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Comparative evaluation of internal bevel and a conventional butt joint at the approximal surface of Class II restoration

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Abstract
Background: The adhesion between composite resin and tooth enamel seems to be almost entirely satisfactory using the enamel etching and bonding methods. Composite resins are mechanically bonded to acid-etched enamel, relying on a large interlocking area between the two, to form an effective bond. The purpose of the present in vitro study was to compare the microleakage between the tooth and the composite restoration by intentionally leaving the undermined enamel (internal bevel) along the cervical margins and conventional butt joint along the cervical margin of Class II composite restorations.
Materials and methods: Thirty freshly extracted human maxillary and mandibular premolars were used in this study. The criteria for selection were that the samples were cleaned free of debris and calculus with ultrasonic scaler, the teeth were stored in normal saline till the period of study at room temperature. Phosphoric acid gel, Bonding agent , Hybrid composite resin, Basic Fauschin dye 20/0, Nail varnish and Polofil Lux - Voco Halogen light cure unit, Stereomicroscope , Diamond disk with mandrel and Thermostat controlled hot water bath equipment were used. Results: The present in-vitro study with 30 premolar, was aimed to comparatively evaluate the microleakage of the dye for a conventional butt joint as a control group and an internal bevel as a experimental group at the approximal surface of a Class II composite restorations under stereo microscope, showed that an internal bevel at a

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cervical cavosurface of Class II composite restorations reduced marginal leakage as compared to a conventional butt joint cavity preparation.
Keywords: Dental Cavity preparation, Dental leakage, Composite resin.

Introduction:

The adhesion between composite resin and tooth enamel seems to be almost entirely satisfactory using the enamel etching and bonding methods. Composite resins are mechanically bonded to acid-etched enamel, relying on a large interlocking area between the two, to form an effective bond.[1]

The traditional form of cavity preparation lost its relevance when the acid-etch technique was found to bind composite materials effectively to enamel. As a result, new conservative cavity preparations were designed preserving the sound tooth structure and involving a wide area of beveled enamel, tending to reduce marginal leakage.[2] Any preparation that employs the acid etch technique, it is desirable to expose as many enamel rod ends as possible to increase resin retention. In addition, the resin-enamel bond is stronger with etched transverse sections of enamel prisms than with longitudinal sections.

Materials and methods:

The present in vitro study was conducted in Department of Conservative Dentistry and Endodontics, Bapuji Dental College and Hospital, Davangere, Karnataka. Thirty freshly extracted human maxillary and mandibular premolars with free of caries, restorations and fractures were used in this study (Fig.l).

Fig1: Specimen teeth

In Class-II cavity preparation for posterior composite, it may be better to provide an internal bevel than a conventional butt joint at the cervical margins of the approximal box. The internal bevel is a modification of the conventional Class II Cavity Preparation. It is prepared by intentionally leaving undermined enamel at the margin of the approximal box. The undermined enamel has an inner surface ready to be etched that serves as an additional barrier to marginal leakage.

Thus, this study has been undertaken to evaluate the benefit of an internal bevel versus conventional butt joint in Class II composite restorations.

The purpose of the present in vitro study was:

1. To compare the microleakage between the tooth and the composite restoration by intentionally leaving the undermined enamel (internal bevel) along the cervical margins and conventional butt joint along the cervical margin of Class II composite restorations.
2. The subsequent application of this method of preparation in routine clinical practice.

then the samples were cleaned free of debris and calculus with ultrasonic scaler. The teeth were stored in normal saline till the period of study at room temperature.

The following instruments were used - Kavo Airotor hand piece Air water syringe, Diamond points - NO.837-012, 835-009M, TR-21EF, Dispodent - Transparent matrix retainer ,Transparent matrix band ,William's graduated probe, Composite finishing kit, Mesial GMT (Hu-Friedy) ,Distal GMT (Hu-Friedy), Phosphoric acid gel (3M Products), Bonding agent (Single bond, 3M Products), Hybrid composite resin (Z100, 3M Products), Basic Fauschin dye 20/0, Nail varnish. Polofil Lux - Voco - Halogen light cure unit(Fig.2), Stereomicroscope (Leica Wild M3Z) (Fig.3), Diamond disk with mandrel, Thermostat controlled hot water bath.

Fig2: Equipment used

Fig 3: Stereomicroscope (Leica Wild M3Z)

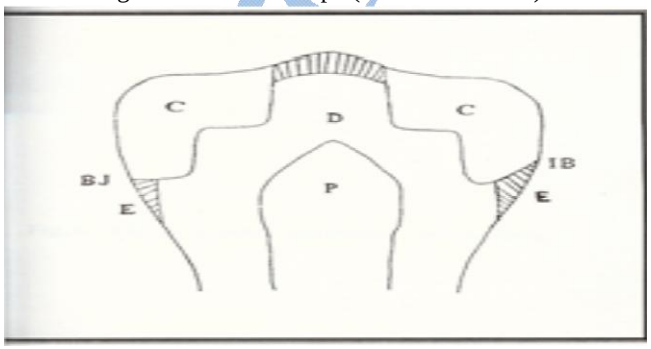

Fig 4: Schematic cavity design C- Cavity;E – Enamel;D – Dentin;P- Pulp; IB – Internal Bevel; BJ – Butt Joint

Conventional MO and DO preparation were prepared (Fig.4) in each teeth using straight fissure 837-012 and 835-009 high speed diamond points with water spray coolant, locating the cervical margins of the approximal box in the enamel. The facio-lingual width of occlusal extension was 2.0 ±0.25 mm. The pulpal depth of the occlusal extension was 2.0 mm ± 0.3 mm. The facio-lingual width of the proximal box were 2.25 ± 0.25 mm occlusally and 3.00 ± 0.25 mm gingivally.

