Original Research Paper

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Evaluation of coronal microleakage in teeth with intraorifice barriers at 2mm and 3mm: An in vitro study

Abstract:

Context: An intraorifice barrier after endodontic therapy could remarkably mitigate the movement of bacteria and their by-products and improve the long-term prognosis of a root canal treated teeth by serving as barriers against fluid and bacterial ingress.

Aims: The idea of the present study was to compare the coronal microleakage in teeth with 2-mm and 3mm intraorifice barriers of Bulkfill flowable composite, Glass Ionomer Cement (GIC), Cention and Biodentin under a stereomicroscope.

Methods and Material: Eighty freshly extracted human single rooted mandibular premolars with single canal were chosen for the study. Teeth were obturated with gutta-percha using AH plus sealer. The teeth were further divided into 5 groups (16 premolars each) on the basis of intraorifice barrier material used: Bulkfill composite, GIC, Cention, Biodentin and control group. These groups were further subdivided into 2 subgroups each of 2mm and 3mm (8 teeth each) and evaluated under stereomicroscope

Statistical analysis used: Coronal microleakage was determined under stereomicroscope using 15X magnification. Data were statistically analyzed using two-way ANOVA

Results: According to the results, GIC at 2mm exhibited the highest micro leakage and least microleakage was shown by Biodentin at 3mm.

Conclusions: Intraorifice barriers play a key role in reducing coronal microleakage.

Key-words: Biodentine, Bulkfill composite, Cention, Coronal microleakage, Glass Ionomer Cement, intraorifice barrier.

Key Message: Cention could prove to be a superior alternative to both Bulkfill composite and GIC

Introduction:

The opinion that the root canal treatment failure may occur because of coronal microleakage is not new.[1] Loss of coronal seal exposes the root canal to the oral environment and the obturated root canal serves as a potential route for microorganisms to gain access to the periapical tissues leading to definite endodontic failure.[2]

Although a good quality endodontic filling and impervious coronal restoration may produce a good coronal seal, data from Ray and Trope's historic retrospective clinical study has suggested that a radiographically favorable outcome can also be obtained in poorly filled root canals if the coronal restoration is adequate.[3]

The placement of a permanent restorative material over coronal gutta percha to act as an intraorifice barrier has proven to reduce the leakage by a substantial amount. It has been shown to act as a second line of defense for the temporary coronal seal.[1-2]

Several materials like amalgam, Cavit, Light cure glass ionomer cement (LCGIC), Mineral Trioxide Aggregate (MTA), Resin modified Glass Ionomer Cement (RMGIC), Luxacore, EndoCEM Zr and Zinc Phosphate cement have previously been tested as intraorifice barriers. However, an

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ideal intraorifice barrier and its ideal depth has not been identified yet, or perhaps not even developed.

Biodentine too has proved to be a suitable material for permanent restoration of dentin as well as for endodontic purposes due to its optimal properties such as easy handling, short setting time and stable seal against leakage and most importantly biocompatibility.[4] Glass ionomer cement, on the other hand, has been advocated for use as an intracanal barrier when microleakage is imminent or recurrent caries is likely because of its adhesive and cariostatic properties.[5] As for composite, recent dentin bonding agent's mechanism is based on the penetration of ambiphilic molecules into acid-etched dentin to form an interconnected structure of collagen and polymerized monomers. This creates a tight seal which could be beneficial in preventing microleakage.[6] Attempts to study Cention as an intraorifice barrier to reduce microleakage have been minimal. This study aims at comparing the sealing ability of Bulkfill composite, GIC, Cention and Biodentin at depth of 2mm and 3mm.

Subjects and Methods:

Eighty mandibular non-carious and non-restored premolar teeth were selected for this study. They were assessed radiographically to confirm the presence of a single canal and evaluated under stereomicroscope for the presence of cracks. Age, gender, and systemic condition of the patient were unknown. The teeth were disinfected by overnight immersion in 5.25% NaOCl (PyraxPolymars, Uttarakhand, India) solution and any attached soft tissue and calculus was removed with an ultrasonic scaler (Acteon, India) followed by storage in 0.9% normal saline solution (Kunal Remedies Pvt Ltd, Faizabad Road, Lucknow).

