

Figure 4 - Generalized attrition with typical wear facets, sharp and very thin enamel edges, and incisal microfractures. Bruxism is the main cause. Numerous enamel cracks are highlighted.

Figure 5 - Accentuated reduction in the clinical crown caused by attrition, with exposure of dentin, which promoted precocious aging.

a) Physiological: when it results from the cumulative effects of age (Fig 1).
b) Intensified: when it is intensified by parafunctional habits such as bruxism and clenching, in addition to excessively abrasive food habits (Figs 4 and 5).
c) Pathological: when it occurs in only one tooth or in group of adjacent teeth.

In Brazil, as well as in most countries, the concept of attrition that predominates is that of mineralized dental tissue wear promoted by tooth-to-tooth contact without interposition of any other physical factor besides food.

Attrition can be classified[12] into:

» Level 1: attrition limited to the enamel.
» Level 2: attrition with exposed dentin.
» Level 3: attrition with reactive dentin and/or dental pulp exposed.

Biological consequences of attrition

Tooth wear worsened by attrition leads to exposure of

dentin not only with sclerosis of many tubules, but also with dead tracts. Dead tracts are empty tubules, without odontoblastic prolongation and without peritubular dentin closure.[5] It can be clinically observed that the pulp space is affected in the central area of the widest and deepest wear facets, and that it is filled with reactive dentin that occupies the pulp chamber and the root canal (Figs 7 and 8). In such conditions, the reactive dentin usually has a darker yellow color.

The inner anatomy of the pulp chamber and the root canal of teeth with attrition usually change because many layers of reactive dentin are formed on the pulp surfaces that correspond to surface tooth wear (Figs 7 and 8). The dental pulp has its volume reduced and usually presents accelerated aging characterized by extensive hyalinization and pulp fibrosis associated with many false pulp nodules. Even a diffuse calcification of the pulp can occur (Fig 7). In summary: attrition can speed up pulp aging, even in young people.[5]

The incisal and occlusal edges affected by severe attrition are usually sharp (Figs 3 and 4) and constantly wound the oral mucosa. In this area, the mucosa presents a diffuse white color, has a well-defined white patch or sometimes presents lesions caused by constant and sharp friction. This change found in the mucosa is known as "frictional keratosis", an adaptive hyperplastic response of the mucosa to a repetitive and constant mechanical aggression, which is not of neoplastic or carcinogenic nature.

Compensatory mechanism for attrition in the clinical and esthetic crown

The compensatory mechanism for occlusal and incisal tooth wear is an important phenomenon associated with attrition. Within physiological limits, occlusal and incisal wear is compensated by cementum deposited in the apical third of the root. That mechanism is known as "passive tooth eruption" which, for being continuous and slow, preserves the height of the clinical crown, even if the enamel-cementum junction is apparent in the mouth[13,14,15,19] and the root is partially exposed (Fig 2D), affecting crown esthetics.

The majority of patients with attrition does not present loss of facial vertical dimension due to this compensatory mechanism. The cementum that is formed in the apical third, faster than it does when it is continuously deposited, tends to be cellular; and the apical part of the root is gradually and naturally rounded. Whenever there is loss of vertical dimension associated with attrition, generalized tooth wear and the high speed of tooth structure loss must be considered.

Attrition: esthetics and prevention

In their incisal edges, the incisors present three tubercles that resemble a fleur-de-lis and remain as such until attrition occurs with the flattening of the incisal surface (Fig 2) and the formation of living angles with free and proximal facets. At the same time, the contact point is also related to young teeth: the wear facets denote longer elapsed lifetime.

Teeth crowding in the anterior region has already been considered as the "wrinkle" of dental arch aging (Fig 6). It is possible to extend that and affirm the same for attrition of incisal edges. The absence of serration, the presence of sharping angles and exposure of dentin between the facets of the worn enamel of anterior teeth give the appearance of precocious aging.

In case of reconstruction of incisors as well as of other teeth that appear in the smile line, the original shape of the crown and the contact points must be considered and compatible with the facial esthetics of the patient's age group. Due to its cumulative effect, attrition is related to age and to the occurrence of aging which, in some cases, is worsened by facial vertical dimension loss.

Figure 6 - Attrition in the incisal edges may be associated with aging that results from teeth crowding, especially when the dentin is exposed, separating buccal and lingual enamel.

