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Review

The Role of Bioactive Glasses in Dental Erosion—A Narrative Review

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Abstract: Dental erosion represents the gradual and irreversible depletion of dental hard tissues due to a chemical process, independent of bacterial influence. It has emerged as a notable clinical concern in recent years, primarily attributed to substantial lifestyle shifts resulting in the heightened intake and frequency of acid-containing foods and beverages. Apart from the extrinsic erosive agents derived from external sources, such as dietary habits or medication, intrinsic erosive agents may exist due to pathological reasons with the contents of the stomach including gastric juice, mainly composed of hydrochloric acid, being their sole source. Currently, bioactive materials are used in various forms for the prevention of dental erosion. Such materials include, among others, bioactive glasses (BAGs). BAGs are a type of glass that, when in contact with biological fluids, can elicit a specific biological response. When they come into contact with bodily fluids, they can initiate a series of processes, including the formation of a hydroxyapatite layer on the glass surface. This bioactivity is particularly advantageous in medical and dental applications, where BAGs are used for bone regeneration, tissue repair, and dental restorative or preventive techniques. The aim of this literature review was to analyze and discuss the role of BAGs in protecting the tooth structures from dental erosion. The analysis of the existing literature regarding this topic indicated that the use of BAGs in preventive treatments against tooth erosion can be useful in dental practice. Further clinical evidence is necessary to confirm the effectiveness of the particular preventive measures.

Keywords: glass; bioactivity; ceramics; tooth erosion; hydroxyapatites; preventive techniques

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1. Introduction

Dental erosion represents the gradual and irreversible depletion of dental hard tissues due to a chemical process, independent of bacterial influence [1]. The etiology of dental erosion is multifactorial. The interplays among chemical, biological, and behavioral factors are crucial and help to explain why some individuals exhibit more erosion than others, even if they are exposed to the same acid challenges in their diets [2]. It has emerged as a notable clinical concern in recent years, primarily attributed to substantial lifestyle shifts resulting in the heightened intake and frequency of acid-containing foods and beverages [3]. The principal risk factor for the onset of this oral health issue is the persistent and excessive intake of low-pH soft drinks (pH < 5.5) [4]. Repeated exposure of dental hard tissues to these beverages can result in irreversible damage [5]. Such erosive agents have the potential to modify the micromorphological surface of dental enamel, leading to diminished microhardness, increased surface roughness and, subsequently, tooth wear [6,7]. The incidence of this condition is on the rise, with the literature indicating that the prevalence of severe dental erosion in young adults is escalating by as much as 30% [8]. This emphasizes the importance of the early diagnosis of the tooth wear process in children and adults and, as a result, dental professionals must rely on the clinical appearance to diagnose dental erosion, most crucially in the early stages of erosive tooth wear [9].

Apart from the extrinsic erosive agents derived from external sources such as dietary habits or medication [10], intrinsic erosive agents may exist due to pathological reasons with

gastric juice, within a pH range of 1–3 and mainly composed of hydrochloric acid (HCl) [11], being their sole source [12]. Dental erosion, often associated with gastroesophageal reflux disease (GERD), a persistent condition causing the regurgitation of stomach contents into the esophagus and oral cavity, is a prevalent ailment. Approximately 10–20% of the population is affected by GERD [13]. In these situations, the acidic properties of the gastric contents can lead to substantial harm to tooth surfaces. Consequently, the timely identification and treatment of the underlying medical condition are crucial, emphasizing the significance of early diagnosis and intervention [3]. Saliva, with its buffering capacity, remineralizing properties, and its pivotal role in forming the acquired enamel pellicle [14], could protect against dental erosion in such patients. However, individuals with low saliva secretion or imbalances in saliva composition may be more susceptible to this pathological condition. As a result, there is a pressing need for preventive measures against dental erosion, including the development of new prophylactic approaches and dental products.

