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Cervical margin relocation in indirect restorations

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ABSTRACT

Cervical margin relocation (CMR) is a technique used to raise the deepest portion of a cavity preparation from a subgingival to a supragingival level. This paper presents an overview of the technique and an analysis of current thinking and practices regarding the use of CMR when carrying out indirect restorations on teeth with deep subgingival margins. Despite promising results, the procedure is still controversial and most studies have been focused on laboratory-based testing of parameters such as bond strength, marginal integrity and fracture behaviour of the restorations. Although long-term clinical survival rates are reportedly high (96%), debate continues regarding the procedure's impact on gingival health. This paper will explore the historical and clinical development of CMR, its indications, advantages and disadvantages, as well as the time and cost implications, and long-term prognosis. While CMR appears to be safe and effective in appropriately selected cases, with meticulous application techniques, further randomised controlled clinical trials are necessary to draw definitive conclusions.

INTRODUCTION

Teeth with large interproximal carious lesions located below the cementoenamel junction (CEJ) almost always require some form of prosthodontic rehabilitation to restore the anatomy and function appropriately.[1] However, the preparation for indirect restorations poses both biological and technical operative challenges.[2] The main biological problem is the potential violation of the biological width, which typically requires a minimum distance of 3mm to be maintained between the restorative margins and the alveolar crest to prevent detrimental effects on the surrounding soft and hard tissues.[3] Technical challenges include inability to visualise the margins, difficulty in placing a rubber dam before carrying out the tooth preparation, salivary control during impression taking and cementation, and access for finishing and polishing the margins.[2,4] Historically, the recommended procedures used to expose deep margins located below the CEJ include clinical crown lengthening or orthodontic tooth extrusion.[1,3] However, in private clinical practice it is often not possible or viable to refer the patient for these procedures due to financial constraints, patient unwillingness to accept invasive surgical procedures, or time implications in situations where multiple appointments are needed.[1] In 1998, Dietsci and Spreafico[2] introduced the cervical margin relocation (CMR) technique, also known as the deep margin elevation technique.[2] Other names for this technique include the proximal box elevation technique or the coronal margin relocation technique.[1]

The CMR technique involves the placement of a composite or glass ionomer material in the deepest portions of the proximal areas to reposition the margin supragingivally.[1,2,5-8] The aim is to make it easier to perform rubber dam isolation, improve impression-taking and adhesive cementation. Early biomechanical studies suggested that restorations placed after using the CMR technique were superior to those done without its use.[9] However, there are a number of factors that need to be considered before deciding to attempt CMR. A recent systematic review by Juloski, Mokken and Ferrari revealed that the success of CMR depends on the periodontal health, meticulous execution of all steps, marginal quality of the adhesively bonded restoration, fracture behaviour of the treated posterior tooth, bond strength, material choice and treatment of the relocated margin prior to bonding of the indirect adhesive restoration.[1] A long-term follow-up study by Bresser et al found a survival rate of nearly 96% in 197 restorations followed up for times ranging up to 12 years after placement. They used composite resin for their CMR and postulated that with appropriate case selection and meticulous execution of the technique, high survival rates appear to be achievable.[4] The above mentioned factors will be considered individually.

Periodontal health

In a controlled study conducted by Ferrari et al, the effect of CMR on periodontal health was investigated.[3] The study included 19 patients who received CMR with resin margins and an indirect restoration of lithium disilicate. At the one-year follow-up, despite a 100% survival rate and no bone loss detected radiographically, they found that 53% of the treated teeth had bleeding on probing (BOP), indicative of an uncontrolled inflammatory response. They, however, did not specify the degree of BOP according to any recognised classified system such as that of Ainamo and Bay.[3]

In a randomised double blind study conducted by Ismail et al they performed CMR on 120 teeth using the sandwich techniques and four different materials, namely resin modified glass ionomer, bulk fill flowable composite, bioactive resin and conventional viscous resin. They found that with all the materials there was epithelial tissue reattachment and no bone loss after a two-year follow-up period.[10] They concluded that subgingival restorations were safe for the

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gingival health with all the materials and techniques they tested.[10] However, they did not test conventional self-cure glass ionomers. Their results support the observations of Mente et al,[7] that as long as the subgingival restoration is well bonded and there are no major overhangs, the restoration will be tolerated by the subgingival tissues.[3] The clinical problem for practitioners is that it is not easy to see or detect subgingival overhangs unless a radiograph is taken after placement and, even if present, they may be difficult to reduce in this location.

