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Review Article

Dental restorative materials and special consideration for the elderly

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ABSTRACT

With the global population aging, the oral health of elderly individuals faces unique challenges, particularly concerning dental caries. Root caries, in particular, have become a growing concern due to the significant number of retained teeth in older adults. This review delves into the frequency of root caries among older individuals and examines the limitations of existing dental restorative materials, including amalgam, glass ionomer cement, and light-cured composite resin, in meeting the unique requirements of the elderly. It underscores the urgent necessity for improving the antibacterial, bonding, remineralization, strength, and durability characteristics of these materials. Additionally, the study discusses factors related to aging, treatment planning, and special considerations in geriatric dental care. The review also delves into the challenges associated with providing dental care to elderly individuals, including depression, postural hypotension, prescribed drugs, delayed healing, adaptive potential, mucosal quality, and poor plaque control. Moreover, it addresses the role of xerostomia, bruxism, and certain medical conditions in exacerbating dental issues in the elderly. It also introduces novel anticariogenic restorative materials, such as antimicrobial materials, remineralization materials, and self-healing/low-shrinkage materials, highlighting their potential to improve oral health in older individuals.

Keywords: Dental caries, Restorative materials, Elderly, Root caries, Oral health

INTRODUCTION

The global population is aging, resulting in increased life expectancy, which in turn has implications for the oral health of individuals. Elderly individuals encounter challenges related to age-related changes in both their overall health and oral health. Dental caries, a common oral health issue, is prevalent among the elderly population, and this has become a growing concern due to the significant rise in the number of retained teeth in older individuals.[1] According to findings from the 2015 fourth oral epidemiological survey of China, there was a

remarkably high incidence of dental cavities among individuals between the ages of 65 and 74, with a prevalence rate of 98%. Additionally, it was observed that older adults within this age bracket were more susceptible to developing root cavities as opposed to cavities on the outer surfaces of their teeth. Specifically, the prevalence of root cavities among this population was 61.9%, and only a small 3% of these cases had been treated or restored. In the United States, it was estimated that approximately 60% of individuals over the age of 65 had been affected by root cavities.[2] Root caries, like other forms of dental caries, are typically addressed through restorative procedures, but they often fail due to a high incidence of secondary caries and restoration fractures.[3] The increased prevalence of recurrent caries among the elderly necessitates more extensive oral treatments, leading to a substantial economic burden on society and healthcare services. Furthermore, the distinct oral microorganisms found in older individuals, along with alterations in their oral anatomy, demand the use of specialized restorative materials to ensure effective caries treatment.[4] Unfortunately, the currently accessible restorative materials like amalgam, glass ionomer cement, and light-cured composite resin frequently do not adequately fulfil these particular demands. As a result, there is an urgent necessity to substantially improve the antibacterial, adhesive, remineralization, mechanical, and anti-aging characteristics of these materials to more effectively cater to the restorative requirements of older individuals. The previous expectation of losing one's teeth at an early age has been replaced by the belief that people can maintain their natural or restored teeth throughout their lives.

While this change is generally considered a significant advancement, it has also brought about certain challenges due to the technological innovations that have enabled improved dental retention. One of the primary issues with complex dental reconstructions is that they rely on the individual's neuromuscular coordination and cognitive abilities for their upkeep.[5] As people age, these maintenance skills tend to decline, and without adequate home and professional care, their heavily restored teeth can deteriorate rapidly.

LITERATURE SEARCH

This study is based on a comprehensive literature search conducted on November 11, 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed dental restorative materials, with special consideration for the elderly population. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

Several studies have consistently revealed a significant disparity between the actual dental treatment required by the elderly population and the demand for treatment as expressed by the patients themselves.[6] This suggests that clinicians should not exclusively rely on patient-initiated requests for dental care. Instead, the dental profession should take a proactive approach by implementing effective screening procedures for dental diseases, including those related to edentulous individuals.

Factors related to aging

The typical factors of old age are often categorized into four components (Table 1). These factors should indeed be considered when providing dental care to elderly individuals to ensure their comfort and well-being during dental treatments.