Currently, bioactive materials are used in various forms for the prevention of dental erosion. Such materials include, among others, bioactive glasses (BAGs) [15–17], casein phosphopeptide–amorphous calcium phosphate (CPP–ACP) [18–20], and nano-hydroxyapatite [21–23]. These substances, if they contain fluoride, function by altering the surfaces of teeth, forming hydroxyfluorapatite or fluorapatite, causing hydroxy- apatite crystals within the tooth tissues to become less soluble in acidic attacks [24], or by creating protective layers on the tooth surfaces [25].

BAGs are substances which are designed to interact with living tissues, promoting beneficial effects such as the formation of a bond between the glass and the surrounding tissue [26]. The term “bioactive” indicates the ability of these glasses to stimulate a positive biological reaction. When bioactive glasses come into contact with bodily fluids, they can initiate a series of processes, including the formation of a hydroxyapatite or carbonate hydroxyapatite layer on the glass surface [27]. Hydroxyapatite is a mineral that is naturally found in bone and teeth, and its formation on the bioactive glass can encourage the integration of the material with the surrounding biological structures. Moreover, application of BAGs on tooth tissues has the potential to release elevated levels of calcium and phosphate ions, as well as other substances such as Si, F, Na, Sr, and Mg. These ions have the ability to penetrate and initiate the remineralization of sub-surface demineralized enamel through porous enamel surfaces that have undergone an acidic assault [15].

This bioactivity is particularly advantageous in medical and dental applications, where bioactive glasses have been used for bone regeneration, tissue repair, and dental restorative and preventive techniques [28,29]. Limited data exist in the literature regarding the effect of BAGs on the prevention of or reduction in tooth erosion, which may have clinical significance in dental practice. Therefore, the aim of this literature review was to analyze and discuss the role of BAGs in protecting the tooth structures from dental erosion. For this purpose, an analytical search was conducted in the PubMed, Scopus, and Web of Science search engines to detect the existing literature related to this topic using relative keywords such as “bioactive glass”, “dental erosion”, and “preventive treatment”. All the studies dealing with the prevention of tooth erosion using bioactive glasses were included in this review till the date of submission. The limitation of this review could be the possibility of a new publication regarding this topic during the gap between submission and publication of this review that would not have been included.

2. Bioactive Materials and Bioactivity

Bioactive materials are substances that have the ability to interact with biological systems, often promoting specific biological responses at the molecular, cellular, or tissue levels [30]. In particular, bioactive materials are capable of creating physico-chemical bonds with tissues by forming a biological layer of hydroxycarbonate apatite (HCA) at their interface [31]. These materials are designed and engineered to have a positive impact on living tissues and are extensively used in various biomedical applications. The term “bioactive” implies a level of interaction that goes beyond mere physical or chemical

compatibility to actively elicit a biological response [32]. Bioactive materials also include tissues that can interact with the entire human body, not only at the level of bones or hard tissues, which do not release ions.

Bioactivity refers to the ability of a material or substance to interact with living biological systems in a way that produces a specific, often beneficial, biological response [33]. In the context of biomaterials or medical applications, a bioactive material is one that can induce a desired response when in contact with biological tissues [34]. This response can occur at the molecular, cellular, or tissue levels. The level of bioactivity (I_B) of a bioactive material is related to the time needed for bonding over 50% of the interface with the bone tissue ($t_{0.5bb}$):

$$I_B = 100/t_{0.5bb}$$

when $I_B > 8$, the material can create bonds with both hard and soft tissues (i.e., bioactive glasses), and when $0 < I_B < 8$, the material can bond only with hard tissues (i.e., artificial hydroxyapatite) [26].

3. Bioactive Glasses

Bioactive glasses (BAGs) are biomaterials with a reactive surface that undergo dissolution upon contact with tooth surfaces and saliva, particularly in acidic conditions where this process is faster. This dissolution releases calcium and phosphate ions, raising the pH and facilitating the remineralization of the sub-surface demineralized enamel that has been damaged by acids, as it occurs in dental erosion [15]. Larry L. Hench aimed to create a graft material suitable for the human body after recognizing the host rejection issues associated with the inert metal and plastic materials commonly used in amputation cases [35]. The resulting material, a glass that precipitated hydroxyapatite in aqueous solutions, demonstrated the capacity to bond with both hard and soft tissues without facing rejection. The bioactive characteristics of this BAG have sparked a healthcare revolution, with applications spanning various clinical scenarios, particularly in the regeneration of hard tissues in the fields of medicine and dentistry [36].

