The Interplay Between Oral Health and Systemic Diseases: Review of the Implications for General Medicine

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Abstract

The correlation between oral health and systemic disorders has garnered considerable interest in recent years, as research increasingly emphasizes the complex relationships among the oral microbiota, periodontal diseases, and other systemic ailments. Substandard oral health has been associated with chronic conditions like diabetes, cardiovascular disease, respiratory infections, and neurological problems, underscoring the need to maintain excellent dental hygiene for overall well-being. The reciprocal association between periodontal disease and ailments such as diabetes indicates that oral inflammation may aggravate systemic problems, while systemic diseases may also lead to the decline of dental health. Moreover, new research has found certain bacterial strains, such as Streptococcus mutans, that may affect illnesses such as atherosclerosis and inflammatory bowel disease. This review shows the relationship between oral health and systemic disorders by reviewing current data on the molecular processes involved, such as inflammation, immunological responses, and microbial translocation. It also investigates the function of oral biofilms in disease progression and addresses how innovations in oral healthcare and preventative measures might reduce the risk of systemic illnesses. The study emphasizes the need for an interdisciplinary strategy that integrates dentistry and general care to enhance patient outcomes. Comprehending these associations may result in enhanced prevention measures, refined diagnostic instruments, and focused therapy approaches for individuals afflicted with both oral and systemic ailments. Future research should prioritize the development of integrated healthcare models that acknowledge the mouth cavity as an essential element of overall health.

Keywords: Oral health, systemic disorders, periodontitis, microbiota, inflammation, chronic diseases.

Significance | This review discusses the critical link between oral health and systemic diseases, promoting integrated healthcare and preventive strategies.

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Editor Mohammed Khadeer Ahmed Basheer, Ph.D., And accepted by the Editorial Board December 06, 2022 (received for review October 02, 2022)

1. Introduction

Dental caries is among the most widespread disorders globally and contribute to considerable morbidity. The incidence of unmanaged tooth decay has risen significantly (Marcenes & Bernabé, 2021, Al-Ajlouni et al., 2023). Untreated tooth decay directly impacts on oral health and quality of life; nevertheless, the exploration of indirect relationships among dental decay, particularly untreated cases, and overall wellness is of possible importance but has been largely overlooked (Chapple et al., 2017, Clark et al., 2021, Di Spirito, 2022).

Research has increasingly focused on the associations among periodontitis and systemic disorders, highlighting the role of mouth

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Please cite this article.
Alanazi, A. J., Alghamdi, &. S., Alanazi, &. M., Alanazi, &. M., Aloudah, &. M., Albalawi, &. E. A., Sulaiman Yahya Alharbi, Y., Almutairi, T. F. A. (2022). "The Interplay Between Oral Health and Systemic Diseases: Review of the Implications for General Medicine ", Journal of Angiotherapy, 6(2),1-7,10156

inflammation as well as microbiota in conditions including diabetes mellitus, coronary artery disease, respiratory infections, rheumatoid arthritis, chronic lung disease, as well as Alzheimer's disease (Iwaki et al., 2022).

Alongside epidemiological data, laboratories as well as animal research offer biological support for the correlations between periodontal and systemic conditions (Lin et al., 2021, Issrani et al., 2022).

Although both dental decay and periodontitis are illnesses mediated by biofilms, the etiology of dental caries is intricate and multifaceted, distinguishing it from periodontal disease. Dental decay is a biofilm-mediated condition characterized by many contributory variables that result in localized calcification of the teeth. The potential systemic effects of untreated dental caries and the molecular involvement of the related oral microbial-inflammatory procedure in such interactions need more investigation via animal and human investigations (Gatrelnada., 2021). The potential for the oral microbiota to disseminate into the circulatory system from dental caries is credible and would align with pathways previously investigated for periodontal disease. In dental caries, the root canal area or marginal periodontium serves as the primary route for the direct systemic dissemination of oral bacteria (Bacali et al., 2022). Host variables and infectious characteristics in oral microbiota may facilitate dental caries and enhance the probability of oral-systemic dissemination. Factors include diseases and medications that diminish saliva generation, adhesin communication in S. mutans for collagen binding, an imbalance of the oral microbiota, and inherited susceptibility to tooth decay that possesses mechanical similarities with systemic illnesses (Hu et al., 2016, Tanner et al., 2018, Nomura et al., 2020, Verstappen et al., 2021, Álvarez et al., 2022, Ghilan et al., 2023).