Application technique

Success of this technique relies heavily on adequate tooth isolation, matrix selection and placement, careful preparation, accurate impression taking and cementation and finishing procedures.[7] Cervical margin relocation is indicated when the margins of the tooth cannot be visualised, or where it cannot be isolated by rubber dam alone and a matrix band is required to fully seal off the lesion from the oral environment in order to avoid contamination and overhangs.[1] According to the classification system of Veneziani, CMR may be considered in Grade 1 interproximal carious lesions when a matrix band can be fitted and it fully circles and seals the margin. In Grade 2 lesions, surgical exposure of the margin may be necessary, while in Grade 3 lesions clinical crown lengthening will be needed and CMR should not be attempted beforehand. Thereafter CMR can be carried out, but in all cases rubber dam isolation is crucial.[8]

To achieve a tight subgingival fit, the use of curved matrices and wedges is recommended, with the height of the matrix reduced to 2-3mm above the height of the CMR.[1] In extremely deep cases, a matrix within a matrix technique can be employed where a layer of MTA is carefully packed in the deepest portion of the matrix band where there are still openings in order to fully seal the restoration.[7] Contamination of the operative field remains a concern, and operators should take great care in avoiding this.[1]

Marginal quality of the adhesive restoration

Ferrari et al reviewed six articles that evaluated the marginal integrity of teeth treated using CMR prior to placement of an indirect restoration. While most of the papers concluded that there were no differences in marginal integrity for indirect restorations placed directly on dentin versus those placed above margins lifted using CMR, one study suggested that the conventional luting procedure directly onto dentin still had superior integrity after teeth had been subject to thermomechanical loading.[1] When evaluating if polymerisation shrinkage may play a role in marginal integrity of CMR, three studies found that if composite resin was placed in three or more increments of 1mm each, there was significantly better marginal integrity than when it was placed in one thicker layer, and a comparable marginal integrity to indirect restoration luted directly to dentin.[1] One has to be cautious that most of the studies were carried out in vitro and thus success rates and clinical safety cannot be assumed.

With regard to choosing which indirect restorative material to use, no conclusive evidence could be found in the literature. Ilgenstein et al showed that composite restorations had better marginal integrity than ceramic materials.[6] They also found a significant reduction in marginal quality in specimens restored with ceramic onlays, whereas teeth restored with composite onlays did not show a reduction in marginal quality.[6] Resin onlays were also more likely to lead to crown root fractures than ceramic crowns, while ceramic crowns were more likely to lead to fractures of the onlay itself.[6] They also suggested that resin-based indirect restorations should not be used for full crowns in the posterior region and only for inlays and onlays, while lithium disilicate could be used in the anterior and posterior for both full crowns or onlays.[1,6] Thus, in partial restorations, a resin-based material is ideal, while in full circumferential crowns lithium disilicate seems to be better to avoid crown fracture.

Grubbs et al suggested filling the entire CMR restoration area with glass ionomer due to its bio-inert nature, natural adhesion to tooth structure, similar coefficient of thermal expansion to dentin, inertness when close to the pulp, and ability to set in a moist environment.[5] They also found that the glass ionomer did not degrade under thermocyclic loading when the material Lava Ultimate was used as the indirect restoration, and it was sufficiently strong in this site and procedure.[5] The biocompatibility profile of glass ionomer thus makes it an attractive choice for use with CMR.