3.1. Composition of Bioactive Glasses

As previously noted, bioactive glasses are surface reactive substances because their surface undergoes structural and chemical changes, resulting in degradation of the glass. They are amorphous materials lacking long-range structural order, unlike crystalline materials, which exhibit a regular array of atomic positions repeated in space, indicating long-range order [37]. Professor Larry Hench discovered the first bioactive glass, Bioglass® 45S5, in the late 1960s. Comprising SiO_2 (46.1 mol%), CaO (26.9 mol%), Na_2O (24.4 mol%), and P_2O_5 (2.6 mol%), this glass has been utilized in clinical applications in both medicine and dentistry since 1985 [38,39]. The properties of bioactive glasses, including mechanical, physical, thermal, and chemical characteristics, vary based on their composition. Several modifications have been made to the initial composition, which received approval from the Food and Drug Administration (FDA) and was named Bioglass. Specifically, the original composition is referred to as Bioglass 45S5 or NovaMin®. These variations encompass 45S5, S53P4, 58S, 70S30C, and 13-93 (Table 1).

Bioactive glasses are classified in the following two main categories: Class A includes BAGs which are predominantly composed of 40–52% SiO_2, 10–50% CaO, and 10–35% Na_2O. Additionally, the glass composition may include 2–8% P_2O_5, 0–25% CaF_2, or 0–10% B_2O_3. Glasses falling into Class B are typically bioinert and possess a silica content exceeding 60% wt [40]. Furthermore, bioactive glasses may incorporate well-known biocompatible and bioactive minerals, such as fluorapatite (FAP), wollastonite, diopside, and tricalcium phosphate [41]. To enhance reactivity, network modifiers like CaO, Na_2O, and P_2O_5 can be integrated into the elemental Na_2O–CaO–SiO_2 composition, thereby affecting the surface and silica network [42].

Table 1. Variations in the composition of Bioglass 45S5.

45S5	S53P4	58S	70S30C	13-93
45 wt% SiO_2	53 wt% SiO_2	58 wt% SiO_2	70 wt% SiO_2	53 wt% SiO_2
24.5 wt% CaO	20 wt% CaO	24.5 wt% CaO	30 wt% CaO	20 wt% CaO
24.5 wt% Na_2O	23 wt% Na_2O	24.5 wt% Na_2O	-	6 wt% Na_2O
6 wt% P_2O_5	4 wt% P_2O_5	6 wt% P_2O_5	-	4 wt% P_2O_5
-	-	-	-	12 wt% K_2O
-	-	-	-	5 wt% MgO

Sodium (Na) has traditionally been regarded as crucial for bioactivity due to its effective disruption of the glass network. However, the development of sodium-free BAG has challenged this belief, demonstrating equivalent dissolution and bioactivity compared to traditional Na-containing BAG. This undermines the notion of sodium as an indispensable component [43].

Moreover, it has been established that the degradation rate and apatite formation are significantly influenced by the connectivity of the glass silica network and the amount of phosphate. While the presence of phosphate (P_2O_5) was previously assumed to be essential for bioactivity, bioactive phosphate-free glasses have refuted this assumption [44]. Substituting CaO and Na_2O with MgO and K_2O, respectively, can influence apatite formation, with MgO promoting this process. Additionally, the inclusion of Al_2O_3 and B_2O_3 can be employed to affect surface reactions and melting properties [45].

