MICROLEAKAGE: An in vitro study

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ABSTRACT

INTRODUCTION

Over the past years, esthetic dentistry has shown considerable progress, leading to the development of a number of improved restorative materials. Currently, the main concerns regarding the performance of these materials refer to their durability and the integrity of marginal sealing.[1] A major advancement in the current practice of dentistry is restoration of teeth with tooth colored, adhesive materials. The success and longevity of a dental restorative material depends on the sealing of the cavity walls.[2]

Microleakage may be defined as the movement of bacteria, fluids, molecules, or ions, and even air between the prepared cavity walls and the subsequently applied restorative materials.[1]

Since the introduction of glass ionomer cements (GIC) in 1972, they have been widely used as restorative materials, luting cements and base materials.[5] These materials have widened the armamentarium of tooth-colored restorative material, and in particular, they have been successfully used for restoration of cervical lesions.[6] Their main advantages are relative ease of use, bonding potential to enamel and dentin, and fluoride ion release.[7]

Composites were introduced in the 1960s and since then have undergone a lot of research and development.[8] Composite possess excellent physical and mechanical properties such as compressive, flexural and tensile strength as well as esthetics. The only disadvantage with composite is that several clinical steps are required to obtain a good interfacial bond.[9]

Compomers were introduced in 1992. These materials contain 20% glass ionomer cement combined with 20% visible light polymerized resin component.[9] Compomers are actually a cross between composite resin and glass ionomer cement and are termed polyacid modified, resin based composite.[2] Their excellent physical properties along with fluoride releasing ability, minimal steps in placement and composite like esthetics make them the strongest and most esthetically desirable material.[9]

AIM: The aim of the study was to evaluate and compare the microleakage of various restorative materials.

MATERIAL AND METHOD:

Material used

1) Extracted teeth
2) saline solution
3) nail paint
4) various restorative materials
5) others

Extracted human teeth will be selected for the present study. The extracted teeth will be cleaned with hand scaling, and disinfected. The extracted teeth will be stored in normal saline until use. Standardized class V cavities will be prepared on the extracted teeth. Restorations will be done according to the manufacturer instructions. Thereafter all the teeth will be subjected to thermocycling process. After the thermocycling process entire surface of each tooth will be covered with two coats of nail paint, leaving a 1mm window around the cavity margin. Teeth will be placed in a penetrating dye for at least 24 hours at 37·C and sectioned longitudinally in a buccolingual direction through the center of the restoration**.** Sections part of teeth with a greater leakage will be evaluated under microscope for microleakage and score will be given. Data will be subjected to statistical analysis

RESULTS:

Glass ionomer cement shows maximum microleakage as compared to all other materials.

CONCLUSION

All the restorative materials used in the study were unable to prevent the microleakage completely.

- Glass ionomer cement had significantly higher microleakage as compared to all the other groups except zirconia reinforced glass ionomer.
- Microleakage can be summarized as:
  Conventional self-cured glass ionomer (GC Gold Label universal restorative material) < Zirconia reinforced self-cured Gic (zirconomer) < Compomer (Dyract) < Microfilled composite (Filtek Z

250 universal Restorative system) < Giomer (Beautyfil II) < Nanocomposite (Filtek Z350XT Universal Restorative System).

KEYWORDS: Microleakage, Thermocycling, Dye penetration

INTRODUCTION

Microleakage may be defined as the movement of bacteria, fluids, molecules, or ions, and even air between the prepared cavity walls and the subsequently applied restorative materials.[3] Microleakage is associated with a number of clinical conditions including, sensitivity, recurrent caries, staining of the restoration margins, pulpal damage, and break down of the restorative material. Therefore, prevention of microleakage is an important consideration when developing an adhesive system for dental restorative applications.[4]

Composite possess excellent physical and mechanical properties such as compressive, flexure and tensile strength as well as esthetic. However, one disadvantage of resin composite is polymerization shrinkage, which can result in marginal discrepancies leading to microleakage.[6,7]

Glass Ionomer cements are clinically attractive dental materials since its introduction in1972. They have certain unique properties that make them a valuable restorative, luting and base material. They include adhesion to moist tooth surface and base metals, anticariogenic properties due to release of fluoride, thermal compatibility with tooth structure, biocompatibility and low toxicity. On the other hand, sensitivity to desiccation and moisture contact during the early setting stages as well as the poor mechanical properties limit their extensive use in dentistry as a filling material in stress bearing areas.[10]