Table 1: Factors related to elderly.[7]

Factors related to elderly	Description
Intellectual impairment	May encompass intolerance
Immobility	Limited mobility and physical activity
Instability	Lack of balance and stability
Incontinence	Includes emotional incontinence (sudden mood swings)

Treatment planning for the elderly

Effective treatment planning for the elderly hinges on communication and recognizing that hearing loss is prevalent among the elderly. Hearing decline often occurs gradually, and patients may unconsciously develop lip-reading skills to compensate. To enhance communication, practitioners should position themselves in front of the patient, speak slowly, and avoid wearing masks. Assessing the patient's cognitive abilities is crucial, with two fundamental principles in the elderly: first, treatment should yield immediate benefits, and second, patients should be presented with straightforward treatment recommendations rather than a confusing array of options. Furthermore, the patient's overall health condition should be taken into account, as around 75% of individuals over 65 have one or more chronic diseases, including cardiovascular disease, diabetes, arthritis, cancer, and nervous system disorders. Undiagnosed diseases, such as genitourinary issues, anemia, heart disease, respiratory disorders, and diabetes, are also common among geriatric patients, who often suffer from multisystem disorders that can affect their ability to receive dental care.[7]

In geriatric dental care, several unique challenges necessitate special attention. Depression is prevalent among the elderly, requiring a compassionate approach

and collaboration with medical professionals for effective anti-depressant therapy.[7] Furthermore, postural hypotension in this age group demands careful adjustment of dental chairs to prevent discomfort or unconsciousness, particularly in those with spinal issues. Additionally, prescribing medications for geriatric patients must be done cautiously, considering potential drug reactions and the altered metabolism in the elderly, especially those with compromised organ function. Moreover, tooth extractions can be more challenging due to factors like ankylosis and reduced blood supply, leading to delayed wound healing.[7] The elderly's declining adaptive potential also impacts their ability to cope with changes in their oral environment, affecting the success of dental procedures such as dentures (Figure 1). Furthermore, the quality of oral mucosa in geriatric patients diminishes, becoming more susceptible to trauma during dental procedures. Poor plaque control, exacerbated by factors like reduced dexterity and eyesight, increases the risk of caries (Figure 2), while root caries are more common due to dietary changes and drug-induced dry mouth, necessitating improved oral hygiene and specific restoration materials.[7-11]

Figure 1: Hands of an elderly patient crippled by rheumatoid arthritis.[7]

Figure 2: Poor oral hygiene predisposing to caries in a geriatric patient.[7]

Additionally, xerostomia, often paired with salivary gland hypofunction, exacerbates dental issues in the elderly, with treatments including saliva substitutes and stimulants.[5] Bruxism, linked to stress, can accelerate dental destruction, necessitating psychological and dental intervention. Also, conditions like diabetes, radical oral irradiation, and bisphosphonate therapy heighten dental risks, emphasizing the importance of diabetes control, periodontal disease management, and pre-treatment dental evaluations to mitigate complications like osteonecrosis.

Restorative materials

They are used for dental treatments in elderly patients and come with their own set of advantages and disadvantages. Here is an overview of these materials:

Amalgam

Amalgam can release silver and mercury ions, which can hinder the proliferation of *Streptococcus mutans* and *Actinomyces biofilms*, rendering it effective in combatting bacterial growth.[12] Additionally, it is recognized for its minimal microleakage and resilience against secondary caries. However, amalgam requires extensive tooth removal to achieve proper retention, which can weaken the remaining tooth structure.[13] On a positive note, its elastic modulus closely resembles that of dentin, and it displays outstanding mechanical properties.[14] Amalgam is durable, resistant to the effects of saliva and gingival fluids, and can endure for an extended period within the oral environment.[15] Nevertheless, its disadvantages include potential health risks due to mercury leakage and environmental pollution.[16] Its distinct color mismatch with natural teeth makes it unsuitable for anterior root caries, and its disadvantages are gradually leading to its reduced use in clinical practice.[17]

