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Electron Beam Irradiation Effect On Compressive Strength Of Resin Modified Glass Ionomer Luting Agent

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ABSTRACT

The purpose of the study is to analyse the changes in compressive strength of resin modified glass ionomer luting agents before and after electron beam irradiation. Methods: A total of two resin modified glass ionomer luting agents, rely x luting cement and rely x luting 2 cement were included in the study. Specimens were prepared on cylindrical specimen 6mm height and 4 mm diameter according to ISO standard 9917. After the standardisation of radiation dose of 200 Gy, a total of 24 specimens were irradiated and 24 specimens of non radiated were analysed for compressive strength using universal uniaxial servo mechanical testing machine after 24 hours. Results: Rely x luting cement of irradiated samples shows an increase in the compressive strength compared to non radiated samples whereas rely x luting 2 cement shows a slight increase for non radiated samples. Conclusion: Increase in the compressive strength of rely x luting agent radiated samples may be because of cross linking of unbound monomers and decreased properties of radiated rely x luting 2 agent may be due to chain scissioning.

Keywords: Electron beam irradiation, Resin modified glass ionomer luting agent, Unbound Monomers, Cross linking, Chain Scissioning.

INTRODUCTION

Dental luting agents forms a link between fixed prosthesis and the tooth structure. A lot of luting agents were introduced in dentistry for luting of prosthesis which includes zinc phosphate luting cement, glass ionomer luting cement and resin modified glass ionomer luting agent[1,2]. Some of the disadvantages of zinc phosphate luting cement such as solubility and lack of adhesion, glass ionomer luting agent was once been a great demand among practitioners[3]. Unfortunately research shows that glass ionomer luting agents also had some disadvantages such as high susceptibility for dehydration, and poor physical properties such as slow setting rate and high solubility[4,5]. Due to its well documented disadvantages of glass ionomer luting agent, further research has occurred in the field of glass ionomer luting cement to improve its properties and this leads to the introduction of resin modified glass ionomer luting agent. . In resin modified glass ionomer luting agent, basic composition of glass ionomer luting agents are maintained but modified by the presence of resin[6]. In resin modified glass ionomer luting agent, hydrophilic monomers and photoinitiaters were added in addition to the basic formulations of conventional glass ionomer cement to improve the physical and mechanical properties of cement[2] .Through the addition of resin, it has been shown in several studies that properties of resin modified glass ionomer cements are superior than conventional glassionomer cements[7-9]. Although, resin modified glass ionomer cements has also been reported in several literatures that these cements possess cytotototoxicity due to the unbound free monomers released by resin during and after polymerisation, presence of HEMA, and due to the release of ions [10-13]. Other than the cytotoxic effect related to resin modified glass ionomer luting agent, release of these unbound free monomers during and after polymerisation may also be able to decrease the properties of resin modified glass ionomer luting agent. Some literatures have been shown that electron beam irradiation of dental materials can able to increase the properties [14,15].

Electron beam irradiation can be used as a method to increase the properties of materials. Basically, electron beam irradiation can give rise to two types of reaction: Cross linking and breakage[16,17]. It was the aim of this study to investigate whether resin modified glass ionomer luting agent can benefit from irradiation in order to achieve an increased compressive strength.

MATERIALS AND METHODS

The compressive strength tests were conducted with the materials listed in table 1. The materials were used in accordance to manufacturers instructions. Dose standardisation was initially finalised through electron beam irradiation and materials were irradiated and finally evaluated for compressive strength.

Table1. Material used and composition

MATERIAL	COMPOSITION
Rely X luting Cement(3M ESPE, St.Paul, MN, USA)	Powder: fluoroaluminosilicate, potassium persulfate, ascorbic acid, opacifying agent Liquid: 30-40% copolymer of acrylic and itaconic acids,25-35% 2-hydroxy ethyl methacylate, 25-35% water.
Rely X luting 2 Cement(3M ESPE, St.Paul, MN, USA)	Paste A: Fluoroaluminosilicate glass, Proprietary reducing agent, HEMA,water, opacifying agent Paste B: Methacrylated carboxylic acid, Bis GMA, HEMA,water, potassium persulfate, zirconia silica filler.

