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Prof. Dr. Emin Caner TÜMEN

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CHAPTER 1

SCIENTIFIC BASIS AND CLINICAL PERFORMANCE OF THE IMMEDIATE DENTIN SEALING TECHNIQUE

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INTRODUCTION

Direct resin composite restorations are widely preferred by patients due to their applicability in both anterior and posterior teeth. Accordingly, the use of these restorations has increased considerably, accompanied by significant advancements in resin material formulations and clinical application techniques in recent years (1,2). However, despite these improvements, direct resin composite restorations present several challenges when used in extensive restorations involving proximal surfaces. These challenges include achieving adequate proximal contact, appropriate anatomical form, sufficient wear resistance, and optimal marginal adaptation (3,4). Indirect restorations fabricated from ceramic or polymer-based materials have been shown to effectively overcome these limitations. Compared with direct restorations, partial adhesive indirect restorations offer notable advantages, including improved anatomical accuracy, contour, esthetics, and enhanced fracture resistance (5).

Traditional indirect restoration techniques involve several complex procedural steps. At least two clinical appointments are required for these laboratory-fabricated restorations, including tooth preparation and impression or model fabrication during the first visit, followed by the adhesive luting procedure during the second visit (6). After tooth preparation at the initial appointment, an impression is taken and a provisional restoration is cemented. Once the indirect restoration has been fabricated, the second appointment involves removal of the provisional restoration, application of a bonding agent to the dental substrate, and adhesive luting using a resin cement (7). This conventional approach, known as delayed dentin sealing (DDS), involves dentin hybridization immediately before the luting of the indirect restoration and after the use of provisional restorations. However, DDS presents certain disadvantages, including potential contamination of the dentin surface by temporary cement remnants and penetration of cement components into the tooth structure (8). Consequently, the final restoration is often bonded to contaminated rather than freshly prepared dentin, which may result in compromised hybrid layer formation and reduced bond strength (9). To overcome these limitations, immediate dentin sealing (IDS) has been recommended as a preventive strategy (10,11).

IDS PROTOCOL

The immediate dentin sealing (IDS) approach is based on four fundamental principles (12). First, optimal bonding can be achieved only on freshly prepared, contaminant-free dentin, as bond strength is reduced under all other conditions (13). Second, simultaneous light curing of the dentin bonding agent (DBA) and the overlying composite may result in collapse of the hybrid layer due to pressure exerted during composite placement or restoration seating (13). Therefore, precuring the DBA prior to restoration placement leads to a more stable and durable adhesive interface. Third, IDS allows the dentin–adhesive complex to mature in an environment free from occlusal loading and polymerization shrinkage stresses associated with the restorative material, particularly when restoration placement is delayed (14,15). Finally, IDS reduces the infiltration of microorganisms and oral fluids, thereby contributing to improved dentin sealing and bond durability (13).

PRINCIPLES OF IMMEDIATE DENTIN SEALING

Hybrid Layer Formation and Stability

Immediate dentin sealing (IDS) involves the infiltration of adhesive resins into demineralized dentin, thereby enhancing the formation and long-term stability of the hybrid layer. This micromechanical interlocking serves as the primary mechanism for the retention of indirect restorations. In contrast to delayed dentin sealing (DDS), which postpones dentin hybridization and exposes the dentin surface to potential contamination, IDS enables immediate resin penetration and polymerization, effectively protecting the dentin substrate from degradation (16). Deniz et al. (2021) investigated the effect of immediate dentin sealing (IDS) combined with chlorhexidine (CHX) pretreatment on the shear bond strength of dual-cure adhesive resin cement to dentin. The study evaluated dentin surfaces treated with IDS, with and without prior CHX application. The results demonstrated that IDS performed with chlorhexidine pretreatment significantly improved bond strength and contributed positively to the stability of the hybrid layer. The authors suggested that CHX, by inhibiting matrix metalloproteinase (MMP) activity, may enhance the long-term durability of the adhesive interface and therefore could be beneficially incorporated into IDS protocols (17).

Protection From Contamination

During indirect restorative procedures, the dentin surface is frequently exposed to contaminants such as saliva, blood, and temporary cement, which can adversely affect bond strength and compromise the integrity of the hybrid layer. Immediate dentin sealing (IDS) eliminates this risk by establishing a protective barrier over the dentin substrate immediately after tooth preparation (17). Ribeiro da Silva et al. (2016) evaluated the interactions between resin-based temporary restorative materials and immediate dentin sealing (IDS). The study assessed the effects of placing different resin-based provisional materials on IDS-treated dentin surfaces and examined their influence on the adhesive layer. The findings indicated that certain temporary resin materials could chemically or physically interact with the IDS layer, leading to alterations of the adhesive surface and potentially compromising subsequent bonding procedures. The authors emphasized that careful selection of provisional materials is essential to preserve the integrity of the adhesive interface when IDS is applied (18).

Redistribution of Polymerization Shrinkage Stress

The shifting of polymerization shrinkage stress is one of the key processes of IDS. IDS increases bond longevity by preventing stress concentrations at the adhesive interface by sealing the dentin prior to the final restoration's cementation (19). According to Magne (2005), immediate dentin sealing enhances the durability of the adhesive interface by allowing maturation of the dentin–adhesive complex and postponing the application of functional stresses to the dentin substrate (20).

Adhesive Interaction with Restorative Materials

By establishing a pre-polymerized bonding layer, immediate dentin sealing (IDS) optimizes the interaction between the dentin substrate and the definitive indirect restoration. During final cementation, this preformed adhesive layer improves the chemical and mechanical compatibility between the resin cement and restorative materials, thereby promoting stronger and more durable adhesive bonding. Moreover, by eliminating the adverse effects of polymerization shrinkage stress and unfavorable configuration factor (C-factor) conditions, IDS enables the dentin–adhesive interface to mature and achieve its maximum bond strength in a stress-free environment (20).

Clinical Benefits

The superiority of IDS over DDS in achieving higher bond strength has been demonstrated in several studies (20). Immediate dentin sealing (IDS) has been shown to enhance resin–dentin bond strength by minimizing contamination of the prepared dentin surface and allowing adhesive systems to polymerize under optimal conditions. In their seminal study, Pascal Magne et al. (2005) reported that sealing freshly cut dentin immediately after tooth preparation contributes to improved bond durability and integrity (19). This finding was further corroborated by Falkensammer et al. (2014), who demonstrated that IDS preserves adhesive performance even after thermocycling, highlighting its resistance to aging-related degradation (21).

In addition to enhancing bond strength, IDS has been associated with a significant reduction in postoperative sensitivity, which is commonly attributed to fluid movement within exposed dentinal tubules. By sealing the tubules immediately after preparation, IDS decreases dentinal fluid dynamics and thereby mitigates hypersensitivity. Consistent with this mechanism, Hu and Zhu (2010) reported that patients treated with IDS experienced significantly lower levels of postoperative sensitivity following cementation compared to those treated with delayed dentin sealing (DDS), (22).

The longevity of indirect restorations is strongly influenced by the increased bond strength and decreased sensitivity related to IDS. The 11-year prospective clinical study conducted by Gresnigt MM, Cune MS, Schuitemaker J, van der Made SA, Meisberger EW, Pascal Magne, and Özcan M, published in Dental Materials (2019), aimed to evaluate the long-term clinical performance of ceramic laminate veneers placed using the immediate dentin sealing (IDS) protocol. In this study, IDS was applied to teeth with partial preparations involving dentin exposure, followed by adhesive cementation of ceramic laminate veneers using resin cement. The restorations were assessed over an extended follow-up period according to predefined clinical criteria, including survival rate, failure modes (such as debonding, fracture, and secondary caries), and biological and technical complications. After 11 years of follow-up, ceramic laminate veneers placed with IDS demonstrated high survival rates and clinically predictable outcomes. The incidence of debonding was low, and the adhesive interface showed long-term stability. Biological complications were limited, and favorable periodontal responses were reported. The authors concluded that the IDS protocol enhances the durability of adhesive bonding, particularly in preparations with dentin margins, thereby supporting the long-term

success of laminate veneer restorations. This study provides strong clinical evidence that IDS is not only effective in vitro but also reliable and predictable under long-term clinical conditions (23).

Immediate dentin sealing (IDS) enhances marginal integrity by establishing an early and stable hybrid layer at the tooth–restoration interface, thereby minimizing the risk of gap formation. By sealing freshly cut dentin immediately after preparation, IDS reduces the potential for interfacial degradation and marginal discrepancies. Several studies have demonstrated that this approach significantly decreases microleakage and limits bacterial penetration along the adhesive interface. Ultimately, IDS contributes to the prevention of secondary caries, which remains one of the primary causes of restoration failure (24,25).

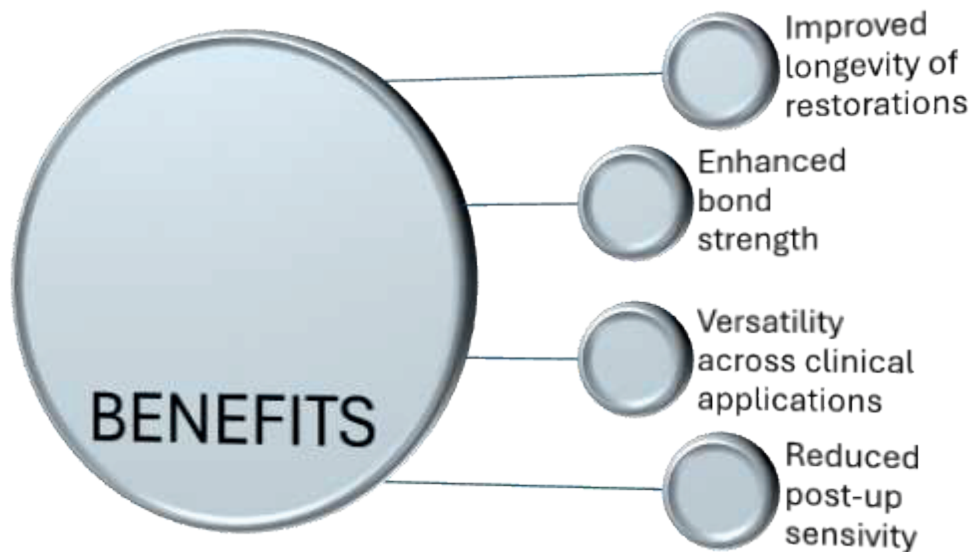

FIGURE 1: Benefits of immediate dentin sealing (16).

A comprehensive review of the literature on the immediate dentin sealing (IDS) protocol

In this literature review section, studies addressing the treatment approach and the technical aspects of the immediate dentin sealing (IDS) protocol were evaluated. The examined studies specifically addressed the following topics: postoperative hypersensitivity; surface conditioning techniques; adhesive luting and film thickness; restorative materials; optimal adhesive system selection; and provisional restorations.

The study conducted by Magne et al., aimed to investigate the thickness of the pre-cured dentin bonding agent applied during immediate dentin sealing (IDS) in onlay preparations and to evaluate the effect of different surface cleaning procedures on subsequent adhesive performance. In this study, IDS was performed on prepared dentin surfaces, and varying thicknesses of pre-polymerized bonding agent layers were created. The influence of provisionalization and subsequent surface cleaning protocols—such as pumice cleaning or mechanical surface roughening—on bond strength was assessed. Particular attention was given to whether increased bonding layer thickness could interfere with restoration seating and affect luting film thickness. The findings indicated that the thickness of the adhesive resin layer formed during IDS may significantly influence marginal fit and internal adaptation of indirect restorations. Excessively thick bonding layers were found to potentially compromise complete seating of the restoration. However, appropriate surface cleaning and reactivation procedures prior to final cementation were shown to help maintain adequate adhesive performance. The authors emphasized that careful control of the bonding layer thickness during IDS, along with proper surface management before cementation, is critical for achieving optimal clinical outcomes in onlay restorations (26).

The impact of storage duration and various surface treatments on the microtensile bond strength of prehybridized dentin was assessed by Dillenburg AL et al. The findings demonstrated that prolonged storage time may adversely affect bond strength; However, appropriate surface cleaning or reactivation protocols performed prior to cementation were able to significantly enhance adhesive performance. The study concluded that the long-term bonding effectiveness to prehybridized dentin surfaces is closely associated with proper surface management procedures (27).

The impact of instantaneous dentin sealing (IDS) on the bond strength of indirect restorations was examined in a research by Pascal Magne et al. (2005). This study compared the delayed

dentin sealing (DDS) method with the IDS procedure, which involved sealing newly sliced dentin right after tooth preparation. The results demonstrated significantly higher bond strength values in the IDS groups. This improvement was attributed to the protection of the dentin surface from contamination and the polymerization of the adhesive under optimal conditions. The authors concluded that IDS enhances the adhesive performance of indirect restorations and represents an effective strategy to improve clinical outcomes (28).

Frankenberger R et al. (2007) evaluated the influence of various factors involved in the adhesive luting procedure on internal dentin bond strength. Specifically, the study investigated the effects of different adhesive systems, temporary cement residues, cavity cleaning protocols, and curing modes (light-cured, chemically cured, or dual-cured) in a comparative manner. The results demonstrated that dentin bond strength is not determined solely by the type of adhesive used but is also significantly affected by the effective removal of temporary cement remnants and the implementation of appropriate cavity cleaning procedures. Moreover, the curing mode was shown to play a critical role in adhesive performance. The authors emphasized that the clinical success of adhesive luting in indirect restorations depends on careful material selection in conjunction with proper surface management and an appropriate polymerization strategy (29).