Glass ionomer cement

Glass ionomer cement (GIC) is available in various types, including conventional, resin-modified, and high-viscosity GIC.[18] GIC has the capability to release fluoride ions, providing antibacterial and remineralization properties thst can be particularly effective against *Streptococcus mutans* and *Lactobacillus*. However, it may not effectively inhibit the growth of *Candida albicans*, a pathogenic bacterium responsible for root caries.[19-22] It is worth noting that conventional GICs tend to have superior antibacterial properties, but high-viscosity and resin-modified GICs release lower amounts of fluoride ions.[23] GIC possesses self-adhesive properties, chemically bonds with tooth structure, and can perform effectively in a moist environment. Unlike some other dental materials, it does not necessitate light curing, which makes it less technique-sensitive and well-suited for elderly patients who may have limited tolerance for lengthy procedures.[24] However, GIC's mechanical properties are inferior to those of other materials, making

it a favorable choice for geriatric patients, especially for root caries treatment.

Light-cured composite resin

Light-cured composite resin is commonly used for dental restorations on elderly patients. While it lacks intrinsic antibacterial properties and tends to accumulate dental plaque[25], some composite resins have fluoride ion-releasing capabilities for antimicrobial effects and remineralization. Composite resins are bonded to tooth structures using adhesives, with self-etching adhesives being preferable for dentin caries. The mechanical properties of composite resins are generally acceptable and better than GIC.[26,27] Nonetheless, it is important to be aware that polymerization shrinkage in GIC can lead to microleakage and impact the bonding.

To mitigate this issue and enhance the material's toughness while minimizing stress concentrations, fiber-reinforced composites (FRC) are sometimes employed.[28] FRCs are especially well-suited for replacing dentin, as they help reduce the risk of secondary caries and bulk fractures.

Nonetheless, composite resin's mechanical properties can be affected by aging and the degree of the polymerization.

Novel anti-cariogenic restorative materials

In recent years, there has been significant research into developing novel restorative materials with enhanced properties for addressing caries, especially in elderly population.[29-32] These aim to combat bacterial growth, promote remineralization, and reduce polymerization shrinkage and microleakage.[33]

Antimicrobial materials

To combat changing landscape of cariogenic microorganisms, researchers have explored antimicrobial materials for dental restorations. These antimicrobial materials have potential to reduce bacterial growth and promote oral health in dental restorations. However, further comprehensive laboratory assessments and clinical evaluations are necessary before widespread clinical use can be recommended.[33] Two categories of antimicrobial materials are being investigated (Table 2).

Remineralization materials

These remineralization materials (Table 3) have demonstrated potential in addressing gingival recession and promoting remineralization. However, further research needed to validate their long-term efficacy and clinical applicability.

Table 2: Antimicrobial materials for dental restorations.[33]

Categories of antimicrobial materials for dental restorations	Description
Non-releasing materials	Incorporate antibacterial components into adhesive systems/restorative materials.
	QAMs are promising candidates with broad-spectrum antimicrobial activity, low drug resistance potential, low toxicity, and ability to be copolymerized with resin matrices, offering prolonged antimicrobial activity.
Releasing materials	Include materials like chlorhexidine (CHX) and silver diammine fluoride (SDF) for their antibacterial properties.
	CHX has a broad-spectrum antibacterial capacity but requires recharging for long-term effectiveness.
	SDF releases silver, inhibiting acid production by bacteria but may become less effective over time.

Table 3: Remineralization materials for the elderly.[33]

Remineralization materials	Description
Calcium phosphate	Integrated into glass ionomer, composite resin materials to enhance remineralization.
Fluoride	Incorporated into restorative materials to promote remineralization.
Polyamidoamine (PAMAM)	Used in restorative materials to augment remineralization properties.
Bioactive glass (BAG)	Integrated into glass ionomer and composite resin materials to facilitate remineralization.
Nano-amorphous calcium phosphate (NACP)	Gained significant interest for its ability to release calcium and phosphate ions, enabling swift remineralization even in acidic conditions and allowing for long-term recharge.
FRC	Exhibit enhanced mechanical characteristics and reduced susceptibility to secondary caries and bulk fractures.
BAG-F composite resin	Shows promise in promoting remineralization and inhibiting MMP and cathepsin K (CTP), which contribute to protein crystal decomposition.