Dose Standardisation: Since there is no literature on radiation dose for resin modified glass ionomer luting agents, standardisation of dose was a prerequisite for the present study. Unmixed portion of material (powder and liquid, Paste A and Paste B) was irradiated starting at 25 KGy, 5 KGy, 1 KGy, 600Gy and 400 Gy initially which all gave totally negative results in handling properties. At 200 Gy, handling properties was similar to the normal resin modified glass ionomer luting agent which are conducted in the present study. Hence, 200 Gy was used as a standard dose to irradiate the material as enclosed in Table 2 and 3.

Table 2. Dose standardisation of resin luting cement

Dose	Powder	Liquid
25 KGy	Visible color change	More viscous
5 KGy	Visible color change	More viscous
1 KGy	Visible color change	More viscous
600 Gy	Visible color change	More viscous
400 Gy	Visible color change	More viscous
200 Gy	Visible color change	Normal State

Table 3 . Dose standardisation of resin luting 2 cement

Dose	Paste A	Paste B
25 KGy	More viscous	More viscous
5 KGy	More viscous	More viscous
1 KGy	More viscous	More viscous
600 Gy	More viscous	More viscous
400 Gy	More viscous	More viscous
200 Gy	Normal State	Normal State

Compressive strength : For determining the compressive strength, a total of 24 radiated sample of rely x luting cement and 24 non radiated sample of rely X luting 2 cement were prepared on cylindrical specimen of 6 mm height and 4 mm diameter according ISO 9917 by placing the freshly mixed luting agents into polytetrafluoroethylene molds held between 2 glass slides.[18,19] After the material setting, Specimens were removed from mould and stored in 37°c distilled water and stored in the dark until setting. After 24 hours , specimens were subjected to 3- Point bend test on a universal uniaxial servo mechanical testing machine(Model 33R 4467; Instron Corp) at a crosshead speed of 1 mm/min using a 5 KN force-measuring device.[20] The maximum load generated on the specimen before failure was captured by Instron's central processing unit. The compressive strength values were determined as follows:

$$CS= 4 F/ \pi d^2$$

Where F is the maximum force (N), d is the specimen diameter(mm) and L is the specimen length(mm).
The data obtained was subjected to statistical analysis with T test.

RESULTS AND DISCUSSION

The result of compressive strength tests are depicted in figure 1 and 2. Irradiated samples of rely x luting cement shows higher compressive strength than non radiated specimens(P = 0.023) whereas in rely x luting 2 cement did not show much difference in irradiated and non irradiated samples.(P =0.067).

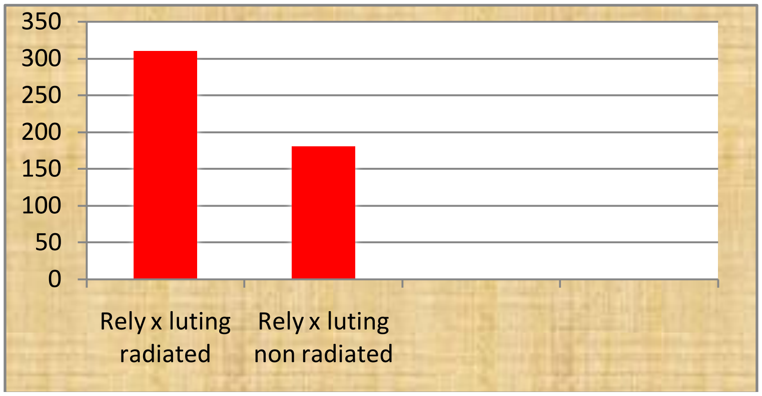

Figure:1- Compressive strength of rely x luting cement radiated and non radiated Where Compressive strength in (MPa)

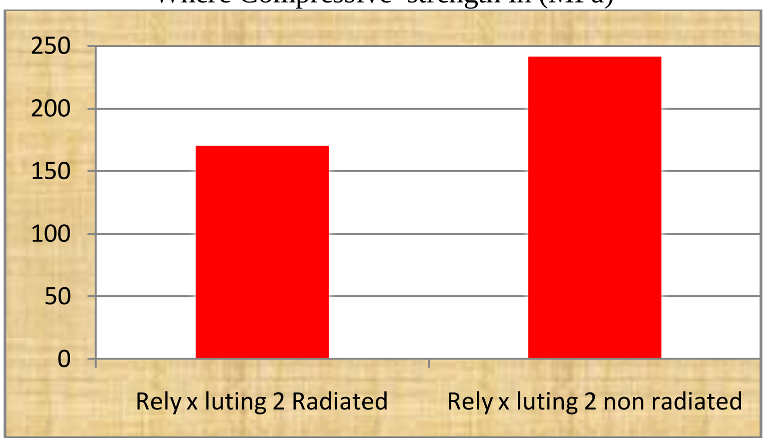

Figure2. Compressive strength of rely x luting 2 cement radiated and non radiated WhereCompressive strength in (MPa)