Strategies to improve adhesion between resin coating materials and resin cements were examined by Udo T et al. (2007). The study assessed how various adhesive procedures and surface treatments affected the interface's binding strength. The findings demonstrated that appropriate surface preparation and adhesive application significantly improved the adhesion between the resin coating layer and resin cement. These results highlight the critical importance of proper surface management prior to cementation in optimizing bonding performance (30).

Okuda M. et al. (2007) looked at whether the resin coating method improved the indirect composite restorations' bonding capacity to the cavity floor dentin. The results demonstrated significantly higher micro tensile bond strength values in the groups where resin coating was applied. The study concluded that the resin coating technique can strengthen dentin bonding and improve adhesive performance in indirect restorations (31).

Ariyoshi M et al. (2008) investigated the effect of the resin coating technique on the micro tensile bond strength of composite core materials to pulpal floor dentin. Micro tensile bond strength (μTBS) values were compared between groups with and without resin coating. The results demonstrated significantly higher bond strength values in the resin-coated groups. The

authors concluded that the resin coating technique enhances adhesive performance in deep dentin areas and may improve the bonding effectiveness of composite core restorations (32).

The impact of the resin coating process on the strength of the connection between a resin cement and dentin was assessed by Santos-Daroz CB et al. (2008). In the study, dentin surfaces with and without a previous resin coating were coated with resin cement, and the binding strength values were compared. The results showed that the resin coating method greatly strengthened the resin cement's connection with the dentin. The application of a resin coating layer before cementation strengthens the adhesive contact and improves overall bonding performance, according to the authors' conclusion (33).

The immediate dentin sealing (IDS) technique's biological justification, clinical principles, and application procedure were all covered by Terry DA et al. (2009). The authors emphasized that sealing freshly prepared dentin immediately with an adhesive system protects the dentin surface from contamination and allows optimal polymerization of the adhesive. This approach was reported to enhance bond strength and to reduce postoperative sensitivity by achieving early sealing of dentinal tubules. Furthermore, IDS was described as contributing to more predictable and durable adhesive performance in indirect restorations (33).

Lee and Park (2009) evaluated three major variables affecting the shear bond strength of resin inlays luted to dentin. The effects of adhesive system type, surface treatment protocol, and polymerization approach were comparatively analyzed. The results showed that compared to the two-step self-etch method, the three-step etch-and-rinse adhesive system produced greater shear bond strength values. Additionally, appropriate polymerization and correct dentin surface preparation greatly improved adhesive effectiveness. The study concluded that three-step etch-and-rinse adhesive systems provide superior bonding performance for indirect resin restorations (34).

Choi and Cho (2010) looked at how the shear bond strength of resin cement used for porcelain restorations was affected by instant dentin sealing (IDS). Prior to final cementation, the investigation contrasted specimens with and without IDS. The findings showed that the shear bond strength of resin cement to dentin was considerably enhanced using rapid dentin sealing. The authors attributed this improvement to enhanced dentin hybridization and reduced contamination during the provisional phase. The study concluded that IDS is an effective

clinical procedure for improving the bonding performance of resin-cemented porcelain restorations (34).

Magne et al. (2011) investigated the effect of an opaque resin layer used for selective masking in thin indirect restorations on the dentin bond strength of immediately sealed preparations. The study specifically evaluated whether the application of an opaque resin over treated surfaces with immediate dentin sealing (IDS) could adversely affect the integrity of the adhesive interface and bonding performance. The findings indicated that the use of an opaque resin on IDS-treated dentin did not result in a statistically significant reduction in bond strength. The authors concluded that, when applied in conjunction with an appropriate adhesive protocol, selective masking with an opaque resin does not compromise dentin bonding and may be considered a clinically reliable approach for thin indirect restorations (35).

Sailer et al. (2012) evaluated the effects of glutaraldehyde- and HEMA-containing desensitizing agents, resin sealing, and provisional cement application on the dentin bond strength of self-adhesive and conventional resin cements. The findings demonstrated that glutaraldehyde/HEMA-based desensitizers may lead to a reduction in bond strength when used in conjunction with self-adhesive resin cements. In contrast, the resin sealing approach significantly enhanced bonding performance, particularly when combined with conventional resin cements. Consequently, it was determined that one of the key elements affecting the performance of the adhesive was the pretreatment procedure used on the dentin surface (36).

The in vitro study conducted by Irena Sailer and colleagues evaluated the effects of desensitizing resins, resin sealing, and provisional cement application on the dentin bond strength of self-adhesive and conventional resin cements. The findings demonstrated that glutaraldehyde/HEMA-containing desensitizing agents may reduce bond strength, particularly when used in conjunction with self-adhesive resin cements. In contrast, adhesive resin sealing of dentin was shown to preserve or enhance bonding performance. Additionally, residual provisional cement was reported to adversely affect bond strength (37).

The impact of instant dentin sealing (IDS) on the shear bond strength of pressed ceramic restorations luted to dentin using self-etch resin cement was examined by R. Dalby et al. (2012). The results demonstrated that the IDS group exhibited significantly higher bond strength values compared to the delayed sealing group. These findings suggest that the IDS technique may enhance dentin–ceramic bonding performance (38).

Ozcan et al. examined how various mechanical and air-abrasion cleaning techniques affect the following adherence of resin composite cement and assessed the impact of temporary cement remnants on the immediate dentin sealing (IDS) layer. The findings indicated that the cleaning method significantly affected the integrity of the IDS layer and the resulting bond strength. Appropriate air-abrasion protocols were found to be more effective in preserving adhesive performance (39).

Leesungbok R et al. (2015) reported that immediate dentin sealing (IDS) enhances dentin bond strength across different thermocycling periods and improves the preservation of bond strength after aging (40).

da Silva CJR et al. assessed how immediate dentin sealing (IDS) and resin-based interim restorative materials interacted. The study investigated the potential effects of provisional materials on the IDS interface and their impact on bond performance. The findings indicated that certain resin-based temporary materials may adversely affect bond strength at the IDS interface, emphasizing the clinical importance of appropriate provisional material selection (41).

Santana VB et al. reported that immediate dentin sealing (IDS) increases resin cement bond strength and reduces nanoleakage, while pulpal pressure may influence adhesive performance (42).

After cyclic stress, Shii N et al. assessed the bonding condition of metal-free CAD/CAM onlay restorations both with and without instantaneous dentin sealing (IDS). The results indicated that IDS better preserved the integrity of the adhesive interface after cyclic loading and improved the durability of the bond (43).

In their comparison of chemical and mechanical techniques for removing temporary cements after an immediate dentin hybridization (IDS) approach, Augusti D et al. found that the cleaning procedure has a major impact on bonding performance, with the right techniques possibly increasing adhesive durability (44).

The impact of several adhesive techniques used for immediate dentin sealing (IDS) on the bond strength of a self-adhesive resin cement to dentin was assessed by Ferreira-Filho RC et al. The findings indicated that the type of adhesive system significantly influenced bonding performance, and certain IDS protocols resulted in higher bond strength when used in combination with self-adhesive resin cement (45).

The impact of immediate dentin sealing (IDS) on the dentin bonding performance of CAD/CAM ceramic onlay restorations was assessed by Murata T et al. The findings showed that IDS increased the adhesive interface's endurance and bond strength (46).

Sag et al. examined how bonding method, restorative material, and immediate dentin sealing (IDS) affected the bond strength of indirect restorations. The findings demonstrated that IDS application, as well as the bonding strategy and restorative material used, significantly influenced bond strength outcomes (47).

The impact of adhesive luting with light-polymerizing and dual-polymerizing resin cements on the enhanced fatigue resistance of thick CAD/CAM composite resin overlay restorations was assessed by Goldberg J et al. The findings indicated that, particularly in thick restorations where light transmission is limited, dual-polymerizing resin cements provided more reliable and higher fatigue resistance. In contrast, exclusively light-polymerizing cements may exhibit reduced polymerization efficiency as restoration thickness increases (48).

The impact of immediate dentin sealing (IDS) and delayed dentin sealing (DDS) on the Weibull features, failure mechanism, and fracture strength of lithium disilicate laminate veneers was assessed by Gresnigt MM et al. The results demonstrated that IDS provided higher fracture strength and more reliable mechanical performance, as indicated by a higher Weibull modulus. Additionally, the IDS group showed better failure patterns. According to the results, IDS may improve indirect adhesive restorations' mechanical performance and clinical predictability (49).

The impact of immediate dentine sealing (IDS) on the fracture strength of composite inlay restorations made of lithium disilicate and multiphase resin was assessed by van den Breemer CRG et al. The findings demonstrated that IDS increased the fracture strength of both materials and improved the mechanical performance of indirect adhesive inlay restorations (50).

Yazigi C et al. assessed how various bonding methods affected the fracture strength of thin occlusal glass-ceramic veneers made using CAD/CAM. The results showed that the bonding protocol significantly affected the mechanical performance of the restorations, with adhesive strategies playing a decisive role in fracture strength and failure patterns. The study emphasized that the selection of an appropriate bonding technique is critical for the clinical success of thin glass-ceramic occlusive veneers (51).

The strength of premolars replaced with composite resin inlays was assessed by Shafiei F et al. in relation to proanthocyanidin-mediated immediate dentin sealing (IDS) and delayed dentin sealing (DDS). The findings demonstrated that IDS combined with proanthocyanidin enhanced the mechanical strength of the restored teeth and improved restorative performance. The results suggest that appropriate biomodification of the IDS protocol may positively influence clinical durability (52).

Hu J and Zhu Q assessed how immediate dentin sealing (IDS) may reduce post-cementation hypersensitivity. The study compared IDS with the conventional delayed dentin sealing (DDS) protocol. The findings demonstrated that IDS significantly reduced the incidence of post-cementation hypersensitivity. This effect was attributed to the sealing of dentinal tubules prior to restoration placement, thereby decreasing microleakage and dentinal stimulation. In conclusion, the study suggests that IDS is an effective and clinically recommended approach for reducing postoperative sensitivity in indirect restorations (53).

A prospective randomized clinical experiment was carried out by van den Breemer C et al. to assess the longevity of posterior partial crowns made of lithium disilicate that were bonded using either delayed dentin sealing (DDS) or instant dentin sealing (IDS). Patient satisfaction and postoperative tooth sensitivity were among the short-term results. The findings showed that IDS enhanced patient satisfaction and decreased postoperative sensitivity. According to the study's findings, IDS could provide therapeutic benefits for posterior lithium disilicate restorations' short-term performance (54).

CONCLUSION

It seems that the instantaneous dentin sealing (IDS) method is better in terms of bond strength, gap development, microleakage, and dentin hypersensitivity. However, further research is warranted to address potential issues related to interactions with impression materials, the provisionalization phase, and surface conditioning protocols prior to definitive cementation. At present, no significant barriers have been identified that would preclude the routine clinical implementation of IDS.

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CHAPTER 2

PSYCHOTROPIC DRUGS AND THEIR IMPACT ON ORAL HEALTH

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INTRODUCTION

Drug abuse remains one of the most devastating global public health crises, affecting millions of individuals and imposing severe medical, psychological, and socioeconomic burdens worldwide (Cossa et al., 2020; Swathy et al., 2024). In 2021 alone, an estimated 296 million people between the ages of 15 and 64 reported using illicit substances, representing a 23% increase from the previous decade (Swathy et al., 2024). While the systemic complications of substance use disorders—such as cardiovascular disease, respiratory depression, and infectious diseases—are widely recognized, the profound and detrimental effects of drug abuse on the stomatognathic system are frequently overlooked by both users and healthcare providers (Chaparro-González et al., 2018; Swathy et al., 2024). Consequently, dental professionals increasingly encounter the severe oral manifestations associated with the use of illicit drugs, including methamphetamine, cocaine, heroin, and cannabis, as well as the effects of prescribed psychotropic medications (Alqarni et al., 2024; Fratto & Manzon, 2014).

The deterioration of oral health in drug-dependent individuals is driven by a complex interplay of direct physiological effects and indirect behavioral changes (Chaparro-González et al., 2018; Swathy et al., 2024). Directly, many psychoactive substances and psychotropic medications act on the central and peripheral nervous systems to significantly reduce salivary flow, leading to severe xerostomia and a highly acidic oral environment (Fratto & Manzon, 2014; Sun et al., 2018). Indirectly, the lifestyle associated with substance abuse exacerbates these physiological vulnerabilities, as individuals struggling with addiction frequently exhibit a marked neglect for personal hygiene, adopt cariogenic diets that are high in refined sugars and carbonated beverages, and typically avoid seeking dental care until their symptoms become severe and unmanageable (Chaparro-González et al., 2018; Swathy et al., 2024).

This combination of reduced salivary protection, extreme neuromuscular activity, and poor oral hygiene precipitates a range of devastating dental pathologies (Sun et al., 2018). The most prominent oral manifestations include rampant and atypical dental caries—frequently referred to as "meth mouth" in methamphetamine users—alongside advanced periodontal disease, extensive tooth wear from drug-induced bruxism, and temporomandibular joint disorders (Alqarni et al., 2024; Rommel et al., 2016; Sun et al., 2018). Furthermore, these debilitating conditions profoundly diminish the oral health-related quality of life (OHRQoL) of affected individuals, causing pain, functional impairment in eating and speaking, and deep psychological embarrassment over their dental appearance (Table 1) (Abed et al., 2025; Sun et

al., 2018). To fully comprehend the scope of this issue, this article will explore seven key subtopics: the direct and indirect links between drug abuse and oral health, drug-induced xerostomia, rampant dental caries, periodontal and soft tissue lesions, bruxism and temporomandibular disorders, the hidden impact of psychotropic medications, and the necessity of interdisciplinary management to restore both oral health and quality of life.

