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Composite Restorations - To Bevel or Not to? - A detailed discussion on purpose of bevels, marginal integrity, microleakage, enamel prisms and restorative technique

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Abstract

Adverse Oral health conditions mostly are related to dental caries, periodontal disease, dental trauma and oral cancers. According to the WHO Global Oral Health Status Report 2022, an estimated 2 billion people suffer from caries of permanent teeth and 514 million children suffer from caries of primary teeth.[1]

Dental caries is one of the most common dental diseases that many dental professionals have historically tried to address. However, it continues to be a daunting challenge to control this disease due to multiple factors that are not completely under the control of an individual professional, organization or patient population. Growing urbanization, access to food and beverages high in sugar, lifestyle changes, suboptimal or no exposure to fluoride and lack of access to oral health care contribute to this ever-increasing menace of dental caries.

The pathophysiology of dental caries consists of multiple factors that could be explained through a Venn diagram of host (tooth), pathogen (bacteria) and contributing factors (diet)as seen in figure 9.[2] Though multiple modifications of risk factors have been experimented, it continues to be a progressive challenge among dental professionals to curb this pandemic of dental caries. As a first line of treatment methodology, medical model is ideal to contain the disease, which includes proper at-home oral hygiene maintenance, judicious use of topical fluoride and sealant procedures as preventative measure. However, in high-risk patients with multiple carious lesions extending in to dentin, such medical models need to be combined with surgical

methods for a successful outcome. Multiple surgical models were implemented to address dental carious lesions which included use of gold foil, amalgam, GIC, inlays and onlay procedures.

The most common and advanced material used in dentistry over last few decades is a highly sensitive technique of composite restorations. Though there is extensive material on cavity preparation designs to improve retention and resistance forms, one aspect that many clinicians differ on, is whether to bevel or not to bevel for all composite restorations. Research and theory has shown that the bonding strength is maximum to cross cut enamel rods on beveled margins.

In clinical practice, bevels are more frequently used in Esthetic class III and class IV preparations than in class I and class II resin restorations. The purpose of this article is to recommend clinical guidelines for all composite restorations based on available research on beveled margins and success of marginal integrity and other characteristics in beveled composite restoration preparations.

Description of technique

A PubMed search was conducted with key terms of "Bevels in composite restorations" with 234 results, "Bevels in direct composite restorations" with 41 results and "Composite restorations with bevels" with 234 results which lead to a total of 509 results. Titles of these research articles were manually scanned through for most relevant terminology pertinent to the question of clinical interest.

A total of 6 research articles were picked to review various research methods that focused on beveled cavity preparations with an outcome related to micro-leakage, structural integrity and longevity of restorations.

Purpose/ Clinical Relevance Statement

Purpose of this article is to determine if bevels are a significantly important feature for success of all composite restorations.

Discussion

Marginal integrity is one of the most important factors that determines longevity of a restoration. Any compromise in marginal integrity could lead to marginal leakage, gap in the tooth-restoration interface, eventual fluid and bacterial penetration leading to secondary caries,[3-6] sensitivity,[7] marginal staining, pulpal response [8-11] and eventual failure of the restoration.

To address the issue of marginal integrity and microleakage, various methods including but not limited to, incremental technique to reduce C-factor,[12] improved adhesive properties of restorative materials,[13] and modification of cavity preparations[14-17] were used. However, a drawback these studies have mentioned was removal of extra sound tooth structure on beveled margins, which in comparison to improved marginal seal of the restoration was not a significant negative characteristic of beveled designs.[14-17] Few other methods used were, exposing transverse enamel prisms for better bonding,[18] increasing the surface area of exposed enamel prisms to increase bonding[19] leading to reduction in microleakage.[14,15] Though many options were available, modification of cavity design using bevels has been extensively researched.

Let us delve in to the question, if bevels in composite restorations are beneficial? Multiple studies have shown benefits of bevels but few of them concluded that there is no significant positive outcome with beveled preparations. Such later studies questioned the success of restorations with bevels due to overextension of the restorative margins and exposure to high stress during mastication, reduced thickness of composite

material on the beveled margins, leading to failure of such restorations.[4,20,21] Though a bevel seems to be an important feature researched to reduce microleakage, significant research has also shown that direction of the exposed enamel prisms is equally important. This was emphasized in a research study on direction of enamel prisms to analyze the need for bevels in composite restoration. The research concluded that there was significant exposure of enamel prisms close to 45 degrees on buccal surfaces of the preparation but the lingual and palatal surfaces showed no statistically significant difference.[21] Bevels should be used for cavity preparation of small to medium size with isthmus less than 1/3 of intercuspal distance but not for restorations that are of larger dimensions.[21] Other literature supports similar recommendations of bevels for smaller preparations[15] and not for wider cavity preparations[4].

