

# PROPERTIES AND CLINICAL APPLICATION OF RESIN BASED SEALERS: A REVIEW

**Running Title:** Resin based sealers – A review

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## ABSTRACT:

The role of endodontic treatment is to provide proper cleaning, shaping and obturation of the root canal system, all three processes are interlinked and dependent on one another. Endodontic sealers are materials which provide a three dimensional fluid- proof seal in the root canal system of a tooth, which provides a favourable environment for periapical healing as well as to prevent chances of re-infection. An ideal endodontic sealer has to possess certain characteristic properties essential for attaining the desired sealing of the root canal system such as high radiopacity, flowability, sealing, biocompatibility, low solubility, reliable working time and adhesion to canal walls. Currently sealers available in the market are zinc-oxide eugenol, calcium hydroxide containing, resin-based, glass-ionomer based, silicone-based, and bioceramic-based sealers.

**KEYWORDS:** Resin based sealers, Epoxy resin based sealers, Methacrylate resin based sealers, Properties, Clinical implication.

## INTRODUCTION:

Root canal sealers have several important functions which include (i) sealing off of voids and multiple foramina, patent accessory canals (ii) create a bond between the core filling material and the root canal wall, and (iii) providing a lubricating effect during the placement of the filling core and trapping any remaining bacteria<sup>[1,2]</sup>. Due to the relative biological and technical importance of sealers, their chemical and physical properties have been the subject of considerable discussion since their initial development in the early twentieth century<sup>[3]</sup>. Sealers are categorised according as zinc oxide-eugenol, calcium hydroxide, glass ionomer, silicon, bioceramic, and resin -based sealers.

## CLASSIFICATION OF ENDODONTIC SEALERS:

Endodontic sealers can be classified widely as:

- 1) Zinc oxide eugenol based sealers (tubliseal, grossman's formula, roth's 801)
- 2) Calcium hydroxide based sealers (sealapex, apexit)
- 3) Glass ionomer based sealers
- 4) Resin based sealers (AH Plus, AH26, Diaket, Epiphany, Endorez, Hydron).

## RESIN BASED SEALERS:

There are two types of resin based sealers namely epoxy resin based and methacrylate resin based.

## **EPOXY RESIN BASED SEALERS:**

Epoxy resin based sealer was introduced by Schroeder in 1957<sup>[4]</sup>. Epoxy resin based sealers are used because of their reduced solubility, good apical seal and its micro-retention to root canal dentin. Nowadays, the current modifications of the original formula are used widely<sup>[5]</sup>. Epoxy resin based sealers are characterized by the reactive epoxide ring and are polymerized by these rings. There are three types of epoxy resin based sealers, they are

- 1) Diaket
- 2) AH26 and
- 3) AH PLUS

### **DIAKET:**

Diaket is a polyvinyl resin (polyketone), works by forming a reinforced chelate between zinc oxide and diketone. It is a modified zinc oxide cement used along with gutta percha. It was introduced by Scheufele in the year 1952. It is a powder and liquid system. Powder contains zinc oxide and bismuth phosphate. Liquid contains B-diketone (propionylacetophenone), triethanolamine, caproic acid, dichlorophen and copolymers of vinyl chloride, vinyl isobutylether and vinyl acetate. Diaket is known for its resistance to absorption, superior to other sealers in tensile strength and resistance to permeability.

### **AH26:**

AH26 is a powder liquid system, which when prepared releases formaldehyde providing antibacterial effect. Powder contains bismuth oxide, hexamethylenetetramine, silver powder, titanium oxide and liquid contains biphenolAdiglycidyle ether (BADGE). It has a film thickness of 39µm and sets over a period of 24-36hours and has better flow. Staining has been the most common adverse effect with use of this sealer.

### **AH PLUS:**

AH PLUS is an epoxy-amine resin based sealer which is available as a two component paste. AH plus paste A contains BADGE (biphenol A diglycidyle ether), calcium tungstate, zirconium oxide, silica and iron oxide pigments. AH Plus Paste B contains Adamantaneamine, silica and silicone oil. It has a short working time and it is easy to mix which allows for close adaptation to the prepared root canal and prevents shrinkage upon setting as well as outstanding long term dimensional stability and a good periapical seal. Adverse effects from unset sealer can be minimised due to its short working time. AH PLUS does not release formaldehyde and is less toxic compared to AH26. Acute inflammation of the oral mucosa can occur leading to irritation and discomfort upon contact with unset paste with resin based sealers. In some cases local and systemic allergies have also been reported.