The occluso-gingival height of the axial wall was 1.75 ± 0.25 mm. The depth of the box gingivally from marginal ridge was 3.50 ± 0.25 mm. The pulpo axial line angles were rounded. In each tooth the cervical margins of one preparation was prepared as a butt joint for the control group (Group BJ=Butt Joint). The approximal cavosurface of the other preparations ill each tooth was modified to create an internal bevel as a experimental group (Group IB = Internal Bevel). This was prepared by a small flame shaped bur by removing of dentin along the approximal dentin enamel junction, intentionally leaving undermined intact enamel of 0.75 ± 0.25 mm.

Etching agent (3M Dental Products) was applied for the cavity preparations for 30 seconds and then the cavities were rinsed with water and air driedBonding agent (Single bond 3M Products) was applied and cured for 20 seconds. The preparations were filled with Z-lOO (3M Dental Products) Composite in increments. A V-shaped increment was attached to the buccal and lingual walls including the cervical floor of the approximal box, leaving a gap for a middle increment and then a final increment was filled to the remaining cavity. For all the restorations the excess was trimmed and each increment was cured separately for 40 seconds and the restorations were polished with a composite finishing kit(Fig.5).

The restored teeth were kept at room temperature and at 100% humidity for 10 days to prevent dehydration and allow hygroscopic expansion. The following steps were carried out to prepare the teeth for evaluation of marginal leakage. The teeth were thermocycled for 500

cycles between 4° C ± 2° C and 60° C ± 2° C, with dwell time of 30

Fig 5: Prepared Specimen

seconds. The surface of teeth, apart from the restoration and 1 mm of surrounding enamel, were coated with nail varnish . The coated teeth were immersed in a 20/0 solution of basic fuchsin for 24 hours. The coatings were then peeled off by grinding. The teeth were then sectioned in a vertical plane parallel to the mesiodistal axis of the tooth into two halves with a diamond disk and a mandrel.

Then the sectioned specimens were observed under a stereomicroscope (Leica Wild M3Z) for the evaluation of dye penetration under each restoration(Fig.6).

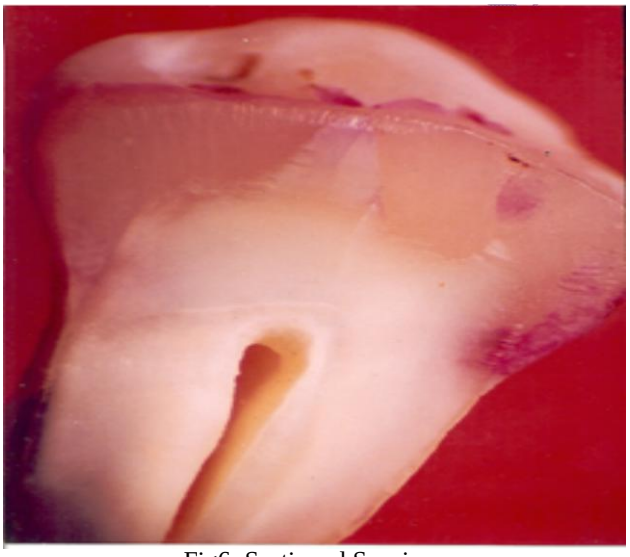

Fig6: Sectioned Specimen

Results:

The present in-vitro study with 30 premolar, was aimed to comparatively evaluate the microleakage of the dye for a conventional butt joint as a control group and an internal bevel as a experimental group at the approximal surface of a Class II composite restorations under stereo microscope.

Dye penetration was rated according to the following scores.
0: No dye penetration
1: Penetration of dye between the restoration and the tooth along the composite - enamel interface at the proximal box.
2:Penetration of the dye along the entire length of the cervical floor and in to the dentin.
3: Penetration of the dye along the entire length of the cervical floor, including the pu1p chamber wall.
- Always the maximum dye penetration observed on any section of each tooth was recorded.
- The resu1ts of dye penetration evaluation in both groups are presented in the Table-I.

