Effect of Different Bevel Designs on Microleakage and Shear Bond Strength of Class IV Composite Restoration: A laboratory Study

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Abstract:

Objective: This laboratory study was conducted to evaluate the effect of different bevel designs (2mm bevel, skirt bevel and scalloped bevel) on microleakage and shear bond strength of class IV composite restorations. **Materials and Methods:** Sixty extracted human permanent maxillary central incisors were selected and a standardized mesio-incisal fracture was created. Teeth were divided into 3 groups (n=20) according to different bevel designs (2mm bevel, skirt bevel and scalloped bevel). All prepared teeth were restored with nano hybrid composite (Filtek Z250, 3M ESPE, St. Paul, MN, USA). Half of specimens were used for microleakage test, specimens were received 3 layers of nail polish, except for a 1 mm around the margins, then immersed in a 0.5% methylene blue dye for 24h. Dye penetration scores were assessed using stereomicroscope. The remaining teeth were utilized for shear bond strength test after measuring the surface area with (Image J) software, specimens were subjected to universal testing machine with crosshead speed of 1 mm/min. **Results:** Regarding microleakage, the result of Chi-Square test revealed that there was no significant difference between different bevel designs ($p>0.05$). Regarding shear bond strength the results of one-way ANOVA revealed the highest mean value for the 2mm bevel (16.74±5.29Mpa), while the lowest mean value recorded for the skirt bevel (12.20±1.54Mpa). **Conclusion:** Bevels can be advantageous in reducing microleakage and increasing shear bond strength in class IV restoration. However, the higher shear bond strength and minimum microleakage can be obtained with 2mm bevel, and it can be recommended for cliniciansn.

Introduction:

The ultimate goal of restorative dentistry is to maintain the integrity of teeth affected by caries, tooth wear or traumatic tooth fracture. Incisal third of the central incisors is the most frequently affected area during accidental traumatic injuries, due to the protrusive and alignment of these teeth. Unfortunately restoring function, shape and aesthetics of fractured anterior teeth is considered as a major challenge to dental practitioners.[1]

Different techniques have been developed to restore fractured incisors to their original colour and shape.[2] Reattachment of tooth fragment is considered as the first treatment option.[3] If fragment is badly broken and smashed, direct or indirect restorations are considered as viable alternatives.[4] Direct composite is usually considered as viable treatment option for restoration of broken anterior teeth (Class IV).[5,6]

Durability and esthetic result of anterior composite restorations are directly related to the quality of marginal adaptation. Therefore, to achieve excellent bond, marginal integrity, durability, and reduce microleakage formation, appropriate resin-based adhesive with bevel preparation at the margins were suggested.[7]

Nevertheless, doubts still exist regarding how to prepare the cavosurface angle prior to class IV composite restoration to enhance the clinical performance. Several studies[8-10] suggested that bevel provide defined marginal termination, allowing for adequate adaptation or marginal integrity of the composite resin. And greater retention as it increases the conditioned area, resulting in more space for the restorative material and thus improving the esthetic aspect of restoration. On the other hand, some studies suggested that the functional and esthetic restoration of Class IV fractures can be accomplished without removing healthy tooth structure, and any reduction in healthy dental structure should be avoided.[5,11,12]

This laboratory study was aimed to investigate the effect of different bevel designs (2mm bevel, skirt bevel and scalloped bevel) on microleakage and shear bond strength of class IV resin composite restoration.

Null hypotheses

This study was conducted to test the null hypothesis that different bevel designs (2mm bevel, skirt bevel and scalloped bevel) neither affect microleakage nor shear bond strength of class IV resin composite restoration.

Materials and Methods:

In this study single type of restoration material conventional Nano hybrid composite (Filtek Z250, 3M ESPE, St. Paul, MN, USA) with Single Bond Universal adhesive (3M ESPE, ST. Paul, MN USA) were used.