Authors/year	OHRQoL scale/index	OHRQoL scores	Impact of amphetamine use on OHRQoL (as compared to non- amphetamine users)
Not assessed or reported clearly			
Abdelsalam *et al.* 2023[16]	OHIP-14[†]	9.63 (95% CI = 7.8 to 11.47)	• Painful aching in mouth[§] • Less satisfying life because of dental problem[§] • Difficulty doing usual activity/work[§] • Affected sense of taste[§] • Particular food avoided[§] • Uncomfortable to eat[§] • Felt embarrassed[§]
Abdelsalam *et al.* 2021[17]	OHIP-14[†]	12.72 (95% CI = 11.8 to 13.6)	• Painful aching in mouth[¶] • Less satisfying life because of dental problem[¶] • Difficulty doing usual activity/work[¶] • Affected sense of taste[¶] • Particular food avoided[¶] • Uncomfortable to eat[¶] • Felt embarrassed[¶]
Significant			
Amiri *et al.* 2021[20]	The OIDP[‡]	22.4 (SD = 8.6)	• Eating and enjoying food[¶¶] • Speaking and pronouncing clearly[¶¶] • Cleaning teeth[¶¶] • Sleeping and relaxing[¶¶] • Smiling, laughing and showing teeth without embarrassment[¶¶] • Smiling, laughing and showing teeth without embarrassment[¶¶] • Carrying out major work or social role[¶¶] • Enjoying contact with people[¶¶]
Mukherjee *et al.* 2018[19]	OHIP-14[†]		• Painful aching in mouth • Less satisfying life because of dental problem • Difficulty doing usual activity/work • Affected sense of taste • Particular food avoided • Uncomfortable to eat • Felt embarrassed

Key:
[†] = OHIP-14: a self-administered questionnaire[21] to assess OHRQoL. It consists of 14 items and seven domains
[‡] = OIDP: a validated OHRQoL tool that measures the impact and extent to which an individual's daily activities may be compromised by their oral health. It consists of eight domains
[§] = OHIP extent: number of OHIP items reported 'fairly often' or 'very often' mean (n/%): (1.58/1.15, 2.01) / OHIP severity: mean of summary scores, ranging from 0–56 (n/%): (9.63/7.8, 11.47)
[¶] = OHIP-14 extent: number of OHIP items reported 'fairly often' or 'very often', ranging from 0–14. Mean score (median) = 2.35 (3.54). OHIP-14 severity: total of scores across OHIP items, ranging from 0–56. Mean score (median) = 12.72 (14.07)
[¶¶] = Indicates that the p-value was not reported.

Table 1: OHRQoL scales/indices details and impact of amphetamine use on OHRQoL (Abed et al., 2025)

FINDINGS

1. The Direct and Indirect Links Between Drug Abuse and Oral Health

Drug abuse impacts the oral cavity through a complex combination of direct physiological effects and indirect behavioral and lifestyle changes (Cossa et al., 2020; Swathy et al., 2024). Direct exposure of oral tissues to illicit drugs—such as during smoking, snorting, or ingestion—biologically interacts with the normal physiology of the stomatognathic system (Chaparro-

González et al., 2018; Cossa et al., 2020). For instance, substances like methamphetamine, cocaine, and cannabis often cause significant vasoconstriction, tissue ischemia, and an immediate reduction in salivary flow rates (Swathy et al., 2024). This leads to severe xerostomia and an acidic oral environment, creating a highly corrosive setting for dental enamel (Chaparro-González et al., 2018; Cossa et al., 2020). Furthermore, the direct toxic and numbing effects of drugs like cocaine can conceal mouth discomfort, allowing direct soft tissue injuries, including mucosal ulcerations, palatal perforations, and gingival necrosis, to progress unnoticed (Swathy et al., 2024).

Indirectly, the lifestyle acquired by drug-dependent individuals plays a massive and equally destructive role in oral health deterioration (Cossa et al., 2020). A hallmark of drug addiction is the profound disregard for personal self-care and hygiene; addicted individuals frequently exhibit heavy plaque accumulation, poor brushing habits, and a general lack of concern for their physical appearance (Cossa et al., 2020; Swathy et al., 2024). Furthermore, these individuals typically experience altered nutritional habits, such as a markedly high intake of refined carbohydrates, sugars, and carbonated beverages (Chaparro-González et al., 2018). These sugary drinks are often consumed in large quantities to alleviate drug-induced dry mouth, which rapidly accelerates the formation of rampant caries and dental erosion. It can be seen in the Figure 1 (Alqarni et al., 2024; Sun et al., 2018).

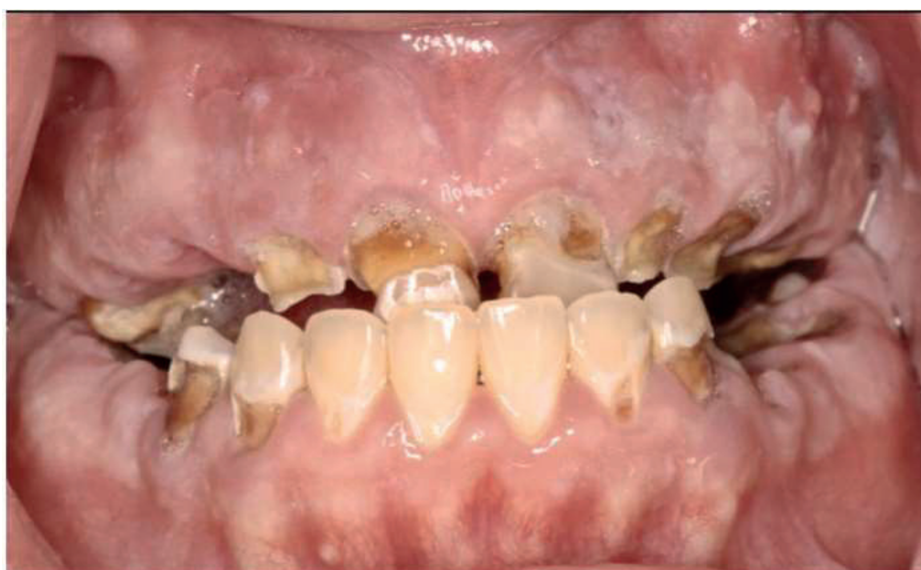

Figure 1: Pre-treatment intraoral frontal view of a crystal meth user. Loss of VDO, reverse articulation, residual roots, and rampant brown carious lesions are shown. (Alqarni et al., 2024)

The indirect consequences of drug abuse also profoundly extend to patients' healthcare-seeking behaviors and compounding risk factors (Chaparro-González et al., 2018; Swathy et al., 2024). Addicts characteristically delay seeking dental or medical attention until their oral diseases have progressed to severe, painful stages, which significantly complicates potential restorative therapies (Chaparro-González et al., 2018; Swathy et al., 2024). Additionally, many substance abusers are polydrug users who simultaneously consume tobacco and alcohol, which synergistically exacerbates oral health issues, increasing the risk of severe periodontal diseases, rampant tooth decay, and precancerous lesions (Chaparro-González et al., 2018; Cossa et al., 2020). Finally, financial constraints, lack of social support, and limited access to health services often prevent these individuals from receiving necessary preventative and curative treatments, worsening the cycle of oral and systemic health decline (Chaparro-González et al., 2018; Rommel et al., 2016).

2. Drug-Induced Xerostomia (Dry Mouth) and Salivary Changes

Drug-induced xerostomia, or severe dry mouth, is one of the most prevalent and debilitating oral manifestations reported among substance abusers (Newell et al., 2025; Sun et al., 2018). Various illicit drugs profoundly disrupt normal salivary gland function through distinct physiological mechanisms (Sun et al., 2018). For instance, sympathomimetic amines like methamphetamine and 3,4-methylenedioxymethamphetamine (MDMA or ecstasy) stimulate alpha-adrenergic receptors within the salivary gland vasculature, causing intense vasoconstriction that severely diminishes salivary flow (Sun et al., 2018; Turkyilmaz, 2010). Similarly, cannabis use restricts saliva production because delta-9-tetrahydrocannabinol (THC) binds directly to cannabinoid receptors located in the salivary glands (Swathy et al., 2024). Additionally, drugs such as heroin and cocaine significantly reduce salivary flow rates, further contributing to the desiccation of the oral cavity (Swathy et al., 2024).

Beyond reducing the absolute volume of saliva, substance abuse severely compromises the qualitative and protective properties of the saliva that is produced (Rommel et al., 2016). Chronic use of methamphetamine and MDMA has been shown to lower salivary pH and significantly decrease the saliva's buffering capacity, creating a highly acidic oral environment (Figure 2) (Newell et al., 2025; Rommel et al., 2016). This functional decline is frequently worsened by systemic dehydration resulting from the hypermetabolic states and increased physical activity associated with stimulant use (Rommel et al., 2016; Sun et al., 2018). Furthermore, studies suggest that the physiological stress of drug withdrawal, particularly in

methamphetamine users, can activate specific neural pathways (such as the PACAP-DBI pathway) that continue to inhibit salivary secretion even when the drug is not actively being consumed (Sun et al., 2018).

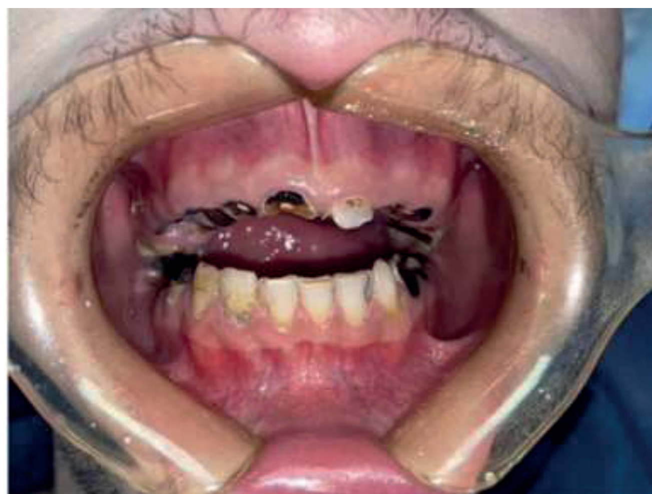

Figure 2: Clinical presentation of a 22 year old male patient using MDMA for 3 years and still consuming at the time of presentation combined with
a 20 cigarettes per day habit since he was 14 years old. (Newell et al., 2025)

It is also critical to recognize that many individuals with substance use disorders suffer from comorbid psychiatric conditions and may be prescribed psychotropic medications that exacerbate salivary hypofunction (Fratto & Manzon, 2014). Prescribed medications, including tricyclic antidepressants (TCAs), selective serotonin reuptake inhibitors (SSRIs), typical and atypical antipsychotics, and mood stabilizers like lithium, frequently exhibit strong anticholinergic or antiadrenergic side effects (Fratto & Manzon, 2014). These pharmacological actions inhibit acetylcholine and other neurotransmitters responsible for stimulating salivary flow, compounding the xerostomia caused by illicit drug use and creating an extreme state of oral dryness (Fratto & Manzon, 2014).

The clinical consequences of drug-induced xerostomia are catastrophic for oral health (Rommel et al., 2016). Saliva plays a vital protective role by neutralizing plaque-induced acids, flushing away food particles, and facilitating the remineralization of dental enamel (Newell et al., 2025; Rommel et al., 2016). Without this protective barrier, the oral cavity becomes a corrosive environment highly susceptible to rampant dental caries, accelerated enamel erosion, and opportunistic infections such as candidiasis (Fratto & Manzon, 2014; Turkyilmaz, 2010). This physiological vulnerability is typically magnified by behavioral

changes; to alleviate the persistent sensation of dry mouth, drug users frequently consume large quantities of highly acidic and sugary carbonated beverages, which further accelerates the rapid destruction of the dentition (Newell et al., 2025; Turkyilmaz, 2010).

3. Rampant Dental Caries and the "Meth Mouth" Phenomenon

A hallmark of severe methamphetamine abuse is a unique and rapid pattern of dental decay commonly referred to as "meth mouth". The American Dental Association has adopted this term to describe the rampant carious lesions that leave users with blackened, stained, rotting, and crumbling teeth. The clinical presentation of meth mouth is highly distinct; atypical carious lesions frequently initiate in the cervical regions of the teeth and rapidly progress to the smooth buccal surfaces of posterior teeth, as well as the interproximal areas of anterior teeth. Without intervention, this aggressive decay can lead to the complete destruction of the coronal portion of the tooth, often leaving behind only retained radicular roots.

The etiology of this rampant dental destruction is driven by a devastating combination of drug-induced physiological changes and acquired lifestyle factors. Methamphetamine severely diminishes salivary flow and reduces the saliva's buffering capacity, stripping the oral cavity of its natural ability to neutralize plaque-induced acids and remineralize enamel. To counteract the intense and persistent dry mouth, addicted individuals frequently consume large quantities of refined carbohydrates and highly acidic, sugary carbonated beverages. This highly cariogenic diet, coupled with the caustic nature of the drug itself and a profound neglect of basic oral hygiene, creates an ideal environment for the proliferation of cariogenic bacteria like *Streptococcus mutans*, resulting in accelerated enamel breakdown. Furthermore, drug-induced bruxism and teeth grinding can cause enamel cracks and wear, which provides early entry points for decay.