Self-healing and low-shrinkage materials

In response to the challenges related to microleakage and polymerization shrinkage associated with conventional materials, self-healing composite resins and low-polymerization shrinkage composite resins have been developed as innovative solutions. Self-healing composite resins contain microcapsules that release a healing fluid when the resin cracks, repairing microcracks within the material. Low-polymerization shrinkage composite resins aim to reduce stress and microleakage caused by polymerization shrinkage, enhancing the longevity of restorations.[33]

CONCLUSION

In light of the challenges in maintaining complex dental treatments for the elderly, the understanding of instituting such restorative procedures for those approaching old age or residing in residential aged care facilities should be critically evaluated. Issues like compromised oral hygiene, dry mouth, and systemic diseases can exacerbate root caries and periodontal disease, compromising existing dental restorations. A conservative approach focusing on routine restorative dentistry and oral hygiene measures is recommended for elderly patients.

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REFERENCES

1. Kassebaum NJ, Bernabé E, Dahiya M, Bhandari B, Murray CJL, Marcenes W. Global Burden of Untreated Caries:A Systematic Review and Metaregression. J Dental Res. 2015;94(5):650-8.
2. Eke PI, Wei L, Borgnakke WS, Gina T-E, Xingyou Z, Hua L et al. Periodontitis prevalence in adults ≥ 65 years of age, in the USA. Periodontology 2000. 2016;72(1):76-95.
3. Fure S. Ten-year cross-sectional and incidence study of coronal and root caries and some related factors in elderly Swedish individuals. Gerodontology. 2004;21(3):130-40.
4. Jiang Q, Liu J, Chen L, Gan N, Yang D. The Oral Microbiome in the Elderly With Dental Caries and Health. Frontiers Cellular Infect Microbiol. 2019;8.
5. Murray C. Advanced restorative dentistry-a problem for the elderly? An ethical dilemma. Australian Dental J. 2015;60(S1):106-13.
6. Lester V, Ashley F, Gibbons D. Reported dental attendance and perceived barriers to care in frail and functionally dependent older adults. Brit Dental J. 1998;184(6):285-9.
7. Gilmour AG, Morgan CL. Restorative Management of the Elderly Patient. Primary Dental Care. 2003;10(2):45-8.
8. Simons D, Brailsford S, Kidd E, Beighton D. Relationship between oral hygiene practices and oral status in dentate elderly people living in residential homes. Community Dentistr Oral Epidemiol. 2001;29(6):464-70.
9. Nunn J, Morris J, Pine C, Pitts N, Bradnock G, Steele J. The condition of teeth in the UK in 1998 and implications for the future. Bri Dental J. 2000;189(12):639-44.
10. Lynch E, Beighton D. A comparison of primary root caries lesions classified according to colour. Caries Res. 1994;28(4):233-9.
11. Nyvad B, Fejerskov O. Active root surface caries converted into inactive caries as a response to oral hygiene. Eur J Oral Sci. 1986;94(3):281-4.
12. Leistevuo J, Järvinen H, Osterblad M, Leistevuo T, Huovinen P, Tenovuo J. Resistance to mercury and antimicrobial agents in Streptococcus mutans isolates from human subjects in relation to exposure to dental amalgam fillings. Antimicrobial Agents Chemotherapy. 2000;44(2):456-7.
13. Setcos J, Staninec M, Wilson N. Bonding of amalgam restorations: existing knowledge and future prospects. Operative Dentistr. 2000;25(2):121-9.
14. Chun KJ, Lee JY. Comparative study of mechanical properties of dental restorative materials and dental hard tissues in compressive loads. J Dental Biomechanics. 2014;5.
15. Caplan DJ, Li Y, Wang W, Kang S, Marchini L, Cowen HJ et al. Dental Restoration Longevity among Geriatric and Special Needs Patients. JDR Clin Translational Res. 2019;4(1):41-8.
16. Thanyavuthi A, Boonchai W, Kasemsarn P. Amalgam Contact Allergy in Oral Lichenoid Lesions. Dermatitis Contact, Atopic, Occupational, Drug. 2016;27(4):215-21.
17. Nakata TT, Bae KS, Baumgartner JC. Perforation repair comparing mineral trioxide aggregate and amalgam using an anaerobic bacterial leakage model. J Endodontics. 1998;24(3):184-6.
18. Sidhu SK, Nicholson JW. A Review of Glass-Ionomer Cements for Clinical Dentistry. J Functional Biomaterials. 2016;7(3):16.
19. Ullah R, Zafar MS. Oral and dental delivery of fluoride: a review. Fluoride. 2015;48(3):195.
20. Wiegand A, Buchalla W, Attin T. Review on fluoride-releasing restorative materials--fluoride release and uptake characteristics, antibacterial activity and influence on caries formation. Dental Materials. 2007;23(3):343-62.
21. Bhavana V, Chaitanya K, Gandi P, Patil J, Dola B, Reddy R. Evaluation of antibacterial and antifungal activity of new calcium-based cement (Biodentine) compared to MTA and glass ionomer cement. J Conservative Dentistr. 2015;18(1):44-6.
22. Naik RG, Dodamani AS, Khairnar MR, Jadhav HC, Deshmukh MA. Comparative assessment of antibacterial activity of different glass ionomer cements on cariogenic bacteria. Restorative Dentistr Endodontics. 2016;41(4):278-82.
23. Cabral MFC, Martinho RLdM, Guedes-Neto MV, Rebelo MAB, Pontes DG, Cohen-Carneiro F. Do

