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REVIEW ARTICLE

Recent advancements in root canal sealers

Goldy Rathee[1], Jaskiran Cheema[2], Gourav Thapak[3], Parul Chauhan[4], Ashwath Kumar V[5]

[1, 2, 3]Senior lecturer, Department of conservative dentistry and endodontics, SGT dental college, Gurugram
[4]Private consultant, Department of conservative dentistry and endodontics, Sudha Rustagi dental College, Faridabad
[5]Post graduate student, Department of conservative dentistry and endodontics, H.P.G.D.C, Shimla

ABSTRACT:
The field of Endodontics is constantly changing due to introduction of new techniques and technological advances. Advances in endodontic material sciences contribute significantly to the exponential growth in endodontics. Root canal sealers can be classified according to the chemical composition in zinc oxide-eugenol-based, calcium hydroxide-containing, glass-ionomer-based, epoxy-resin-based and methacrylate-resin-based sealers. Bio-ceramics are amongst the recently introduced materials in endodontics which have changed the face of endodontics. The present review focused on some of the important aspects of root canal sealers.
Key words: Root canal, Sealers

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Corresponding author: Dr. Jaskiran Cheema, Senior lecturer, Department of conservative dentistry and endodontics, SGT dental college, Gurugram

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INTRODUCTION

Root canal therapy targets to eliminate infection of the root canal and to completely fill the root canal space in three-dimension, in order to prevent apical and coronal penetration of liquids and microorganisms. Most root canals are filled with gutta-percha points in combination with an endodontic sealer which are essential components of root canal obturation to establish a fluid-tight seal. The main function of a sealer is to fill the spaces between the core material and the walls of root canal and between the gutta-percha cones, in an attempt to form a coherent mass of obturating material without voids.[1] The sealer is expected to fill irregularities and minor discrepancies between the filling and canal walls, accessory canals, and multiple foramina. By its germicidal action, it is also expected to destroy the remaining bacteria left after cleaning and shaping of the root canal. Although all efforts are concentrated to confine the sealer within the root canal space, some extrusion inadvertently occurs during obturation procedure. When the sealer cement comes in contact with soft and hard tissues apically, it can cause persistent inflammation of periradicular tissues and may result in delayed wound healing manifesting as pain, tenderness, and swelling of the affected area; hence, biocompatibility of sealers is an important issue in selecting the right type of sealer for different types of endodontic cases.[2]

Due to the complexity of root canal systems, pulp tissue and inorganic debris remain in areas instruments and irrigation solutions cannot easily access after root canal treatments. Thus, microorganisms surviving in the root canal will subsequently grow and spread to the periradicular areas between the sealer and dentin. Permanent coronal restorations also provide seals equally as important as the apical seal after the root canals are filled. When insufficient coronal sealing occurs or the root canal remains open (e.g., when sealing is delayed for permanent fillings, broken fillings, or secondary caries formation; etc), oral bacteria will access the apical foramen.[3- 5]

It is not easy to achieve a complete filling with the current root-filling materials used in the clinic, due to the dimensional changes and lack of adhesion from gutta-percha, which is also the reason to use endodontic sealers in combination of gutta-percha. Thus, the adaptability of a sealer to the dentin is the primary factor influencing microleakage and reinfection of the root canal. Many endodontic sealers are used in clinical practice, including the recently-introduced calcium silicate-based sealers. The EndoSequence BC sealer

(Brasseler USA, Savannah, Georgia, USA; also named the iRoot SP; (Innovative. BioCeramix Inc, Vancover, Brtish Columbia, Canada) has been introduced as an ideal premixed and injectable biomaterial in the clinical, exhibiting excellent radiopaque, zero-shrinkage, insoluble, and hydrophilic (using moisture from the dentinal tubules to initiate and complete its setting reaction) characteristics.[6, 7]