Furthermore, the modification of bioactivity and antimicrobial properties can be achieved by incorporating ions such as Si, P, Sr, Cu, Ag, Zn, and F. In dental applications, fluoride plays a crucial role in enhancing bioactivity by facilitating the formation of the more acid-resistant fluorapatite, as opposed to hydroxyapatite [46]. Conjugating fluoride with BAG may also boost dentin remineralization and reduce the risk of dentin matrix degradation [47].

It is beyond doubt that the formation of hydroxyapatite is significantly influenced by the composition of bioactive glass. Various compositions have been developed, demonstrating varying degrees of release of soluble ions (Si, Ca, P, and Na) from the glass surface. This variance impacts the bioactivity mechanism, kinetics, as well as the intracellular and extracellular response. Additionally, the properties of bioactive glasses have been altered through doping with elements, such as Cu, Zn, In, Ba, La, Y, Fe, Cr, and Sr [48].

3.2. Mechanism of HCA Formation

Currently, BAGs find clinical applications either as bulk bioactive materials or as fillers and coatings within composite structures. As it was mentioned before, silicate BAGs, rooted in the original glass pioneered by Larry Hench (Bioglass®) [49], undergo a bioactivity mechanism observable in vitro through the following five distinct steps [31,49]:

1. Initially, cation exchange occurs, involving glass network modifiers (Na^+ and Ca^{2+}) and H_2O from body fluid.

$$\text{Si-O-Na}^+ + \text{H}^+ + \text{OH}^- \rightarrow \text{Si-OH}^+ + \text{Na}^+_{(aq)} + \text{OH}^-$$

2. This results in a silica-rich layer with the formation of silanol groups and a silica gel layer measuring 1–2 μm in thickness. This process raises the solution's pH due to an increased number of OH^- ions, dependent on the glass' composition.

$$\text{Si-O-Si} + \text{H}_2\text{O} \rightarrow \text{Si-OH} + \text{OH-Si}$$

3. Then condensation and re-polymerization of Si–O bonds occur to form a silica-rich layer on the surface.

4. Subsequently, amorphous calcium hydroxyl phosphate precipitates on the silica-rich layer through calcium ion precipitation ($CaO–P_2O_5$),
5. Eventually, the incorporation of OH^-/PO_4^{3-} anions from the supersaturated solution takes place and this material then crystallizes to form calcium-deficient HCA.

Through this series of chemical reactions, an HCA layer can be formed and chemically bonded to the enamel surface [39]. Although this apatite layer requires several hours for formation in teeth, it serves as a protective barrier against erosive agents, thereby enhancing resistance to enamel demineralization [15].

Several characteristics of biological hydroxyapatite attract interest, especially when compared to the HCA formed on bioactive materials [50]. These include low crystallinity, crystal sizes smaller than 500 Å, a calcium deficiency structure, non-stoichiometric phases, a significant presence of lattice defects, and micro-stresses within the network due to the inclusion of carbonate groups. These stresses and defects play a crucial role in determining the solubility of hydroxyapatite [51].

Biological hydroxyapatites, categorized as type B, exhibit carbonate substitution for PO_4^{3-} due to the presence of dissolved CO_2 in the aqueous phosphate solution. In contrast, synthetic hydroxyapatites, classified as type A, involve carbonate ions substituting for OH^- groups. The stoichiometry, acidity, and solubility of hydroxyapatites can be assessed through the Ca/P ratio. A higher Ca/P ratio results in lower acidity and solubility, and conversely, a lower ratio leads to higher acidity and solubility [51].

3.3. Preparation of Bioactive Glasses

Typically, the conventional method of creating glass involves rapidly cooling a highly viscous molten liquid to a temperature below its melting point (Tm). This process results in the formation of a viscoelastic solid state, known as glass, without the occurrence of crystallization. As the molten liquid cools, its atomic arrangement undergoes gradual changes, leading to the development of either a periodic, long-range ordered atomic structure (crystal) or a random, short-range ordered atomic structure (glass) [52].