The concept of the systemic dissemination of oral bacteria from painful lesions is plausible; nonetheless, the mechanisms via which systemic disorders aggravate dental caries demand further investigation (Li et al., 2022, Gachova et al., 2023). Metabolic disorders, particularly obesity and type 2 diabetes possess some shared external variables with tooth decay, particularly hyperglycemia and a diet heavy in carbohydrates and sugars (Chi et al., 2017). Various present comprehensions of the links between metabolic disorders and dental caries, alongside the utilization of animal models, may enhance the knowledge of the relationships between dental caries and additional systemic ailments (Nakahara et al., 2012, Nakahara et al., 2013, Claudino et al., 2015, Nishimoto et al., 2017, Sabharwal et al., 2021, Ribeiro et al., 2022, Saghiri et al., 2022, Iorga et al., 2023, Mazur et al., 2023). Animal models facilitate the examination of systemic factors in dental caries by enabling the longitudinal investigation of disease phenotypes over a very short period. This review is to assess contemporary research on tooth decay and systemic illnesses, to identify existing data and possible explanations.

Search Strategy

The subsequent search methods in PubMed, Google Scholar, CINCHAL, as well as Scopus, used both keyword words inside the title and abstract sections.

Pulmonary Disorders

Investigations concerning dyspnea and tooth decay mostly concentrate on pediatric demographics. Research indicates that kids with asthma frequently show elevated caries rates, which may be ascribed to causes like the utilization of tablet forms of asthma drugs that may enhance cariogenic potential (Heidari et al., 2016, Moreira et al., 2023). Elevated levels of S. mutans as well as decreased salivary flow speeds have been linked to asthma (Khalifa et al., 2014, Hatipoğlu et al., 2022). Genetic variables, including SNPs within the ameloblastin gene, are associated with cavities in asthmatic individuals, however, the results are not consistently corroborated (Kim & Ober, 2018, Demenais et al., 2018, Gachova et al., 2023).

Research studies on CF individuals have revealed varied findings concerning caries prevalence. Certain human research reveals reduced caries rates in cystic fibrosis patients, perhaps attributable to frequent antibiotic administration, however, animal models demonstrate increased caries prevalence and decreased salivary bicarbonate levels. The discrepancies in results underscore the need for more research into the salivary biochemical makeup in cystic fibrosis patients (Willis et al., 2021, Van Meijeren et al., 2021).

Coronary Artery Disease with tooth decay

Research demonstrates that dental caries prevalence does not markedly vary between patients with cardiac as well as peripheral artery conditions and controls; nonetheless, the total oral inflammatory load is considerably elevated in these instances owing to heightened gum disease. Research assessing tooth decay in people with inherited heart defects revealed that these individuals who had received cardiac transplants had markedly reduced caries incidence. This disparity may be ascribed to improved oral care in transplant recipients, but regular antibiotic usage was ruled out as a confounding variable (Karikoski et al., 2021, Riham, 2021, AlSuliman et al., 2023, Karhumaa et al., 2023).

The perspectives of dentists as well as caregivers for kids at elevated risk for infectious endocarditis, especially those with inherited heart disorders, have been assessed, indicating that pediatric dental professionals and medical professionals are becoming more knowledgeable about suitable dental services for these kids. Cooperative initiatives among dentists, healthcare professionals,

and parents are crucial for successful preventive interventions (Fernandes Forte et al., 2022).

Experimental investigations have shown a correlation between particular strains of Streptococcus mutans as well as the development of atherosclerotic plaque in animal models (Abranches et al., 2009). The invasive capability of some S. mutans strains, especially those possessing collagen-binding protein molecules, has been emphasized, indicating a potential method via which oral bacteria may affect heart health (Abranches et al., 2009, Álvarez et al., 2022). Professional groups avoid recommending regular antimicrobial therapy for dental operations since the risk of bacteremia resulting in infective endocarditis is minimal compared to common activities such as brushing teeth (Selekman et al., 2018, Wilson et al., 2021).

Gastric Disorders

Studies investigating the correlation between gastrointestinal disorders and dental caries have been sparse; however, current research suggests a substantial association, especially with inflammatory bowel illnesses (IBD) including Crohn's disease (CD) as well as ulcerative colitis (UC). Case-control research indicated that juvenile patients with inflammatory bowel disease (IBD) had a greater frequency of tooth decay and periodontal disease than healthy subjects (Zhang et al., 2020, Naka et al., 2021). This tendency has also been seen in adult populations, corroborating the idea that IBD may lead to tooth health problems (Tan et al., 2021). Subsequent examinations of CD patients who had surgical resection demonstrated a significant rise in caries prevalence, cariogenic flora, inadequate oral hygiene, and detrimental dietary practices related to control categories (Marruganti et al., 2021). The incidence of caries in CD patients has been repeatedly recorded, with research demonstrating heightened sugar intake and a greater prevalence of Streptococcus mutans, an organism directly linked to caries formation (Tragnone et al., 1995, Zhang et al., 2020, Agossa et al., 2021, Tan et al., 2021, Nijakowski et al., 2021, Bialic et al., 2023). The interplay of these elements fosters an environment favorable to increased caries activity. Recent data indicate that individuals with inflammatory bowel disease (IBD) have a heightened probability of acquiring dental decay, having probability ratios of 4.27 for Crohn's disease (CD) and 2.21 for ulcerative colitis (UC) (Zhang et al., 2020). Compelling research by Kojima et al. used a colitis animal model to examine the effects of a particular variety of S. mutans. Their findings demonstrated that variant k of S. mutans may circumvent host immunological responses owing to alterations in glucose surface chain structure. Furthermore, the absorption of S. mutans by hepatocytes, perhaps aided by collagen-binding proteins, intensified colitis via the liver's generation of interferon-gamma (IFN-γ) (Tan et al., 2021).