In an oral health program, in addition to the aspects related to oral hygiene and a cariogenic diet, the orientations must — or at least should — include not only the type of food (in terms of its abrasiveness),[21] but also prevention and limitation of the damages caused by bruxism and clenching, as well as a periodic evaluation of occlusion. In addition to causing precocious aging of the dental pulp, attrition also affects the shape of the tooth and the patient's esthetics.[2,16]

In many cases, attrition will be compensated by esthetic and functional restoration of tooth wear. However, with the night use of bite plates, it is necessary to prevent new accelerated losses by avoiding tooth-to-tooth contact that promotes attrition during sleep, especially if the patient presents bruxism or other parafunctional habits.

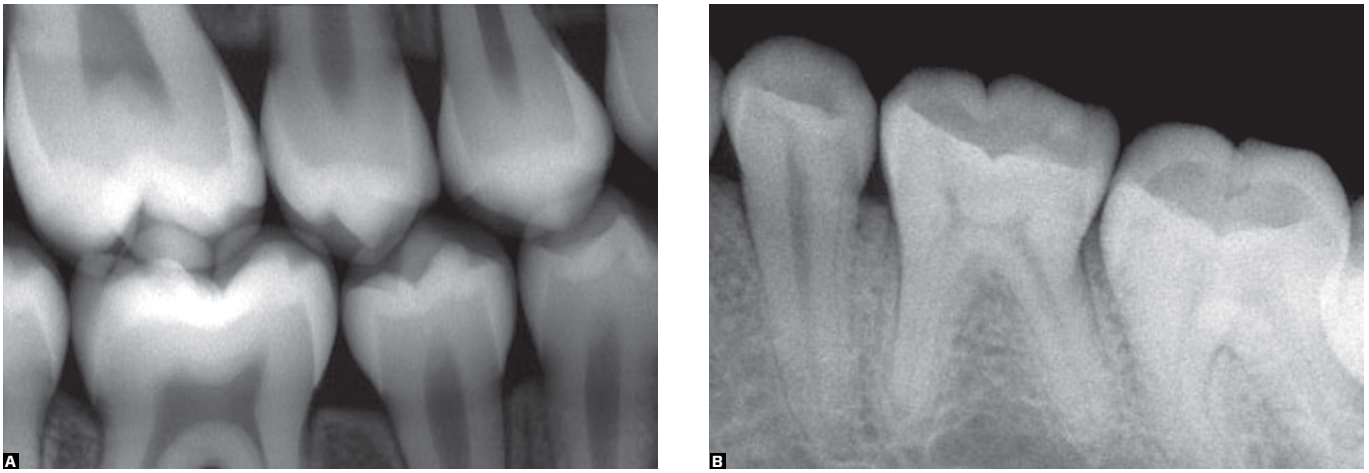

Figure 7 - Reduction in pulp spaces (**B**) due to reactive dentin deposition induced by attrition between teeth affected by bruxism, in comparison to normal pulp spaces (**A**).

Alterations in the shape of teeth and the line of the occlusal plane, flattening of the incisal edge, presence of enamel-cementum junction and root surface are within a context that involves the skin, the hair and the smile, and is associated with deepening the expression lines, including the nasolabial fold and the facial vertical dimension. Recovering tooth esthetics and function without harmonizing them with the face, including the lips, the skin and the expression lines, is having the contrary as the truth. In other words, it is caring about the face without concerning the teeth!

Nowadays, esthetics is highly valued, therefore, preventing and correcting attrition is relevant. In a population in which tooth loss is decreasing, the preservation of teeth becomes more and more thorough.

Implications and specific situations: attrition and dental implants

The possibility of increasing attrition with natural antagonist teeth must be taken into account in cases in which prosthesis is placed onto osseointegrated implants.

Nevertheless, when the prosthetic crowns are being prepared, they must be in accordance with the patient's age group because attrition not only alters the incisoapical crown height and the facial angles near the incisal edges, but also transforms the contact points into wear facets.

Similarly to what occurs to ankylosed teeth, osseointegrated implants do not have intra-alveolar mobility due to the absence of periodontal ligament. Additionally, when osseointegrated implants are placed in the supero-anterior region of younger patients, they tend to be in infraocclusion after a few years.

