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Original Research Article

A Comparative Analysis of Microleakage around Composite Restoration and Zirconium Ceramic Inlay under Confocal Microscope - An In Vitro Study

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ABSTRACT

Aim & Objective: To detect and compare micro leakage of nano composites and zirconia restorations done on extracted teeth using nano composites and zirconium restorative material under confocal microscope.
Materials and Methods: 20 caries free maxillary premolars were collected for the study. Class II - box only preparation was done on all extracted teeth out of which 10 teeth were restored using nano composite (ivoclar) and remaining 10 teeth were restored with zirconium ceramic material designed using CAD\CAM. All samples were subjected to thermocycling followed by immersion in Rhodamine-B dye solution for 48 hrs. The samples were sectioned in mesiodistal direction using minitom and dye penetration observed under a confocal laser electron microscope. The results were subjected to statistical analysis.
Results: Group II Zirconia ceramic material shows lesser microleakage than group I nano composite.
Conclusion: Based on this study it is advisable to use Zirconia ceramic Material for restorative purpose to minimise the micro leakage, further studies with greater sample size is a must to prove its accuracy.

Key words: Microleakage, composite, zirconia, thermo cycling, confocal microscope.

INTRODUCTION

"Something that is constant is change". There have been more changes and developments in dentistry over the past decade than in the previous hundred years combined, and the pace is accelerating! In the current age of adhesive dentistry or micro dentistry, conservation of tooth structure is paramount. Rather than using extension for prevention as a treatment guideline, emphasis now is placed on restriction with conviction. [1]

Microleakage is defined as the passage of bacteria, fluids or molecules between a cavity wall and the restorative material applied to it. [2] Microleakage may cause hypersensitivity, recurrent caries and pulpal pathoses. [3] Besides pulpal irritation and secondary caries, microleakage also results in marginal discoloration. It is one of the major problems in clinical dentistry. It is very important to achieve a micromechanical and biomechanical bond between the restoration and tooth as it is

considered effective and a standard procedure in clinical practice.

For many years clinicians have recognised the conservative approach to cavity preparation. Objectives of tooth preparation are 1.Remove of all carious lesions 2.To remove diseased tissue as necessary and at the same time provides the protection to the pulp. 3. To locate the margins of the restoration as conservative as possible. 4. Cut away all significantly unsupported enamel. 5. To restore form or function and aesthetics.6.To allow the functional replacement with a suitable restorative material. [4]

Teeth weakened by cavity preparation are reinforced by restorative materials. Ever since the beginning of the restorative dentistry micro leakage has been identified as one of the reasons for failure. [5]

Since then there have been a lot of research and development of various restorative materials leading to the introduction of adhesive techniques with a hope to eliminate the micro leakage and to increase the longevity of restoration. The integrity and durability of the marginal seal is essential for any restorative system to maintain pulp health and to maintain the restoration permanently.

Unfortunately the initial hopes have never become real. As the usage of these material increased, unearthing certain drawback. Including the micro leakage if it is due to excessive corrosion in amalgam, it is due to polymerization shrinkage in composites. One of the weak links with class II composite resin restorations is micro leakage at the gingival margins of the proximal box which contributes to postoperative sensitivity, high incidence of secondary caries accounting for many clinically failed restorations. [6] Presently advanced ceramic materials have been used in conservative dentistry for cosmetic purposes and increase longevity of restorations.

Hence the present study is undertaken to verify occurrence of micro leakage around nano- hybrid composites and zirconium ceramic restorative material, if the later has any beneficial effect.

MATERIALS AND METHODS

Twenty caries free maxillary premolars extracted for orthodontic purpose were taken in this study. Calculus was removed with a scaler followed cleaning with water. The teeth were stored in Thymol solution until used for the study. Then class II box only cavities were prepared in each sample with ISO Size (No.1) round and (No.256) straight fissured diamond burs using high speed water cooled hand piece. The dimensions of cavities are 3mm bucco-lingual width, 1mm gingival seat width, and 1mm below the CEJ for all the samples the dimensions were measured with Williams periodontal probe.

Twenty samples were divided into two groups, each group consisting of ten samples.

Group I: Restored with nano composite [Fig:1] (Tetric N - Ceram, Ivoclar vivadent).