The epidemiological impact of methamphetamine on caries prevalence is severe. Studies indicate that methamphetamine users are up to four times more likely to have dental cavities and twice as likely to have untreated caries compared to the general population. Consequently, these individuals often exhibit significantly higher Decayed, Missing, and Filled Teeth (DMFT) scores and experience a massive rate of tooth loss. The structural damage is often so extensive that traditional restorative treatments are rendered hopeless, forcing users to undergo widespread extractions and requiring complex, full-mouth prosthetic rehabilitation to restore normal appearance and function.

4. Periodontal Disease and Soft Tissue Lesions

Substance abuse significantly elevates the risk of developing severe periodontal diseases, characterized by widespread gingival bleeding, deep periodontal pockets, and advanced clinical attachment loss (Cossa et al., 2020; Sun et al., 2018). The etiology of this periodontal breakdown is multifactorial, driven by chronic plaque accumulation, drug-induced xerostomia, and the direct immunosuppressive effects of various illicit substances (Sun et al., 2018). For instance, methamphetamine has been shown to increase bacterial lipopolysaccharide-stimulated interleukin-1 beta (IL-1β) production in macrophages and suppress overall immune system activity, creating a disordered inflammatory response that accelerates the destruction of periodontal tissues (Sun et al., 2018). Similarly, long-term heroin injection compromises the user's immune system, drastically raising the risk of severe infections such as necrotizing ulcerative gingivitis and advanced periodontitis (Swathy et al., 2024).

In addition to widespread periodontal destruction, drug abuse frequently causes distinct and severe soft tissue lesions within the oral cavity (Cossa et al., 2020). Cocaine, due to its potent vasoconstrictive and local anesthetic properties, presents exceptionally high risks to mucosal integrity. The chronic snorting or intraoral application of cocaine induces severe tissue ischemia, which frequently leads to mucosal ulcerations, extensive gingival necrosis, and the characteristic perforation of the hard palate and nasal septum (Cossa et al., 2020; Swathy et al., 2024). Because the drug simultaneously numbs the local tissues, these destructive, necrotic lesions often progress painlessly and unnoticed by the user until the anatomical damage is extensive and irreversible (Swathy et al., 2024).

Other illicit substances also contribute to varying degrees of soft tissue trauma and mucosal pathology. Prolonged cannabis smoking exposes oral tissues to high levels of combustible carcinogens, which significantly increases the risk of developing precancerous lesions, leukoplakia, and potentially oral carcinoma (Cossa et al., 2020; Swathy et al., 2024). Furthermore, synthetic drugs like 3,4-methylenedioxymethamphetamine (MDMA or ecstasy) and synthetic cathinones are associated with recurrent oral ulcerations, mucosal burns, and diffuse tissue swelling (Newell et al., 2025; Swathy et al., 2024). In some instances, the direct mucosal contact of these caustic chemicals—such as when users store ecstasy tablets directly in the labial vestibule or dissolve powder in their mouths—can precipitate sudden, localized periodontal attachment loss and massive tissue necrosis (Newell et al., 2025).

5. Bruxism, Tooth Wear, and Temporomandibular Disorders (TMD)

The consumption of illicit psychostimulants, such as methamphetamine, cocaine, and 3,4-methylenedioxymethamphetamine (MDMA or ecstasy), is strongly associated with severe parafunctional oral habits, particularly bruxism (teeth grinding) and involuntary jaw clenching. These behaviors are primarily driven by the potent sympathomimetic properties of the drugs, which stimulate the central nervous system by increasing the release and inhibiting the reuptake of key neurotransmitters like dopamine, serotonin, and norepinephrine. This profound pharmacological alteration induces a state of extreme energy and heightened neuromuscular activity, leading to choreiform motor activity that frequently manifests as persistent masticatory muscle contractions, muscle trismus, and lockjaw. Clinical studies have demonstrated that the prevalence of both awake and sleep bruxism is significantly higher among drug-addicted individuals compared to the general population; for instance, up to 89% of MDMA users report active teeth clenching during intoxication, and approximately 81% of methamphetamine users exhibit clinical symptoms of bruxism.

The relentless and involuntary grinding forces exerted during drug-induced bruxism result in catastrophic structural damage to the dentition. Affected individuals frequently exhibit excessive tooth wear, characterized by flattened cuspal inclinations, extensive attrition, dentin exposure, and visible enamel cracks. In MDMA users, this wear is often significantly more pronounced on the posterior teeth due to the intense nature of the clenching. Furthermore, the structural deterioration caused by bruxism is often compounded by other drug-related oral complications, such as drug-induced xerostomia (dry mouth) and the heavy consumption of acidic, carbonated beverages that users drink to alleviate their thirst. The combination of a dry, highly corrosive oral environment and extreme mechanical friction rapidly accelerates the loss of tooth surface structure, rendering the teeth highly susceptible to rampant decay and catastrophic fractures.

Consequently, the persistent hypertonicity of the masticatory muscles and the resulting abnormal mechanical stresses heavily predispose substance abusers to temporomandibular joint disorders (TMD). Drug-dependent individuals frequently report a range of debilitating TMD symptoms, including severe myofascial pain, tenderness in the masseter and temporalis muscles upon palpation, joint clicking or popping during jaw movement, and restricted mouth opening. Statistical analyses indicate that substance abusers possess a multifold increased risk of developing TMD compared to non-users, severely impairing their ability to chew and speak

comfortably. Addressing these parafunctional and joint-related complications requires a comprehensive approach, as the chronic pain associated with TMD can significantly diminish the user's mental health and quality of life, potentially complicating their overall addiction recovery process.

6. The Hidden Impact of Prescribed Psychotropic Medications

Individuals struggling with substance use disorders frequently suffer from comorbid psychiatric conditions, necessitating the prescription of psychotropic medications to manage symptoms of anxiety, depression, bipolar disorder, and schizophrenia (Fratto & Manzon, 2014). While the devastating oral effects of illicit drugs are widely documented, the hidden impact of these prescribed medications—including antipsychotics, antidepressants, and mood stabilizers—often profoundly exacerbates the deterioration of the stomatognathic system (Fratto & Manzon, 2014). The pharmacological mechanisms of these drugs target central nervous system neurotransmitters, but they concurrently interact with peripheral receptors in the oral cavity, leading to significant and often unavoidable side effects (Fratto & Manzon, 2014).

One of the most severe consequences of antipsychotic medications, particularly typical antipsychotics like haloperidol and certain atypical variants like risperidone, is the induction of extrapyramidal motor disorders (Fratto & Manzon, 2014; George et al., 2021). By acting as dopamine antagonists, these drugs can trigger involuntary, hyperkinetic motor activities in the orofacial region (Fratto & Manzon, 2014; George et al., 2021). Patients often develop tardive dyskinesia, orofacial dystonia, and severe bruxism, which subjects the dentition to extreme mechanical stress (Fratto & Manzon, 2014; George et al., 2021). Additionally, some individuals develop "rabbit syndrome," an antipsychotic-induced rhythmic motion of the mouth and lips that resembles the rapid chewing movements of a rabbit (Fratto & Manzon, 2014). These continuous parafunctional habits accelerate tooth attrition, enamel fracturing, and the development of debilitating temporomandibular joint (TMJ) disorders (George et al., 2021).

Beyond motor control issues, prescribed antidepressants and mood stabilizers heavily compromise the oral environment by severely reducing salivary flow and altering oral mucosal health (Fratto & Manzon, 2014). Tricyclic antidepressants (TCAs) and selective serotonin reuptake inhibitors (SSRIs) exhibit strong anticholinergic properties, leading to profound xerostomia (dry mouth) (Fratto & Manzon, 2014). The absence of saliva's protective buffering

capacity leaves the oral cavity highly susceptible to rampant dental caries, periodontal disease, and opportunistic infections such as candidiasis (Fratto & Manzon, 2014). Furthermore, mood stabilizers like lithium and anticonvulsants like valproic acid are associated with additional complications, including gingival overgrowth, geographic tongue, and severe mucosal ulcerations (Fratto & Manzon, 2014). Consequently, the compounded effects of illicit drug use and prescribed psychotropic therapies create a highly destructive synergistic environment that demands vigilant, interdisciplinary dental and psychiatric management (Fratto & Manzon, 2014).

7. Dental Management, Interdisciplinary Care, and Quality of Life

Substance abuse disorders inflict a profound and detrimental impact on an individual's Oral Health-Related Quality of Life (OHRQoL). Patients suffering from drug-induced oral pathologies frequently report experiencing severe, recurrent toothaches, difficulty chewing and swallowing, and an altered sense of taste. Beyond these functional impairments, the catastrophic aesthetic damage—often characterized by blackened, rotting, and missing teeth—causes deep psychological distress. Addicted individuals commonly express profound embarrassment and self-consciousness regarding their dental appearance, which frequently exacerbates social withdrawal, isolation, and comorbid mental health conditions. Consequently, restoring oral function and aesthetics is a critical step in improving the overall well-being, confidence, and social reintegration of recovering addicts.

The clinical dental management of substance abusers is highly complex and requires specific pharmacological and restorative modifications. Because the structural dental damage is often too extensive for conventional fillings, patients frequently require widespread extractions and full-mouth rehabilitation utilizing dental implants or fixed and removable prostheses to restore normal function. Crucially, dentists must take rigorous pharmacological precautions; for instance, administering local anesthetics containing vasoconstrictors (such as epinephrine) to a patient who has consumed methamphetamine within the previous 24 hours can trigger severe, life-threatening cardiovascular events, including cardiac dysrhythmias, acute hypertension, or myocardial infarction. Furthermore, practitioners must carefully manage post-operative pain by avoiding the prescription of opioid analgesics to prevent triggering a relapse, instead relying on nonsteroidal anti-inflammatory drugs (NSAIDs). Supportive therapies, including nutritional counseling, oral hygiene education, and the prescription of artificial saliva

or parasympathomimetic drugs like pilocarpine, are also vital to manage chronic drug-induced xerostomia.

Because the etiology of drug-related oral disease encompasses physiological, psychological, and behavioral dimensions, successful management necessitates a comprehensive, interdisciplinary care model. A collaborative team comprising dental professionals, addiction specialists, mental health counselors, and public health officials is essential to address the multifaceted needs of these patients. While dentists manage the immediate oral pathologies, addiction experts are crucial for understanding the behavioral facets that influence treatment compliance, and mental health professionals can assist in addressing the underlying psychological triggers of substance abuse. Ultimately, public health strategies must advocate for the integration of accessible oral healthcare services directly into substance abuse rehabilitation programs, ensuring that dental care is recognized as an integral component of the holistic recovery process.

DISCUSSION

The pervasive deterioration of oral health among individuals with substance use disorders underscores a critical, yet frequently neglected, public health challenge. The literature consistently demonstrates that the severe oral manifestations of drug abuse—ranging from the rampant caries characteristic of "meth mouth" to advanced periodontal disease and extreme tooth wear—are not solely the result of the chemical properties of the drugs themselves. Rather, these pathologies emerge from a destructive synergy between direct pharmacological effects, such as sympathomimetic-induced xerostomia and bruxism, and profound behavioral changes, including cariogenic diets and a near-complete abandonment of personal oral hygiene. Furthermore, the frequent co-prescription of psychotropic medications to manage comorbid psychiatric conditions compounds these issues by further reducing salivary flow and inducing involuntary extrapyramidal motor activities, creating an exceptionally corrosive and mechanically stressful oral environment.

A significant barrier to mitigating these catastrophic oral health outcomes is the complex socioeconomic and psychological profile of the addicted population. Substance abusers typically experience severe financial constraints, social marginalization, and intense

psychological embarrassment regarding their dental appearance, which collectively deter them from seeking routine or preventative dental care. Consequently, dental professionals often only encounter these patients when they are in acute pain or require extensive, full-mouth rehabilitative procedures, such as widespread extractions and prosthodontic reconstructions. Additionally, practitioners must navigate significant clinical challenges, including managing the severe risks of drug interactions—such as the administration of local anesthetics containing vasoconstrictors in active methamphetamine users—and addressing the erratic compliance commonly seen in this demographic.

Ultimately, resolving the oral health crisis within drug-addicted populations necessitates a paradigm shift from isolated dental treatment to comprehensive, interdisciplinary healthcare. As highlighted by recent reviews, successful dental rehabilitation must be integrated directly into broader substance abuse recovery and rehabilitation programs. A collaborative framework involving dentists, psychiatrists, addiction counselors, and social workers is essential to address the physiological, psychological, and behavioral facets of addiction simultaneously. By restoring oral function and aesthetics, healthcare providers can profoundly improve the Oral Health-Related Quality of Life (OHRQoL) of recovering individuals, thereby bolstering their self-esteem, facilitating social reintegration, and actively supporting their broader journey toward long-term sobriety and recovery.

CONCLUSION

Drug abuse presents a profound and multifaceted threat to the stomatognathic system, leading to devastating clinical consequences that extend far beyond general systemic health issues. As explored throughout this article, the severe oral pathologies observed in addicted populations—such as rampant dental caries, advanced periodontal disease, extensive tooth wear, and destructive soft tissue lesions—do not arise from a single cause. Instead, they emerge from a destructive synergy between direct pharmacological effects, most notably drug-induced xerostomia and extreme bruxism, and indirect behavioral changes, including a profound neglect of personal oral hygiene and the heavy consumption of cariogenic diets. Whether stemming from illicit substances like methamphetamine, cocaine, and cannabis, or from prescribed psychotropic medications used to manage comorbid psychiatric conditions, the resulting damage creates a highly corrosive and mechanically stressful oral environment that rapidly destroys the dentition.