conventional glass ionomer cements release more fluoride than resin-modified glass ionomer cements? Restorative Dentistr Endodontics. 2015;40(3):209-15.
24. Berzins DW, Abey S, Costache MC, Wilkie CA, Roberts HW. Resin-modified Glass-ionomer Setting Reaction Competition. J Dental Res. 2010;89(1):82-6.
25. Carlén A, Nikdel K, Wennerberg A, Holmberg K, Olsson J. Surface characteristics and in vitro biofilm formation on glass ionomer and composite resin. Biomaterials. 2001;22(5):481-7.
26. Van Dijken JWV, Pallesen U. Fracture frequency and longevity of fractured resin composite, polyacid-modified resin composite, and resin-modified glass ionomer cement class IV restorations: an up to 14 years of follow-up. Clin Oral Investigations. 2010;14(2):217-22.
27. Xie D, Brantley WA, Culbertson BM, Wang G. Mechanical properties and microstructures of glass-ionomer cements. Dental Mat. 2000;16(2):129-38.
28. Vallittu PK. An overview of development and status of fiber-reinforced composites as dental and medical biomaterials. Acta Biomaterialia Odontologica Scandinavica. 2018;4(1):44-55.
29. Cao W, Zhang Y, Wang X, Yinyan C, Qiang L, Xiaodong X et al. Development of a novel resin-based dental material with dual biocidal modes and sustained release of Ag+ ions based on photocurable core-shell AgBr/cationic polymer nanocomposites. J Materials Sci. 2017;28(7):103.
30. Cheng L, Weir MD, Xu HHK, Joseph MA, Alison MK, Nancy JL et al. Antibacterial amorphous calcium phosphate nanocomposites with a quaternary ammonium dimethacrylate and silver nanoparticles. Dental Materials. 2012;28(5):561-72.
31. Chen S, Gururaj S, Xia W, Engqvist H. Synthesis of Ag doped calcium phosphate particles and their antibacterial effect as additives in dental glass ionomer cements. J Materials Sci. 2016;27(11):172.
32. Breschi L, Mazzoni A, Nato F, Marcela C, Erika V, Leo T et al. Chlorhexidine stabilizes the adhesive interface: A 2-year *in vitro* study. Dental Materials. 2010;26(4):320-25.
33. Huang Y, Song B, Zhou X, Chen H, Wang H, Cheng L. Dental Restorative Materials for Elderly Populations. Polymers. 2021;13(5).

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