Wear Behavior of Human Enamel Against Translucent Zirconia and Lithium Disilicate

Thesis

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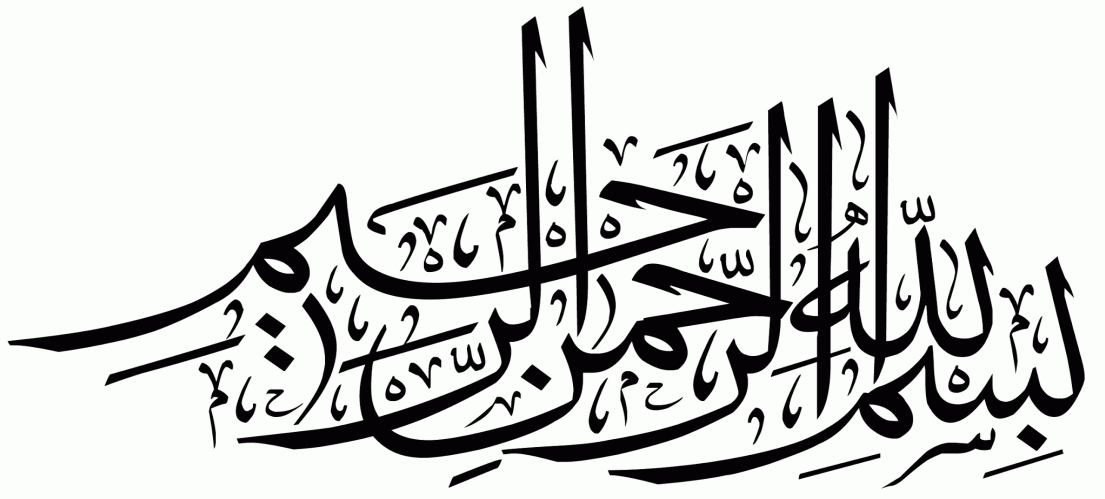

﴿يُؤْتِي الحِكْمَةَ مَن يَشَاءُ وَمَن يُؤْتَ الحِكْمَةَ فَقَدْ أُوتِيَ خَيْراً كَثِيراً وَمَا يَذَّكَّرُ إِلاَّ أُوْلُوا الأَلْبَابِ﴾

البقرة: 269

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Introduction

Tooth wear is a complex, multifactorial phenomenon that involves the interplay of biological, mechanical, chemical and tribological factors. [1, 2]

The amount of tooth wear depends on factors such as, parafunctional habits, neuromuscular force, enamel thickness and hardness, pH and nature of the saliva, patient diet habit and the type of the restorative material used. Of these, the dentist has the most control of the material selected. Appropriate selection of a restorative material is crucial for preserving occlusal harmony and normal masticatory function. Ideally, the wear rate of a dental restorative material should be compatible with that of natural tooth enamel. [3-7]

Except for their esthetic limitations, gold-based casting alloys are considered the most ideal restorative material because they are wear resistant and cause minimal wear of opposing enamel. With the increasing demand for aesthetically pleasing, natural looking restorations, the use of all-ceramic restorations has increased remarkably. All-ceramic crowns with high strength ceramic cores such as alumina, zirconia or lithium disilicate glass ceramic have been developed to eliminate a metal framework traditionally used for metal-ceramic crowns to improve the optical translucency and provide natural appearance. [8-10]

The survival and complication rates of zirconia-based FDPs indicate that the most frequent technical complication with zirconia-based FDPs was chipping of the veneering porcelain. [11, 12] Fabricating mono-block restorations from pure zirconia could increase the mechanical stability and expand the range of indications. Although, zirconia is known as a whitish, opaque core material, recently, polycrystalline zirconia with improved translucency has been used for full-contour crowns in the molar region. [13-15]

A second system that involves using a single material for full contour crowns is leucite-reinforced glass–ceramic that have been highly appreciated for more than 20 years thanks to their outstanding esthetic performances. With the development of lithium disilicate -pressed or milled-, thanks to some technical improvements in the production process, favorable survival rates for SCs have been reported. These mono-block restorations, however, are fabricated from glass ceramics, which are less stable in comparison to zirconia-based restorations. Therefore, the indication range is clearly limited to single crowns and small FDPs. [13, 15]