Addressing this silent epidemic requires a fundamental paradigm shift from isolated dental procedures to comprehensive, interdisciplinary healthcare. Dental professionals serve as critical first responders in identifying the clinical signs of substance abuse and must exercise vigilant patient screening and pharmacological caution to ensure safe and effective treatment. However, successful rehabilitation goes beyond merely treating the teeth; it involves restoring oral function and aesthetics to alleviate the deep psychological embarrassment and social withdrawal frequently experienced by recovering addicts. By integrating accessible and compassionate oral healthcare directly into broader addiction recovery programs, healthcare providers can profoundly improve patients' oral health-related quality of life, thereby restoring their self-esteem, confidence, and actively supporting their successful long-term reintegration into society.

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CHAPTER 3

ORAL AND DENTAL HEALTH PROBLEMS IN THE GERIATRIC PERIOD

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1.Aging and Physiological Changes in the Oral Cavity

Old age is a period corresponding to the advancing years in the human life cycle, characterized by physical and mental changes (Bozdemir & Amasya, 2019). During the aging process—a natural phenomenon—irreversible structural and functional changes occur at the molecular, cellular, tissue, organ, and system levels as time progresses. In other words, aging affects all tissues and organs of the body.

As an inevitable biological phenomenon, the concept of old age has extended to older ages due to changes in the population's age composition, which has led to the further aging of the elderly population. The World Health Organization defines individuals aged 65 and older as elderly and those over 85 as very elderly. In contrast, gerontologists evaluate the aging process in three stages: they describe the 65–74 age range as early old age, the 75–84 age range as middle old age, and the period after 85 as late old age (old age) (Beğer & Yavuzer, 2012).

While global population growth stands at approximately 1.7% annually, this rate is higher among older adults. In particular, the annual growth rate of the population aged 65 and older reaches 2.5%, indicating a faster increase than the general population. This trend signals that both developed and developing societies will experience fundamental changes in their demographic structures in the coming years. According to United Nations projections, by 2050, individuals aged 80 and older will constitute the fastest-growing demographic group and account for approximately one-fifth of the global population (Harris, 1999; Park, 2011).

The example of India vividly illustrates the effects of this process. In this country, with a population exceeding one billion, individuals aged 60 and older account for 7.6% of the total population, which corresponds to approximately 76 million people. Furthermore, oral cancer, which holds a significant place among age-related diseases, is most prevalent in India (Panchbhai, 2012).

During the physiological aging process, which involves a gradual decline in organ and system functions, functional changes are observed in the respiratory, cardiovascular, gastrointestinal, endocrine, immune, musculoskeletal, neurological, and urinary systems. In addition, significant age-related physiological differences emerge in skin structure and sensory perceptions such as vision, hearing, taste, and smell (Ağar, 2020).

Beyond these, aging also affects the various tissues and functions of the oral cavity. Consequently, the density of the jaw bones decreases due to loss of calcified tissue and changes in collagen structure. The dental pulp becomes increasingly calcified, resulting in a reduction in its size along with the content of its blood and nerve supply. Oral sensory function decreases, and changes in taste perception occur; these changes may be attributed to alterations in taste buds, receptors, the central nervous system, or dietary habits (Belibasakis, 2018).

One of the fundamental goals of dentistry is the lifelong preservation and maintenance of functional teeth. With the increasing advancements in oral health, there has been a significant decrease in the prevalence of cavities, particularly during childhood. Consequently, an increase in the number of individuals retaining their natural teeth into older age is expected (Hicks & Flaitz, 1993; Burt, 1994).

Based on this, changes in hard tissues can be classified as tooth loss, wear and decay formation, problems associated with poorly made restorations, and periodontal diseases. Changes observed in soft tissues, on the other hand, can be grouped into conditions such as infectious lesions of the oral mucosa, functional disorders of the salivary glands, xerostomia, and burning mouth syndrome, as well as oral side effects of medications used in the treatment of systemic diseases, pathologies arising from denture use, and precancerous lesions.

In addition to these, histopathological changes also occur in the salivary glands. This leads to a decrease in saliva production and secretion, as well as changes in saliva composition (Choi et al., 2013). Atrophy of the salivary glands can contribute to the development of periodontal diseases and malignancies. Additionally, tooth wear occurs with age (Al-Drees, 2010).

Furthermore, various biological transformations occur in the teeth with aging. During this process, while significant changes in tooth morphology occur, a darkening of the shade may be observed due to increased secondary dentin formation. Furthermore, increased fluoride accumulation, more frequent cracks on the enamel surface, thickening of the cementum layer, and narrowing of the dentinal tubules are among the typical manifestations of aging. The decrease in blood supply to the pulp tissue observed with advancing age is also one of the significant changes affecting the tooth’s physiological structure (Holm-Pedersen & Löe, 1996).

It is generally observed that systemic health is prioritized over oral health in the elderly. Oral health is often neglected. This is because activities such as nutrition, medication intake, self-

care, and physical therapy take precedence in the elderly, resulting in less time being allocated to oral health (Hoeksema et al., 2017).

It can sometimes be difficult to determine whether certain changes in the oral mucosa are due to aging or another cause. Examples include changes in epithelial growth and repair, or a decreased sensitivity to mechanical and chemical irritants (Ekelund, 1988).

The thinning of the oral mucosa over time weakens local mucosal immunity, leading to a reduction in antimicrobial defense capacity. In addition, age-related natural immunological changes reduce the effectiveness of the general immune system and make the elderly individual more vulnerable to infections. Consequently, the chemotaxis of innate immune cells—including neutrophils, monocytes, and dendritic cells—is impaired, and their ability to migrate toward the infection site and, when necessary, withdraw from it is significantly reduced. The delayed arrival of these immune cells at the site of microbial invasion creates a time window that allows pathogens to establish themselves and multiply. Conversely, their slow withdrawal from the infection site may have the opposite effect, leading to prolonged inflammation, delayed healing, and increased potential damage to surrounding tissues. This situation compromises the functional capacity of immune cells in older individuals. Consequently, it reduces their ability to neutralize invading microorganisms through phagocytosis or via extracellular “trapping” mechanisms. At the same time, while there is a decrease in the number of naive and regulatory T and B lymphocytes, there is an increase in cells with memory and cytotoxic phenotypes. This leads to the formation of a more intense and cytotoxic inflammatory microenvironment (Ebersole et al., 2016).

Along with changes in living standards, mortality rates have decreased, and people are living longer. While the elderly population was 8.0% in 2014, it reached 9.1% in 2019. These data indicating the growing elderly population were determined by the Turkish Statistical Institute. When examining age groups, the majority of the elderly population consists of those aged 65–74. Consequently, new regulations must be implemented to make life easier for the elderly. These should include provisions for dental care and oral health, as significant physiological changes occur in the mouth with age (Karabulut Gençer et al., 2021).

2. Oral Health Problems and Masticatory Function in Older Adults

Oral health problems, particularly in older adults, lead to serious consequences such as difficulty chewing, malnutrition, and a corresponding decline in quality of life. Impaired eating or swallowing capacity, weakened oral motor skills, damage to hard and soft oral tissues, and a reduction in the number of teeth are among the other issues associated with aging that contribute to impaired oral function (Iwasaki et al., 2020; Matsuo et al., 2021; Hakeem et al., 2020; Hasegawa et al., 2019).

Chewing is one of the primary issues among oral health problems. There are three main factors that significantly affect masticatory function in the elderly population. These can be attributed to the number of opposing (antagonist) natural teeth, the quantity and/or quality of saliva, and functional impairments in the motor system. The wide variability in the number of natural teeth among elderly individuals is a significant factor affecting masticatory function (Hirano et al., 1999). However, since each of these three factors is significantly associated with aging, a comprehensive consideration of these factors is necessary when assessing masticatory capacity in older adults (Peyron et al., 2017).

However, epidemiological studies on oral health in the elderly population are not sufficiently comprehensive, and there is a marked research imbalance between countries, primarily driven by socioeconomic differences. Furthermore, the unequal access to oral health services across regions constitutes a problem in itself (Gil-Montoya et al., 2015).

3. Age-Related Changes in Teeth

Macroscopic changes in teeth that occur with age are closely related to the transformations that both enamel and dentin undergo over time. As the perikymata and imbrication lines become faint or disappear entirely, the fine details on the tooth surface become indistinguishable, resulting in a smoother, more homogeneous appearance (Bozdemir & Amasya, 2019). Wear and attrition resulting from lifelong mechanical forces lead to significant changes in tooth form.

Attrition is the wear that occurs on the occlusal and approximal surfaces of teeth due to tooth-to-tooth contact during occlusion. Clinical signs of attrition include smooth, shiny surfaces primarily observed on the cusps or incisal edges, as well as tooth impressions in soft tissues; cracks and fractures in both natural tooth structure and restorative materials as the wear process progresses; and finally, the formation of wider contact surfaces due to the gradual wear of

natural contact points between teeth over time (Kaidonis, 2008). As this process progresses, the anatomical crown length shortens, and as the enamel layer thins, the underlying dentin tissue may approach the surface and become visible at times (Bozdemir & Amasya, 2019). Since attrition generally progresses slowly, the pulp forms tertiary or reparative dentin to protect itself. As a result, even if half of the crown is worn away, vitality in the pulp may persist. Attrition is one of the most common dental findings in older adults.

Dental abrasion refers to pathological losses in hard tissue resulting from the exposure of tooth surfaces to mechanical forces beyond physiological chewing forces (Addy & Shellis, 2006; Alhilou et al., 2015). Various factors contribute to the development of this condition; these include, primarily, acquired habits, occupational requirements, and improper oral hygiene practices. A prime example is the constant holding of tools between the teeth in certain professions. For instance, the prolonged contact of wind instrument mouthpieces with the teeth, or carpenters and tailors carrying nails or needles in their mouths while working, can lead to characteristic abrasion lesions over time (Litonjua et al., 2003 & Rath et al., 2017).

Various habits observed in daily life can similarly cause wear on tooth structure. Behaviors such as nail-biting, cracking sunflower seeds, and pipe smoking increase the risk of abrasion by applying repetitive mechanical stress to tooth surfaces. Brushing teeth with an incorrect technique can also cause abrasion in the cervical region. Among the primary causes of this are the stiffness, density, and structure of the bristles, as well as the abrasive properties of the toothpaste used. In particular, vigorous brushing in the elderly can lead to significant abrasion on exposed root surfaces (Cinel Şahin & Koyal, 2021). Additionally, in older individuals, root surfaces may become exposed due to gum recession.

In the treatment of tooth wear in the elderly, the primary evaluation criteria include the method's cost-effectiveness, clinical ease and speed of application, and the ability to be repaired when necessary. For this reason, composite materials and ceramic restorations are frequently preferred in treatment. Composite restorations, in particular, are frequently used as they represent the simplest treatment option for achieving both aesthetics and function (Reston et al., 2012). However, in cases where vertical dimension loss is significant, the treatment approach may require a different protocol. In such cases, the use of indirect restorative materials is considered (Jaeggi, Grüninger, & Lussi, 2006; Muts et al., 2014).

With advancing age, it is observed that calcifications in the pulp tissue increase in terms of both number and size, as well as prevalence. In elderly individuals, significant narrowing of the pulp chamber and root canals, along with the formation of widespread calcified areas, is a common finding. Although cementum tissue continues to be produced throughout life, the rate of this production process slows significantly in advanced age. Age-related changes in tooth morphology are numerous. These changes have significant clinical importance; because these structural transformations play a distinct role in both the success of restorative treatments and tissue repair processes (Razak et al., 2014).

4. Periodontal Diseases in Older Adults

Periodontal diseases are one of the most common chronic conditions in the elderly. The severity and prevalence of periodontal diseases increase with age. This is due to the prolonged exposure of periodontal tissues to bacterial plaque (Suresh, 2006).

Biologically, aging is characterized by progressive and irreversible impairments in the functional capacity of the body's tissues and organs that emerge over time. The structural and functional changes that occur during this process may also alter the host's response to microorganisms present in dental plaque. Consequently, these age-related physiological changes can influence the rate and severity of periodontal destruction in older adults (Razak et al., 2014).

Factors such as neglecting regular dental check-ups, insufficient attention to oral hygiene, smoking habits, and depression significantly increase the risk of periodontal tissue deterioration in older adults. Another important reason for the increased susceptibility to periodontal diseases in older adults is the weakening of the immune system with age and the inability of the immune response to be sufficiently strong. This situation leads to periodontal tissues becoming more vulnerable to infection (Nazlıel, 1999).

The most fundamental practice for maintaining dental plaque control and oral hygiene in older adults is regular tooth brushing. However, the limited mobility and reduced fine motor skills commonly seen in this age group can make effective brushing difficult. For this reason, the use of electric toothbrushes is particularly recommended to make oral care easier and more efficient (Karabulut Gençer et al., 2021).

5. Xerostomia and Salivary Alterations

Another common oral finding in the elderly is a decrease in saliva production. Saliva, which plays a multifaceted role in maintaining oral health, ensures that the oral mucosa remains sufficiently moist, contributes to maintaining the balance of the oral microbial system, and helps remove debris through its mechanical cleansing function. Additionally, saliva acts as a protective barrier against pathogens through its antibacterial and antifungal effects, neutralizes acids to serve as a buffer, and supports the remineralization process of teeth. It makes significant contributions to the healthy functioning of the sense of taste, the initial stage of digestion, and the protection of both the upper respiratory tract and the gastrointestinal system. A lack of or reduced saliva production, however, is an extremely adverse condition for the host (Razak et al., 2014; Nazlıel et al., 2007).

