Content available at: https://www.ipinnovative.com/open-access-journals

IP Indian Journal of Conservative and Endodontics

Journal homepage: https://www.ijce.in/

Case Report

Managing the deep carious lesion biomimetically without pulpal involvement

Rishu Mittal[1]*, Shivani Hooda[2]

[1]*Subdivisonal Hospital, Kalka Health Department, Haryana, India*
[2]*Deputy Civil Surgeon (Dental) Panchkula, Health Department, Haryana. Fax: India*

ARTICLE INFO

Article history:
Received 12-02-2024
Accepted 14-03-2024
Available online 20-03-2024

Keywords:
Vital pulp
Rubber Dam Isolation
Caries Detecting Dye
Peripheral Seal Zone
Immediate Dentin Sealing
Deep Margin Elevation
Biobase
Semidirect Composite Onlay
Magnification

ABSTRACT

During the last 20 years, the restorative approach has evolved from the mechanical retention to the advanced adhesion. This transition was fostered by the development and the improvements in the adhesive materials and the increasing demand of the esthetics among the patients. Resultingly, Composites today have become the material of choice for both the anterior as well as posterior restorations. The Science, Principles and the techniques of advanced adhesive dentistry are known as biomimetic dentistry. The major goal of biomimetic dentistry is to preserve the vitality of the pulp and conserve maximum intact tooth structure. The management of deep carious lesions approaching a healthy pulp presents a significant challenge to a clinician. The traditional management of carious lesions dictates the removal of all the infected and affected dentin. Several studies call this approach into question. This article presents a systematic approach to manage the deep carious lesions in the vital teeth preserving its vitality & conserving maximum intact tooth structure for the long term biomimetic function.

1. Introduction

'*Caries Treatment is our most important professional duty*'- **Takao Fusayama**

Today is the era of adhesive dentistry. Resin composites have replaced the amalgam & have become the material of choice for almost all the restorations. With this evolution in restorative materials from amalgam to composite has resulted in the complete change in operator's strategy. The principles of the cavity designs for these adhesive restorations are different from the principles established by GV Black as resistance and retention forms are not required for the cavity design anymore.[1]

The traditional way of detecting caries by explorer and mirror is a subjective method & can never be an objective guide. It is quite surprising that we dentists have to perform our most important professional duty while relying on such an ambiguous means of detection which has no scientific basis. Researchers have always struggled with the problem of too much versus not enough when it comes to the removal of the decayed tissue.[2]

This article presents a systematic approach to manage the deep carious lesions in the vital teeth preserving its vitality & conserving maximum intact tooth structure for the long term biomimetic function.

2. Case Report

A 21-year-old female patient was referred to the Dental Outpatient Department of Subdivisional Hospital, Kalka from a private practitioner with the chief complaint of pain in relation to lower right back tooth region. Clinical examination revealed mandibular right first molar having a temporary restoration over a deep carious lesion (Figure 1). The tooth was non tender on percussion. Medical history was noncontributory. Tooth was vital when

* *Corresponding author*.
E-mail address: dr.rishumittal@gmail.com (R. Mittal).

https://doi.org/10.18231/j.ijce.2024.012

pulp sensibility tests were conducted. The radiographic examination revealed the radiolucency close to the pulp and there was slight widening of lamina dura apically with respect to both the roots. (Figure 2)

Since the symptoms disappeared immediately after removal of stimulus during cold test using endo ice, a diagnosis of asymptomatic reversible pulpitis was established. To preserve the pulp vitality, restorative treatment was planned using biomimetic restorative protocols.

First of all, occlusion was checked with the articulating paper so as to keep restorative margins out of occlusal contact points and the shade of the tooth was also taken.

With informed consent, local anesthesia was administered using 2% lignocaine and 1: 200,000 adrenaline and the treatment was initiated under rubber dam isolation (Figure 3).

Temporary restoration was removed and the carious lesion was then stained with caries detecting dye (Kuraray, Tokyo, Japan) which was rinsed after 10 seconds. Starting near the dentinoenamel junction (DEJ), round bur (FG4 Mani) was used so as to remove all the caries near the DEJ area so as to establish clean peripheral seal zone devoid of any stain.