However, the main shortcoming of ceramics is their abrasiveness to enamel. It has been reported that the polished surface of glass ceramic caused significantly less wear than the glazed surface. Fine polishing has been suggested as an alternative to glazing by several investigators. Furthermore, reglazing or repeated firing of the surface requires additional time and may also lead to devitrification, resulting in increased opacity and loss of vitality.[16-21]

Review of literature

The following review provide an appraisal of the literature concerning tooth wear and wear investigations concluded in dentistry, focusing on understanding the wear behavior and the factors affecting the wear of dental enamel against Zirconia and lithium disilicate.

Tooth wear

Loss of tooth structure may occur through non-carious processes. Regressive alterations may vary in etiology, extent, and clinical presentation among individuals and may be associated with physiologic or pathologic processes.

Traditionally, those entities have been classified as attrition, erosion, and abrasion. Attrition is defined as a gradual loss of hard tooth substance from occlusal contacts with an opposing dentition or restorations, whereas abrasion involves a third material, the abrasive, which is present between both antagonist surfaces. Erosion is defined as loss of tooth structure by chemical dissolution without involvement of bacteria. [22, 23]

Because a single etiologic factor is usually difficult to identify, Eccles [24] suggested that the term *tooth surface loss* be used to encompass all those descriptions. Later, Smith and Knight [25, 26] proposed the term tooth wear to embrace all those conditions and their combinations whether or not the etiology is known. They contended that the term tooth surface loss did not adequately reflect the severity of the condition and advocated the use of the term tooth wear.

A**ttrition** is derived from the Latin verb "attritum" which describes the action of rubbing against something. [27] Russell [28] distinguished

physiologic and normal from pathologic and abnormal attrition. He contended that occlusal wear that renders itself vulnerable even to normal functional loading couldn't be regarded as normal. In addition, if occlusal wear occurs at a rate faster than compensatory physiologic mechanisms, this is not physiologic.

In attrition, the occlusal condition influences the quantity and distribution of the tooth wear pattern. One longitudinal study demonstrated that increased incisal wear correlates with horizontal overjet and vertical overbite. Therefore, the anterior guidance as determined by the overbite and overjet, and the ratio between these, can be used as predictors of attrition tooth wear of the maxillary and mandibular incisors. In the case of the anterior open bite, where no occlusal contact exists between the maxillary and mandibular anterior teeth, greater wear is anticipated on the posterior teeth than on the anterior teeth. [29, 30]

Attrition is related to aging, but may be accelerated by extrinsic factors such as parafunctional habits such as bruxism, traumatic occlusion in the partially edentulous dentition, and malocclusion. [22, 31]

While the prevalence of bruxism is unclear, studies report between 5% to 96% of the population may be affected. Epidemiology surveys on the prevalence of attrition have been reported as tooth wear or tooth surface loss. The exact prevalence of tooth wear or tooth surface loss is unclear, primarily due to different assessment criteria, but has been reported to range from 13% to 98%. [32-34]

Smith and Robb, [35] in a cross-sectional study observed that tooth wear is common in adults; with up to 97% of the study cohort experiencing some tooth wears. However, only 5–7% of 1007 adults in the study exhibited

severe tooth wear, for which intervention restorative treatment was justified.

Clinically, occlusal wear attributable to attrition will produce equal and matching wear facets on opposing teeth. In early stages, there appears a small polished facet on a cusp tip or slight flattening on an incisal edge, while severe attrition leads to dentine exposure, which may result in an increased rate of wear. It has been suggested that progressively greater loss of tooth structure occurs towards the anterior teeth, due to leverage changes produced by eccentric posterior interferences [30,33,36,37] Sehgman and Pullinger[38] concluded that attrition has a multifactorial etiology with age and canine guidance having significant influence in addition to parafunction, crowding, occlusal slides, crossbites, chewing habits, and diet.