There is a significant decrease in saliva secretion associated with aging. However, this decrease cannot be explained solely by the natural changes brought about by aging. Certain medications the individual takes, medical treatments administered, or existing health issues can impair the function of the salivary glands, leading to a reduction in secretion volume. Therefore, it is understood that the decrease in saliva secretion is not solely the result of natural physiological processes but that various external factors and applied treatments can also play a role in this condition (Yiğit, 2018). This condition negatively impacts oral and dental health. Consequently, it can lead to various problems such as an increased risk of cavities, the development of periodontal diseases, impaired chewing function, a diminished sense of taste, and difficulties with speech and swallowing (Nazlıel, 1999; Pontefract, 2002).

6. Oral Microbiome in Aging

The primary factors enabling the retention of more natural teeth in the mouth in older age are advancements in oral health practices and increased life expectancy. As a natural consequence, the cumulative effects of dental caries and periodontal diseases over a lifetime become more pronounced in aging populations. This leads to an increased need for supportive periodontal treatments and heightens the requirement to strengthen awareness that oral health is a fundamental component of healthy aging (Nalbantoğlu, 2021). Current epidemiological estimates indicate that approximately three-quarters of individuals over the age of 65 have periodontal pockets, while a significant portion of the population over 60 has root surface caries or restorations extending to the root surface. With aging, a vicious cycle develops between

periodontal disease and dental caries. Gum recession and the exposure of root surfaces following periodontal treatment create a more susceptible area for caries development. The oral microbiome is a term referring to the ecosystem formed by all microorganisms living in the oral cavity. With age, changes begin to occur in the composition of this microbiome. When the microbial composition of the oral biofilm in older adults is examined, it is observed to change with age. Among the microorganisms naturally present in the mouth, *Actinomyces* species are seen more frequently as age advances. It is thought that this increase may be related to the exposure of root surfaces resulting from periodontal disease associated with aging (**Simon-Soro & Mira, 2015**).

In individuals over 60–70 years of age, an increase in *Actinomyces* species, lactobacilli, and yeast cells was observed in supragingival plaque and saliva samples compared to younger groups, while levels of *S. mutans* and spirochetes did not show a significant age-related change (**Percival et al., 1991**).

The microbial balance of the oral cavity undergoes continuous change over time, regardless of the aging process or the presence of any systemic disease. This change leads to various transformations in the species distribution and proportions of microorganisms naturally present in the mouth.

7. Oral Motor Function and Mastication

Impaired motor skills governing tongue movements, along with reduced muscle tone in the muscles involved in the chewing process, significantly hinder the effective breakdown and grinding of food in the mouth. The tongue, a structure crucial for sensory information transmission and oral motor control, can grind food by compressing it against the hard palate, form appropriately sized bites, moisten it by mixing with saliva, and contribute to oral hygiene after eating (Peyron et al., 2017).

Functional impairments of the tongue, jaw, and other oral muscles—commonly observed in older adults—can manifest in various clinical conditions. Parkinson's disease (**Nakayama et al., 2004; Bakke et al., 2011**), stroke (**Schimmel et al., 2011**), Alzheimer's disease (**Kieser et al., 1999**), and various neurodegenerative conditions are typical examples of such muscle and coordination disorders. Furthermore, similar functional losses are quite common in edentulous individuals because the masticatory muscles are not sufficiently stimulated (**Woda et al., 2006**).

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CHAPTER 4

ORAL POTENTIALLY MALIGNANT DISORDERS

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In recent years, the World Health Organization (WHO) has categorized a diverse group of conditions and lesions as Oral Potentially Malignant Disorders (OPMD). In its publications, OPMDs are listed based on the available evidence regarding their worldwide prevalence and risk of malignant transformation. The OPMDs with the highest clinical relevance and prevalence are included in the WHO Classification of Head and Neck Tumors series (1), whereas a more extensive list, encompassing less common OPMDs, is available in the WHO Oral Cancer Collaboration Center consensus documents (2). According to the 5th edition of the WHO Classification of Head and Neck Tumors, Chapter 5, "Tumors of the Oral Cavity and Mobile Tongue," and the WHO 2020 Oral Cancer Collaboration Center reports, OPMDs include (3):

1. Leukoplakia

Leukoplakia has been defined in multiple ways over the past 40 years, with definitions evolving continuously. The most widely accepted current definition was proposed by the WHO Oral Cancer Collaboration Center in 2007 and reaffirmed in 2020. Leukoplakia is described as "a predominantly white plaque with a suspicious risk, excluding known diseases or disorders that do not carry a cancer risk" (2). The term is applied only when other white lesions of the oral mucosa such as oral lichen planus, frictional keratosis, white spongy nevus, or hairy leukoplakia are excluded (4). By definition, leukoplakia is a clinical diagnosis without a specific histopathological feature (5).

This condition is relatively common, affecting about 4% of the global population (6). Among OPMDs, leukoplakia is the most frequent. It occurs more often in men compared with women and is typically observed in individuals over 40 years old. Its prevalence varies geographically, often higher in Southeast Asia compared to Western countries, likely due to differing etiological factors (7).

The causes of leukoplakia appear similar to those of oral cancer, including tobacco use in all forms, betel nut chewing, and alcohol consumption. Nevertheless, it is notable that older women who have never smoked can also develop leukoplakia, and these lesions may carry a greater risk of malignant alteration compared to those in patients with known risk factors (2).

Clinically, leukoplakia can be grouped into two types: homogeneous and heterogeneous. This distinction is based entirely on clinical features such as surface, color, and texture (2):

Homogeneous leukoplakia: presents as smooth-edged, thin, flat white plaques or spots, sometimes with fine cracks in the keratin layer (8).

Heterogeneous leukoplakia: exhibits an irregular surface, potentially with superficial ulceration and poorly defined borders (8, 9).

Heterogeneous leukoplakia may present with various clinical appearances (2, 10):

Specular: mixed red and white areas, predominantly white, also called erythro-leukoplakia.

Nodular: small, round, polypoid projections that can be white or red.

Exophytic or Verrucous: furrowed or wrinkled surface pattern.

The risk of malignant transformation in leukoplakia can vary depending on clinical, histological, and molecular characteristics. Key risk factors for cancer development include (4):

- Irregular clinical appearance
- Female gender
- Long duration of the lesion
- Idiopathic leukoplakia (non-smoker/non-chewer)
- Location on the floor of the mouth or lateral side of tongue
- Lesion size > $200\ mm^2$
- Occurrence of epithelial dysplasia
- Existence of Candida albicans (11)

The severity of dysplastic changes correlates with cancer risk, with more pronounced dysplasia carrying the highest transformation potential. In non-smokers, oral epithelial dysplasia (OED) is associated with approximately a twofold higher risk of progression to cancer (12).

2. Verrucous Proliferative Leukoplakia

Verrucous proliferative leukoplakia (PVL) represents an aggressive subtype of leukoplakia. It initially appears as keratosis without dysplasia but can gradually evolve

sometimes over 20 years into confluent, multifocal oral keratosis (13). According to the WHO, PVL is defined as "a persistent, irreversible, and progressive disorder marked by multiple leukoplakic lesions," which frequently develops a verrucous appearance (2).

PVL is usually seen in women with a female-to-male ratio of 4:1 (14). The mandibular gingiva, buccal mucosa and tongue are the most frequently affected sites (15). The exact cause of PVL is unclear, and unlike many other oral lesions, tobacco use does not appear to be a primary factor, as PVL occurs in both smokers and non-smokers (14). Human papillomavirus (HPV) has been detected in PVL lesions, with 89% of specimens testing positive and HPV 16 identified in most cases (16). Additionally, Epstein-Barr virus (EBV) was present in 60% of PVL samples (17). Among all OPMDs, PVL has the highest malignant transformation rate, reaching 49.5% (18).

Diagnosis of PVL relies on both clinical and histological evaluation. The disease progresses from early hyperkeratosis to epithelial hyperplasia and atypia, potentially advancing to verrucous carcinoma and finally, squamous cell carcinoma (SCC). This progression underscores the need for multiple biopsies and ongoing follow-up (19). Histopathological features vary depending on disease stage, biopsy site, and lesion location. Lesions typically show hyperkeratosis and acanthosis with lymphocytic infiltration of the lamina propria. As lesions evolve, histology may reveal hyperplasia, with or without dysplasia, and irregular surface morphology (20).

3. Erythroplakia

Erythroplakia was originally defined by the WHO as "oral mucosal lesions appearing as bright red velvety plaques that cannot be classified as any other pathologically or clinically identifiable condition" (21). The most often cited definition in the scientific literature describes it as a bright red patch that cannot be categorized as any other pathologically or clinically identifiable lesion (22). Similar to leukoplakia, erythroplakia is defined mainly by exclusion (21).

The exact cause of erythroplakia is not fully clarified. Known contributing factors include chewing tobacco, betel quid, cigarette smoking, and alcohol intake (21). Erythroplakia is most commonly observed in middle-aged individuals, especially in the sixth and seventh decades of

life, and affects both sexes equally. Its prevalence ranges from 0.02% to 0.83%, with an average of 0.11% in the general population (23).

A meta-analysis and systematic review published in 2022 reported a malignant transformation rate of 12.7% (24). Lesions with moderate to severe dysplasia carry a significantly higher risk of progressing to cancer (21).

Clinically, erythroplakia appears as a bright red macule or patch with a soft velvety surface. The lesions are usually soft upon palpation, with induration present only when malignancy is involved. Borders can be irregular, though they are often well demarcated, and the surface may occasionally appear granular (25).

The most commonly affected sites include the floor of the mouth, soft palate, ventral side of tongue, tonsillar fossa, and buccal alveolar mucosa. Affected areas can vary between studies, with tongue involvement reported less frequently. Lesions are generally small (<1.5 cm), though larger lesions (>4 cm) have been documented. Involvement of multiple sites is rare (21). Symptoms are usually absent, but some patients report vague pain or a burning sensation at the lesion site. A metallic taste has also been described (26).

Histopathologically, erythroplakia is characterized by thin, atrophic epithelium, absence of keratin, and epithelial hyperplasia. These features account for the deep red appearance of the lesions. The absence of surface keratin, which normally diminishes red coloration, is particularly notable. Prompt biopsy is recommended to exclude neoplastic changes. Histological evaluation reveals mild to severe dysplasia or SCC in 60–90% of cases (21).

4. Oral Submucosal Fibrosis

Oral Submucosal Fibrosis (OSMF) is a chronic fibrotic disorder of the oral mucosa described by epithelial immune cell intrusion, followed by fibroelastic changes in the submucosa and lamina propria, ultimately leading to stiffening of the oral mucosa (27). Clinically, it has been described as "a debilitating, irreversible, progressive collagen metabolic disorder caused by commercial preparations and chronic areca nut chewing; affecting the oral and pharynx mucosa; resulting in functional impairment and mucosal stiffness with a potential for malignant transformation (28).

The global prevalence of OSMF is approximately 4.96%, with a clear geographical distribution, being largely confined to South and Southeast Asia. The condition is strongly associated with paan (betel quid) chewing and areca nut consumption; over 90% of OSMF patients have a history of paan chewing (29).

The rate of malignant transformation in OSMF ranges between 1% and 9%, with higher rates observed in patients who also present with oral leukoplakia. Oral cancers developing from OSMF may be less frequent but more aggressive compared to those arising from other oral lesions (30).

Clinically, OSMF is recognized by restricted tongue mobility, blanching of the oral mucosa, leathery texture, loss of papillae, progressive reduction in mouth opening, and depigmentation. Staging of OSMF early, intermediate, and advanced guides both treatment planning and patient management (31).

Histopathological examination confirms the clinical diagnosis, revealing features such as loss of rete ridges, epithelial atrophy, hyalinization of the lamina propria, and alterations in the underlying muscle layer (32).

5. Oral Lichen Planus

Oral Lichen Planus (OLP) is a chronic inflammatory disorder of the oral basal epithelium mediated by T lymphocytes, particularly CD8+ cells. The WHO defines OLP as "a chronic inflammatory disorder of unclear etiology, characterized by white reticular lesions with recurrent remissions and exacerbations, which may be accompanied by atrophic, ulcerative, plaque-type, or erosive areas. Lesions are often bilaterally symmetrical (2).

OLP is a moderately common mucocutaneous disorder, with a prevalence of 1–3% in the general population. It is more frequently observed in women than men. Although the exact etiology remains unclear, genetic predisposition, immunological disorders, nutritional deficiencies, psychological stress, and infectious agents have been proposed as contributing factors (33).

Despite being classified as a potentially malignant disorder, the definitive diagnostic criteria for OLP and its malignant transformation potential remain under debate, with conflicting reports in the literature (34).

Six classical clinical subtypes of OLP have been described, which may occur individually or in combination: reticular, atrophic/erythematous, plaque-like, ulcerative /erosive, bullous and popular forms. The reticular and erosive subtypes are the most frequently observed. Atrophic and erosive forms are most commonly associated with malignant transformation, possibly due to the atrophic nature of the mucosa rather than the disease itself (35, 36).

Reticular: The most common type, characterized by fine, shiny, white lines known as Wickham striae, often surrounded by an erythematous line. The buccal mucosa is the most frequently affected site, with lesions typically bilateral and symmetrical (37–40).

Plaque-like: These lesions resemble leukoplakia, appearing as homogeneous white patches. They may be slightly raised or irregular and are often multifocal, affecting the dorsum of the tongue and buccal mucosa (40).