Traditionally, glasses, including Bioglass® 45S5, have been crafted through the melt quenching process [53]. In this method, powdered ingredients are fused at elevated temperatures, usually exceeding 1300 °C, and swiftly cooled to solidify the atomic structure. Despite its historical use, melt quenching exhibits drawbacks such as diminished bioactivity at higher sintering temperatures and the inability to create porous scaffolds [54]. In the early 1970s, the sol–gel technique emerged as an alternative approach to glass synthesis [55]. This method allows for the production of a diverse range of glass compositions and forms, including fibers, coatings, scaffolds, and nanoparticles [56]. Sol–gel glasses exhibit superior porosity, apatite-forming capacity, and increased surface area when compared to melt-quenched glasses. While melt-quenched glasses have the advantage of higher mechanical properties, sol–gel glasses offer unique benefits in terms of their porosity and apatite-forming ability [57].

4. Discussion

There are multiple studies that have investigated the protective effect of bioactive glasses against dental erosion (Table 2). Different methods have been used for the application of BAGs including airabrasion with BAG-containing powders [6,16,58–60], pastes [15,61–63] or slurries [64,65]. Most of them tested Bioglass 45S5, but some studies evaluated the effectiveness of fluoride-containing BAGs [16,62] or other types of BAGs [61,64].

Table 2. The methodology of the studies that investigated the effectiveness of bioactive glass products against dental erosion.

Authors and Year of Publication	Form of BAG	Type of BAG	Type of Tooth Tissues	Erosive Challenge	Methods	Effectiveness
Araujo et al., 2023 [64]	Slurry	Biosilicate	Bovine enamel	Erosive cycling (soft drink)	Rugosimeter, hardness tester	Yes
Salma et al., 2023 [59]	Air-abrasion powder	45S5	Human enamel primary and permanent	Erosive cycling (citric acid)	Lining stylus profilometer, SEM-EDS	Yes
Viana et al., 2022 [61]	Paste	58S	Human dentin	Erosion-abrasion cycling (citric acid)	Optical Profilometer	No
Karaoulani et al., 2022 [16]	Air-abrasion powder	45S5, BioMinF	Human enamel	Erosive cycling (hydrochloric acid)	Confocal microscope, SEM-EDS	Yes
Nyland et al., 2022 [65]	Slurry	45S5	Human enamel	Erosive cycling (citric acid)	Optical profilometer, hardness tester, SEM	Yes
Abbassy et al., 2021 [62]	Paste	Four fluoride-containing BAGs	Human enamel	Erosive cycling (citric acid)	FTIR/ATR, SEM	Yes
Suryani et al., 2020 [63]	Paste	45S5	Human enamel	Erosive cycling (citric acid)	Hardness tester, SEM	Yes
Dionysopoulos et al., 2020 [58]	Air-abrasion powder	45S5	Bovine enamel	Erosion-abrasion cycling (soft drink)	Optical profilometer, hardness tester, SEM-EDS	Yes
Dionysopoulos et al., 2019 [6]	Air-abrasion powder	45S5	Bovine enamel	Erosive cycling (soft drink)	Optical profilometry hardness tester, SEM-EDS	Yes
Bakry et al., 2014 [15]	Paste	45S5	Human enamel	Erosive cycling (soft drink)	Hardness tester, SEM-EDS	Yes

Moreover, various acidic challenges were applied utilizing soft drinks [6,15,58,64], citric acid [59,61–63,65], or hydrochloric acid [16], and in some of them, abrasion challenges were also applied [6,61]. The tooth substrate was different among the studies. Some studies used human enamel [15,16,59,60,62,63,65] and others used bovine enamel [6,58,64]. One study evaluated both primary and permanent teeth [59], while another one used human dentin [61]. The methodology for evaluating the protecting effect of the tested BAGs involved profilometry [6,16,58,59,61,64,65], hardness testing [6,15,58,63–65], scanning electron microscopy (SEM) [6,15,16,58,59,62,63,65], energy dispersive X-ray spectroscopy (EDS) [6,15,16,58,59], Fourier transform infrared spectroscopy (FTIR) [62], and confocal microscopy [16,60].