Abrasion is derived from the Latin verb *abrasum* (to scrape off), which describes the wearing away of a substance or structure through mechanical process. Dental abrasion is the pathologic wearing of teeth as a result of abnormal processes, habits, or abrasive substance. Forms of dental abrasion may be related to habit or occupation. Notching of incisal edges may be caused by pipe smoking, nut and seed cracking, nail biting, or hairpin biting. Carpenters, tailors, and musicians may exhibit similar notched teeth due to nails, tacks, and instrument mouthpieces, respectively. The location and pattern of abrasion may be dependent upon the cause. Proximal root abrasion may be due to improper flossing and toothpicks. However, the most common cause of dental abrasion found at the cervical areas is tooth brushing, which may be related to technique, intense and vigorous methods, time and frequency, bristle design, and abrasive dentifrices,[22,39-41] This is termed toothbrush abrasion and has

merited the most attention. The prevalence of toothbrush abrasions varies anywhere from 5% to 85%, depending on the population studied. Remarkably, there are reported conflicts on the role of contributing factors, Kitchin[42] divided 200 individuals aged 20 to 59 into four age classes and found 42% of the 20-to-29-year age group with abrasions, while the 40-to-49-year age group exhibited 76% with abrasions. Deep lesions were found in the older groups, and good oral hygiene was associated with frequency of abrasion. Radentz et al [43] found half of the subjects aged 17 to 45 with cervical abrasions related to dentifrice use. However, they found no relationship of the lesions to toothbrush technique and frequency. Sangnes and Gjermo[44] found 32% of their youngest age group and 50% of subjects over 30 years with at least one tooth with wedge-shaped defects. The higher prevalence of lesions was associated with higher frequency of toothbrushing.

Erosion is derived from the Latin verb "erosum" (to corrode) which describes the process of gradual destruction of a surface, usually by a chemical or electrolytic process. Dental erosion is defined as loss of tooth structure by a nonbacterial chemical process. Some authors however, disagree with the term erosion due to its remarkably different meaning between dentistry and engineering tribology, and the term 'corrosion' has been advocated to correctly describe the process of tooth surface loss due to chemical or electrochemical action. [41,45-47]

The solubility of enamel is pH dependent, and the rate at which apatite precipitates depends on certain factors, such as calcium binding in saliva. Saliva contains calcium and phosphate ions and exists in a supersaturated state at neutral pH with respect to enamel hydroxiapatite. As the pH of saliva decreases, it crosses the saturation line at a point known as the

critical pH. Since the critical pH of enamel is approximately 5.5, any solution with a lower pH may cause erosion, particularly if the attack is lengthy and intermittent over time. [48]

The source of acid can be endogenous, such as from gastric reflux, or exogenous from acidic foods and drinks; the distribution and wear pattern of erosion is specifically associated with the origin of the acid and the posture of the head when the acid is present. As intrinsic acid enters the oral cavity from the oesophagus, it tends to produce significant tooth surface loss on the lingual and occlusal surfaces of teeth. On the other hand, extrinsic acid often results in erosive wear on facial and occlusal surfaces of teeth by its nature of entering the oral cavity from the anterior aspect. For instance, patients with bulimia or gastric reflux, the lingual surfaces of the maxillary anterior teeth are severely affected, while the mandibular teeth are protected from the erosive effect by the tongue and saliva. [30, 49]

Prevalence surveys are few in number, while case reports or small case series occupy most of the epidemiologic literature on dental erosion. It is also difficult to compare prevalence studies because of different indices and different sampled teeth. A recent International Dental Federation (FDI) commission report reviewed and analyzed the past data. It concluded that tooth enamel erosion is rare, easily misdiagnosed, and occurs only in susceptible individuals regardless of food and beverage consumption patterns. Therefore, consumption of acidic food or beverage alone is highly unlikely to cause erosion. Moreover, susceptibility is highly variable from one individual to another, and erosion is multifactorial in nature. [50, 51]

Although research into tooth wear has grown considerably over recent