Zirconomer defines a new class of restorative glass ionomer that promises the strength and durability of amalgam with the protective benefits of glass ionomer while completely eliminating the hazards of mercury. The inclusion of zirconia fillers in the glass component of zirconomer reinforces the structural integrity of the restoration and imparts superior mechanical properties for the restoration of posterior load bearing areas where the conventional restorative of choice is amalgam.[11]

Compomers were introduced to the profession in1992. The trivial name was devised from the names of two “parents” material, the “comp” coming from the composite and “omer” from ionomer. Compomer are the single component materials that combine the advantages of both composites and glass ionomer restorative materials having capabilities of fluoride release adhesive to tooth structure, biocompatibility and being cured with visible light.[12]

Giomers are relatively a new material and has introduced as the true hybridization of glass ionomer and composite resin. These hybrid materials are manufactured by adding surfaces pre-reacted glass filler particles in the resin matrix. Manufacture of these materials have claimed to show better physical and mechanical properties.[13]

MATERIALS AND METHOD

One hundred and two, extracted, not carious, single rooted human anterior teeth were collected from dental clinics. The teeth selected for the purpose of this study were.

1- Teeth extracted for orthodontic reasons
2- Teeth extracted for periodontal reasons

EXCLUSION CRITERIA

Specimen selected had no caries and restoration. After extraction, debris was cleaned, and the teeth were stored in normal saline at room temperature until use.

ARMAMENTARIUM USED

- Air rotor handpiece (Suz-Dent India Pvt. Ltd.)
- Flat end diamond fissure burs (D&Z, Hilzingen,Germany)
- Mixing pad and plastic spatula
- Curing light (Guilin Woodpecker Medical Instrument Co. Ltd.)
- Digital vernier caliper (South India Trading Co.)
- Teflon coated composite instrument (G.D.C., India)
- Disposable Applicator tips
- Finishing and polishing kit (Shofu Inc. Kyoto, Japan)
- Diamond disk (Lemgo,Germany)
- Stereomicroscope (Leica Microsystems, Germany)
- Thermocycling unit (Genei)

CAVITY PREPARATION

Standardized class V cavities measuring 4mm(mesiodistal) x 2mm (occluso gingival) x 2mm(depth) were prepared on the buccal surface of each teeth with no mechanical retention using flat end diamond straight fissure burs along with highspeed, watercooled spray handpiece. Burs were replaced after every ten preparations. Digital vernier caliper was used to measure the length and width of the cavity. Depth of cavity was measured with a periodontal probe.

GROUPING

After the completion of class V cavity preparation, a total of 102 samples were randomly assigned into 6 experimental groups (n=17)

GROUP 1 – Glass ionomer cement (GC Gold Label Universal Restorative GC Corporation Tokyo, Japan)

GROUP 2 – Zirconia Reinforced Glass ionomer (Zirconomer, Shofu Inc. Kyoto, Japan)

GROUP 3 – Compomer (Dyract, Densply, Gmbh, Germany)

GROUP 4 – Giomer (Beautiful II, Shofu Inc, Kyoto, Japan)

GROUP 5 – Microhybrid composite (Filtek^{TM} Z250 Universal Restorative System, 3M ESPE, Saint Paul, MN, USA)

GROUP 6 – Nanofilled composite (Filtek^{TM} Z350 Universal Restorative System, 3M ESPE, Saint Paul, MN, USA)

THERMOCYCLING

After restoration all the teeth were subjected to thermocycling for 250 cycles between two temperature water baths at 10^{o}c and 55^{0}c respectively with a dwell time of 60 seconds in each bath.

DYE PENETRATION

After thermocycling the entire surface of each tooth with the exception of the restoration and 1mm of tooth structure adjacent to the restoration was covered with two coats of nail paint to prevent dye penetration into the tooth except at the restoration to tooth surface. After coating nail paint and drying, samples were immersed in 2% methylene blue dye solution for 24 hours at room temperature. After 24 hours the samples were removed from the dye solution and washed under running water for 5 minute and nail paint was removed by B.P Blade No. 15.

