Selective Caries Removal- A New Improvised Technique for Caries Management

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Abstract

The strategies to manage deep caries are constantly evolving as evidence heaps for the use of minimal conservative techniques which would prevent pulpal exposure leading to preservation of pulp vitality, remineralisation of the carious dentin and arrest the progression of caries and offer a predictable success of the restoration. Changes in our understanding about the caries process, advent of new adhesive restorative materials and the possibilities of remineralization of demineralized dental tissues helps us to explore different techniques in caries management. Selective caries removal is now considered an efficient and evidence based approach in deep caries management and focuses on maximum retention of tooth material thus avoiding the probability of pulp exposure to provide a sound peripheral bondable surface for restoration and creating excellent hermetic seal.

Key Words: *Caries, caries removal, pulp protection*

Introduction

Dental caries result from an ecological shift in the dental biofilm from a healthy balanced state of microbial population to an unbalanced population of microbials dominated by acidogenic and aciduric bacteria, developed and maintained by the frequent consumption of fermentable carbohydrates, eventually leading to further imbalances in demineralization- remineralization cycle manifesting the carious lesion.[1] This understanding of caries has changed the treatment strategies from a traditional "drill and fill" approach to a minimal invasive approach aiming at the control of biofilm activity.[2]

Great many options are available for such a biofilm activity control in non cavitated lesions. Strategies for noncavitated lesions include diet control to manipulate the composition of biofilm, inactivation or removal of biofilm by mechanical and chemical means as well as use of fluoride agents to minimize the susceptibility of demineralization.[3] Micro invasive methods like resin infiltration is recommended for early caries.[4] Cavitated lesions warrants an conservative operative technique facilitating effective restoration of form and function.[5]

With the changing of our understanding about the caries process, advent of new adhesive restorative materials and the possibilities of remineralization of demineralized dental tissues emphasis is on the selective removal of carious tissue to create a favorable surface for bonding as well as for supporting a restoration with good resistance and hermetic coronal seal.[6]

This review explores this concept of selective caries removal, detailing the different techniques involved and the materials used for restoration following selective caries removal.

Evolution

More than a century ago, G V Black in his bookmentioned that an ideal cavity preparation needed removal of all the carious lesion. He believed that it was better to expose the pulp than leave it covered

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with a layer of soft dentin.[7] There was a change from this belief when Fusyama et al[8,9] identified two layers of carious dentin namely, inner demineralized dentin & outer microbial contaminated dentin and recommended that only the contaminated dentin needed to be removed and the inner layer (firm) would be remineralized. This marked the beginning of a minimally invasive treatment in cavity preparationand was termed as selective caries removal.

Massler et al coined the terms infected (previously termed outer contaminated) and affected (previously termed inner demineralized) dentin. Little was known that these terms would have a huge impact on the current concepts of caries management and how caries should be removed.[10]

The techniques mentioned above have approximately 40% (in permanent) and 53% (in primary) risk of pulpal damage or exposure in cavitated moderate- deep lesions. In such a case, treatment modalities would include direct pulp capping, pulpotomy, pulpectomy/Root Canal Treatment or extraction of teeth. The success rate of pulp therapy in mechanical exposure of pulp is reported to be high especially in young permanent teeth with an open apex. However, a carious exposure significantly brings down the success rate to 33-37% after 3 years to as low as 13% after 10 years.[11]

In International Caries Consensus Collaboration meeting in 2015, participated by 21 experts in Cariology from 12 countries assessed a compilation of evidences from various studies and discussed on different treatment strategies for caries management. This consensus elaborated on various methods and techniques of caries tissue removal and management with special focus of teeth that could be retained and with pulp with a potential to respond positively to pulp testing as well as with reversible pulpitis.[6]

Objectives

The objectives of selective caries removal are to avoid exposure of the pulp during cavity preparation in an attempt to preserve the pulp vitality, manipulate the microbial population, provide a sound peripheral bondable surface for restoration creating excellent hermetic seal thereby cutting off the residual microbes of substrate/carbohydrates for survival subsequently preventing the progress of the carious lesion.[6]