Fracture behaviour

Studies on the fracture behaviour (fracture resistance and pattern) of root treated teeth restored using CMR and subject to thermomechanical loading and load until failure revealed that the group without CMR and restored with feldspathic ceramic onlays had the lowest mean fracture value. The highest mean value was recorded for the group without CMR and resin onlays.[6] The two groups that had CMR and onlay restorations had similar fracture resistances compared to each other and higher than that of feldspathic porcelain without CMR, regardless of the restoration material used for the onlays.[1,6] The only statistically significant difference was found in the groups without CMR in the load to fracture tests. The ceramic restorations had less catastrophic failures when subjected to load until failure, while the resin restorations show the best marginal integrity compared to other crown types after thermomechanical loading.[1,2,5,6] CMR appears not to influence the fracture behaviour of treated teeth compared to controls significantly.

Bond strength

The microtensile bond strength of composite inlays to the proximal box floor has been evaluated to determine the influence of CMR on bond strength.[1] A study was carried out to compare groups of teeth with cervical margins located 1mm below the CEJ and into dentine to those with margins relocated to 1mm above the CEJ via CMR. The study utilised a restorative composite (Filtek Z-250) applied in two 1mm thick increments. It found no differences in bond strength compared to when indirect restorations were placed directly onto dentin[1]. Another study compared the bond strength of self-adhesive cements versus total etch adhesive systems and found that the microtensile bond strength of the inlays was higher to the elevated composite margins than directly to dentin margins. However, the results were only statistically significant when a self-etch adhesive system was used for adhesion of the indirect restoration. It was further noted that the interfaces for failure were different, with bond failure occurring between dentin and resin cement in 60% of specimens using self-etch adhesive systems, while mixed interface failures were observed with adhesive resin.[1,6] Grubbs et al recommended using total etch adhesive resin for the bonding procedure due to its superior bonding to dentine and its capacity to

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bond adhesively to glass ionomer.[5] Total etch adhesive also displays excellent bonding to indirectly luted restoration.[1] Ultimately, the use of indirect restorations has been found to significantly improve the long-term survival rate of the tooth and appears not to be affected by the use of CMR as the long-term survival rate of CMR in indirect restorations is comparable to indirect restorations placed directly onto tooth structure.[4]

CMR material

Numerous recommendations regarding the most appropriate composite material for CMR and adhesive systems have been proposed.[1] Most authors recommended a traditional three-step adhesive system which involves etching, application of a primer and a bonding agent. Both bulk fill flowable composite and traditional viscous composite can be used; however, the flowable composites should be placed in increments no larger than 1.5mm, while the traditional viscous composites in increments no larger than 2mm to compensate for polymerisation shrinkage. However, due to the thin layer or absence of enamel below the CEJ, etching cannot be carried out for longer than five seconds.[1] Bonding to enamel is considered safe and consistent, but bonding to dentin and cementum relies on a myriad factors, including the substrate morphology, adhesive type and sensitive application technique.[1] The main problem at the moment is that progressive degradation of the hybrid layer cannot be prevented and thus alternative materials must be considered to improve long-term success rates.[1,11]

The use of glass ionomer for CMR has been proposed. Glass ionomer is a biomaterial consisting of fluoro-aminosilicate glass that naturally bonds to tooth structure (enamel and dentin) and is capable of bonding adhesively to MTA. Extensive literature supports its use in both class 1 and 2 cavities.[12-14] Glass ionomer is frequently recommended as a periodontal restoration in root caries, and the addition of hydroxyapatite enhances fibroblast proliferation and attachment.[12] Due to its bio inert and potentially bioactive nature, it appears to be an ideal material for CMR. Additionally, glass ionomer releases fluoride over time, which can assist in the remineralisation of tooth structure and prevent restoration leakage.[12-14] Fluoride also exhibits mild antibacterial properties which is beneficial for preventing bacterial overgrowth which may lead to gingival inflammation, and appears to be biocompatible in subgingival restorations.[10,13] A glass ionomer primer composed of polyacrylic acid can be used to bond glass ionomer to dentin without the need for etching and other surface treatments, but a glass ionomer primer appears to be beneficial in wetting and uniform adhesion to tooth structure.[14] Furthermore, glass ionomer materials have been proven safe as subgingival open sandwich restorations so may be a suitable material for CMR as well.[10]