Inside the peripheral seal zone, all the red stained outer carious dentin was removed using round bur at slow speed. All the pink stained area between the pulp horns was left intact. Next moving to the deep dentin, the red stained outer carious was carefully removed. Measurements with the perio probe was then taken and the excavation was stopped 5mm from the occlusal surface and 3mm from the adjacent marginal ridge. Simultaneously to caries removal, crack removal was also done on the distal marginal ridge using the same round bur. These were the final caries removal and crack removal end points (Figure 4).

After this step, the entire surface was sandblasted and the cleaned with 2 percent chlorhexidine and the preparation was dried for the next 10 seconds. This step was done so as to deactivate all the matrix metalloproteinase and preserve the maximum bond strength.

In the next Step immediate dentin sealing (IDS) was done using mild self-etch dentin bonding system (Clearfil SE bond-Kuraray,Tokyo,Japan) in which self-etch primer was applied for 20seconds with the light brushing motion, air dried for 10seconds following which self-etch adhesive was applied for 20 seconds and thinning of bonding agent was done with the microbrush followed by the 20seconds light cure. This step was then followed by the application of the thin layer of 0.5mm of the flowable Composite (3M ESPE, St Paul,MN,USA) to the dentin surface. In the next step deep margin elevation was done using garrison reel matrix(Figure 5).

After raising the margin with the composite, ribbond fibers were placed which was then covered with 1mm thick layer of Composite material (Clearfil APX-Kuraray,Tokyo,Japan). At this step the biobase was complete (Figure 6). The biobase was then covered with the glycerine jelly so as to remove the oxygen inhibition layer. For the enamel replacement, a semidirect composite onlay (Clearfil APX-Kuraray,Tokyo,Japan)was fabricated using indirect chairside procedure where alginate impression of the preparation was taken.

Following the impression the restoration was covered with the temporary filling material. Both the heavy body and the light body polyvinyl siloxane material was injected into the alginate impression. The die was then removed and the flowable composite was placed on the floor of the restoration. Next the composite was injected for the enamel replacement which was then sculpted to the ideal contours. This restoration was first cured on the die for 20seconds.Composite onlay was then removed from the die and was cured extraorally for 20seconds from each surface. Further to increase the conversion of onlay restoration, it was cured in the dry oven for 100 degree Celsius for 5-7 mins. The composite onlay was then finished and polished.

During the bonding appointment, temporary restoration was removed and try in was done.The restoration was fitting accurately on the tooth surface.

Under the rubber dam isolation, the intaglio surface of the restoration was sandblasted and also the biobase (Figure 7). Etching of the restoration was done with the 37% phosphoric acid (3M ESPE,St Paul,MN,USA) for 1min and for 30 seconds to the biobase. Next the bonding agent (3M ESPE,St Paul,MN,USA) was applied on both the restoration and the tooth. The tooth surface was then covered with the heated composite and the composite onlay was bonded over it. This was tack cured with the curing light & was then covered with the glycerine air barrier and cured (Figure 8). Occlusion was checked and the restoration was finally polished using composite polishing kit. Post-operative radiograph was also taken(Figure 9).

The entire procedure was done under dental operating microscope under 10x magnification.