Atrophic: Widespread, red lesions often surrounded by fine white striae, typically involving adjacent gingiva. This form is commonly stated as "chronic desquamative gingivitis" and may present with symmetrical patchy distribution across all quadrants (40).

Erosive: Irregularly shaped lesions covered by fibrous pseudomembranes or plaques. The periphery may display reticular lines. Disruption of the pseudomembrane or plaque causes pain. Erosive OLP is considered to carry a higher risk for malignant transformation (41).

Papular: Small white papules (~0.5 mm) that may be overlooked during routine examination due to their size. Rarely observed (40).

Bullous: Small vesicle or bullae that ruptures easily, leaving painful ulcerated surfaces. Nikolsky's sign may be positive. Lesions most commonly appear on the buccal mucosa of the region adjacent to the second and third molars, with less frequent involvement of the lateral tongue, gingiva, or inner lips (40, 42).

Histopathological findings alone may not be sufficient for diagnosis, as discrepancies between clinical and microscopic features are possible. Therefore, OLP diagnosis requires correlation between clinical presentation and histopathology (43).

OLP must be distinguished from OLP-like lesions, including lichenoid reactions, frictional keratosis, lupus erythematosus, leukoplakia, pemphigus, erythematous candidiasis, mucous membrane pemphigoid, graft-versus-host disease (GVHD), and chronic ulcerative stomatitis. Among these, drug-induced lichenoid reactions are the most challenging to differentiate clinically and histopathologically from OLP (42, 44).

6. Oral Lichenoid Lesions

Oral Lichenoid Lesions (OLL) are intraoral lesions appearing as white or red patches with a reticular streaked pattern similar to Oral Lichen Planus (OLP), but they are linked to identifiable triggers. OLL can be categorized into oral lichenoid contact lesions (OLCL), drug-induced OLL, and GVHD-associated OLL (45).

The term OLCL refers to oral lesions that resemble OLP both clinically and histopathologically but are believed to result from localized hypersensitivity reactions (delayed immune-mediated) to dental restorative materials, particularly amalgam, or other contact agents such as cinnamon. Other restorative substances, including gold, nickel, and acrylic resin, may also contribute to lichenoid lesion formation (46, 47).

OLCL typically appears as white or mixed red-and-white lesions and can sometimes be ulcerated. These lesions are generally less symmetrical and more often unilateral compared to OLP, and they lack the classic reticular pattern, instead presenting as plaques or atrophic areas (48).

Clinically and histologically, OLCL can be indistinguishable from OLP. A key diagnostic feature is the lesion’s location, which is directly related to the suspected triggering agent. The lateral tongue and buccal mucosa are the most frequently affected sites (48). Although OLP may also occur near dental restorations, these lesions are usually more widespread, affecting additional areas. The duration of contact between the agent and the oral mucosa is considered important in OLCL development (45).

Diagnosis primarily relies on clinical observation, and lesion resolution following removal of the suspected causative material confirms the diagnosis. Biopsy is recommended when clinical features are atypical or when malignancy cannot be excluded (48).

Removal of neighboring amalgam fillings or those in direct contact leads to complete healing in 39–89% of cases, whereas lesions where restorations are left in place heal in only 0–29% of cases (49).

Drug-induced OLL are uncommon and arise from exposure to various medications. Systemic drugs linked to OLL include non-steroidal anti-inflammatory drugs, antihypertensives, oral hypoglycemics, antifungals, monoclonal antibodies and antibiotics. Usually, there is a temporal relationship between drug exposure and lesion onset; however, reactions can occur even years after drug use (50). These lesions may have an uncertain clinical appearance, but unilateral presentation can assist in diagnosis (51).

GVHD occurs in recipients of bone marrow or hematopoietic stem cell transplants (25). Acute GVHD rarely affects the oral cavity, but in chronic GVHD, the mouth is frequently involved. Oral manifestations may include papules, white plaques, and hyperkeratotic lines resembling Wickham striae, alongside erythema and pseudomembranous ulcers (52).

7. Palatal Lesions in Reverse Smokers

Reverse smoking is an uncommon smoking habit in which the burning end of the cigarette or bidi is placed inside the mouth while inhaling the smoke. This practice is particularly prevalent in the Indian subcontinent (53). Temperatures in the oral cavity can reach up to 120°C, and the products of combustion increase the occurrence of oral lesions compared to conventional smoking. However, epidemiological and controlled studies examining these lesions are relatively limited (53). Thermal injury combined with prolonged exposure to various carcinogens causes changes in the palatal mucosa (54).

In 2020, the WHO described palatal lesions in palatal lesions in reverse smokers (PLRS) as "white and/or red patches on the hard palate mucosa often stained with nicotine" (2).

Clinical features in reverse smokers differ from those seen in regular smokers. The primary sites affected are the palate and tongue. Lesions range from palatal keratosis, exfoliative lesions, leukoplakia, and ulcers to frank malignancy. Other observed abnormalities include mucosal thickening, fissures, pigmentation, nodularity, erythema, and ulceration (55).

Palatal hyperpigmentation gives a gray-black appearance due to increased melanin production by melanocytes. This melanin synthesis is a protective mechanism against heat and acts as an

antioxidant against toxic compounds generated during reverse smoking. In some cases, patchy depigmented areas surrounded by hyperpigmented mucosa have been reported. These findings are often associated with heavy alcohol use and smoking. Depigmentation has also been linked to reduced melanin production, and hyperchromasia has been detected in the basal epithelial layer (55).

Given the malignant potential of PLRS, biopsy of these lesions is essential and may reveal various stages of dysplasia or carcinoma. Histological evaluation may also show ductal epithelial hyperplasia (55).

For differential diagnosis, conditions such as OLP, oral lupus and oral candidiasis should be considered. A thorough history regarding reverse smoking habits can help rule out these conditions. Oral candidiasis can be excluded through culture, and other risk factors like immunosuppression should also be evaluated (53).

8. Discoid Lupus Erythematosus

Discoid Lupus Erythematosus (DLE) is a chronic inflammatory disorder that affects both the skin and oral mucosa (25). It is the most prevalent form of chronic cutaneous lupus, representing about 80% of cases. The disease pathophysiology is multifactorial, involving genetics, environmental triggers, and both innate and adaptive immune responses (56). Key environmental triggers include ultraviolet radiation, certain medications, radiotherapy, and smoking (57).

DLE is more common in women, with a female-to-male ratio of 3:1. While it can occur at any age, it most often presents between 20 and 40 years old (58). Oral lesions without skin involvement are uncommon, reported in roughly 10% of patients (59).

Oral involvement occurs in approximately 20% of cases, usually affecting the lips, buccal alveolar mucosa and hard palate (60). Lesions typically appear as hyperkeratotic papules or spreading striae surrounding central erythema or ulceration, sometimes with peripheral telangiectasia. Chronic lesions may show a “honeycomb” pattern. Mucosal lesions can precede or occur independently of skin lesions. Lip lesions may extend to adjacent skin, blurring the vermilion border, and desquamative gingivitis may be present on the upper and/or lower gingiva (61). Healing may result in post-inflammatory hyperpigmentation. Common

symptoms include burning sensation (66.6%), photosensitivity (57.1%), dryness (23.8%), tenderness (14.3%) and pain (4.8%), although some lesions remain asymptomatic (59).

The WHO classifies DLE as a potentially malignant oral disorder, but malignant transformation is uncommon (62). When it does occur, it is usually in lesions on the vermilion border of the lips, more frequently affecting the lower lip. Risk factors for malignant transformation include prolonged UV exposure, chronic scarring, HPV infection, and long-term immunosuppression. The interval from DLE onset to lip cancer development is shorter than for cancers arising from DLE in other locations (63).

Differential diagnosis of oral DLE includes OLP, OLL, leukoplakia, and actinic keratosis (when the lower lip is involved) (64). OLP lesions are typically more extensive and symmetrical, with a more distinct reticular pattern. OLP appears as white striae in areas directly contacting dental restorations and resolves after removal of the restoration. Oral leukoplakia does not show the characteristic hyperkeratotic striae or central atrophy. Actinic keratosis generally affects the lower lip and presents with scaling rather than striae (64).

9. Graft Versus Host Disease

Graft Versus Host Disease (GVHD) is an immune-mediated condition that can develop after allogeneic hematopoietic stem cell transplantation. GVHD may present with both acute (aGVHD) and chronic (cGVHD) oral manifestations. Clinically and histopathologically, GVHD lesions resemble those seen in OLP (2).

In aGVHD, oral involvement is uncommon, and lesions are usually nonspecific. They may present as gingivitis, mucositis, erythema, or ulceration on the oral mucosa or lips (65).

In contrast, more than 70% of patients with cGVHD have oral involvement. Clinical features include mucosal inflammation, atrophy, and lichenoid hyperkeratotic changes such as striae, papules, plaques and patches. Additional findings may include pseudomembranous ulceration, perioral fibrosis and mucoceles. Other characteristic changes include vasculitis-like patterns, telangiectasia, and sclerotic alterations, which can reduce mouth opening. Patients often report oral pain, sensitivity to normally tolerated foods or substances, dry mouth, and sometimes altered taste (66).

Diagnosis of oral GVHD can be made clinically when lesions display typical lichenoid features. If lesions present as erythema, ulceration, or white plaques without the classic white striations, biopsy is required to confirm the diagnosis (67).

10. Human Papilloma Virus-Associated Dysplasia

The 2022 WHO classification recognizes Human Papilloma Virus (HPV)-associated oral epithelial dysplasia (OED) as a distinct OPMD category (68). The morphological characteristics of HPV-OED are now well documented (69, 70). Although HPV-positive SCC cases are relatively rare, a subset of OED is strongly associated with HPV infection. HPV-OED predominantly affects males (M:F = 6:1) and typically occurs in the sixth decade, although it can present across a wide age range (71).

The most frequently affected sites are the ventral and lateral side of tongue and the floor of the mouth, though lesions can also appear on the buccal mucosa, palate, lip mucosa, and gingiva (69). Clinically, HPV-OED usually appears as a flat, well-defined patch ranging from white to red, resembling other oral leukoplakias. Its etiology is mainly linked to high-risk HPV types, primarily HPV 16. The pathogenesis is not fully understood but is considered similar to HPV-associated cervical dysplasia. Invasive squamous cell carcinoma develops in approximately 5–15% of cases (72).

11. Familial Cancer Syndromes

Some case reports suggest that oral cancer can occur in families (73). Several genetic syndromes are linked to increased susceptibility to oral cancer. Individuals with conditions such as dyskeratosis congenita (DC), Fanconi anemia (FA), xeroderma pigmentosum, Bloom syndrome, ataxia-telangiectasia, Li-Fraumeni and Cowden syndromes have a higher risk of oral cancer due to genomic instability (43).

Dyskeratosis congenita (DC) is a rare multisystem genetic disorder affecting the skin, characterized by chromosomal instability and reduced telomerase activity (74). DC usually presents between ages 5 and 12 and is more common in males (75). Zinsser described the classic triad of DC in 1906 (76):

- Reticular atrophy with cutaneous hyperpigmentation
- Nail dystrophy

- Oral leukoplakia

Because of chromosomal instability, DC patients have a markedly increased risk of developing cancers in multiple organ systems. Children with DC have been reported to have a 100-fold higher risk of Acute Myeloid Leukemia. Additionally, the risk of squamous cell carcinoma (SCC) in the head and neck, cervix, and anogenital regions is elevated (77). Leukoplakia in DC progresses to cancer in roughly 30% of cases between ages 10 and 30 (78).

Fanconi Anemia (FA) is a rare autosomal recessive disorder involving defects in DNA repair, especially cross-link repair. FA is associated with congenital physical abnormalities (e.g., skeletal malformations), aplastic anemia, and progressive pancytopenia. Patients with FA are at risk of bone marrow failure, leukemia, and solid tumors, including head and neck cancers (2).

Overall, the risk of head and neck cancers in FA patients is estimated to be 500–700 times higher than in the general population (79), and these cancers often occur at a young age. Young individuals presenting with head and neck SCC should be evaluated for FA. FA patients may also show potentially malignant lesions, such as leukoplakia (80).

Conclusion

Potential malignant oral disorders include various lesions and conditions. Sometimes these lesions may be too vague or small to be noticed. During routine examinations, the oral mucosa should be thoroughly examined, and in the presence of suspicious lesions, potential malignant disorders of the mouth and their differential diagnoses should be considered. These patients should be informed about risk factors. Observed lesions should be monitored and biopsied when necessary.

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CHAPTER 5

EFFICACY OF GUIDED BIOFILM THERAPY IN PERIODONTAL AND PERI-IMPLANT DISEASES

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Introduction

Periodontitis is defined as an inflammatory, destructive and chronic disease primarily initiated by the accumulation of a microbial biofilm on the tooth surfaces of a host (Löe et al., 1965) (Chapple et al., 2018). This biofilm represents an expand microbial community that triggers a host immune-inflammatory response, eventually leading to the irreversible destruction of periodontal supporting tissues (Chandki R, 2011). The primary aim of periodontal treatment is the systematic elimination and management of the microbial biofilm, which serves as the fundamental etiological agent for the disease (Belibasakis et al., 2023). Regular mechanical disruption of this bacterial community is essential to halt the host immune-inflammatory response and prevent the irreversible destruction of periodontal supporting tissues (Hasturk & Kantarci, 2015).