Group II: Restored with Zirconia ceramic material using CAD\CAM[Fig:2](Sirona)

In group I all samples were first etched with 37% phosphoric acid then rinsed with water after that applying bonding agent (5th generation, Tetric N-Bond)and restored with nano composite using of incremental technique as per manufacturer's instructions (Ivoclar vivadent). Then curing was done with light curing unit at each increment level by 20 secs at a light intensity of 350 mW/cm^2. (QHL75, dentsply).

In group II all zirconium inlays were prepared using CAD/CAM machine (Ceramill model, Ammangirbach company, Austria). Then all the samples were subjected to sandblasting with aluminium oxide crystals. Try in was done to check the fit of restoration in the cavity before cementation. Dual cure resin cement (GC Link Ace, GC company, Japan) was used to cement the zirconia inlays as per manufacturer instructions. Finger pressure was applied until initial setting of luting cement was completed according to manufacturer instructions. The light source was directed to the inlay margins. Intensity of light unit was checked with radiometer. (350 mW/cm^2)

All the samples were stored in distilled water at room temperature for 24 hours and final finishing and polishing done with finishing and polishing kit (SHOFU). Then specimens were subjected to 500 cycles of thermo cycling between temperatures 5° c and 55° c with dwell time of 20 seconds and 15 seconds interval between the baths. After that teeth were covered with sticky wax to occlude all the openings. Two coats of nail varnish were applied to all tooth surfaces except for 1mm around the restoration margins. Then the teeth were immersed in 0.6 % rhodamine b solution for 48 hours. After the dye exposure, the teeth were thoroughly cleaned under running tap water for 5 minutes to remove the superficial dye and nail varnish also was removed. All samples were sectioned mesio distal direction with a minitome (low speed diamond saw) [Fig 3] through the center of the restoration.

Fig.3 Minitom

Micro leakage observation:

The degree of dye penetration in both enamel and dentinal walls of each specimen was assessed under a confocal laser scanning microscope (Olympus Lext OLS4100, Germany) [Fig.4] at 5x magnification. That half of the each sample with no damage was used to study under the confocal laser scanning microscope.

Fig.4 Confocal laser electron microscope

The dye penetration for composite/tooth interface and zirconium inlay/luting agent, luting agent/tooth interface was scored for occlusal/cervical margins on a non parametric scale from 0 to 4 based on the normal ranking system.

Scoring criteria

0 - no dye penetration

1 - dye penetration involving half the enamel/dentin wall

2 - dye penetration involving more than half the enamel/dentin wall
3 - dye penetration involving up to the axial wall
The data obtained from the present study were statistically analyzed by Mann-whitney U test.

RESULTS

When the data was subjected to statistical analysis, the following results were obtained [Table 1]:

GROUPS	N	MEAN RANK AT ENAMEL MARGINS	MEAN RANK AT DENTINAL MARGINS
Group I	10	4.25	10.75
GROUP II	10	2.75	5.75

The comparison of mean percentage leakage at the enamel and dentinal margins among the two groups showed statistically significant results; however, in this experimental study group II shows lesser micro leakage at both enamel and dentinal margins compare than group I.

