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Bioceramic Sealers: The New Way To Deal With The Seal.

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ABSTRACT
Root canal sealers made of bioceramics are regarded as a beneficial advent to endodontics. In comparison to traditional root canal sealers, bioceramic-based root canal sealers have a higher potential for bioactivity. In addition to potential mutagenicity, cytotoxicity, inflammatory response, and hydrophobicity, sealers that are currently in widespread use have many drawbacks. Because of their physical and biological characteristics, bioceramic-based sealers containing calcium silicate and calcium phosphate are attracting a lot of attention. An in-depth analysis of specific bioceramic sealers currently in use and an examination of their characteristics are the main goals of this review.

Keywords:*bioceramics, bioceramic sealers, calcium silicates, calcium phosphate, MTA.*

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I. INTRODUCTION

The three-dimensional obturation of the endodontic spaces is the most desired outcome of endodontic treatment [1].To achieve a hermetic seal of the root canal system, root canal sealers are used in conjunction with a biologically acceptable core material. Root canal sealers function as a lubricant during the placement of the core material and aid the sealing of irregularities while also helping in the formation of a bond between the core of the filling material and the root canal wall [2].

Sealers are divided into groups based on their primary chemical components: silicone, glass ionomer, calcium hydroxide, zinc oxide eugenol, resin, and bioceramic-based sealers. Due to their superior physical, chemical, and biological characteristics over conventional endodontic sealers, bioceramic-based sealers have been introduced in endodontics. These materials include radiotherapy glasses, alumina and zirconia, bioactive glass, glass ceramics, calcium silicates, hydroxyapatite, and resorbable calcium phosphates.

The mechanism of action for bioceramic sealers is as follows:

1) Dentinal tubular diffusion of the sealer particles results in mechanically interlocking bonds between tubules[8].

2) The infiltration of the mineral content into the intertubular dentin, creates a mineral infiltration zone with a potent alkaline sealer[9].

3) Calcium silicates react with calcium hydroxide and hydroxyapatite along the mineral infiltration zone, producing phosphate in a partial reaction with calcium hydroxide and calcium silicate hydrogel[10].

II. CLASSIFICATIONS OF BIOCERAMIC SEALERS

	Type	Brand Name	Manufacturer
1	Calcium silicate-based	• iRoot SP	• Innova_veBioceramix, Vancouver, Canada
		• EndoSequence BCS	• Brasseler USA, Savannah, US
2	MTA based	• MTA Fillapex	• Angelus, Londrina, PR, Brazil
		• Endo CPM sealer	• EGEO SRL, Buenos Aires, Argentina
		• MTA-Angelus	• Angelus, Londrina, PR, Brazil
		• ProRoot Endo Sealer	• Dentsply, York, USA
3	Calcium Phosphate based	• Sankin apatite root canal sealer (I, II, and III)	• SankinKyogyo, Tokyo, Japan
		• Capseal (I and II)	• Experimental Material

Delivery -1 component	Delivery -2 component

iRoot SP	Endo CPM
Endosequence BC Sealer	Tech BioSealer
Total Fill BC Sealer	BioRoot RCS
Endoseal MTA	ProRoot ES
MTA-Fillapex	NeoMTA Plus
Well-Root ST	
Nano-Ceramic Sealer	
EndoSequence BC Sealer Hi-Flow	
Ceraseal	

Figure 1 : Various Commercially available Bioceramic Sealers.

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(e)

Endo-CPM-Sealer(Fig.-1.a)

- It was introduced in 2004 and combines the biological qualities of MTA with a root canal sealer.
- It has an antibacterial effect on E. faecalis before setting , but not after setting[13].
- Calcium carbonate isadded to lower the setting pH from 12.5 to 10.0 [14] and also leads to the deposition of mineralized tissue.

Fillapex MTA(Fig.-1.b)
- MTA Fillapex is made of resin MTA and nano silicate particles[16].
- The total setting time is between two and four hours, with the working time being roughly 30 minutes.
- The lateral and accessory canals are easily penetrated by MTA Fillapex due to their high flow rate and thin film thickness[17].
- The resin component is to be blamed for MTA Fillapex's noticeably higher cytotoxicity[18].

Endoseal-MTA(Fig.-1.c)
- MTA serves as the main component of this sealer, and is non resin based.
- It doesn't contain eugenol and doesn't interfere with adhesion inside the root canal.
- Due to its exceptional flowability, this premixed, injectable endodontic sealer fills the entire root canal system, including accessory and lateral canals.
- Sets in about 12.31 minutes with a radiopacity greater than 3 mm aluminum thickness.
- After 30 days in the water, it expanded less than epoxy resin-based sealers.
- In contrast to BioRoot RCS, it is less biocompatible with human periodontal ligament cells (PDL)[19].

Endo Sealer ProRoot (Fig.-1.d)
- A water-soluble polymer has been added to a calcium silicate-based endodontic sealer, in ProRoot Endo Sealer.
- Even at high powder-to-liquid ratios, the increased flow has been documented.
- It is suitable to usewith a carrier-based obturation technique or cold lateral warm vertical filling technique.
- It demonstrates good biocompatibility, and [20] calcium and hydroxyl ions are released from the set sealer which is responsible for its bioactivity[21].
- It also has favorable cytotoxicity, which means that when it is extruded through the apical constriction, it only mildly irritates the tissue[22].