This study evaluated the benefits of electron beam irradiation of resin modified glass ionomer luting agents in compressive strength. Electron beam irradiation is an excellent way to provide structural modification of materials and modification in the properties due to cross linking or chain scissioning. When an electron beam hits a specimen, it will interacts with the atoms in that specimen. This will leads to formation of backscattered electrons, secondary electrons, X rays and visible light [21]. This will make the specimen a more reactive material which may provide increased compressive strength properties. Electron beam irradiation have been shown to increase the properties of dental composites and Zinc Oxide Eugenol Cements [22]. In all these studies, materials were irradiated at different doses without standardisation of dose and all these conducted in set materials after mixing. If a dental luting agent are aiming to enhance the property through electron beam irradiation clinically, we recommend that the material has to irradiate without mixing the two components, so that after irradiation material may provide an increased properties which can be used clinically for luting of prosthesis. In the present study our prerequisite was to standardise the dose of dental luting agent by irradiating both the powder/ paste and liquid separately. In the present study, electron beam irradiation of greater than 200 Gy altered the material leading to difficulty in handling properties, change in consistency of the liquid and discolourisation of the material(table 2 and 3). So we standardized the dose of electron beam irradiation as 200 Gy for resin modified glass ionomer luting agent to evaluate the technical properties of the material.

Majority studies shows that resin containing dental cements are able to produce unbound free monomers during and after polymerisation[23,24)].We believe that these unbound free monomers may act as a responsible factor for decreasing the properties of resin modified glass ionomer luting agent. So it was the aim of the study to crosslink these unbound free monomers by using electron beam irradiation of 200 Gy , so that we may produce more enhanced compressive strength property for resin modified glass ionomer luting agents.

In the present study radiated samples with 200 Gy of rely x luting cement possess high compressive strength when compared to non radiated samples (fig 1).The increased properties may be because of powder/ liquid system, presence of 30-40% copolymer of acrylic and itaconic acids,25-35% 2-hydroxy ethyl methacrylate. Increase in the compressive strength of radiated samples may be due to the cross linking of these unbound monomers. In the present study radiated samples wih 200Gy rely x luting 2 cement did not show any value addition properties with respect compressive strength property (fig 2).
Dental luting agents used in the present study was self cure, resin modified glass ionomer luting agent. Basic difference between the luting agent we found was one is with powder and liquid form and the other one is with paste- paste system. Other main difference between the luting agents are the difference in the composition and the percentage of each components. Our present study noted that these difference plays a very important role in variation of compressive strength properties between the cements after electron beam irradiation. Rely x luting cement shows a high increase in the compressive strength properties may be because of the cross linking of more unbound monomer when compared to rely x luting 2 cement and rely x luting 2 cement may be affected with chain scissioning. This may be the reason rely x luting 2 cement shows reduced compressive strength properties for radiated specimens.

APPLICATIONS

This study is useful to investigate the resin modified glass ionomer luting agent can benefit from irradiation in order to achieve an increased compressive strength. Dental luting agent properties can be enhanced through electron beam irradiation.

CONCLUSIONS

Dental luting agent properties can be enhanced through electron beam irradiation. Even though a question need to be answered regarding how the material can be used in dentistry for luting of prosthesis. A lot of factors need to be studied while aiming to improve the material properties through electron beam irradiation such as the dose of electron beam irradiation, material composition, type of material used, when to irradiate the material such as before mixing or after mixing and cytotoxicity of the material . In the present study we found that compressive strength of resin modified dental luting agent are enhanced through electron beam irradiation which may be due to cross linking of unbound monomers and decreased properties may be due to chain scissioning . Within the limitations of the present study, it is concluded that further research is needed in the field of electron beam irradiation of dental luting agents.

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