From a study performed on 43 composite restorations that evaluated specific characteristics of color matching ability, interfacial staining, secondary caries, loss of anatomic form, marginal adaptation, surface texture and the outcome, the conclusion stated that there was no significant difference in the performance of composite restorations with occlusal Cavo surface beveled margins for the above mentioned characteristics[22] and did not see any reduction in in-vitro microleakage.[23] Data from extensive research on restoration of anterior teeth with bevels was used to recommend bevels on posterior teeth.[24,25] Such efforts are not valid as enamel rods are not always perpendicular to the external surface of posterior teeth.[26]

A study was conducted to determine success of bevels on posterior teeth but the study concluded that bevels did not eliminate marginal leakage but only reduced it.[26] Also, that the effectiveness of bevels on maxillary teeth VS mandibular teeth, buccal vs lingual surfaces need further examination and an in vivo method of research on clinical effectiveness of occlusal Cavo surface beveled margins in decreasing marginal leakage would be beneficial. Studies to determine the surfaces that need to be beveled in cavity designs and on direction of enamel rods would be needed.[26] The marginal sealing appears to be better with bevels; though the behaviour of occlusal restorations with and without bevels appeared to be similar[27]

Contrary to above mentioned information on lack of absolute evidence on benefits of beveled margins, multiple other studies have shown significant positive outcomes for composite restorations with beveled margins. Some of the findings and conclusions of such studies could be noted below.

Placement of a bevel helps in removal of a prismatic areas of enamel and leads to removal of fragile prisms improving the adhesive properties[13,27.] Though certain areas on a tooth surface could have a prismatic regions[13,28] it is very common for enamel prisms to be parallel to each other and perpendicular to the DEJ/external surfaces.[28] Multiple studies have shown similar conclusions on beveled margins with a positive outcome of removal of a prismatic layer of enamel with increase in surface energy and wettability, increase surface area for acid etching, decreased microleakage, better marginal seal, better marginal adaptability with non-conspicuous restorative margins, improved retention of restoration and difficulty for bacterial by-products to pass through the composite tooth interface,[14-16,18,19,29,30.]

Less microleakage in beveled preparations in comparison to preparations with butt joint in total-etch technique was also noted.[31] Laboratory studies concluded less marginal staining of beveled designs but the behaviour of beveled margins and non-beveled margins was similar for evaluated criteria.[32]A 6-month evaluation

of restorations has shown less marginal and surface staining of restorations with bevels.[32] When Cavo surface margins are on the enamel, the adhesive properties are significantly better due to advanced properties of newer restorative materials.[33,34] Removal of fragile prisms is important as they could lead to fracture during condensation of the restorative material, from polymerization shrinkage or masticatory forces.[27,35,36] Such an interface should be able to resist stress from masticatory forces and polymerization shrinkage during restorative procedures.[36,37]

A successful bond at the interface is only possible from micromechanical bond to the etched enamel.[20,37] Beveling enamel will lead to exposure of larger enamel prisms and removal of weak unsupported enamel leading to a better adhesive bond,[28] in turn leading to better esthetics and adhesion.[38] Effectiveness of acid etching is higher to such exposed perpendicular prisms to the external surface[37,38,39,40] and also through hybrid layers in dentin.[41] Other studies have noted that modulus of elasticity of composites is close to tooth structure[42] which enhances bonding of composite material over the beveled surfaces[43]. Due to availability of high filled resin composites, the chances of fracture of thin composite material over the beveled margins is unlikely[44,45] and that occlusal cavity preparations with bevels improved fracture resistance and fracture patterns of restorations.[19,46] Cavo surface modification with a bevel exposes more enamel surface area[47-50] and enamel rod ends for optimal bonding. Increased surface area has a positive impact on resin tenacity.[51,52] Bevels exposes transverse sections more commonly in class III and class IV restorations[54,55] which have a better bond than longitudinal sections.[53,54] They also provide greater surface area to compensate for polymerization shrinkage and less in vitro leakage.[23] Laboratory studies performed to determine the effectiveness of bevels in non-carious cervical lesions also established reduction in microleakage,[31,56,57] decreased enamel fracture,[58] improved adhesion[58,59] and improved esthetics.[60]