Endosequence BC Sealer (BCS) (Fig.-1.e)
- It is a calcium silicate-based insoluble, radiopaque, and aluminum-free material.
- It needs water to set and harden and is an injectable root canal material that has been pre-mixed and is ready to use[27].
- It is designed to be used in the single cone and lateral condensation techniques.
- At room temperature, the working time can last up to more than four hours. The setting time is 4 to 10 hours depending on the moisture content.

Endosequence BC Sealer HiFlow
- It is a sealer suitable for use in warm canal filling techniques, and a modification of Endosequence BC Sealer with a variation in calcium and zirconium content.
- However, Endosequence BCS is more radiopaque when heated.
- In terms of cytocompatibility, cell migration, cell adhesion, and bioactivity potential, BCHiF performed similarly to its predecessor BCS[28].

Total Fill BC Sealer (Fig.-1.f)
- It is an injectable bioceramic paste for usage as permanent root canal filling material and as a sealer as well.
- It is a calcium silicate-based material that is insoluble, radiopaque, and aluminum free.
- Compared to AH Plus or MTA Fillapex, it showed greater cell proliferation and collagen type I adhesion[18].
- It was also found that it had more observations of full apical healing[29].

iRoot SP (Fig.-1.g)
- It is a ready to use sealer and made of calcium silicate but without aluminum.
- In an antibacterial investigation, it was able to kill E. faecalis and displayed and pH of up to 7 days after setting[24].
- It is more radiopaque than 3 mm of aluminumthickness[25].
- In a filter diffusion test, it was discovered that fresh iRootSp was significantly more toxic than ProRoot MTA and that iRoot SP had more residual filler after retreatment than epoxy resin- and zinc oxide-eugenol-based sealers.

- Additionally, it has stronger push-out bond strength and greater resistance to fracture than epoxy resin-based sealers, showing deeper dentinal tubule penetration[13].

BioRootRCS (Fig.-1.h)
- It is ready to use and made of calcium silicate but without aluminum.
- In an antibacterial investigation, it was able to kill E. faecalis and displayed and pH of up to 7 days after setting[24].
- It is more radiopaque than 3 mm of aluminumthickness[25].
- In a filter diffusion test, it was discovered that fresh iRootSp was significantly more toxic than ProRoot MTA and that iRoot SP had more residual filler after retreatment than epoxy resin- and zinc oxide-eugenol-based sealers.
- Additionally, it has stronger push-out bond strength and greater resistance to fracture than epoxy resin-based sealers, showing deeper dentinal tubule penetration[13].
- It is a powder/liquid hydraulic tricalcium silicate-based cement.
- Heating it at 250 °C for 11 min or more causes BioRoot RCS to lose 15% of its weight[30] hence single cone technique or cold lateral condensation root filling are both recommended.
- It has a high flow rateand a radiopacity greater than 3 mm aluminum thickness.
- It has a setting time of roughly five hours.
- It releases more calcium ions than other CSBS and exhibits long-lasting alkaline activity[32].
- When applied using the single-cone technique, BioRoot RCS's push-out bond strength was lower than AH Plus[33] and was negatively impacted by the use of EDTA as a final irrigant, whereas chlorhexidine improved its dislodgement resistance[34].
- When tested on human PDL cells and gingival fibroblasts, BioRoot RCS was found to be biocompatible and to have low toxicity and genotoxicity [19].

Cera seal (Fig.-1.i)
- Is supplied as a premixed syringe.
- Cera seal is a bioceramic sealer with a calcium phosphate base.
- It has a 3.5-hour setting time and a radiopacity of less than 8mm aluminum, and high pH (12.73).
- In comparison to endoseal, it exhibits a significant calcium ion release, induces a higher rate of cell migration, and has higher cell viability[36].

NeoMTA Plus (Fig.-1.j)
- Tantalum oxide (Ta2O5) acts as the main radiopacifying agent in NeoMTA Plus, a new finer-powder tricalcium silicate material, which is combined with a water-based gel to improve handling characteristics.
- One can use a thin mixture as an orthograde sealer or a thick mixture as root-end filling by adjusting the powder-to-gel mixing ratio[35].

Well Root ST (Fig.-1.k)
- It is an injectable, premixed sealer.
- Zirconium oxide serves as a radio pacifier.
- It produced clinically noticeable discoloration, just like MTA Fillapex and Dia-Proseal[37].
- Due to the high pH in the fresh state, it shows significantly higher cell viability at 3 days, but it shows decreased cell viability over time in fresh media.

Cera Fill RCS(Fig.-1.l)
- It is a ready-to-use injectable premixed filling and sealing material.
- It is a radiopaque calcium silicate-based material made without alumina that has excellent handling qualities and superior physical properties. It requires water to set.

Nano ceramic sealer
- It is cytocompatible, though not as good as Bioroot RCS.
- Cell viability is significantly increased for 7 days with nanoceramic sealer.
- Its smooth surface enables favorable cell attachment and proliferation.
- Its favorable initial osteoblastic potential is more advantageous for the early stages of periapical healing [38].

III. CONCLUSION

The characteristics that make bioceramic-based sealers a modern alternative to the current "golden" standard techniques are strong antibacterial activity, absolute biocompatibility, osseoconductivity, ability to achieve excellent fluid-tight seal in a constantly wet environment, formation of the chemical bond with dentin, insolubility in tissue fluids, expansion during time of set, very good radiopacity, and easy handling. To evaluate the clinical results connected with the use of these sealers, however, more research is needed.

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