Dye leakage at enamel margin **Dye leakage at dentin margin**

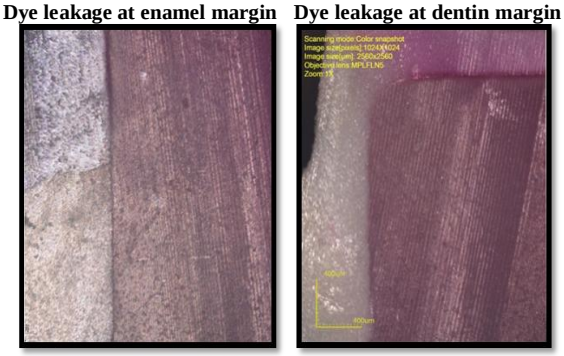

Fig.5 nano composite (group I) confocal microscope images

Dye leakage at enamel margin **Dye leakage at dentin margin**

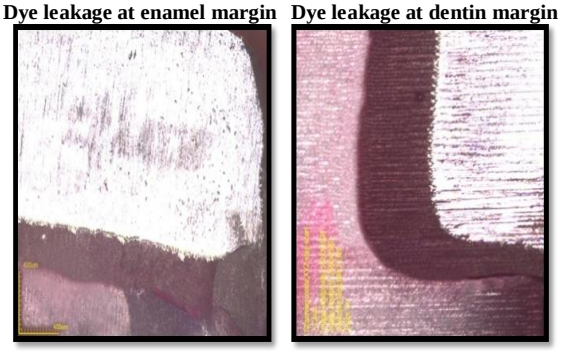

Fig.6 Zr inlay (group II) confocal microscope images

DISCUSSION

As recent advance in dentistry has increased the demand for aesthetic restorations in posterior teeth also increased. The new composites have been introduced for clinical use with a promise to sustain the occlusal loads placed. As the usage has increased some of their drawbacks, like gingival gap formation, became more apparent which has been attributed to the polymerization shrinkage. Various clinical techniques have been introduced to answer this problem but with limited success. Also this is due to the inherent properties of dentine, where many studies have shown that, adhesive strength is not as great as that achievable with enamel.

In order to achieve better dimensionally stable restorations, yet to obtain uncompromised aesthetics in the posterior region, various Zirconia restoration using CAD- CAM technology have been introduced.

Thus the present study investigated the micro leakage around the restorations of Nano composite (Tetric N ceram, ivoclar) and zr inlay (sirona).

According to the results in the present study –Group I (Tetric N-Ceram) showing higher micro leakage when compared to the Group II (Sirona Zirconium), in both enamel and dentinal margins. Composite restorations because of Shrinkage produces stress at the adhesive interface which could lead to the bonding failure with gap formation and increased micro leakage. [7] Here dentin shows more micro leakage compared to enamel. Dentin is less favorable substrate for bonding than enamel. Main reason for more micro leakage at dentin surface includes following features: unfavorable cavity configuration, Dentinal tubule orientation at the cervical wall, Organic content of dentin substrate, Incomplete removal of smear layer, Insufficient penetration of primer components into the demineralized collagen fibers and hydrolytic degradation. [8] 5th generation bonding agents showed minimum microleakage as compared to 6th

and 7th generation adhesive systems, so 5th generation adhesive was preferred to evaluate the microleakage of restorative materials in our study. [1]

Andrain et al (2011) found Zirconium ceramic inlay restoration shows lesser micro leakage because of luting with Dual cure resin cement which is more dimensionally stable than composites and lesser dimensional changes of zirconium inlay itself. Here luting agent plays a important role in decreases the micro leakage.

In this study we used Dual cure resin cement for luting because it shows lesser micro leakage and better marginal adaptation than zinc phosphate and conventional GIC. There was reduced or no micro leakage present at the luting agent and zirconium restoration interface. 'Romao et al' study says luting cement thickness is smaller in CAD/CAM zirconia ceramic inlays as they are more dimensionally stable. So, micro leakage is lesser in zirconium ceramic inlays. [9] In this study all samples were subjected to thermo cycling to mimic intraoral temperature variations and subjecting the restoration and the tooth to the temperature extremes compatible with oral cavity and also to verify the effect aging on micro leakage around the composite and Zirconium restorations. [10]

In the present study Confocal laser electron microscope was used to assess the extent of micro leakage. Confocal is an ion destructive technique for visualizing subsurface tissue features. One of its advantages is clear indication of leakage limits due to a lens focus that can occur some microns beneath the observed surface compare than the stereo microscope.

In the present study all the groups showed some amount of microleakage when comparative with the enamel- restorative margin. Microleakage is observed to be more in group I ie. interphase between enamel and nanocomposite,dentin and nano composite when compared to enamel and Dual cure resin luting agent, dentin and zirconia inlay in group II.

When comparing the microleakage between group I enamel nano composite interphase and group II enamel Dual cure resin luting agent/ Zr inlay interphase. Group I is significantly more.

Also when comparing the microleakage between group I dentine nano composite interphase and group II dentine zirconia inlay interphase, group I is significantly more.

In over all the study, group I shows both enamel and dentinal margins greater microleakage when comparing group II.

CONCLUSION

Under the limitations of the present study, none of the tested materials was able to eliminate micro leakage at enamel or dentin margins completely. There is statistically significant difference between the groups. Here Group II (Sirona, Zirconia material) shows lesser micro leakage at both enamel and dentin margins compare than the Group I (Tetric N-Ceram).

Hence, it is suggested to use the recent zirconium material for the optimum success of conservative treatment, when indicated.

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