Neurological Disorders

Recent studies have emphasized the substantial correlation between neurological disorders and dental caries, especially in at-risk groups including those with intellectual disabilities and ADHD. Cardoso et al. (2015) documented a significant incidence of tooth decay in individuals with intellectual disabilities, with median DMFT (Deteriorated, Missing, Filled Tooth) as well as dmft (deteriorated, missing, filled tooth in basic dental problems) levels of 1.71 as well as 2.22, accordingly. Their results demonstrated that caregiver knowledge and education substantially affected the dental decay occurrence in these individuals, with an average incidence rate of 1.439, highlighting the significance of caregiver participation in dental wellness maintenance.

Managing dental biofilm in patients with restricted physical and cognitive skills requires a cooperative approach among caregivers as well as dental practitioners. This partnership highlights the necessity for medical knowledge to proficiently oversee oral health (Cardoso et al., 2015). The senior population is at heightened risk for dental caries owing to diminished motor skills and masticatory effectiveness, often resulting in a predilection for softer foods. The alteration in nutrition, coupled with accessible root surfaces, significantly increases the susceptibility to caries (Elsig et al., 2015, Weijenberg et al., 2015).

Delwel et al. (2017) underscored the need to assess the composite character of the DMFT index, recommending the distinct evaluation of the decaying component to enhance comprehension of caries load and enable statistical comparisons across various groups.

Metabolic Syndrome

Several empirical studies have focused on the association among metabolic illnesses, including obesity and Type 2 diabetes, as well as tooth caries. Studies demonstrate that diabetes significantly alters salivary composition, thus influencing oral health. Hegde et al. discovered that diabetes patients with active caries had reduced salivary calcium and elevated alkaline phosphatase levels in comparison to non-diabetic persons (Hegde et al., 2014). Al-Badr et al. (2021) additionally showed that kids with diabetes type 1 had reduced salivary pH and elevated Lactobacilli numbers, both of which are essential for dental decay and the advancement of caries. Kamran et al. (2019) underscore the multifaceted character of dental caries, indicating that cariogenic dietary habits and inadequate oral hygiene may aggravate these disorders. Comprehending the relationship between diabetes management and caries susceptibility is crucial for successful preventive measures (Schmolinsky et al., 2019, Pachoński et al., 2020).

Research on employing animal models, especially rodents with diabetes, supports these results. Hyperglycemia in diabetic rats has been associated with heightened dental caries and significant

histological alterations in tooth tissues (Nakahara et al., 2012, Nakahara et al., 2013, Claudino et al., 2015, Nishimoto et al., 2017, Sabharwal et al., 2021, Ribeiro et al., 2022, Saghiri et al., 2022, Iorga et al., 2023, Mazur et al., 2023). These investigations indicated that therapies including fluoride therapy as well as insulin injections helped alleviate caries and related periodontal problems (Nakahara et al., 2013, Sabharwal et al., 2021).

The relationship among obesity as well as tooth decay seems less direct. A study of twenty-two adult clinical investigations, involving eight follow-up investigations, showed contradictory results about the association among obesity as well as caries (Chala et al., 2017, Fernandes Forte et al., 2022). Several studies indicated a high probability for the link between 1.01 and 3.7, but others observed an inverse correlation among low BMI as well as decay (63). Chala et al. discovered a U-shaped correlation between BMI and caries, suggesting that both underweight as well as overweight people may be susceptible (Chala et al., 2017). The intricacy of this association is exacerbated by variables like the availability of dental services, financial standing, and eating habits (Al Mahmud et al., 2023).

The inconclusive findings about the relationship between systemic diseases and dental caries underscore the need for dependable risk assessment instruments (Tellez et al., 2013). The present study indicates that frequent dental check-ups, assessment of previous caries history, and the use of fluoride therapy remain the most efficient approaches for avoiding tooth decay in dental clinics. Longitudinal studies are essential to clarify the relationships among dental curies, metabolic diseases, and general health outcomes.