The storage was performed as per Occupational Safety and Health Administration guidelines and regulation.

The teeth were decoronated at the level of cementoenamel junction (CEJ) and apical patency was checked by passing a #10K file (Dentsply Maillefer, Ballaigues, Switzerland) through the apical foramen. Working length was determined by keeping the file 0.5 mm short of the apex. Glide path was established by preparing the decoronated samples till #20K file. 15%W/W EDTA (Dental Avenue Pvt Ltd, Maharashtra, India) and 3% NaOCl (PyraxPolymars, Uttarakhand, India) along with normal saline was used. All canals were prepared to a size of either 25-4% or 30-4% using V Taper rotary file system (SS White, LakeWood, NewJersey). The canals were then obturated with custom 25-4% or 30-4% using AH Plus sealer (Dentsply Maillefer, Ballaigues, Switzerland).

Intraorifice space of 2mm and 3mm was created using finger pluggers (Dentsply Maillefer, Ballaigues, Switzerland) corresponding to the orifice size. Material of interest was then inserted into the space created for intraorifice barrier. The teeth were radiographically assessed to confirm the depth, length and adaptation of the material.

The teeth were then divided into 5 groups of sixteen samples each with eight each belonging to depth of 2mm and 3mm respectively. The control group had no subgroup.

Group 1	Bulk fill composite
Group 2	GIC
Group 3	Cention
Group 4	Biodentine
Group 5	Control

Samples were covered with 2 coats of nailpaint (Elle 18, Hindustan Unilever Limited, Mumbai). After each coat of nailpaint dried, (except around the orifice where the material was placed), samples were immersed in Methylene Blue 2% (RANKEM, Avantor Performance Material India Ltd, Maharashtra) dye after the nailpaint had set for 7 days. The samples were retrieved from the methylene blue dye they were immersed in, allowed to dry and then longitudinally cut using a micromotor (Marathon M4, China) and a carborundum disc (Bharat Industrial Corporation, Ghaziabad, India). The samples were then inspected under stereomicroscope (Olympus, Tokyo, Japan) (15X) to check for microleakage under a graph paper in mm.

Results:

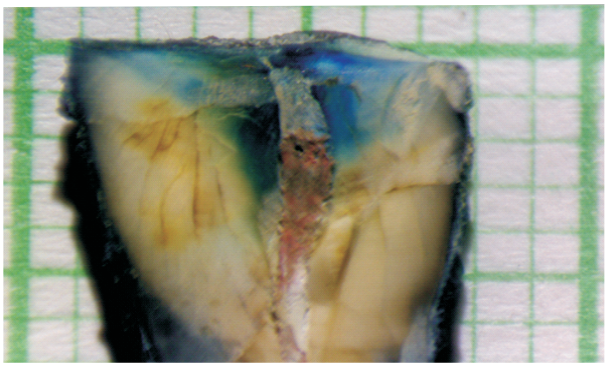
The data was analyzed and subjected to statistical analysis by ANOVA test.

Table 1 shows the mean depth of penetration of the dye for each material of the experimental group.

Group		Micro leakage in 2mm		Control Group		t-Value	p-Value
	M	Mean	Std. Deviation	Mean	Std. Deviation		
BULKFILL COMPOSITE	4	1.00	0.71	1.80	1.28	1.097	0.315#
SIG	4	1.50	0.41	1.88	0.85	0.792	0.458#
CENTION	4	0.63	0.63	1.38	0.48	1.686	0.143#
BIODENTIN	4	0.50	0.50	1.23	0.21	2.365	0.056#

Two way ANOVA test proved there was significant difference in microleakage in between different groups (P<0.001). There was significant difference in microleakage in 2 mm and 3 mm subgroups of different materials. (P=0.012). (Table 2)