A shallow lesion which is not extending into the inner 1/3rd to 1/4th of the total dentin thickness, is at low risk of pulpal damage and therefore priority has to be given for restoration success than pulpal health. But, in deep carious lesions extending into the inner 1/3rd to 1/4th of dentin, priority should be for preservation of pulp vitality and reducing risk of pulpal damage which may lead to pulpal necrosis demanding invasive painful procedures later.[10]

Procedure

Selective caries removal in shallow to moderate cavities:

This technique is employed in primary & permanent dentition with shallow and moderately deep cavities (radiographically extending less than the pulpal 1/3rd or 1/4th of dentin).[2] The carious tissues are removed with the help of a spoon excavator from the base of the cavity until a resistance is felt. At this point, firm dentin is reached which is more often not discolored. The carious tissue from the walls of the cavity is excavated completely up to hard dentin which is "scratchy" when felt with a probe.[10]

Selective caries removal in deep cavities:

Attempt is made to avoid the chances of pulpal exposure and preserve pulp vitality. A layer of 'soft to touch', 'wet and moist' dentin is left deliberately at the base of the cavity over the pulp. But a complete caries excavation on the walls is done to ensure a good coronal seal and a durable restoration.[2] A provisional restoration which is durable up to a year is given keeping in mind the patient may not return to complete the treatment. This would also give time for dentinal changes to take place. During second visit, cavity is reentered, the formation of tertiary dentin confirmed by visual and tactile criteria and caries removal is continued up to leathery dentin after which a durable restoration is given. The reasoning for this method is that after the initial visit, the microbial diversity significantly reduces, remineralization of demineralized dentin and formation of tertiary dentin take place.[12]

Methods of carious tissue removal

There is a wide array of criteria useful for evaluation of caries removal including tactile (hardness) and visual evaluation (dryness & color) of dentin, use of caries detector dyes.[6]

Although there is no strong recommendations, hardness of dentin may be used as a primary criterion for assessing the effectiveness of carious dentin.[6]

Polymer burs work on the principle of differential hardness of the tooth tissues. The Knoop Hardness of a sound dentin is 66-80 while that of carious dentin is around 30. A polymer bur of Knoop Hardness Number 50 removes caries selectively. [13]

The erbium laser at 2940 nm is absorbed by water and hydroxyapatite crystals. This absorbed energy causes vaporization of the water making the area dry and results in micro- explosions and expulsion of the target material. This helps to remove the tooth structure rapidly especially having higher water content. This is of importance in cavity preparation since the carious tissue has more water content than healthy tissue which facilitates its easy and rapid removal. However, lasers are comparatively slow in the removal of carious lesions as compared to using a dental handpiece.[14]

Air abrasion makes use of the kinetic energy of aluminium oxide particle stream to remove carious lesion. They abrade the lesions without any vibration, sounds or heat production. Since the particles exist at the end of the tip, it is an end cutting instrument. There is evidence that the tooth preparation done using this technology results in rounder internal angles as compared to conventional cavity preparation, thus resulting in restorations with more longevity.[15]

Cavity disinfection following selective caries removal

Cavity disinfection following selective caries removal is a debated topic. It is said that microbial numbers play a limited role in the success of this treatment provided, a tight and good hermetic seal is achieved. Cavity disinfection with anti-microbial agents like 0.12% chlorhexidine with 35% phosphoric has been found to reduce the bacterial penetration into the dentinal tubules after selective caries removal. Phosphoric acid removed the smear layer which opens up the dentinal tubules and facilitates effective penetration of chlorhexidine.[16]

Use of Cavity liners

Cavity liners are routinely used in deep caries management in an attempt to keep the pulp viable, reducing the bacterial numbers, promote reactionary dentin formation, remineralization of demineralized dentin and to isolate the pulp from noxious stimuli.

Cavity liners are beneficial while using resin-based cements as the final restoration after selective caries removal as it prevents the seeping of the monomers through the dentinal tubules.[17] Also, the caries affected dentin has a low elastic modulus and poorly withstand the tensile forces which may lead to fracture lines in dentin during the polymerization shrinkage of resin-based cements due to which cavity liners are beneficial.[18]

Calcium hydroxide, used as a liner material reduces the number of microorganisms, promotes remineralization and aids in the formation of dentin bridge formation. However, its use as cavity liners following partially excavationd of caries has shown unsatisfactory results.[19] The high solubility of calcium hydroxide over time, tendency to cause internal resorption, tunnel defects in the dentin bridge formed makes it unfavorable for cavity lining after selective caries removal.