## **METHACRYLATE RESIN BASED SEALERS:**

Methacrylate resin based sealers are classified according to the different generations. The first generation of methacrylate based sealers, **Hydron** appeared in the mid-1970's<sup>[6]</sup> when dentinal bonding were at their initial stage of development. The second generation of bondable sealers were non-etching and hydrophilic in nature and does not require the adjunctive use of a dentin adhesive. In order to simplify bonding procedures, new generations of self-etching (third generation) and self-adhesive (fourth generation) resin composites have been introduced to restorative dentistry and are awaiting trials for clinical use.

Methacrylate sealers create a solid, bonded, continuous material from one dentinal wall of the canal to the other forming a fluid proof seal without forming any gaps or voids

Resins added to the different sealers in different generations are

1. 1<sup>st</sup> generation –hydron
2. 2<sup>nd</sup> generation-endorez
3. 3<sup>rd</sup> generation-epiphany, fiberfil
4. 4<sup>th</sup> generation –metaseal

#### **HYDRON:**

It was introduced by Wichterle and Lim in the year 1960. It is a rapid setting air injectable root canal filling material which is hydrophobic and is used as a root canal sealer without the use of a core<sup>[7]</sup>. It is a polymer of HEMA (hydroxyl ethyl methacrylate). It requires the use of a special syringe and needle. Hydron is a biocompatible material that confirms the shape of the root canal because of its plasticity.

#### **ENDOREZ:**

It is hydrophilic, non-etching dual cure radiopaque sealer supplied in a Two-spense mixing and delivery syringe. The matrix constitutes of urethane dimethacrylate resin, barium sulphate and zinc oxide. Hydrophilic nature of this sealer when used in wet environment of the root canal system can be very effective in penetrating dentinal tubules and forming long resin tags<sup>[8]</sup>.

#### **EPIPHANY:**

It is a dual curing, hydrophilic resin sealer, used with resilion core materials. It is dispensed with an automixing barrel for ease of use and accurate mixing. An adhesive primer containing sulfonic acid terminated functional monomer, HEMA and water and filler content is 70% by weight. Matrix is constituted by mixture of bis-gma,UDMA and ethoxylatedbis-GMA. It has excellent sealing ability because of monobloc creation which adheres to dentinal

walls. Drawbacks include water sorption leading to disruption of bonds.

#### **METASEAL:**

Metaseal is a fourth generation self adhesive dual cure sealer, available in powder-liquid form<sup>[9]</sup>. It is a radiopaque,insoluble material that can be used either with Resilon or normal guttapercha. Powder contains zirconia oxide filler, silicon dioxide fillers, polymerisation initiators and liquid contains 4META monofunctional methacrylate monomers and photoinitiators. Formation of hybrid dentin is the major mechanism of bonding.

#### **PROPERTIES OF RESIN BASED SEALERS:**

##### **RADIOPACITY:**

Radiopacity is considered as one of the most important properties of a root canal sealer. Root canal sealers should be sufficiently radiopaque so as to be distinguishable from adjacent anatomical structures during radiography<sup>[10]</sup>. This allows the precision and quality of the root filling to be evaluated through radiographic examination. 3.00 mm of aluminium is the reference standard of minimum radiopacity for a root canal sealer . AH PLUS has higher radiopacity when compared to AH26 due to its shade and colour stability which make it material of choice when high esthetic are demanded.(AH Plus - 13.6/mm Al thickness, AH26 - 9.3, Diaket - 4.0). Epiphany has highest radioapcity among other mythacrylate sealers(Epiphany - 6.1).

##### **SOLUBILITY:**

Solubility is the loss of mass of a material during a period of immersion in water. The solubility of a root canal sealer should not exceed 3% by mass. A highly soluble root canal sealer would facilitate the formation of gaps within and between the material and the root dentin disrupting the seal, thereby providing space for leakage from the oral cavity into the periapical tissues. AH26 is not moisture sensitive, has low solubility and can even set under water. (AH Plus - approx. 1%, AH26 - approx 3%, Diaket - approx. 2%). Though low solubility is an advantage, extrusion of such sealers does not get resorbed<sup>[11]</sup>. Extrusion into the inferior alveolar canal can cause parasthesia and pain<sup>[11]</sup>.

#### **FLOW:**

Flow is a crucial property that allows the sealer to fill inaccessible areas, such as the narrow irregularities and crevices of the dentin, isthmus, accessory canals, and voids between the master and accessory cones. The flow rate of a root canal sealer should be 20 mm or higher. Factors significantly affecting the flow rate are shear rate, temperature, particle size and mixing time. AH Plus has better flow compared to AH26 due to lesser film thickness.

