A REVIEW ON BIOACTIVE TEETH FILLING MATERIALS

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Abstract: Materials that are taken from plants or animals and used for replacing and repairing are known as natural bioactive materials. These materials may interfere with the formation of a bond between the material used on the teeth and tissue. Bioactive materials with unique properties are on increased demand in all fields, for long term usage. In place of dental materials also, bioactive dental filling materials are now widely used. Bioactive dental filling materials hold a lot of advantages. Bioactive materials mimic materials such as bioactive dentin, bioactive aggregate, bioactive calcium hydroxide, bioactive glass, bioactive polymers, bioactive metals, bioactive mineral trioxide, aggregate, bioactive ceramics and so on. All bioactive materials do have their own advantages and some disadvantages on the teeth structure. These materials do have some challenges like some materials are ideal for certain patients and vary depending on the restorative needs of the patients, as options and opinions vary with patients. The need for these bioactive materials is mainly because of its demand and reducing the effects of secondary decay once it is replaced or done in the patients. These bioactive materials have more advancements and will change the future dentistry with its emerging technology. This article summarises the concept of bioactivity and compares the various available bioactive materials that are quintessential in every field and showcases the advancements in this topic of dental materials.

Keywords: Bioactive materials; advancements; dentin; dental filling materials.

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INTRODUCTION

Bioactive dental filling material has a biological effect on the surrounding tissues. (Hooper and Cassidy, 2006) Desirable bioactive dental filling materials creates a bond with surrounding tooth structure and releases ions to allow the remineralization (Rajendran *et al.*, 2019) of tooth which is lost at the tooth margins and elicits a chemical reaction from the tooth. (Cornara *et al.*, 2017) These bioactive materials last longer when compared to the other dental filling materials. Bioactive materials that are taken from plants or animals used in replacing and repairing are known as natural (R, Rajakeerthi and Ms, 2019) bioactive materials. Bioactive dental filling materials have many physical properties that make them avaiable in every field. (Jesumani *et al.*, 2019). Bioactive restorative materials have long term reduction among all other dental filling materials and are more efficient in treatments where at a times, can be used also as a drug delivery (Zhao, 2011a, 2011b) (Ramanathan and Solete, 2015) vehicles in conservative endodontic treatments. (Oracz *et al.*, 2019) Drugs or medications are delivered inside the root canal (Kumar and Delphine Priscilla Antony, 2018)) in endodontic treatments. (Manohar and Sharma, 2018) Emphasis on the term disinfection is beneficial rather than cleaning. (*Shape optimal and clean more*, no date)) Medications depending on the bioactive dental filling materials vary for treatment. These restorative materials are commercially available at their union levels. Bioactive dental materials form apatite (Ramesh, Moratti and Dias, 2018) like materials on their surface and help in the remineralisation of the last minerals in the tooth margins and strengthens the tooth structure through fluoride release. (Tanaka *et al.*, 2019) Bioactive materials protect against the dental caries and mostly slow down the secondary tooth decay, which is the most common form of tooth decay. (Khvostenko *et al.*, 2013; Tanaka *et al.*, 2019) Bioactive dental filling materials also reduce matrix metalloproteinase (Teja, Ramesh and Priya, 2018)) by mediating dentin collagen degradation. Secondary caries are the most commonly affected caries and these bioactive materials protect materials against it. To reduce caries effect or to prevent it from getting decayed, mouthwashes and certain toothpaste can be used. Chlorhexidine mouthwashes when compared to mouthwashes prepared from natural products such as neem, tulsi and so on are more effective than the chemical mouthwash used. Chlorhexidine (Noor, S Syed Shihaab and Pradeep, 2016) mouthwashes reduce microorganisms and natural mouthwashes from neem,tulsi (Siddique *et al.*, 2019) and also papaya extract reduce the caries effect in patients. Bioactive restoration has a newer unique mechanism for their adhesion, integration and scaling. (Michou *et al.*, 2018) Bioactive restoration materials stay strong and effective mostly due to these potencies compared to other materials. (Tanaka *et al.*, 2019) Bioactive materials regenerate tissue, promotes tissue healing, repair and maintenance. (Greenspan and Hench, 2013) Bioactive materials combine bioactivity,

biocompatibility and theological properties. (S. R. Jefferies, 2014)(Nandakumar and Nasim, 2018) Bioactive materials are increasing its demand with its recent advancements in dentistry (Ravinthar and Jayalakshmi, 2018) and gaining popularity among the people.Previously our team has a rich experience in working on various research projects across multiple disciplines (Ramesh Kumar *et al.*, 2011; Jain, Kumar and Manjula, 2014; Krishnan, Pandian and Kumar S, 2015; Keerthana and Thenmozhi, 2016; Sivamurthy and Sundari, 2016; Felicita, 2017a, 2017b; Kumar, 2017; Sekar *et al.*, 2019; Johnson *et al.*, 2020). Now the growing trend in this area motivated us to pursue this project.

BIOACTIVE MATERIALS

Bioactive Calcium Hydroxide: Bioactive materials have chemical and physical properties of novel and long standing calcium hydroxide. Calcium hydroxide dissociates generally into calcium and hydroxide ions. (S. R. Jefferies, 2014) The high rate of calcium release and the fast formation of apatite that have a role in calcium silicate biomaterials to induce new dentin bridge formation and clinical healing. These properties contribute a critical role in both. Mechanical and biological properties of glasses (S. Jefferies, 2014) are based on calcium source selection, proposed for hard tissue repair and regeneration. (Greenspan and Hench, 2013).

