JOURNAL OF HEALTHCARE SCIENCES
Volume 3 Issue 12 2022, Article ID: JOHS2023000800
http://dx.doi.org/10.52533/JOHS.2023.31228
e-ISSN: 1658-8967

Review

The Impact of Saliva and Oral Microbiome on Restorative Dental Materials

Tarik Alakkad [1*], Omar Fergani [2], Lolwa Abulhamail [3], Abdullah Tajuddin [3], Yara Ashy [2], Lulu Munshi [2], Fatmah Aljehani [3], Ghazal Bokhari [3], Ghalia Sabir [3]

[1] *Department of Restorative Dentistry, Al Thager Hospital, Jeddah, Saudi Arabia*
[2] *College of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia*
[2] *Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia*

Correspondence should be addressed to **Tarik Alakkad**, Department of Restorative Dentistry, Al Thager Hospital, Jeddah, Saudi Arabia. Email: tm.akkad@gmail.com

Received: 22 December 2023, Revised: 23 December 2023, Accepted: 26 December 2023, Published: 28 December 2023.

Abstracts

Saliva and the oral microbiome play critical roles in the performance and longevity of dental restorative materials. Saliva's buffering capacity, pH regulation, and remineralization impact the durability and stability of materials. Variations in saliva composition among individuals can influence wear resistance and surface degradation of these materials. This review explores the intricate relationship between saliva, the oral microbiome, and restorative dental materials, emphasizing their mutual influences and the implications for dental practice. The oral microbiome, consisting of diverse microorganisms, further complicates this interaction. Bacterial adhesion, biofilm formation, and microbial metabolism significantly affect the integrity of restorative materials. For example, the degradation of composite resins by oral bacteria and their acidic byproducts can compromise the mechanical properties of these materials. Clinical manifestations of these interactions include deterioration of composite resin restorations, biofilm formation, and corrosion of amalgam restorations. Recognizing these manifestations is crucial for dentists to implement timely interventions and personalized management strategies. Regular monitoring and timely intervention, coupled with advancements in biomaterials, are key to enhancing the durability and effectiveness of restorative dental treatments.

Keyword: *Restorative dental materials, Oral microbiome, Saliva, Clinical manifestations, Biomaterials in dentistry*

Introduction

Restorative materials used in dentistry have a role in repairing and enhancing the functionality and appearance of damaged teeth. However, it's essential to consider the nature of the environment, where saliva and the oral microbiome can significantly affect how these materials perform and last over time (1, 2). This review delves into the relationship between saliva, the oral microbiome and restorative dental materials providing insights into how they influence each other. Saliva is a fluid with components that create a natural environment, for restorative materials once they are placed in the mouth (3). The ability of saliva to buffer regulates pH. Remineralize plays a role in maintaining oral balance. Additionally, it has an impact on the durability and stability of materials by affecting their surface properties both mechanically (4, 5). Studies have shown that variations in composition between individuals can lead to interactions with dental materials ultimately influencing factors like wear resistance and surface degradation (6, 7). The presence of a range of microorganisms in the microbiome further complicates the behavior of restorative materials within the mouth. Bacterial adhesion, biofilm formation and microbial metabolism collectively affect the integrity of materials (8, 9). For example, Streptococcus mutants, a bacterium for tooth decay can degrade composite resins through acid production and enzymatic activities. Moreover, biofilm formation on materials promotes secondary tooth decay which compromises their long-term success (10-12). Composite resins used for restorations are particularly vulnerable to the influences of saliva composition and oral microbiome dynamics. Research indicates that salivary enzymes and esterase's can degrade the matrix in composites leading to changes in their mechanical properties (13, 14). Furthermore, composite resins are prone to colonization and biofilm formation which pose challenges in maintaining hygienic restorations within the mouth. On the hand glass ionomer cements known for their fluoride releasing capabilities interact differently with saliva composition well, as oral microbiome dynamics. The utilization of fluoride helps in preventing the occurrence of cavities showcasing an effect on the effectiveness of the material. Nevertheless, differences, in the rate and composition of saliva can impact the speed at which ions are released and subsequently affect the properties of the material (15, 16). The connection between saliva, the oral microbiome and dental restorative materials also applies to amalgam restorations. The corrosion of amalgam often attributed to the byproducts produced by bacteria demonstrates how microbial activity affects the durability of the material. Moreover, changes in pH and composition can impact the corrosion processes ultimately affecting the stability of dental amalgam restorations in the mouth. Recent advancements in biomaterials like glass and antibacterial composites aim to minimize the influence of saliva and oral bacteria on restorative materials. Bioactive glass has shown promise in promoting demineralization and hindering growth offering an avenue for developing more robust restorative materials. Similarly, antibacterial composites that contain substances like silver nanoparticles exhibit effects on growth addressing the challenges posed by oral bacteria. In summary, understanding how saliva and the oral microbiome interact with materials is a complex and ever-changing phenomenon. These interactions affect their properties, degradation processes and overall clinical performance. Gaining insight into these relationships is crucial for advancing the field of dentistry and guiding the development of materials capable of withstanding challenges in the oral environment. In order to advance our understanding of these interactions it is essential for future research to delve deeper into their intricacies. This will pave the path towards developing groundbreaking solutions that can effectively improve the durability and efficacy of treatments. Hence the purpose of this review is to provide an overview on how saliva and the oral microbiome impact restorative materials.