Other bioactive materials that induce deposition of minerals in the dentin leading to the formation of apatite-like material protecting the underlying pulp are MTA, Biodentine, light cured calcium silicate base materials (TheraCal LC) . MTA is considered the most validated material for use as lining the base of the cavity.[20]

There is a lack of consensus in the literature about the ideal cavity liners to be used after selective caries removal. While some argue that liners don't contribute to the success of selective caries removal if a good hermetic seal is achieved, some studies show that MTA be preferably used because of their high biocompatibility, osteoconductive properties as well as superior dentin bridge formation. It has been shown that MTA produces less pulpal inflammation and a thicker dentinal bridge with an odontoblastic layer formation. It maintains the vitality of the pulp and ensures a normal physiological pulpal function.[21] A randomized clinical trial compared calcium hydroxide and MTA after selective caries removal in primary molars and reported no statistical differences after a 6 month and 1 year follow up.[22]

The key factors to be considered is the bond between the cavity liners and the residual dentin as well as the bond between the cavity liner and the final restoration. Even though its proved time and again that MTA and Biodentine may be used as reliable pulp capping agents, evidence suggest that MTA continues to mature a year after placement beyond the setting time. This would impact its mechanical integrity and bond strength.

Likewise, studies show that Biodentine matures up to 2 weeks after its placement.[23]

Restorative materials used following selective caries removal

The primary objective of a restorative material is to promote the remineralization of carious left out dentin to restore the original mechanical properties and the choice is made based on the remaining coronal tooth structure, size of restoration, occlusal forces, caries risk of the patient, location of the carious lesion, esthetic needs of the patient and other related factors.[24]

Amalgam and composite resin are globally accepted permanent restorations. Recent meta-analysis indicates that amalgam has better longevity as compared to composite restorations.[25,26] In spite of good mechanical properties of amalgam, the poor esthetics and limitations of use of mercury containing materials and procedures,[27] its use as a restorative material has drastically reduced globally.

Composite restorations form a tight micromechanical bond at the cavity margins by forming resin tags. But this bond with the carious dentin is very poor.[28,29] Among the various systems, etch and rinse adhesive system yield a better bond to carious dentin as compared to self-etch systems.[29] Some clinical available techniques to improve the bond strength is the pretreatment of cavity with chlorhexidine and use of Quaternary Ammonium Methacrylate containing products like 12-Methacryloyloxy-odecylpyridinium bromide (MDPB). They are polymerizable anti-microbial agents which inhibit collagenolytic enzymes that degrade the adhesive collagen, preventing cohesive failure.[30]

Conventional Glass Ionomer Cements (GIC), Resin Modified Glass Ionomer Cements (RMGIC), compomers are cariostatic restorative materials due to their fluoride releasing properties and may be used as alternatives to composites. High viscosity GICs (HVGIC) are gaining increasing popularity as a restorative material after selective caries removal. Unlike the adhesive systems, HVGIC has similar bond strengths to both sound dentin and carious dentin. (31) In a study carried out in head and neck irradiated xerostomia patients providing ideal conditions for study of restorative material over a short period of time, HVGIC has been shown to have good longevity. Also further studies have proven that both Low Viscosity GIC (LV GIC) and HV GIC completely prevented the development of secondary caries even after the restoration was lost and in low fluoride compliant patients. Most notably, deteriorated restorations could be transformed into sandwich restorations.[31-33]

Follow up

Any deep caries management places the patient under medium and high risk category which warrants the requirement of a follow up at 6 months. A positive pulpal response may be ensured by assessing the dentin beneath the restoration and non-progression of carious lesion compared to baseline.[34]

Conclusion

The strategies to manage deep caries are constantly evolving as evidence heaps for the use of minimal conservative techniques which would prevent pulpal exposure leading to preservation of pulp vitality, remineralisation of the carious dentin and arrest the progression of caries and offer a predictable success of the restoration. Selective caries removal is now considered an efficient and evidence based approach in deep caries management. The decision to use cavity liners should be based on the need for additional pulp protection. The choice of final restoration should be based on clinical factors like size of cavity, type of carious dentin left behind, location of the cavity.

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