TABLE 1: The degree of dye penetration for the control group and experimental groups

Degree of dye Penetration	Control group (MEAN ± S.D. 0.5 ± 0.72)	Experimental grou (MEAN ± S.D. 1.33 ± 1.04)
Score 0	30.0%	63.4%
Score 1	20.0%	23.3%
Score 2	36.7%	13.3%
Score 3	13.3%	0%

Discussion:

Microleakage of composite restoration occurs because of the dimensional changes of the material, attached to the cavity walls. These change involve; Polymerization shrinkage (Contraction),

differences in coefficient of thermal expansion and hygroscopic absorption of the materials. These alterations of the materials produce internal forces that result in gap formation at the tooth-material interface. This in turn causes microleakage which is followed by sensitivity, recurrent caries and possible pulpal pathosis. [3,4] there are two types of gaps formation (a) Initial gap formation: When a resin restorative material polymerizes, it undergoes a volumetric contraction. Even though this contraction can be compensated for subsequently by hygroscopic expansion, but still there will be a gap between the tooth and the restoration, if contraction exceed the adhesive force of the material to the cavity wall.[5] (b)Secondary gap formation: After polymerization, there is a gradual absorption of water into resin materials. The resulting hygroscopic expansion is in many brands sufficient to compensate for the wall to wall polymerization contraction. This can even result in an elastic compression of the restoration against the cavity walls. [5]

Interestingly, Isengerg and Leinfelder studied the influence of beveling the occlusal cavosurface on the wear rate of posterior composite resins. Throughout a two-year period of observation, they found a significantly greater rate of wear associated with the beveled preparation than with those featuring a conventional butt joint. Beveling the occlusal cavosurface angle appreciably increases the bucco-lingual dimension of the restoration, this increases the potential for contact of the antagonist cusp on the composite resin surface.[6]Bevelling of enamel has proven to be effective in completely exposing the enamel rods for resin attachment and then restorative bonding.[7] In dentin, the tubules run parallel to the enamel rods; therefore, beveling of dentin should also expose opened tubules for more efficient attachment of the adhesive resins.[8]

However, no microleakage studies have provided adequate information concerning dentin bonding with a gingival(dentin or cementum) bevel. The increased enamel surface area is important with the acid etch technique because greater resin tenacity, is positively correlated with increased surface area. Therefore, with any preparation that employs the acid-etch technique, it is desirable to expose as many enamel rod ends as possible to increase resin retention. In addition, resin-enamel bond is stronger with etched transverse section of enamel prism than with longitudinal section.

Enamel bonding depends on resin tags becoming interlocked with the surface irregularities created by etching. [9] Several difficulties may arise when trying to prepare an external bevel at the cervical margin of the approximal box and restoring the tooth in the clinical setting. The internal bevel is a modification of the conventional class 2 cavity preparation. It is prepared by intentionally leaving undermined enamel at the margins of the approximal box. The undermined enamel has an inner surface ready to be etched that serves as an additional barrier to marginal leakage. The present invitro study showed that preparation of an internal bevel at the approximal cervical margin significantly reduced microleakage, compared to the conventional butt joint cavosurface and which it has been supported by Vanous Stules. [10,11,]

In permanent teeth enamel prisms located in the cervical region are oriented apically.[12] The internal bevel design exposes the enamel prisms in a cross section. It has been suggested that bonding to the surface of longitudinally cut enamel prisms is not as strong as to cross-cut enamel prisms. The butt joint and traditional external bevel, on the contrary are directed almost parallel to the enamel prisms, resulting in a poor[13].

The gingival floor should be extended in a cervical or apical direction just beyond the region of the lesion. One of the most important considerations in dealing with the gingival floor is the extent of remaining enamel. Every effort should be made to preserve as much enamel thickness as possible[14].

Maximizing the enamel thickness helps ensure against microleakage in this region.[15]Preserving the sound tooth structure, while

preparing the internal bevel, fits the general concept of cavity preparation. So, this study throws a light on the desirability of preserving the sound tooth structure by preparing the internal bevel in-vivo. But further studies are to be conducted to gain the knowledge on the fracture resistance of undermined enamel, where an internal bevel is given.

To summarize, this in-vitro study was conducted to evaluate the microleakage for a conventional butt joint and an internal bevel at approximal surface of Class-II Composite Restorations.

Thirty freshly extracted premolars were taken in the study. MO and DO conventional cavity preparation were done. Conventional butt joint preparation (or control group) was prepared on one side and an internal bevel (or experimental group) by leaving undermined enamel was prepared on the other side.

The cavity preparations were acid etched, and single bond (3M Products) bonding agent was applied. The cavities were restored with Z-100 (3M Products) composite resin. The teeth were thermo cycled and the surface of teeth apart from the restoration and 1mm of surrounding enamel, were coated with nail polish and then immersed in 2% basic fuschin dye for 24 hours. The teeth were sectioned in a vertical plane and the results of microleakage were observed in a stereomicroscope and evaluated statistically.

The results showed that an internal bevel at a cervical cavosurface of Class II composite restorations reduced marginal leakage as compared to a conventional butt joint cavity preparation. To conclude, this in vitro study showed that an internal bevel at the cervical cavosurface of Class 2 composite restorations reduced marginal leakage as compared to conventional butt joint cavity preparations. The preparation of internal bevel at the proximal surface of Class-2 composite restorations can be implied in clinical practice.

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