Discussion

The effects of saliva and the oral microbiome on materials used in procedures are complex and require careful attention. Dentists often encounter challenges related to the degradation of resin,

http://dx.doi.org/10.52533/JOHS.2023.31228

formation of biofilms and corrosion of amalgam (17, 18). It is important for clinicians to closely monitor these issues during examinations so that timely interventions and personalized management strategies can be implemented. When changes in texture surface roughness or discoloration are identified decisions regarding repair, polishing or replacement of restorations need to be made. The presence of biofilms highlights the significance of measures. Emphasizes the importance of educating patients about maintaining meticulous oral hygiene practices and considering antibacterial materials. Additionally, it is crucial to consider factors such as flow rates and composition when planning treatments involving restorative materials that have therapeutic effects like fluoride releasing glass ionomer cements. Dental professionals must navigate these variations effectively in order to optimize the performance of restorations and prevent complications such as caries. The integration of biomaterials like glass and antibacterial composites shows promising potential for mitigating the impact caused by the oral environment. Clinically implementing these materials may lead to outcomes including improved stability and a reduction in complications related to activity.

Clinical Manifestation

The impact of saliva and the oral microbiome on materials has a profound effect on the success and longevity of dental treatments. Dental practitioners face challenges in dealing with the environment, which results in various clinical observations during restorative dental procedures. One significant manifestation is seen in the deterioration of composite resin restorations (19, 20). Despite their use for purposes and versatility composite resins are vulnerable to the enzymatic activity present in saliva. Salivary enzymes and esterases can compromise the matrix of composites leading to a decrease in properties and potentially affecting the overall integrity of the restoration. Clinically this may result in changes to restoration texture, surface roughness or even partial loss of the restoration over time. Dentists often notice changes during examinations necessitating careful monitoring and sometimes intervention to address deteriorating restorations. Another crucial clinical observation is related to biofilm formation on materials. The oral microbiome consists of microorganisms that contribute to the formation of biofilms on material surfaces. If not properly managed this microbial colonization can lead to complications such, as caries (tooth decay) and inflammation of the gums (inflammation). In practice dental professionals frequently encounter issues related to biofilm during examinations. Signs, like changes in color or texture on the surface of a restoration can suggest the existence of biofilm and activity. Therefore, effectively handling and preventing biofilm formation are considerations when making decisions, in restorative dentistry. The vulnerability of amalgam to corrosion is a reflection of how the oral microbiome and restorative materials interact. Bacterial byproducts, which are acidic in nature can cause the deterioration of amalgam over time. Dentists may notice changes in the appearance and texture of amalgam restorations indicating that corrosion has occurred. Addressing these issues may involve replacing deteriorating restorations and considering materials that're less susceptible to microbial induced corrosion. Glass ionomer cements, known for their ability to release fluoride can be influenced by variations in saliva flow rates and composition. The therapeutic benefits of release depend on how the material interacts with saliva. In cases where there are compromised saliva flow rates or differences in composition the expected advantages of release may be affected. Dental professionals may observe differences in how these restorations prevent cavities emphasizing the importance of considering individual patient factors when planning treatment. Advancements in biomaterials like glass and antibacterial composites introduce new possibilities for clinical outcomes. By utilizing glass, which has potential for promoting remineralization and inhibiting growth, improved clinical results can be achieved. Dentists might notice a decrease in cavities or enhanced durability of restorations that use bioactive glass, which is a positive outcome, in the clinical setting. Similarly, the use of composites in settings can help reduce complications caused by microbes, giving

http://dx.doi.org/10.52533/JOHS.2023.31228

dentists a valuable tool to address the challenges posed by the oral microbiome. As a result, the impact of saliva and the oral microbiome on materials can be observed in aspects of routine dental practice. These include the degradation of resins, formation of biofilms, corrosion of amalgam and the therapeutic effects of fluoride releasing materials. These observations play a role in guiding decision making. The introduction of biomaterials brings an aspect by offering clinicians options to manage the dynamic oral environment effectively. It is vital for dental practitioners to understand these manifestations in order to provide long lasting restorative treatments tailored to each patient's specific needs.