Treatment of CMR prior to bonding

When using CMR technique, finishing and polishing of the area is required before impression taking to obtain well-defined margins.[1] It has been suggested that margins can be reduced with fine diamond burs of decreasing grit. However, a challenge lies in assessing how deep the margins are that need to be polished, as well as how far one can go below the CEJ and gingival margin to remove overhangs and achieve a smooth restoration without causing too much soft tissue damage. Radiographic x-rays have been recommended to aid in determining the areas needing refinement.[1] Some authors have suggested that sandblasting could be used to prepare the margin prior to bonding; however, this opinion was not widely supported due to its uncontrollable nature and potential for damage.[1] Minor adjustments, such as removing visible overhangs and improper contours, should rather be made with fine diamond burs, under radiographic guidance. Dentine sealing must be carried out on the tooth immediately following preparation to ensure ideal bonding.[15] While initial studies have suggested that resins may be safe subgingivally provided there are no overhangs, short margins, voids or air bubbles present, glass ionomers may be preferable, however, as they do not appear to cause as much gingival inflammation after placement.[10,12,13,15]

DISCUSSION

The concept of using a base layer to address the challenges of deep restoration margins originated from the open sandwich technique.[3] This led to the concept of CMR to raise the margins of teeth with deep subgingival margins. Early clinical studies have shown promising results when CMR is carried out with both resinous and ionomer-based materials.[10] The assumption is that it will then be safe to place indirect restorations on top of these elevated margins. Advocates of CMR also propose that the newly elevated margins will help improve contact and prevent food trapping between the teeth.[4] While most studies on this topic have been conducted in laboratory settings, they have shown no significant difference between indirect restorations placed directly onto dentin and those placed onto an elevated material.[5] Furthermore, the use of the CMR technique appears to offer biomechanical advantages[9] and it does not impact the bond strength, marginal integrity or fracture behaviour of indirect restorations, regardless of the materials used.[7]

Microleakage concerns have been investigated with resinous materials for CMR. While laboratory studies found no difference in leakage after thermomechanical loading, the biggest challenge is how to avoid moisture contamination in clinical setting.[5] Glass ionomer-based materials may be a more viable option to address this problem due to their natural adhesive properties to dentine and cementum, as well as their ability to set in a moist environment. The biocompatibility of ionomer-based materials has been extensively studied, with reports indicating that glass ionomer does not cause gingival inflammation when placed subgingivally.[10,12-14] Additionally, it has been used successfully in apicoectomy, external cervical resorption cases and orthopaedic surgery, demonstrating a clinical ability to bond to bone. Further research is recommended using glass ionomer as a base layer in the CMR process.[3] More research is needed to investigate parameters such as long-term success and survival of restorations placed after CMR, as well as patient preferences with regard to clinical crown lengthening or orthodontic tooth extrusion. While these methods are the preferred clinical procedures, they may not be desirable to all patients due to cost and time factors.

CONCLUSION

Initial studies using the CMR technique show promising results with reportedly high survival rates over a number of years. The biggest drawback is that it is still recommended to maintain at least 3mm space between the alveolar crest and restorative margin, and determining the depth and extent of this gap during the procedure is challenging. When considering whether to attempt CMR in place of

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crown lengthening, factors such as connective tissue compartment violation, inability to place a matrix band and inability to isolate the field are contraindications for the former. The main concern with proposing CMR for widespread clinical use at the present time is that there is a lack of large controlled clinical trials and further research is recommended in this potentially viable treatment modality.

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