TEETH SECTIONING AND MICROLEAKAGE EVALUTATION

The teeth were then sectioned longitudinally through the center of the restoration in bucco-lingual plane using a micromotor straight hand piece mounted with a rotating diamond disc. For each restoration section, both the incisal and gingival margins and axial walls of both the halves of the sectioned teeth examined with the help of a stereomicroscope at a magnification of 40X. Dye penetration was scored using the following scoring criteria.[4]

TABLE1 SCORING CRITERIA TABLE[4]

score	Criteria
0	No Leakage
1	Leakage restricted to the enamel
2	Leakage into the dentine but not reaching the axial cavity wall
3	Leakage reaching the axial cavity wall
4	Leakage beyond the axial cavity wall reaching the pulp

RESULTS

TABLE NO.- 2 Summary Statistic for microleakage measurements in different groups

Group	N	Mean	Std. Deviation	Median	Minimum	Maximun
I	17	2.14	0.51	2	2	3
II	17	1.94	0.75	2	1	3
III	17	1.71	0.47	2	1	2
IV	17	1.59	0.51	2	1	2
V	17	1.65	0.93	1	1	3
VI	17	1.47	0.80	1	1	3
Total	102	1.79	0.74	2	1	3

TABLE NO.-3 Inter group comparison (kruskall-wallis test Non-parametric ANOVA)

GROUP	N	Mean Rank

I	17	74.76
II	17	57.09
III	17	49.79
IV	17	44.91
V	17	44.26
VI	17	38.18
Total	102	

H=19.197; p=0.002(kruskall-wallis H test)

DISCUSSION

Microleakage may be defined as the passage of bacteria, fluids, molecules, or ions between the cavity wall and the restorative material applied in it.[1] Microleakage is related to several factors, such as dimensional changes of materials due to polymerization shrinkage, thermal contraction, absorption of water, mechanical stress, and dimensional changes in tooth structure.[2] Researchers are constantly trying to develop a material and technique that ensures adhesion to the tooth structure in order to minimize the leakage potential.

Standardized class V cavities to a size of 4x2x2 mm were prepared with a highspeed air rotor and water spray coolant. Class V cavity design has a high configuration factor (C- Factor) value i.e ratio between number of bonded and unbonded surfaces, which can cause adhesion breakdown between the restorative system and cavity wall.[3] All the cavities were prepared and restored by single operator.

After restoring with respective restorative material the sample were subjected to thermocycling. Thermocycling is the in vitro process of subjecting the tooth to temperature extremes compatible with the oral cavity. This stimulates introduction of hot and cold extremes in the oral cavity and shows the relation between coefficient of thermal expansion between the tooth and restorative material. The difference in coefficient of thermal expansion is said to cause fatigue of the bond between the restoration and the tooth, leading to a gap formation, which could lead to microleakage.

In this study, 2% methylene blue was used since its particle size less than of the bacterial cell. In general, diameter of bacterial cell is 0.3-1.5 microns and calculated area of methylene blue is approximately $0.52nm^2$. There for dye may diffuse more easily than bacteria and their byproducts. Hence, if a material responds positively to the dye test, it is likely to respond even better on a clinical level.[4]

Stereomicroscope is a gold standard in microleakage studies and hence was used here. In stereomicroscope investigation the method is based on the interpretation of the leakage of dye on the cavity wall and is defined as a semi-quantitative approach where the leakage is calculated solely at the surface where the section is made.

After the teeth were sectioned they were observed foe leakage under stereomicroscope at 40X magnification. Upon examining the samples under stereomicroscope.

Group VI Nanofilled composite (Filtek^{TM}Z350XT) exhibited the least microleakage. This observation may be due to nano size of the filler particles, higher filler loading and higher molecular weight of the resins which result in less shrinkage.

Group I glass ionomer cement exhibited maximum microleakage because of poor bonding between cavity wall and glass ionomer cement.

LIMITATION

- This was an in vitro study, where the extract oral environment could not be stimulated.
- Marginal integrity was evaluated using a single parameter, that is, estimation of microleakage by dye penetration method only. Dye penetration test is considered to be a harsh test because size of methylene blue is smaller than the bacteria.

CONCLUSION

- All the restorative materials used in the study were unable to prevent the microleakage completely.
- Glass ionomer cement had significantly higher microleakage as compared to all the other groups except zirconia reinforced glass ionomer.
- No significant difference in microleakage was observed between zirconia reinforced glass Ionomer (zirconomer), compomer (Dyract), Giomer (beautiful II), Microhybrid composite (Filtek Z250) and Nanomer Composite (Filtek Z350)
- Microleakage can be summarized as:
  Conventional self-cured glass ionomer (GC Gold Label universal restorative material) < Zirconia reinforced self-cured Gic (zirconomer) < Compomer (Dyract) < Microfilled composite (Filtek Z 250 universal Restorative system) < Giomer (Beautyfil II) < Nanocomposite (Filtek Z350XT Universal Restorative System).

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