Bioactive Mineral Trioxide Aggregate: Mineral trioxide aggregate is mostly composed of silicate and calcium as major components. The major mixture of bioactive mineral trioxide aggregate is dicalcium silicate, tricalcium silicate. Materials having common characteristics and apatite formation. Mineral trioxide aggregate is a material of choice in vital pulp therapy, apexification (Vidal *et al.*, 2016) and also apexogenesis. Mineral trioxide has few drawbacks of discolouration potential and systemic effects. MTA is used as a pulp capping agent as it induces cytological and functional changes resulting in the formation of fibrodentin. Current articles as said MTA provides a significant clinical advantage over all the traditional cements used (Benetti, 2019) and over different treatment modalities as followed by general dental practitioners. (Jose, P. and Subbaiyan, 2020).

Bioactive Dentin: Bioactive dentin is also called and known as ,SMART DENTIN ,which is popularly used as replacement material or effective dentin substitute that can be used as a coronal restoration material for indirect pulp capping having similar properties of dentin. (Smith *et al.*, 2016) Biodentin is chiefly composed of highly purified calcium silicate based dental cements. Bioactive dentin has the potential to revolutionize the management of the deep carious cavity in operative dentistry. This material has a positive effect in vital (Sonoyama *et al.*, no date) pulp cell-stimulating (Janani, Palanivelu and Sandhya, 2020) tertiary dentin formation. The efficiency of the diagnostic aids play an important role in treatment plans. Among all other bioactive materials, biodentine has the maximum calcium ion release concentration.

Bioaggregate: Bioaggregate has its composition mostly similar to mineral trioxide aggregate and described by its insoluble, radiopaque and primarily composed of calcium hydroxide, calcium silicate and also calcium phosphate. Bioaggregate is used for root end filling materials that shows an excellent biocompatibility (Benetti, 2019) and also has an excellent sealing ability. Bioaggeregate exhibits excellent antimicrobial action and a significant induction of bone (Zhao, 2011a) and periodontal regeneration. Bioaggregate are normally produced under controlled pressure, which results in fine and pure whire hydraulic cement like powder. Studies have shown that bioaggregate promotes a better adhesion, migration and attachments. (Michou *et al.*, 2018)

Bioactive Ceramics: Bioactive ceramics are materials that bond directly with bone without having any fibrillar connective tissue between them. Bioactive ceramics increases the need for bone repair and helps in bonding with bone. (Tirapelli *et al.*, 2011) Bioactive dentin replaces the missing tooth volume and possesses a therapeutic function. Bioactive ceramic forms chemical interfacial bonds with tissue. Bioactive ceramics have a higher stiffness than polymers, inducing the osteogenic stem cell differentiation. (James, 1995) Bioceramics increases its demand due to the increasing need for bone repair due to the prevalence of osteoporosis in the aged population .

Bioactive Composite: Bioactive composites help in remineralisation (Ramesh, Moratti and Dias, 2018) and have antibacterial characterisation and inhibits the caries activity. These two factors enable bioactive composites to have caries preventive effects. Bioactive composites replace missing tooth volume and possess many functions. (Iannazzo *et al.*, 2017) Bioactive composites promise in reversing lesions and thereby inhibiting the caries activity. Bioactive composites (Hussainy *et al.*, 2018) were introduced and developed as an aesthetic alternative to dental amalgams which are very widely used in dentistry and intended for anterior teeth restoration. (Tanaka *et al.*, 2019) The main advantage of this material is its capability of regenerating the dental hard tissues, reducing dentin hypersensitivity, postoperative pain and sensitivity (Ramamoorthi, Nivedhitha and Divyanand, 2015) and mainly inhibiting bacterial growth.Our institution is passionate about high quality evidence based research and has excelled in various fields (Pc, Marimuthu and Devadoss, 2018; Ramesh *et al.*, 2018; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Ramadurai *et al.*, 2019; Sridharan *et al.*, 2019; Vijayashree Priyadharsini, 2019; Mathew *et al.*, 2020). We hope this study adds to this rich legacy.

CONCLUSION

Bioactive dental filling materials are rapidly growing and gaining popularity among the newer generations. Bioactive with its unique properties and advantages in all fields, increases its demand on long term usage. Bioactive dental filling materials play a major role in reducing the risk and the extent of secondary caries most commonly in the patients. Bioactive materials also have hyphophilic formation, bond between tissue of the tooth structure and the materials. Bioactive materials are ideal for some patients as it varies depending on the patients restorative need and have various opinions and limitations in the treatments. Bioactive will have more demanding future needs with its advancing properties in dentistry especially in the field of dental materials. Bioactive dental filling materials in restorations have newer mechanisms for adhesion, integration and sealing has a strong effective potency. Bioactive dental filling

materials have bioactive ceramics, bioaggregate, bioactive dentin, bioactive calcium hydroxide, bioactive mineral trioxide aggregate, bioactive polymers, bioactive glass and so on with their uniqueness of properties on bonding ability with the tooth structure, remineralising ability by release of calcium, and also reduces the extent of secondary caries in the patient. Bioactive materials have close resemblance with natural tooth in many ways and will change the future dentistry with all its evolving advancements in all fields.

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