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Value Addition Property of Zinc Oxide Eugenol after Electron Beam Radiation

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ABSTRACT

Electron beam irradiation has proved their influence on properties of polymers. In the present study, the effect of Electron beam irradiation on the ease of manipulation of Zinc oxide eugenol root canal sealer was evaluated in order to improve its technical considerations. Samples were electron beam irradiated with 10kGy using an electron accelerator of 8 MeV. Technical considerations were compared with non-irradiated specimens. The irradiated powder and liquid showed positive results of value addition in manipulation of Zinc oxide eugenol. Plastic consistency of cement could be obtained. Clinical relevance to this study shows better handling properties for zinc oxide eugenol cement, which could otherwise not show a hook consistency.
Keywords: Electron beam,radiation, dental materials, root canal sealing materials, zinc oxide eugenol.

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INTRODUCTION

The main objective of root canal sealer is to provide a fluid tight seal between the root canal system and periodontium. Thus it's the sealer which provides the fluid tight seal and guttapercha (GP) fills the core space. Scientific evidences prove that the root canal system is connected with the periodontium apically, laterally and furcally [1]. Properly sealing of all these portals of entry to periodontium will lead to successful endodontic treatment. The better the seal, the better is the prognosis.

A time – tested material for this purpose is Zinc – Oxide Eugenol cement. As a root canal sealer it has retained its position in endodontics irrespective of introduction of newer materials. ZOE consists of two main components: zinc oxide powder and eugenol (2-methoxy-4-allylphenol). When zinc oxide is mixed with eugenol, a zinc oxide–eugenol chelate will form in the presence of humidity [2].

The mixture sets within a period of 12–24 h. The addition of resin, quartz, calcium phosphate, or zinc acetate accelerates the setting of the material. Because oil of cloves contains about 70% eugenol, some products use it instead of pure eugenol.
The setting reaction of ZOE to zinc-oxide-eugenolate is reversible. If ZOE is located in an aqueous environment, then the superficial eugenolate complex is hydrolyzed, eugenol leaches, and zinc hydroxide as well as zinc oxide remain in the material [3].

Eugenol release depends on the powder–liquid ratio. ZOE with a powder–liquid ratio of 2:1 releases high quantities of eugenol during hydrolysis because of its high share of eugenolate. Maximum eugenol release from ZOE was observed within the first 5 h after mixing and represented 4–5% of the entire quantity of eugenol [4].

ZOE sealers set in a humid environment, forming ZOE chelates. This setting reaction takes about 24h. Additives, however, such as colophony, dicalcium phosphate, or zinc acetate can accelerate the speed of the setting reaction [5].

The setting reaction is reversible – hydrolytic conditions may cause the release of eugenol and zinc ions. A further degradation of the material releasing eugenol may be caused by HCO3 – (derived from tissue fluid), since the affinity of zinc to HCO3 – is greater than to eugenol [6].

Cements of this type have been used extensively since the 1890s. Tissue tolerance of this sealer is satisfactory, with little inflammation and no inhibition of repair.
The quality of the material used is crucial for successful dental treatment.

Much research has been carried out in the field of Endodontics in order to produce a better material. According to the requisites that a sealing material must have, it is possible to establish research parameters for developing new products, as well as to evaluate those already available. Thus, research and methods could be easily reproduced, making accurate comparisons between different materials and results possible [7].

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MATERIALS AND METHODS

1. Zinc – oxide eugenol cement (Zinc oxide eugenol, Bombay, India)

   Composition :-

   Powder Zinc oxide 69 wt%
   White rosin 29.3 wt%
   Zinc stearate 1 wt%
   Zinc acetate 0.7 wt%

   Liquid Eugenol: It is a clear to pale yellow oily liquid extracted from certain essential oils especially from clove oil, nutmeg, cinnamon, basil and bay leaf.
2. Polypropylene microvials – 1.5 ml
3. Self - sealing plastic pouches
4. Microtron (Irradiation unit)

EXPERIMENTAL

To test the material, the cement was dispensed separately in microvials as powder and liquid. To find out the ease of manipulation, samples were divided into irradiated and non – radiated groups. The microvials of irradiated group were exposed to electron beam irradiation individually at 10 K_{Gy}. With the equal quantity of powder and liquid (zinc oxide eugenol) on a glass slab the non-radiated and irradiated samples were mixed separately according to the manufacturer's instructions and observed for changes.

RESULTS

The irradiated sample was thicker and more pasty in consistency, hence an improved ease of manipulation was noticed.

DISCUSSION

Electron beam radiation is described as a method to change the mechanical properties of polymers. It can increase the stiffness of polymers as well as the links between polymer chains which results in higher bond strength.[8]

Irradiation –initiated reactions can be classified as :-[9]

1) Chain linkage
2) Chain breakage
3) No reaction (Resistant to Radiation)

The mechanism of cross linking by irradiation has been studied for years. However, there is still no agreement as to its exact nature. The mechanism involves the cleavage of a C-H bond on the polymer chain to form a hydrogen atom, followed by removal of the second hydrogen atom to produce molecular hydrogen [10].

Thereafter, the two adjacent polymeric radicals combine to form a crosslink. The overall effect of crosslinking is that the molecular mass of polymer steadily increasing with the radiation dose. This leads to branched chains until ultimately a three-dimensional network is formed when each polymer chain is linked to another chain [11-13].
On the other hand, chain breakage occurs through the cleavage of C-C bond, if the radiation energy is high. E.g. in poly - (methyl-methacrylate) resins [8].

The radiation effect differs from the structure of the polymer, functional groups and on the irradiation parameters like dose rate or accelerating of the electrons [14-16].
The setting reaction of zinc oxide eugenol is as follows:-[17]

1) Hydrolysis :- ZnO + H2O ---- Zn(OH)2
2) Acid –Base reaction :- Zn(OH)2 + 2HE ---- ZnE2 + 2H2O

Base + Acid (eugenol) ----- Salt (zinc eugenolate)

The powder contains Zinc oxide as the principal ingredient.
White rosin is added to reduce brittleness of set cement.
Zinc stearate acts as a plasiticizer and accelerator. Zinc acetate is also an accelerator and it improves strength.

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