Further Infections

Studies have also shown correlations among rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), as well as chronic kidney disorder (CKD) and tooth caries. Rheumatoid arthritis patients have elevated concentrations of S. mutans as well as an augmented oral inflammatory load (Loyola Rodriguez et al., 2016, Äyräväinen et al., 2018). Active SLE patients have increased caries activity, perhaps associated with worse dental hygiene (Gofur et al., 2020). Patients with chronic kidney disease (CKD) have demonstrated inconsistent findings concerning the frequency of caries, with some studies suggesting reduced decay prevalence (Andrade et al., 2014, Tadakamadla et al., 2014).

Prospective Research

Future investigations on the relationship between oral health and systemic disorders should concentrate on many critical domains to augment comprehension and boost therapeutic results. A vital focus is the comprehensive investigation of the oral microbiome's influence on systemic inflammation and disease advancement. Progress in metagenomics and microbiome sequencing might facilitate the identification of particular bacterial strains associated with systemic illnesses, offering insights into their pathogenic processes and prospective treatment strategies.

The development of customized medicine techniques that incorporate oral health data into systemic illness care is another potential area. Researchers may create non-invasive diagnostic methods that identify early indicators of illnesses such as diabetes, cardiovascular problems, and neurodegenerative ailments by using biomarkers obtained from saliva, dental plaque, and gingival crevicular fluid. These developments have the potential to transform preventative healthcare by enabling early interventions and personalized medicines tailored to particular patient profiles.

Moreover, multidisciplinary cooperation among dentists, doctors, and researchers is crucial for the development of integrative healthcare models. Future healthcare frameworks must advocate for regular oral health examinations within medical environments and urge clinicians to see oral health as an essential element of disease prevention and treatment. Educational and awareness initiatives for healthcare professionals and the public may underscore the systemic ramifications of oral health.

Future research should examine the efficacy of innovative therapy approaches, including probiotic medicines, anti-inflammatory drugs, and microbiome-targeted interventions, in alleviating the connections between oral and systemic diseases. Clinical research evaluating the effects of enhanced oral hygiene on diminishing systemic inflammation and illness severity may provide significant information for informing public health policy and treatment protocols. Addressing these areas would enhance the knowledge of oral-systemic interactions and provide better patient treatment and disease-preventive methods.

Conclusion

The correlation between oral health and systemic disorders has become more apparent, underscoring the need for a comprehensive healthcare strategy that integrates both dental and medical viewpoints. This analysis illustrates how inadequate dental health, especially periodontal disease, may exacerbate the advancement of chronic illnesses like cardiovascular disease, diabetes, respiratory infections, and neurological disorders. The processes driving these relationships, such as chronic inflammation, immunological dysregulation, and microbial translocation, underscore the need to maintain proper oral hygiene as a preventative strategy against systemic disorders.

An essential conclusion from this discourse is the need for multidisciplinary teamwork in healthcare. Dentists and medical practitioners must collaborate to include oral health evaluations in standard medical examinations, facilitating early identification and action for diseases with potential systemic consequences. Furthermore, patients must be informed about the extensive

repercussions of disregarding their oral health and motivated to implement improved hygiene habits.

Innovations in diagnostic instruments, especially those using salivary biomarkers and microbiome analysis, provide exciting opportunities for early illness identification and tailored treatment approaches. By identifying people predisposed to systemic illnesses via oral health evaluations, healthcare professionals may execute targeted therapies that may hinder disease development and enhance patient outcomes.

Future research on oral-systemic relationships will be essential for creating novel therapies and enhancing public health strategies. Mitigating oral health inequities and guaranteeing access to sufficient dental treatment globally must be a priority for healthcare systems. In conclusion, acknowledging oral health as a fundamental aspect of total well-being is crucial for promoting preventive healthcare, alleviating disease burdens, and eventually improving quality of life worldwide.

Author contributions

A.J.A., A.S.A., A.M.A., R.M.A., Y.M.A., A.E.A.A., Y.S.Y.A., and T.F.A.A. contributed to the conceptualization, literature review, and manuscript preparation. A.J.A. and A.S.A. coordinated the research and supervised the review process. A.M.A., R.M.A., and Y.M.A. collected and analyzed relevant literature. A.E.A.A. and Y.S.Y.A. contributed to manuscript drafting and editing. T.F.A.A. provided critical revisions and final approval of the manuscript. All authors read and approved the final version of the manuscript.

Acknowledgment

Not applicable

Competing financial interests

The authors have no conflict of interest.

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