Non-surgical periodontal therapy (NSPT), also known as initial or cause-related therapy, remains the "gold standard" for the management of periodontal diseases. It is a complex approach that incorporates patient motivation, individualized oral hygiene instructions, and the systematic mechanical removal of supra- and subgingival plaque and calculus, alongside the modification of local and systemic risk factors (Haas et al., 2021) (Plessas, 2014).

Throughout the history of periodontology, numerous methods have been proposed for the systemic elimination of microbial biofilm. Historically, the primary implementation of NSPT relies on scaling and root planing (SRP), which utilizes a combination of ultrasonic and manual instruments for the resolution of the periodontal disease (Feres et al., 2009). The primary objective of this therapy is to achieve clinical health on a reduced periodontium, with the ultimate endpoint being the closure of periodontal pockets (Plessas, 2014). While SRP is a standard procedure, it has been shown to cause adverse effects such as the irreversible removal of root cementum and the induction of microcracks within the dentin structure. These mechanical traumas are primary contributors to the development of patient discomfort and tooth hypersensitivity following therapy (Bozbay et al., 2018). However, as the understanding of periodontal biology and the nature of the biofilm evolved, modern protocols shifted towards a more conservative "periodontal debridement" approach (Mensi et al., 2024).

A novel approach to professional dental biofilm management has emerged, known as Guided Biofilm Therapy (GBT) (Shrivastava et al., 2021). This systematic, evidence-based protocol represents a paradigm shift from traditional mechanical debridement by integrating minimally invasive technologies with a patient-centered workflow (Mensi et al., 2024).

Guided Biofilm Therapy (GBT)

GBT relies on utilizing air-polishing technology with erythritol powder and specialized nozzles to effectively eliminate supra and subgingival biofilm around both natural teeth and implant surfaces (Mensi et al., 2020). Within this framework, the initial removal of biofilm serves as a professional guide, facilitating more targeted and effective debridement with ultrasonic devices. The GBT method is characterized by a systematic treatment protocol consisting of eight sequential steps designed to ensure a predictable and minimally invasive clinical outcome.

1. **Role of Disclosing Agent**

To ensure the long-term health and stability of teeth, dental implants, and surrounding soft and hard tissues, successful oral biofilm management should begin with a comprehensive assessment of all patient-specific risk factors (Kurtiş B, 2024). This diagnostic procedure aims to assess the clinical severity of periodontal disease and employs disclosing agents to visualize the precise distribution of microbial biofilm across both tooth and implant surfaces (Kurtiş B, 2024) (Mensi et al., 2020). A disclosing agent is a non-toxic substance designed to bind to and color bacterial plaque deposits, allowing them to be identified and removed with high accuracy. The utilization of disclosing agents is advantageous across all clinical stages, encompassing both the active treatment phase and long-term periodontal maintenance (Kurtiş B, 2024) (Shrivastava et al., 2021). In the context of modern protocols like GBT, this step is fundamental because making the otherwise invisible biofilm visible serves as a definitive "road map" for targeted and complete removal, ensuring a predictable and minimally invasive clinical solution. Since a significant proportion of patients are visual learners, the utilization of intraoral camera images to display disclosed plaque accumulations serves as a powerful educational and motivational tool for patients (Mensi et al., 2020). The Electromedical System (EMS) facilitates this process by providing the disclosing solution in the form of pre-loaded pellets, which consist of sponges pre-soaked with the agent. This innovation allows for a more controlled, efficient, and hygienic application on tooth surfaces, requiring significantly less effort than traditional methods. However, several technical considerations must be strictly observed during the application of these agents to ensure clinical accuracy and safety. Clinicians should exercise caution when working with restorative materials, as the dyes may cause unwanted staining.

Figure 1- Disclosing Agent, EMS Electro Medical Systems, Nyon, Switzerland

2. The Mechanical Disruption of Biofilm: Air Polishing Technology

The historical foundation of air-polishing technology traces back to 1945, when air abrasion was first utilized for cavity preparation using aluminum hydroxide powder (Black, R. B. 1945). Originally developed as a method for debriding tooth structures with aluminum-based abrasive particles, this technology has since evolved into the contemporary clinical application frequently termed air-polishing (Vouros et al., 2022). The clinical success and safety of GBT are fundamentally dependent on the type of abrasive powder utilized (Rajesh et al., 2023). Since the late 1970s, sodium bicarbonate (NaHCO3) has been the primary abrasive powder utilized in air-polishing systems; however, its substantial particle size—which can reach up to 250 µm—and high abrasiveness have been shown to cause irreversible damage to both dentin and radicular cementum surfaces (Olszowska, J et al., 2020). On the other hand, modern GBT utilizes erythritol powder, which is characterized by a significantly smaller particle size, typically ranging between 14 and 31 µm (Shrivastava et al., 2021; Rajesh et al., 2013). Researchs indicate that erythritol is significantly more conservative than previous materials, allowing for the safe cleaning of soft tissues and delicate implant surfaces without causing structural alterations or gingival erosion. Furthermore, erythritol has been shown to exert an antimicrobial effect against key pathogens such as *Porphyromonas gingivalis*, making it a choice for periodontitis management (Reinhardt et al., 2019). Glycine powder enables the removal of biofilm in subgingival areas due to its significantly lower abrasiveness compared to traditional sodium bicarbonate powders (Petersilka et al., 2008). In a randomized clinical trial conducted by Flemmig et al. in 2012, it was demonstrated that the application of full-mouth glycine powder air polishing (GPAP) results in a significantly decreased load of *Porphyromonas gingivalis* throughout the oral cavity (Flemmig et al., 2012). This research highlighted that utilizing low-abrasive glycine powder as part of a full-mouth debridement

protocol not only effectively disrupts subgingival biofilm but also facilitates a positive microbiota shift by specifically suppressing key periodontal pathogens more effectively than some traditional methods (Caygur, A et al.,2017).

3. **Supragingival and Subgingival Management: Airflow® and Perioflow®**

The fourth stage of the protocol involves the systematic removal of current biofilm accumulations utilizing advanced air-water-powder polishing technology (Airflow**®,** EMS Dental GBT Machine, Nyon, Switzerland). Subsequently, comprehensive surface debridement of both supra- and subgingival biofilm and calculus is conducted using minimally invasive **Piezon®** Perio Slim (PS) tips, which are designed to safely access the full extent of periodontal pockets up to a maximum depth of 10 mm (Mensi et al., 2025).

A. **Airflow®:** Utilizing the standard nozzle (such as Airflow® MAX), this stage targets supragingival biofilm, extrinsic stains, and shallow subgingival areas up to 4 mm. To maximize efficacy and minimize soft tissue trauma, the nozzle should be held at a distance of 3 mm from the tooth surface, with an angulation of 30° to 60° for anterior teeth and up to 90° for occlusal surfaces.

Figure 2- Airflow® MAX

B. **Perioflow® Technology:** For deeper periodontal pockets (ranging from 4 mm up to 10 mm) and complex peri-implant sites, GBT employs the Perioflow® handpiece equipped with a specialized, flexible subgingival nozzle. This nozzle features multiple lateral outlets (usually three) that deliver the air-powder-water slurry horizontally, ensuring a thorough decontamination of the pocket base while significantly reducing the risk of air emphysema.

Figure 3- Perioflow® MAX

Clinical Advantages of GBT

The integration of air-polishing into the GBT workflow offers substantial clinical benefits over SRP. Clinical trials, including those by Mensi et al. (2024) and Vouros et al. (2022), have demonstrated that air-polishing is perceived by patients as significantly less painful and more comfortable than hand instrumentation From a clinical efficiency perspective, GBT reduces treatment time by approximately 5 to 7 minutes per appointment, saving up to 12.4% of total chair time compared to conventional methods. By removing the soft biofilm first, the clinicians gain better visual access to any remaining mineralized deposits, allowing for more targeted and minimally invasive ultrasonic instrumentation in the subsequent steps (Mensi et al., 2024) (Vouros et al., 2022). According to the systematic analysis by Marcoccia et al., confirmed that the GBT protocol is at least as effective as conventional approaches such as ultrasonic debridement followed by rubber cup polishing in reducing oral biofilm, with some evidence indicating that air-polishing with erythritol powder achieves comparable or even superior plaque reduction (Marcoccia S et al 2025). A major finding of this systematic review is the significant optimization of chair time, as GBT was shown to reduce treatment duration by up to 25% compared to traditional workflows. This increased efficiency benefits both the patient and the clinician by reducing exposure to procedural noise and vibrations while simultaneously minimizing operator hand fatigue (Mensi et al., 2022; Mensi et al., 2024) (Marcoccia S et al., 2025). From a patient-centered perspective, GBT is recognized as a minimally invasive approach that is perceived as significantly less painful and more comfortable than traditional hand or power-driven instrumentation. This leads to higher levels of patient satisfaction and a superior "feeling of cleanliness" following the procedure, which is critical for long-term treatment compliance. Furthermore, the study emphasized the superior tissue safety and biocompatibility of the GBT protocol (Marcoccia S et al 2025). It was determined that air-polishing with low-abrasive powders, such as erythritol or glycine, is less aggressive on gingival soft tissues than high-frequency ultrasonic vibrations, which pose a greater risk of

mucosal damage and erosion (Shrivastava et al., 2021). The protocol is associated with fewer side effects and better preservation of the integrity of both natural dental tissues and restorative materials. Ultimately, the systematic review concluded that clinicians find the GBT procedure easier to perform, more manageable, and more structured than traditional hygiene workflows, making it a highly viable and predictable option for modern preventive dental care.

Following the systematic removal of the microbial biofilm from tooth and root surfaces, the sixth stage of the GBT protocol involves the implementation of the non-surgical "gold standard" for the removal of remaining mineralized deposits. This step is characterized by a targeted approach where minimally invasive Piezon® Perio Slim (PS) tips are utilized to access the full extent of periodontal pockets up to a maximum depth of 10 mm without damaging the root surfaces. The use of mini curettes and scalers is recommended for final debridement in cases of persistent deep pockets exceeding 10 mm (Bywaters, J et al., 2019). By eliminating the soft biofilm first via air-polishing, the clinicians gain superior visual access to the remaining calculus, ensuring that manual or power-driven instrumentation is applied selectively only where necessary (Mensi et al., 2020). This sequence effectively reduces the total volume of mechanical scraping required, thereby preserving radicular cementum integrity, minimizing post-treatment sensitivity, and significantly enhancing patient comfort.

Guided Biofilm Therapy: A Modern Approach to Peri-implant Management

While dental implant therapy has emerged as the leading solution for treating edentulous areas in modern clinical practice, the unavoidable progression of peri-implant diseases over time continues to pose a major challenge (Barootchi et al., 2025). As the prevalence of biological complications continues to rise, there has been a significant shift toward prioritizing peri-implant health and implementing proactive strategies to prevent the onset of peri-implantitis. In this aspect, the management of peri-implant mucositis is considered paramount, as it serves as the essential and reversible inflammatory precursor to more severe peri-implant destruction (Berglundh, J et al., 2021). In a recent research article by Pereira et al. (2025), the authors present a practical guide for the resolution of peri-implant mucositis, emphasizing the use of powdered air polishing and ultrasonic devices as essential components of professional mechanical debridement. This decisional workflow provides clinicians with structured recommendations to effectively decontaminate implant surfaces and manage soft tissue inflammation, thereby preventing the potential progression to peri-implantitis.

In recent years, performing treatments that preserve the surface characteristics of dental implants has become a big concern in clinical practice, as the surface roughness essential for osseointegration can simultaneously provide a niche for pathogenic biofilm colonization (Quirynen et al., 1996). To address this challenge, GBT implements a minimally invasive approach that prioritizes the structural integrity of implant surfaces (Kurtiş, B et al., 2024). Within this protocol, the use of thin carbon fiber tips (PI max) is used to manage mineralized deposits around dental implants and porcelain-crowned teeth. These specialized instruments are specifically designed to provide a deeper and more thorough decontamination compared to standard polyether ketone plastic (PI) tips, which are typically limited to shallow subgingival areas up to 3 mm (Kurtiş, B et al., 2024).

A critical advantage of PI max tips is their ability to effectively remove calculus without compromising the delicate titanium surface or the glaze of aesthetic restorations. By avoiding the creation of surface irregularities or roughness, these tips prevent new niches for future bacterial accumulation, which is essential for the long-term success of the implant (Sahrmann et al., 2021). Furthermore, because the biofilm is systematically removed first through air-polishing stages, the clinician can apply these carbon tips selectively only where necessary, ensuring a safe, efficient, and tissue-friendly methodology for maintaining peri-implant health. Additionally, the literature emphasizes that regular supportive care during the recall phase of this protocol, which represents the final and most vital step of GBT, plays a paramount role in preserving implant stability and achieving stable peri-implant bone levels over time (Roccuzzo et al., 2018)

CONCLUSION

Guided Biofilm Therapy (GBT) represents a systematic and minimally invasive modern management strategy that provides clinical outcomes at least equal to traditional methods in the treatment and prevention of periodontal and peri-implant diseases. The integration of advanced technologies, such as low-abrasive erythritol powder and thin carbon fiber tips (PI max) specifically designed to preserve the structural integrity of delicate titanium surfaces, maximizes patient comfort and procedural efficiency while effectively supporting tissue repair. Ultimately, the long-term maintenance of clinical success and the continued stability of dental implants depend on the consistent integration of this biofilm-focused protocol with regular recall visits and high levels of patient motivation. To further validate these findings, additional long-term randomized clinical trials are required to establish the longitudinal efficacy and durability of this therapeutic approach.

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