#### **ADHESION:**

Root canal sealer adhesion is the capacity of a sealer to adhere to the dissimilar root canal dentinal surface and promote Guttapercha cone adhesion to each other and to the dentinal wall. Tagger et al. argued that the term *adhesion* should be replaced with *bonding* in the case of root canal sealers because the attachment principle behind substances involves mechanical interlocking forces rather than molecular attraction. In common microleakage and bond strength tests<sup>[12]</sup> adhesion potential of the root canal filling material is usually considered as there is no standard test for measuring adhesion of the sealer to root dentin. Solubility and bonding capacity to dentin and filling material affects the sealing ability of a sealer. Endorez forms long resin tags and provides better adhesion due to effective penetration of dentinal tubules.

**BIOCOMPATIBILITY:** AH26 revealed high cytotoxicity in cultures of mouse fibroblasts directly after mixing owing to its initial formaldehyde release. This reaction was significantly lower when the material was tested 7 days after mixing. The initial high cytotoxicity was explained by the formation of formaldehyde during the setting reaction. In vitro study show that AH26 inhibited the nerve conduction, which was partially reversible. Oral mucosal irritation occurs on contact with unset cement with AH-Plus. Epiphany has superior biocompatibility and is less irritating compared to epoxy resin based or zinc oxide eugenol based sealers. Over filling with hydron causes long term periapical inflammation questioning its tissue compatibility.

Metaseal is non-toxic and proven non-mutagenic.

#### **DIMENTIONAL STABILITY:**

Polymerisation shrinkage associated with resin based sealers leads to compromised dimensional stability. Polymerization shrinkage of certain sealers are AH Plus = 1.76% of total volume. AH26-1.46, Diaket-1.18, Epiphany-2.31. AH Plus has long term dimensional stability due to minimal shrinkage and low linear expansion.

#### **ANTIMICROBIAL:**

Ah26 has better antimicrobial effect due to initial formaldehyde release but it not widely used due to coupled cytotoxic effect<sup>[13]</sup>. AH Plus has comparatively lesser antibacterial activity due to lack of formaldehyde release. AH Plus were effective in reducing the number of cultivable cells of *E. faecalis*.

### **SETTING TIME:**

An ideal root canal sealer setting time should permit adequate working time for proper manipulation of the material. However, a slow setting time can result in prolonged tissue irritation, with most root canal sealers producing some degree of toxicity until being completely set, leading to adverse effects.

### **CLINICAL IMPLICATION:**

#### **MONOBLOCK EFFECT:**

Monoblock effect is a phenomenon in which the sealer bonds to both the core and the dentinal wall, which enhances sealing capability and strengthens the root canal treated tooth against fracture. The bond between the root canal sealer and the radicular dentin should be strong enough to maintain the integrity of the sealer-dentin interface. Monoblock obturation is a technique which involves a single cone and a sealer, providing adhesion at both the sealer-dentinal tubule interface and the sealer core interface.

#### **SMEAR LAYER REMOVAL:**

Resin based endodontic sealers warrant removal of smear layer before application to facilitate resin tag penetration into dentinal tubules and facilitate a fluid-proof seal. Epiphany sealers use 17% EDTA to remove smear layer before application. In Endorez NaOCl or 17 % EDTA is used. Sodium hypochlorite is not advised to be used with metaseal as it affects bond strength.

#### **TOOTH STAINING AND DISCOLOURATION:**

Tooth colouration occurs mostly due to chromogenic effects of sealers when excess sealer is left in dentin of pulp chamber<sup>[14]</sup>. Diaket causes a mild pink discolouration whereas AH26 gives a distinct colour shift towards gray due to formaldehyde release which is not evident in AH PLUS.

#### **RETREATABILITY:**

A major part of residual material during retreatment is endodontic sealers and warrants complete removal during retreatment to re-establish healthy periapical tissues. Sealers can be removed from the root canal using conventional retreatment techniques, including heat, chloroform, rotary instruments, and hand files. Many cases have been reported in which obstruction of the apical foramen has resulted in a loss of patency<sup>[15]</sup>. Difficulty of removal of root canal sealer depends on material remaining in the canal, dentin removal, and time taken to reach working length. Hydron can be removed from the canal and retreatment is very difficult.

#### **CONCLUSION:**

Resin-based root canal sealers show promising results as root canal sealers. However, discrepancies in the results of some studies reveal that these sealers do not fulfil all of the requirements demanded of an ideal root canal sealer. Further studies are required to clarify the clinical outcomes associated with the use of these sealers.

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**CONFLICT OF INTEREST:** Nil

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