More specifically, Araujo et al. [64] evaluated the effect of phytosphingosine and a bioactive glass–ceramic (Biosilicate 10%) on bovine enamel, in terms of color alteration, microhardness, and surface roughness, when submitted to an erosive challenge using a soft drink (Coca Cola). They concluded that biosilicate may prevent the enamel mineral loss induced by erosion better than saliva because it presented a higher surface microhardness of enamel (44.21 $\pm$ 11.06 KHN) compared to saliva (31.30 $\pm$ 4.22 KHN).

In another study, Salma et al. [59], who compared the surface morphology alterations, mineral content, and surface roughness of an eroded enamel surface versus another eroded enamel surface, which was preceded by BAG 45S5 application in both primary and permanent human dentitions, found that it could be effective against erosive conditions in both primary and permanent teeth, with better performance in the permanent dentition.

Karaoulani et al. [16] reported that a fluoride-containing BAG (BioMinF®) and BAG 45S5 (ProSylc) air-abrasion treatments are beneficial against the dental erosion induced by artificial gastric juice, and that both materials could promote the formation of apatite crystals on enamel in acidic conditions. In particular, following the erosive challenge, the untreated control group presented the highest surface loss (6.52 ± 1.15 μm), while pre-treatment with BioMinF® (4.40 ± 1.01 μm) and ProSylc (5.26 ± 0.86 μm)significantly reduced surface loss. In this investigation, BioMinF application resulted in the formation of sizable crystals (10–50 μm in diameter) on acid-etched enamel. These crystals exhibited a plate-like structure, suggesting the development of hydroxycarbonate apatite. According to Fan et al. [66], fluoride demonstrated a dose-dependent impact on crystal morphology in highly saturated calcification solutions. Specifically, a fluoride concentration of 1 mg/L effectively transformed the crystal nanostructure from a porous plate-like octacalcium phosphate to a needle-like arrangement of fluoridated hydroxyapatite nanocrystals (20–30 nm in diameter). Fluoride concentrations ranging from 0.1 to 2 mg/L were found to induce the hydrolysis of octacalcium phosphate into apatite [67]. At fluoride concentrations of 0.1–1 ppm F, the ribbon-like octacalcium phosphate changed into an interlayered structure, while at 2 mg/L, needle-shaped fluoridated apatite crystals were formed [68]. It is possible that the fluoride concentration in the experimental conditions of this study was insufficient for the formation of fluorapatite crystals.

Nyland et al. [65] investigated the effect of 45S5 bioglass, strontium-containing Ti-doped phosphate bioactive glass, strontium-containing Mg-doped phosphate bioactive glass, and strontium-containing Ti- and Mg-doped phosphate bioactive glass on the control of dental erosion. All the tested bioactive materials protected the enamel against erosion. Nevertheless, strontium-containing phosphate BAGs showed lower enamel loss, and the presence of Mg in these bioactive glasses provided a greater protective effect.

Abbassy et al. [62] evaluated the protective effect of using four different fluoride bioactive glasses based on 37 mol% SiO_2, 43.9–53.9 mol% CaO, 6.1 mol% P_2O_5 and CaF_2, and 0–10 mol% of Na_2O composition, against an acidic erosion challenge on enamel. FTIR/ATR analysis indicated that fluoride bioactive glasses' applications resulted in the formation of a hydroxyapatite-rich layer, and SEM analysis revealed that the aforementioned layer significantly resisted erosion challenge.

Suryani et al. [63], who focused on evaluation of the effect of BAG 45S5 paste on surface microhardness of demineralized enamel, demonstrated significantly higher microhardness after erosive challenge (0.1% citric acid) compared to the control group, which did not receive treatment. It is important to note that, quantitatively, dental erosion can be evaluated by measuring surface loss using profilometry, microradiography, or confocal laser scanning microscopy [69]. Changes in surface microhardness, surface roughness, surface morphology, or mineral content after an erosive challenge evaluate dental erosion only qualitatively [58].