Management

Managing the effects of saliva and the oral microbiome on materials is a complex and thorough process that requires a strategic approach to optimize treatment outcomes. Dentists navigate through the interaction between factors and restorative materials aiming to minimize potential complications and improve the lifespan of dental restorations (21, 22). A crucial aspect of management involves choosing resilient restorative materials that can withstand the challenges posed by the oral environment. Understanding how certain materials are susceptible to activity, colonization or corrosion assists dentists in selecting materials that are compatible with each patient's specific oral conditions. For instance, taking into account factors such as caries risk and salivary flow rates can influence the choice of materials, with fluoride release properties like glass ionomer cements. Biomimetic materials aim to replicate the structure and composition of teeth providing a way to choose materials that can minimize the effects of saliva and the microbiome on dental restorations. To effectively manage a patient's oral health, it is important to take steps in preventing or reducing the formation of biofilms on materials. This involves providing instructions on hygiene practices such as regular brushing, flossing and using antimicrobial mouthwash. Dental professionals may suggest using materials that possess properties like incorporating silver nanoparticles into composites to discourage growth. Additionally, applying agents or sealants can be considered as methods to hinder biofilm formation and prolong the lifespan of restorations. It is crucial to monitor and follow up with patients to ensure the stability and durability of restorations over time. Clinical examinations along with assessments play a role in identifying early signs of degradation, biofilm development or other oral environment related issues. Early detection allows for intervention potentially preventing serious complications and ensuring the long-term success of restorative treatments. It's important to recognize that treatment planning should be tailored individually considering factors such as flow rates, composition and specific bacteria present, in a patient's microbiome since these factors influence the approach taken in clinical management. To improve the success of treatments it is important to customize treatment plans based on the challenges posed by each patient's oral condition. This individualized approach increases the predictability and effectiveness of interventions. Embracing the progress made in biomaterials is an approach to clinical management. When we incorporate materials like glass or remineralizing agents we can have a positive impact on how restorative materials interact with the oral environment. These materials help minimize the effects of saliva and the microbiome on restorations providing a dimension to our clinical management. It's crucial to empower patients with knowledge about how saliva and the oral microbiome can affect materials for management. By educating patients about maintaining hygiene practices, following recommended recall appointments and understanding how diet influences oral health we foster collaboration in clinical management. Informed patients are more likely to participate in their oral care creating a partnership with dental practitioners for long term success. Despite planning complications may arise that require targeted management. Clinical signs like degradation of resins or corrosion of amalgam might need intervention, like repair or polishing of restorations or even complete replacement. The ability to effectively diagnose and address these complications is an aspect of management. It's

http://dx.doi.org/10.52533/JOHS.2023.31228

important for practitioners to stay updated with the research findings and technological advancements as part of effective clinical management. Continuous learning allows us to incorporate approaches and emerging biomaterials into our practice. Ongoing studies regarding materials that have improved durability, against breakdown and microbial colonization provide insights, for developing clinical management approaches based on scientific evidence. Hence dealing with the effects of saliva and the oral microbiome on materials requires an approach. This includes choosing the materials taking measures monitoring progress creating customized treatment plans using advanced biomaterials educating patients and addressing any complications. By adopting this strategy dental professionals can ensure that restorative treatments are resilient in the changing oral environment. This leads to results. Promotes long term oral health for patients.

Conclusion

The complex relationship between saliva, the oral microbiome and dental materials used for restoration requires an approach to effectively manage cases. The signs and symptoms observed emphasize the importance of personalized strategies such as selection of materials, preventive measures and educating patients. Regular monitoring and timely intervention are essential for management ensuring that treatments last longer. Incorporating biomaterials adds to the aspect of clinical management and has the potential to bring significant advancements in restorative dentistry. As our understanding of these interactions continues to evolve future research holds promise for solutions that further strengthen materials durability in the oral environment.

Disclosure

Conflict of interest

There is no conflict of interest.