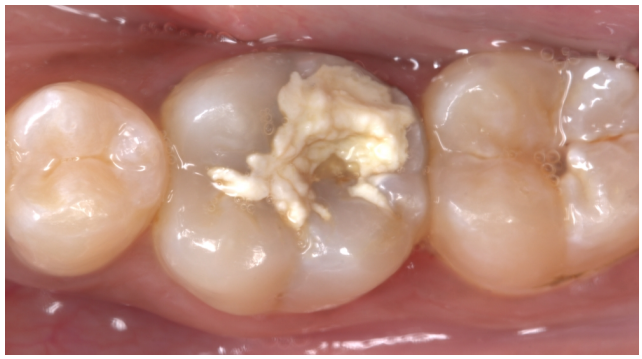

Figure 1: Preoperative clinical picture

Figure 2: Preoperative radiograph

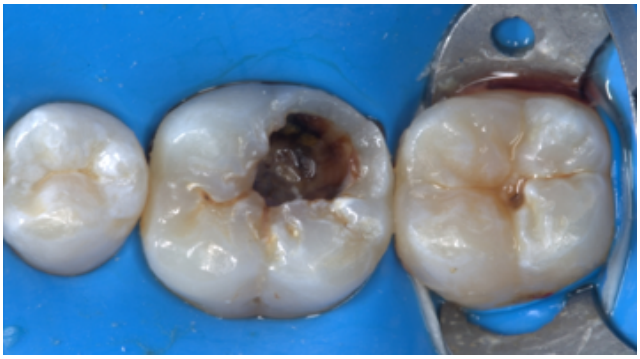

Figure 3: Rubber dam isolation

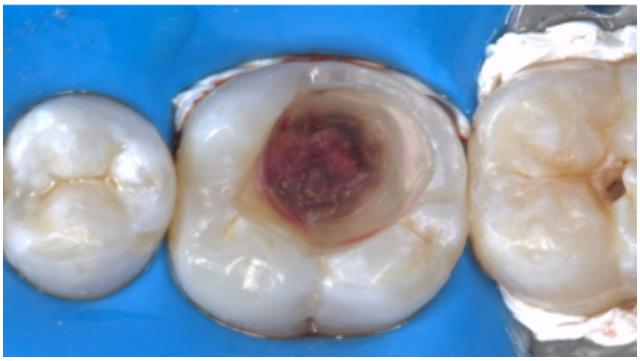

Figure 4: Caries and crack removal end points

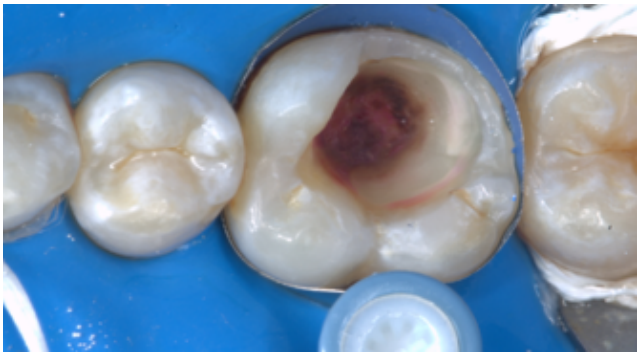

Figure 5: Deep margin elevation

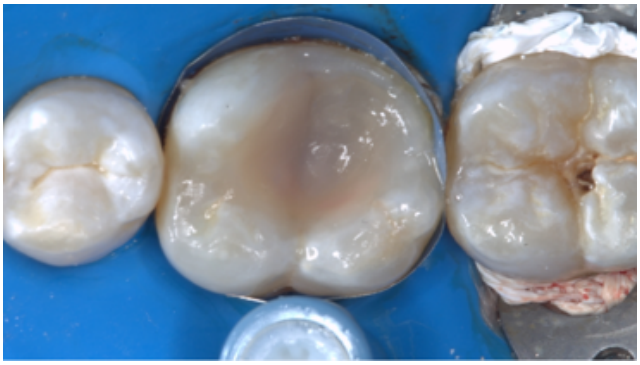

Figure 6: Biobase

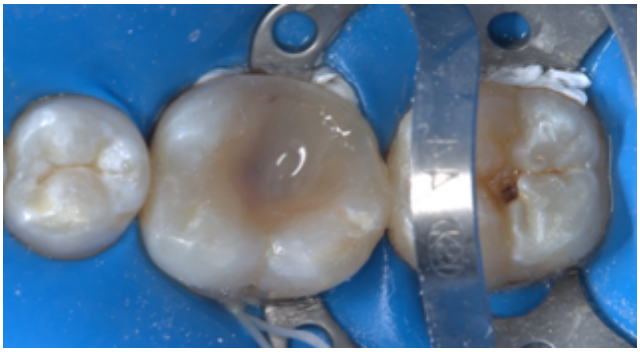

Figure 7: Post sandblasting image

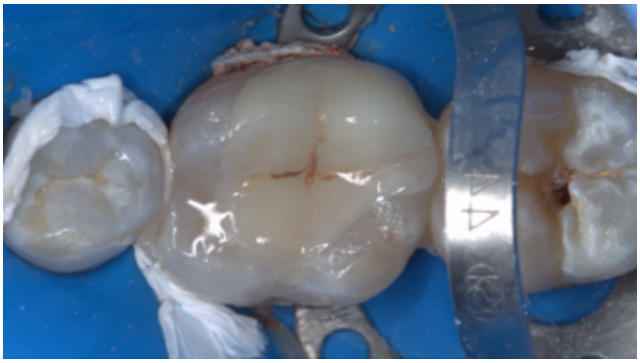

Figure 8: Postoperative clinical picture

Figure 9: Postoperative radiograph

3. Discussion

Reproducing the original performance of the intact tooth should be the driving force in restorative dentistry.[3] Biomimetic approach at its core respect the simple philosophy that is to adequately restore the teeth we must mimic the nature.[4] Replicating this natural state begins with removing caries & cracks while preserving maximum intact tooth structure.

The tooth is then sealed to protect the nerve preventing symptoms like pain & sensitivity & preserving the vitality of the tooth. Once sealed, composite restorations are used along with the gold standard dentin bonding systems to connect the tooth side to side, front to back and top to bottom restoring the tooth's its original performance. This also blocks the bacteria from entering, prevent cracks and also preserves the vitality of the pulp indefinitely.

All these steps begin with the diagnosis of the caries. The method used most commonly to diagnose the caries is mouth mirror and explorer. This is a subjective method and has many shortcomings.

A study was done in the year 1985 that compared the optical and digital criteria with the dye enhanced method to determine whether carious affected dentin remained within the prepared cavity & they concluded that 59% of the teeth still stained at DEJ despite being judged caries free by the tactile sensation.[5]

Caries detector dye was used in this study. Use of Caries detector dye allow the greater accuracy in removing the tissue that is infected and irreversibly deterioted. Unstained uninfected dentin is left intact whereas stained hard tissue is removed. The dye may not penetrate the tissue in one application so multiple applications are required until it produces no further staining.[6]