RESIN-BASED ROOT CANAL SEALERS

Root canal sealers used in combination with solid core materials can provide a fluid-tight hermetic seal. They are used mainly to fill in gaps present between the core filling material and the dentinal wall. Gutta-percha (GP) is the most commonly used solid-core filling material, and only few materials were used as alternatives to GP. Researchers have mainly focused on finding an ideal root canal sealer to use in combination with GP. Polymeric resin-based root canal sealers were introduced to overcome shortcomings associated with conventional zinc oxide eugenol (ZOE) sealers. Those shortcomings include inability to strengthen root structure, lack of bonding to dentin, microleakage, and the high solubility, all of which may compromise the longevity of root canal therapy.[8]

Polymeric root canal sealers, such as silicon-based sealers and resin-based sealers were introduced to the market to overcome limitations associated with conventional sealers. AH Plus (Dentsply DeTrey, Konstanz, Germany) is an epoxy-resin based paste-paste sealer system and is widely accepted in root canal therapy. It consists of an epoxide paste and an amine paste that consists of three different types of amines. AH Plus has demonstrated low solubility and good dimensional stability in solutions. It can adhere to root dentin due to its creep properties and long setting times. Regarding the antimicrobial properties, epoxy-resin based sealers have shown to produce some antibacterial properties but mainly before their setting due to the release of some of the constituents like formaldehyde. Many efforts have been made to prolong the antimicrobial properties of epoxy-resin sealers through the addition of antibacterial agents, such as silver, quaternary ammonium compounds, chlorhexidine, calcium hydroxide and many more, which have shown improved antimicrobial activity and minimal adverse effects on physicochemical and biological properties.[9- 12]

Methacrylate-resin based root canal sealers were introduced to provide the concept of a “mono-block” by bonding the core filling material to the canal wall and forming a single unit. They were developed to provide a better seal and mechanically reinforce compromised roots, which have been suggested to reduce bacterial ingress pathways and strengthen the root structure. Methacrylate-based sealers are meant to infiltrate the partially demineralized collagen matrix and create micromechanical retention to root dentin. Despite the desirable concept of the mono-block, the lack of relief of polymerization shrinkage stresses associated with these sealers that occur as a result of the unfavorable cavity configuration of the root canal, result in the pulling out of the resin tags from the dentinal tubules. This can compromise the sealer-dentin bond and result in micro-gaps that can act as a source for micro-leakage. For these specific reasons, efforts have been made to improve the bond and antibacterial properties of methacrylate-resin based root canal sealers.[13- 15]

ROUTINELY USED SEALERS

Apexit Plus (Ivoclar Vivadent, Schaan, Liechtenstein) is a calcium hydroxide (Ca(OH)2)-based root canal sealer. It triggers healing by inducing hard tissue formation, has antibacterial activity, and mediates the degradation of bacterial lipopolysaccharides thereby controlling inflammatory root resorption. Ca(OH)2-based root canal sealers have been found to have good biological apical sealing with deposition of calcified tissue at the apical foramen. The therapeutic property of this sealer depends on its ionized form, for which it must be partly soluble.[16]

AH Plus (Dentsply, Konstanz, Germany) is an epoxy resin-based sealer with properties including easy handling, potential for better wettability of the dentine and Gutta-percha surfaces, and good sealing property. Resin-based root canal sealers are considering as the material of choice due to their ability to penetrate into dentinal tubule and the possibility of creating monoblocks between the root canal filling material and intraradicular dentin. These properties are considered to be of paramount importance among root canal sealers.[15]

MTA Fillapex (Angelus, Londrina, Brazil) is a mineral trioxide aggregate (MTA)-based, salicylate resin root canal sealer containing 13% MTA and salicylate resin for their antimicrobial and biocompatibility properties. It has high radiopacity, low solubility, and low expansion during setting, cementum regeneration with good sealing property, bactericidal property, and biocompatibility. MTA Fillapex releases free calcium ions (Ca2+) which help in the healing process by stimulating tissue regeneration.[14- 16]