Moreover, Dionysopoulos et al. [6,58], in two in vitro studies, reported the beneficial outcomes following erosive [6] and erosion/abrasion [58] challenges with a soft drink (Coca Cola) on bovine enamel surface when using airabrasion with 45S5 BAG particles. The authors interpreted this beneficial effect of BAG 45S5 due to the fact that it undergoes a sequence of chemical reactions when it comes into contact with tooth surfaces and saliva in acidic conditions, involving the release of calcium and phosphate ions. This leads to the formation of a hydroxycarbonate apatite layer that chemically bonds to the tooth surfaces [39]. The bioactive cycle of 45S5 bioglass requires a minimum of 2 h to complete [15]. The resulting layer serves as a protective barrier against acidic attacks, thereby enhancing the enamel's resistance to dissolution. Following the air-abrasion

treatment and during the erosion/abrasion cycle, calcium, phosphate, and sodium crystals leach out of the bioglass network into the acidic solution. Simultaneously, calcium and phosphate ions are released from the demineralized enamel. Sodium is washed away by the aqueous solution, while the phosphate ions from both enamel and 45S5 BAG react with calcium ions, forming acidic calciumphosphate salts such as brushite. These salts precipitate on the enamel surface [70]. The silica network of the 45S5 BAG reacts with hydroxyl ions released from the aqueous storage media, forming silanol compounds [71]. These compounds are soluble in water, potentially explaining why only trace amounts of silica were detected during elemental analysis by EDS in this study.

Bakry et al. [15] evaluated the effect of using a 45S5 BAG paste on the cross-sectional microhardness and the chemical surface changes of human enamel which was eroded by an orange juice. The results of microhardness showed that 45S5 BAG paste application significantly improved the sub-surface eroded enamel when compared to fluoride and control (untreated) specimens. As a result, the authors recommend the use of 45S5 BAG pastes as a potent remineralizing agent for the sub-surface enamel lesions resulting from erosive challenges induced by soft drinks.

Another study, conducted by Johnson King et al. [60], investigated the importance of powder selection when using airabrasion in dental practice. When using airabrasion clinically, dental practitioners must be aware that abrading sound enamel excessively renders that surface more susceptible to the effects of acid erosion. BAG powders were less invasive (1.3 ± 0.6 μm step height) when compared to the alumina (Al_2O_3) powder (2.7 ± 1.7 μm step height), supporting their use for prevention of dental erosion. This step height in a previous study from Dionysopoulos et al. [6] was recorded as 2.4 ± 0.6 μm for BAG 45S5 (ProSylc) using the same settings for air-abrasion procedure.

It is worth noting that all the studies indicated a positive effect of BAGs against acidic attacks, except for Viana et al. [61], who did not find any advantage of using a paste containing BAG 58S on the dentin surface. In this study, although the BAG 58S paste did not protect the dentin surface against erosive–abrasive challenges, it was useful for treating dentin hypersensitivity because decreased dentin permeability. As a matter of fact, the author claimed that BAG 58S deserves to be further explored and oriented on this topic.

It is important to mention that all the investigations regarding the evaluation of the protecting effect of BAGs against dental erosion that were detected were in vitro. This means that although there is a strong indication that BAGs may protect tooth surfaces from acidic attacks, clinical studies are necessary to confirm this evidence and to determine the significance of this protection.

5. Conclusions

Based on the existing literature, the use of products containing bioactive glasses may be beneficial for protecting the surface of tooth tissues from erosive attacks, such as those inducing dental erosion. Dental practitioners should bear in mind that adequate preventive measures can only be initiated if the different risk factors of dental erosion are known. Subsequently, an individually tailored preventive program against dental erosion should be suggested. Preventive treatment involves neutralizing the effects of acids and improving the resistance of teeth to acidic attacks. In this context, the use of bioactive glasses may be beneficial. However, obtaining clinical evidence byconducting randomized controlled trials (RCTs) or split-mouth clinical studies is necessary to confirm the effectiveness of these preventive techniques.

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