1. Specimen preparation

Sixty freshly extracted human permanent maxillary central incisors were collected from the oral surgery clinic in Faculty of Dentistry, Mansoura University, after approval from the research ethics committee of Mansoura University (A04160321). Standardized mesio incisal fracture (Ellis class II fracture) were done for all specimens.

2. Groups and preparation technique:

Different bevels were prepared and restored according to the following groups (Figure.1).

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Group 1; 2mm bevel

Bevel was prepared in the facial surface of enamel and extending cervically approximately 2 mm beyond the edge of the fractured enamel and involved half of the enamel thickness.

Group 2; Skirt bevel

Skirt bevel was prepared around the entire enamel periphery extending cervically 3 mm and involved half of the enamel thickness.

Group 3; Scalloped bevel

It had 1 mm step over distance in the facial surface of enamel and extends cervically approximately 3mm beyond the edge of the fractured enamel and involved half of the enamel thickness in depth.

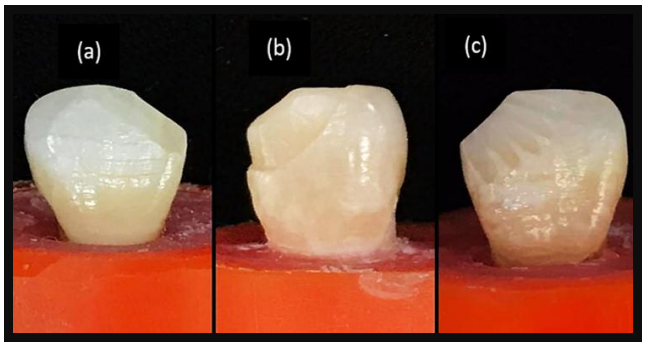

Figure 1: Bevel designs (a) 2mm bevel, (b) skirt bevel, (c) scalloped bevel.

3. Microleakage test

After preparation and restoration, specimens of this group received three layers of nail polish except for a 1 mm around the margins. Then the specimens were immersed in a 0.5% methylene blue aqueous solution with neutral pH, for 24 h. crowns received three parallel cuts perpendicular to fracture line. Each tooth provided four surfaces for microleakage evaluation. Dye penetration was evaluated at 25X in a stereomicroscope (OLYMPUS-SZ61).

4. Shear bond strength test

After the teeth were fractured in standard position and prepared according to different bevel designs. With Nikon® D3200 digital camera 4 X photo adaptor photographs were taken to measure the irregular surface area (mm^2) of the fractured segment. The result images were analyzed on Intel® Core I7® based computer using Video Test Morphology® (Image J) software (Russia). After the surface area of prepared teeth measured, restorations were done. The specimens were stressed in shear at a constant crosshead speed of 1 mm/min with Universal Testing machine (Model 3345, Instron, USA) until failure occurred. And the fracture load was recorded in Newton with the appropriate software (Universal Bluehill®).

Statistical analysis methods:

All the collected data was tabulated, then statistically analyzed using version 22.0 computer software SPSS® (Statistical package for social science). Data was explored for normality using Shapiro-Wilk test and its result revealed that, the data were located within normal distribution. One-way ANOVA test used for detecting the effect of different bevel designs on microleakage and shear bond strength of class IV resin composite restorations. Tukey's post-hoc used when ANOVA is significant at (p value<0.05). Significance of the obtained results was judged at the (0.05) level.

Results:

Microleakage test

Chi-Square test was used for quantitative assessment of microleakage. It revealed that the different bevel designs have no statistically significant difference on microleakage in class IV resin composite restoration (p=0.88) as shown in (Figure 2).