BIOACTIVE GLASS-BASED ENDODONTIC SEALER

Bioceramic-Based Root Canal Sealer

General practitioners desire a root canal sealer capable of strongly bonding to root canal walls with high sealing properties, high biocompatibility, as well as removability to accommodate retreatment. Researchers have found promising results in the application of bioceramics to solve these issues. Bioceramic-based materials have recently been introduced as endodontics materials as both repairing cement and root canal sealer. Bioceramic-based materials show an alkaline pH, antibacterial activity, radiopacity, biocompatible, nontoxic, non-shrinking, and are chemically stable within the biological environment. A further advantage of bioceramic materials is that they promote the formation of hydroxyapatite, ultimately facilitating a bond between dentin and the filling material during the setting process. However, conventional bioceramic-

based sealers show clinical disadvantages such as difficulty in handling, higher cytotoxicity in its freshly mixed state, a high pH during setting, long setting times, and that hardening requires sufficient moisture. An additional disadvantage is that bioceramic-based sealers are difficult to remove when facilitating retreatment. To overcome these disadvantages, we developed a next-generation bioceramic-based root canal sealer based on previous medically reliable BG-based materials, Nishika Canal Sealer BG (Nippon Shika Yakuhin, Yamaguchi, Japan).[17- 19]

Bioactive Glass-Based Root Canal Sealer

There are two well-known commercialized root canal sealers that include BG. One is GuttaFlow Bioseal (GFB) (Coltène/Whaledent AG, Altstätten, Switzerland), which is composed of gutta-percha, polydimethylsiloxane, platinum catalyzer, zirconium dioxide, and BG. GFB has shown a low solubility, low porosity, alkalization capacity, dentin penetrability, and cytocompatibility. At present, only limited evidence is available concerning either the mechanism of GFB hardening or its ability to seal the canal and be removed for retreatment. The second product is Nishika Canal Sealer BG (CS-BG) presently there exists compelling evidence concerning, with evidences about its physicochemical properties, biocompatibility, sealing ability, and removability. CS-BG was developed from BG-based biomaterials and originally intended for both dental pulp and bone regeneration therapies. CS-BG is a two-phased paste; Paste A consists of fatty acids, bismuth subcarbonate, and silica dioxide, whereas Paste B consists of magnesium oxide, calcium silicate glass (a type of BG), and silica dioxide, etc. By pushing the plunger of a double syringe, the two-phase paste can be dispensed at a 1:1 ratio. A stainless-steel spatula may be corroded by the ingredients of the paste, we recommend the use of a plastic spatula to avoid contamination of metal implements. CS-BG paste tends to get hardened when exposed to heat or moisture. Therefore, it is recommended to store the syringes in the resealable aluminum foil bag, then placing the bag in a cold storage location (1–10 °C) without freezing.[20- 22]

ADHESION

Root canal sealer adhesion is defined as its capacity to adhere to the root canal dentin and promote GP cone adhesion to each other and the dentin. Previous authors argued that the term adhesion should be replaced with bonding in the case of root canal sealers because the attachment between the substances involves mechanical interlocking forces rather than molecular attraction. There is no standard method used to measure the adhesion of a sealer to the root dentin; therefore, the adhesion potential of the root filling material is commonly tested using microleakage and bond strength tests.[22]

The sealing ability of a sealer is related to its solubility and to its bonding to the dentin and root canal filling cones. Several studies have evaluated the sealing abilities of different bioceramic-based sealers in vitro. Regardless of the different methodologies used, the sealing ability of bioceramic-based sealers has been found to be satisfactory and comparable to other commercially available sealers. However, until recently, there had been a paucity of literature concerning the long-term sealing ability or clinical outcomes associated with bioceramic-based sealers.[20- 23]

CONCLUSION

The inclusion of novel, biocompatible and bioactive agents into dental products to achieve strong antibacterial and tissue-remineralization functions is highly desirable. These strategies are highly promising to improve the endodontic treatment outcomes and can potentially prevent and control endodontic diseases.

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