A study conducted with different groups with and without bevel, noted that, there was 95% of restorations without microleakage on facial and palatal bevels and only 30% of non-beveled restorations did not have microleakage, stating microleakage was seen if the margins weren't beveled. Cervical unbeveled margins on class II restorations lead to 70% with microleakage and 15% did not have microleakage.[15] Multiple studies have shown that beveled margins reduced microleakage and also that enamel cracks were seen in unbevelled margins.[61,62,23] Opdam NJ et al's[15] results were in agreement with other above mentioned past research articles. There was reduction in microleakage on beveled cervical and ascending walls of the preparation of small class II restorations and bevel is a recommended design for both preparations analyzed in this study.[15]

After considering all the research information on pros and cons of beveled designs, it is evident that placing bevels at Cavo surface margins would improve biomechanical properties of all composite restorations. After many years of clinical experience and using bevels regularly on all restorations, the clinical success of composite restorations for marginal integrity, sensitivity, recurrent caries and marginal staining is impeccable and close to 100%. Below is a step-by-step description of class I, class II, class III & IV composite restorations followed in our practice.

Clinical Technique

After patient is seated and roomed in for the restorative procedure, patient's medical history is reviewed and topical anesthetic is applied as per manufacture's recommendations. Typically drying oral mucosa with

gauze and applying topical anesthetic is more effective. Patient is then anesthetized locally with 2% Lidocaine with 1:100000 epinephrine either as local infiltration or IAN block depending on the tooth being treated. Once patient is anesthetized, isolation is achieved with cotton rolls and with the help of a high vacuum suction by a dental assistant. Though using a rubber dam would be an ideal option, due to our staffing model and patient flow, we continue to isolate with dry angles, cotton rolls and suctions successfully.

For all restorations, a 330/556/557 carbide diamond is used for initial entry through enamel and DEJ. Once primary outline form is achieved, all suspicious pits and grooves are included. If it is a class II, III or IV restoration, a proximal ditch cut method is used to prevent damage to adjacent tooth surface. Gently the proximal enamel is removed with either hand instruments or by cautious use of carbide burs.

Once initial caries excavation is completed, round burs and a spoon excavator is used to excavate carious lesions close to pulp to prevent iatrogenic pulp exposure. As a last step in cavity preparation a flame shaped diamond bur is used to place a bevel along all Cavo surface margins. The gingival seat is usually not beveled due to difficulty in access and risk of iatrogenic abrasion of enamel on adjacent tooth.

For class II preparations either a Tofflemire or sectional matrix system is used making sure gingival seat is completely secured and there is no compromise in isolation. Placing a wedge further helps in isolating the gingival seat region of the preparation.

For class III and class IV preparations, a Mylar strip is placed and facial, lingual surfaces of the Mylar strip are held tight making a loop around the surface being restored. Then with an index finger, the loop of the Mylar strip is dipped/pushed down and tucked in to the gingival sulcus. A wedge is placed to hold the Mylar strip in place securely for further steps to be conducted without displacement of the strip.

Acid etching is performed for 15-20 seconds. A total etch technique is used unless the preparation has close proximity to pulp, where a selective etch technique is used on Cavo surface margins only. In selective etch technique a bonding system with etch (single bottle system) is used. Bonding agent is air dried with air-water syringe using air alone for 5 seconds. Then the bonding agent is cured for 20 seconds and restoration is completed in incremental build up.

A final step of using a micro brush with slight amount of bonding agent and spreading the final composite layer on to the beveled margins is performed and restoration is completely cured. All isolation materials, wedge and matrix bands are removed. Occlusion is checked and adjusted with white Arkansas stone with no contacts in centric and eccentric motions.

It is important to always adjust, finish and polish composite restorations from the center to periphery. Final polishing of composite is performed with diamond polishing paste. Proximal contacts are checked for ideal contact with a floss. Post-operative instructions are given to the patient. This technique has given a consistent success of composite restorations in our clinical practice. Before taking any clinical photographs, all patients signed a consent to be photographed. Attached are sample before and after procedure pictures along with some pictures from periodic examinations of patients who had received composite restorations with bevels. Notice the continuity of the Cavo surface margin without any demarcation between restoration and tooth surface both immediately after the procedure and at periodic examinations.