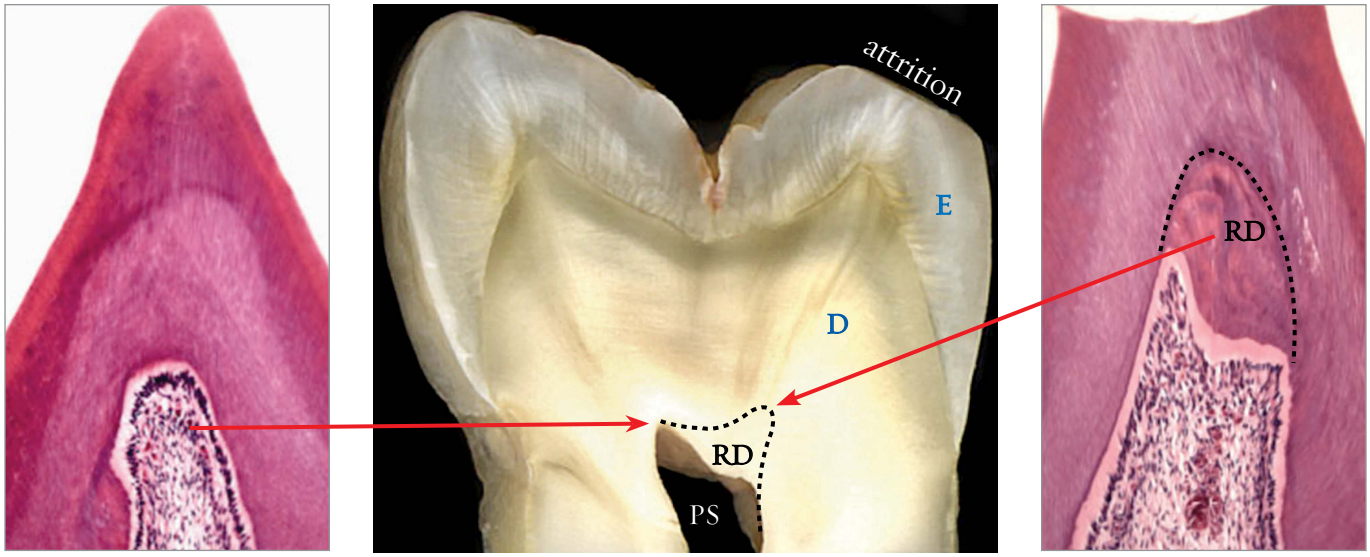

Figure 8 - Reduction in pulp space (PS) due to reactive dentin (RD) deposition induced by attrition in human teeth of which inner anatomy was altered (H.E.; original magnification = 40X). E = enamel; D = dentin.

Likewise, osseointegrated implants do not undergo the same type and extension of natural tooth movement, which results from growth and functional vectors and tend to move the teeth towards the central region of the mandible.

With age, this process, which results from active vectors, naturally leads to teeth crowding of lower incisors in most patients. For many years, it was believed that those vectors were a result of the presence of third molars that would "push" the other teeth to the central line. Now, it is understood that even without the third molars, patients present teeth crowding, as a result of congenital absence.

The presence of osseointegrated implants does not intervene in the occurrence of neither growth nor arrangement vectors of the dental arch throughout life. Moreover, it does not prevent teeth crowding, except in very specific conditions. Similarly, the presence of osseointegrated implants does not prevent proximal attrition in natural teeth.

Over the years, gaps in the form of diastema can be observed between osseointegrated implants and natural teeth as a result of attrition and/or teeth crowding. Those gaps can cause food impaction or can intervene in esthetics. It is possible to understand them and plan their readjustment, but nothing can be done to avoid these gaps, given that they are a result of the natural aging process that happens in the dental arch.

Synthesis and final considerations

Dental attrition may:

1) Represent a sign of occlusal maladjustment.
2) Suggest the existence of parafunctional habits such as clenching and bruxism, which must be considered in treatment prognosis.

3) Reduce the circumference of the dental arch because the proximal dental contact points turn into wear facets over the years.
4) Age the mouth due to some morphological details that vary with age, namely: absence of serration caused by smoothing of the incisal edge until the dentin is exposed and a dark yellow line can be seen between the buccal and the incisal enamel of incisors and canines.
5) Worsen aging caused by dental crowding.
6) Aggravate aging by causing loss of facial vertical dimension.
7) Be associated with diastemata between osseointegrated implants and natural teeth a few years after rehabilitation treatment is finished.

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