Group	Micro leakage in 2mm		Control Group		t-Value	p-Value
	Mean	Std. Deviation	Mean	Std. Deviation		
BULKFILL COMPOSITE	1.80	1.28	6.19	0.65	8.087	<0.001*
SIG	1.88	0.85	6.19	0.65	9.807	<0.001*
CENTION	1.38	0.48	6.19	0.65	12.997	<0.001*
BIODENTIN	1.23	0.21	6.19	0.65	14.564	<0.001*



Discussion:

The primary goal of a successful endodontic therapy is mainly to eliminate infections and prevent reinfections from the apical and coronal directions.[7] The most commonly encountered problem that influences the long-term success of endodontic therapy is microleakage. Magura et al. found that the failure rate was twice as high in cases lacking adequate coronal restoration when compared to cases which were adequately restored.[8] Among the modern approaches aimed at limiting contamination, one technique of sealing the root canal orifices with various restorative materials prior to the placement of the final restoration, has been widely applied. It consists of removing the gutta-percha from the canal orifice till a specific depth and replacing it with a restorative material that prevents coronal microleakage in scenarios presenting with loss of the final restoration.

In this study, intraorifice barriers placed at depths of 3 mm were also used along with depths of 2 mm, considering deeper placement of material would result in formation of a stronger barrier, would be impervious to microleakage and also accomodate the probable need to remove the intraorifice barrier if at all retreatment was required. Placing the restoration deeper than this would result in greater difficulty and risk while removing it during retreatment. Single rooted mandibular premolars with a single root canal were selected in order to minimize anatomical variation, allow standardization, and moreover because they can be easily restored.[9] AH Plus sealer was chosen to avoid the potentially detrimental effect eugenol based sealers have on the adhesion between root dentin and composite resin.[10] Methylene blue dye was used to evaluate the microleakage in samples as it offers the advantage of low molecular weight and therefore deeper penetration than other dyes.[11]

The control group samples, where an intraorifice barrier had not been introduced, showed extensive dye penetration in comparison to the other groups. This can be considered an indicator of immense microleakage and in concurrence with studies by Torabinejad et al and Magura et al who showed that gutta percha and sealer do not provide an adequate barrier to coronal leakage.[12,13]

Coming to the intervention groups, GIC demonstrated the greatest leakage among the four tested materials. This was consistent with the findings of Zaia et al and Sauaia et al. as both authors of these studies have reported that the increased microleakage may be attributed to polymerization contraction.[14,15]

Cention N is a urethane dimethacrylate based restorative material, available in self cure light cure powder liquid system. Due to its cross-linking of methacrylate monomers with an efficient self-cure initiator, Cention N displays a high polymer network density and a greater degree of uniform polymerization throughout the depth of the restoration.[16]

Biodentin exhibited a good coronal seal thereby resulting in minimum microleakage within the 4 groups. Biodentin is composed of a highly purified tricalcium silicate powder containing small portions of dicalcium silicate, calcium carbonate and a radioopaquer.The nanostructure and small size of the gel formed (of calcium silicate cement) can be considered to be one of the main factors influencing the sealability as this allowed Biodentin to better spread onto the surface of the dentine. Growth of crystals into the dentinal tubule could also have contributed to superior bonding to dentin.[17,18]

Bulk-filling techniques have become more widely used following the development of materials with improved curing, controlled polymerization contraction stresses, and reduced cuspal deflection. Using this approach, the number of increments required for filling a cavity is reduced in comparison with traditional incremental filling techniques. As a consequence of the polymerization rate and the magnitude of polymerization, contraction gap formation may result in excessive contraction stresses at the tooth restoration interface. In cases where interfacial stresses exceed those that can be supported by the adhesive layer, gap formation occurs.[19] Therefore, this phenomenon of gap formation due to polymerization shrinkage can be considered to be a reason for the inferior quality of seal displayed by bulkfill flowable composite as compared to Biodentine and Cention.

Though none of the materials used prevented microleakage completely; subgroups restored with Biodentin, Cention, Bulkfill Flowable composite and GIC showed significantly less microleakage than the control group respectively in the specified order

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