This is possible only with an ideal bevel around Cavo surface margins.

Potential problems

Placing an ideal bevel needs clinical expertise and fine dexterity/ motor skills. Incorrect beveling might not give the expected beneficial outcome.Having students practice this preparation design on typodont teeth before performing such procedures on patients would be beneficial.

Advantages and Disadvantages

Though there is significant research information available on advantages of bevels in composite restorations, further research on bevels would be beneficial to include them in routine clinical guidelines. Although, the usage of marginal bevels for composite restorations is a clinical asset; it is imperative that the operator trains and orients to the preparation design sufficiently in order to make sure there are no post-operative adverse events including, but not limited to sensitivity, marginal leakage and discoloration of the restoration margins.

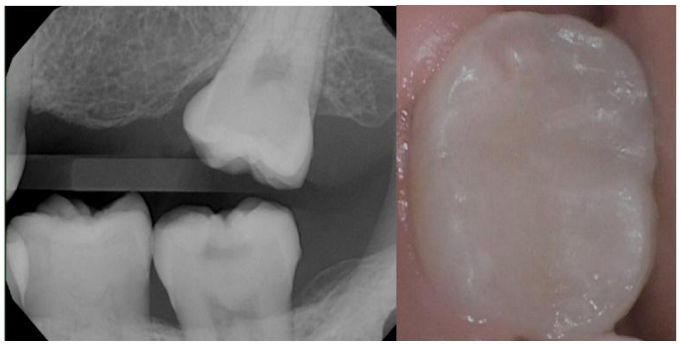
Meanwhile, after honing skills of placing bevels on typodont teeth, including bevels in regular restorative procedures would surely change one's perception about bevels and would be surprised with the outcome of their restorations in periodic examinations. Once mastered, placing a bevel would take only a few extra seconds to complete the preparation that would improve the longevity of composite restorations.

Competing interests

The authors declare no competing interest.

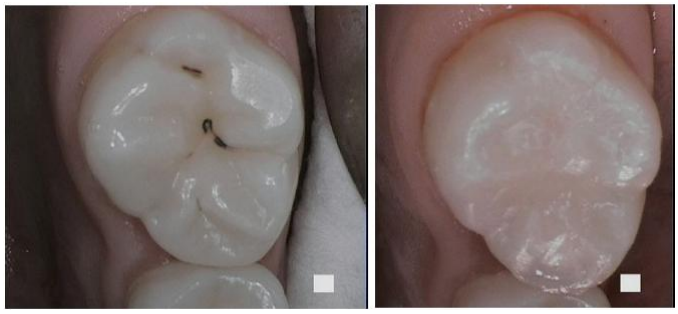
There is no personal or commercial endorsement and interest in the product manufacturers or vendors mentioned in this article if any.

Case 1: Mandibular molar occlusal composite restoration.



Case 2: Mandibular molar occlusal composite restoration.

Case 3: Maxillary Molar MO composite restoration.



Case 4: Maxillary incisor composite restoration

Case 5: Mandibular molar composite restoration.

Case 6: Premolar composite restoration.

Case 7: Maxillary composite restorations.

Case 8: Madibular molar MOB composite restorations.

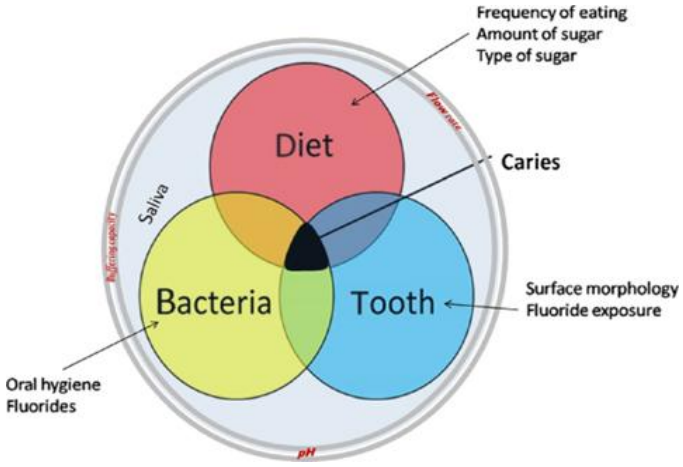


Figure 1

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