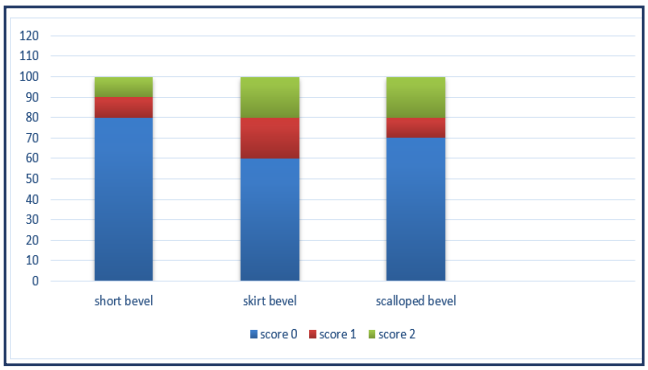

Figure2: Mean microleakage distribution among studied groups.

Shear bond strength test:

The result of Shapiro-Wilk test revealed that all data showed normal distribution. The outcome of One-way ANOVA revealed that there was a statistically significant difference of shear bond strength among all groups. Post Hoc Tukey test used to detect pair-wise comparison. It revealed that there was statistically significant difference of SBS between different bevel groups (p=0.026). Short bevel revealed highest SBS value (16.74±5.29Mpa) followed by scalloped bevel (16.37±3.88Mpa) and the lowest value was showed by skirt bevel (12.20±1.54Mpa) as shown in (Figure 3).

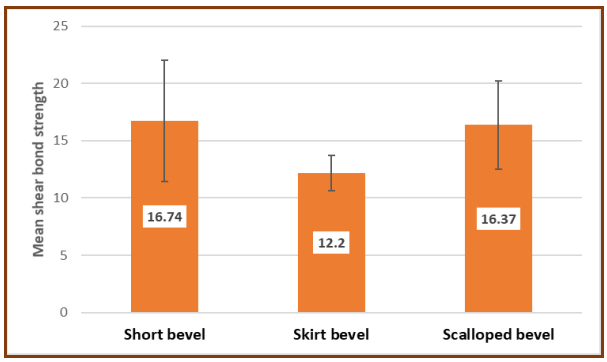

Figure3: Mean Shear bond strength distribution (Mpa) among studied groups.

Discussion:

Results of ML in current study showed that the greater marginal integrity achieved in 2mm bevel followed by scalloped and skirt bevel, it revealed that bevels of enamel advantageous for ML, especially, when the bevel preparations more conservatively designed, in the way that provide the larger surface area for etching without unrequired over extension.[13]

The results of this study are consistent with the results reported by Swanson et al. Who studied the effect of different adhesive systems in bonding to beveled and nonbeveled margins. They concluded that beveled margins displayed least microleakage, and margin bevel was more effective than the type of adhesive used in eliminating microleakage.

On the other hand, the findings of the current study were in disagreement with Swanson, et al.[7] Heintze, et al.[5] and Santini, et al.[12] who reported that the additional beveling of the enamel did not improve marginal integrity in anterior restorations. The result of SBS evaluation revealed that the highest shear bond strength was in short bevel then scalloped and skirt. As beveling of cavosurface angle was capable to promote higher exposure angles between the enamel prisms and the resin composite, but this effect was limited to the labial face as it showed in short and scalloped bevel in current study. On the other hand the beveling of the lingual aspect of the tooth preparation did not increase the angles of the exposed enamel rods as it showed in skirt bevel and it was negatively affected SBS of the restoration.[13] The results of the current study were in agreement with Xu, et al.[14] Who studied the effect of different cavity designs on fracture resistance in Class IV restoration and they found that the 2mm bevel produced higher fracture resistance.

Conclusion:

Within the limitations and according to the results of the current study, the following conclusions can be drawn:

1. Different designs of bevels can be advantageous in reducing 70% of ML in class IV restoration.

2. Different designs of bevels can be beneficial in increasing SBS in class IV restoration.

3. Lingual bevel and over extension beyond 2 mm do not afford additional advantage, so it is not recommended.

4. Higher SBS and adequate marginal integrity can be obtained with 2 mm marginal bevel and it can be recommended for clinicians.

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