The specific objectives of caries removal end point determination are the creation of a peripheral seal zone and the absolute avoidance of the pulp exposure while generating highly bonded restoration. First, by creating a peripheral seal zone consisting of normal superficial dentin, DEJ, and enamel, a bond strength of approximately 45–55 MPa can be generated.[7] Second by leaving the partially demineralized but highly bondable inner carious dentin, bondability of 30MPA will be obtained in the deeper areas of the preparation.[8]

When the exacavation is 5mm from the occulusal surface & 3mm from DEJ, exacavation should be stopped. This protocol would eliminate most of the pulp exposures. The final goal of caries removal end point and peripheral seal zone is to create adhesive bond that will be preserved as long as possible. Such a bond should mimic the strength of the tooth.

Using the gold standard 3step total etch or 2 step mildly acidic self-etch bonding systems are the most consistent ways of achieving these high bond strengths.[9]

The acid from the carious lesions also activates matrix metalloproteinases which causes 25-30% reduction in the bond strength. A 0.2 to 2% chlorhexidine will deactivate MMPs and preserve the maximum bond strength.[10]

Using these gold standard dentin bonding agents, dentin is sealed immediately after the tooth preparation just before making the impression. this is also called as immediate dentin sealing.

Freshly cut dentin is an ideal substrate for the dentin bonding. Dentin bond takes time to mature. IDS allows stress free dentin bond development. IDS protects against bacterial leakage and sensitivity during provisional phase which also increases the patient comfort and reduced post-operative sensitivity.[11]

IDS is than followed by application of 0.5mm of resin coating technique. Resin coating resulted in higher bond strength. The elastic modulus of flowable composite is higher than dentin bonding agent, so it acts like a stress breaker that can relieve polymerization stress to the hybrid layer. Secure bond is created that means even if the restoration fails, you just need to replace Enamel.[12]

But this layer of flowable composite alone cannot resist deformation under load from the occlusal forces hence it is covered by highly filled microhybrid composite.[13]