Funding

No funding

Ethical consideration

Non applicable

Data availability

Data that support the findings of this study are embedded within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

References

1. Farooq I, Bugshan A. The role of salivary contents and modern technologies in the remineralization of dental enamel: a narrative review. F1000Res. 2020;9:171.

2. Pratap B, Gupta RK, Bhardwaj B, Nag M. Resin based restorative dental materials: characteristics and future perspectives. Jpn Dent Sci Rev. 2019;55(1):126-38.

3. Tiwari M. Science behind human saliva. J Nat Sci Biol Med. 2011;2(1):53-8.

4. Wang P, Li C, Zhang D. Recent advances in chemical durability and mechanical stability of superhydrophobic materials: Multi-strategy design and strengthening. Journal of Materials Science & Technology. 2022;129:40-69.

5. Fode TA, Chande Jande YA, Kivevele T. Effects of different supplementary cementitious materials on durability and mechanical properties of cement composite - Comprehensive review. Heliyon. 2023;9(7):e17924.

6. Popescu AD, Ţuculină MJ, Gheorghiță LM, Osman A, Nicolicescu C, Bugălă SA, et al. An In Vitro Study regarding the Wear of Composite Materials Following the Use of Dental Bleaching Protocols. J Funct Biomater. 2023;14(10).

7. Dionysopoulos D, Gerasimidou O. Wear of contemporary dental composite resin restorations: a literature review. Restor Dent Endod. 2021;46(2):e18.

8. Zhao A, Sun J, Liu Y. Understanding bacterial biofilms: From definition to treatment strategies. Front Cell Infect Microbiol. 2023;13:1137947.

http://dx.doi.org/10.52533/JOHS.2023.31228

9. Tu Y, Ren H, He Y, Ying J, Chen Y. Interaction between microorganisms and dental material surfaces: general concepts and research progress. J Oral Microbiol. 2023;15(1):2196897.

10. Matsumoto-Nakano M. Role of Streptococcus mutans surface proteins for biofilm formation. Jpn Dent Sci Rev. 2018;54(1):22-9.

11. Bourbia M, Ma D, Cvitkovitch DG, Santerre JP, Finer Y. Cariogenic bacteria degrade dental resin composites and adhesives. J Dent Res. 2013;92(11):989-94.

12. Bhadila G, Filemban H, Wang X, Melo MAS, Arola DD, Tay FR, et al. Bioactive low-shrinkage-stress nanocomposite suppresses S. mutans biofilm and preserves tooth dentin hardness. Acta Biomaterialia. 2020;114:146-57.

13. Guo X, Yu Y, Gao S, Zhang Z, Zhao H. Biodegradation of Dental Resin-Based Composite-A Potential Factor Affecting the Bonding Effect: A Narrative Review. Biomedicines. 2022;10(9).

14. Ilie N. Degradation of Dental Methacrylate-Based Composites in Simulated Clinical Immersion Media. J Funct Biomater. 2022;13(1).

15. Horst JA, Tanzer JM, Milgrom PM. Fluorides and Other Preventive Strategies for Tooth Decay. Dent Clin North Am. 2018;62(2):207-34.

16. Medjedovic E, Medjedovic S, Deljo D, Sukalo A. IMPACT OF FLUORIDE ON DENTAL HEALTH QUALITY. Mater Sociomed. 2015;27(6):395-8.

17. Cieplik F, Aparicio C, Kreth J, Schmalz G. Development of standard protocols for biofilm-biomaterial interface testing. JADA Foundational Science. 2022;1:100008.

18. Hao Y, Huang X, Zhou X, Li M, Ren B, Peng X, et al. Influence of Dental Prosthesis and Restorative Materials Interface on Oral Biofilms. Int J Mol Sci. 2018;19(10).

19. Drummond JL. Degradation, fatigue, and failure of resin dental composite materials. J Dent Res. 2008;87(8):710-9.

20. Blum IR, Lynch CD, Wilson NH. Factors influencing repair of dental restorations with resin composite. Clin Cosmet Investig Dent. 2014;6:81-7.

21. Stewart CA, Finer Y. Biostable, antidegradative and antimicrobial restorative systems based on host-biomaterials and microbial interactions. Dent Mater. 2019;35(1):36-52.

22. Frencken JE, Peters MC, Manton DJ, Leal SC, Gordan VV, Eden E. Minimal intervention dentistry for managing dental caries - a review: report of a FDI task group. Int Dent J. 2012;62(5):223-43.

http://dx.doi.org/10.52533/JOHS.2023.31228