This was followed by the application of ribbond fibres as the fibres allows the composite to move in the different directions hence minimizing the stress to the developing

hybrid layer.[14] These fibres are always protected by dentin replacement composite. Clearfil APX composite was used because this has very less polymerization shrinkage and MOE is also around 17GPa.[15] This minimizes the overall stress to the developing hybrid layer. Also the margin was raised from the subgingival to the supragingival margin which is also called as Deep margin elevation.[16] The deep margin elevation, immediate dentin sealing,resin coating, and the composite "dentin re-placement," is referred to as the "bio-base"—a term used by the Academy of Biomimetic dentistry for the stress-reduced, highly bonded foundation that the indirect or semi-direct onlay will be bonded to.[17]

Semidirect composite onlay was fabricated in this case which was then cemented with the heated composite, since it reduces volume of shrinking restorative material which further reduces stress to developing hybrid layer.[18] Such minimally invasive procedures are best performed under magnification using Loupes or Dental Operating Microscope.

Reducing residual stress while maintaining maximum possible bond strength is the ultimate goal of biomimetic restorative dentistry.[19]

4. Conclusion

The purpose of using biomimetic restorative concepts and protocols is to increase the longevity of restorations and to reduce or eliminate future cycles of retreatment. Traditional, full-coverage treatment, much often intact tooth structure would have to be sacrificed. However, employing biomimetic restorative protocols can solve many of these problems by conserving tooth structure and promoting vitality of the pulp. By combining the stress-reducing and bond-maximizing protocols, biomimetic restorative dentistry is able to connect all parts of the tooth with all parts of the restoration while maintaining a life-like tensile/cohesive strength in the 30 to 50MPa rang

5. Source of Funding

None.

6. Conflict of Interest

None.

References

1. Urabe I, Nakajima S, Sano H, Tagami J. Physical properties of the dentin-enamel junction region. *Am J Dent*. 2000;13(3):129–35.
2. Neves ADA, Coutinho E, Cardoso MV, Lambrechts P, Van Meerbeek B. Current concepts and techniques for caries excavation and adhesion to residual dentin. *J Adhes Dent*. 2011;13(1):7–22.
3. Magne P, Belser UC. Rationalization of shape and related stress distribution in posterior teeth: a finite element study using nonlinear contact analysis. *Int J Periodontics Restorative Dent*. 2002;22(5):425–33.
4. Magne P, Belser U. Bonded Porcelain Restorations inthe Anterior Dentition: A Biomimetic Approach. Chicago, iL: Quintessence Publishing; 2002.
5. Anderson MH, Charbeneau GT. A comparison of digital and optical criteria for detecting carious dentin. *J Prosthet Dent*. 1985;53(5):643–6.
6. Fusayama T. Clinical guide for removing caries using a caries-detecting solution. *Quintessence Int*. 1988;19(6):397–401.
7. Alleman DS, Magne P. A systematic approach to deep caries removal end points: the peripheral seal concept in adhesive dentistry. *Quintessence Int*. 2012;43(3):197–208.
8. Nakajima M, Ogata M, Okuda M, Tagami J, Sano H, Pashley DH, et al. Bonding to caries-affected dentin using self-etching primers. *Am J Dent*. 1999;12(6):309–14.
9. Shirai K, De Munck J, Yoshida Y, Inoue S, Lambrechts P, Suzuki K, et al. Effect of cavity configuration and aging on the bonding effectiveness of six adhesives to dentin. *Dent Mater*. 2005;21(2):110–24.
10. Pashley DH, Tay FR, Yiu C, Hashimoto M, Breschi L, Carvalho RM, et al. Collagen degradation by host-derived enzymes during aging. *J Dent Res*. 2004;83(3):216–21.
11. Magne P, Kim TH, Cascione D, Donovan TE. Immediate dentin sealing improves bond strength of indirect restorations. *J Prosthet Dent*. 2005;94(6):511–9.
12. Jayasooriya PR, Pereira PN, Nikaido T, Tagami J. Efficacy of a resin coating on bond strengths of resin cement to dentin. *J Esthet Restor Dent*. 2003;15(2):105–13.
13. Charton C, Colon P, Pla F. Shrinkage stress in light-cured composite resins: influence of material and photoactivation mode. *Dent Mater*. 2007;23(8):911–20.
14. Belli S, Orucoglu H, Yildirim C, Eskitascioglu G. The effect of fiber placement or flowable resin lining on microleakage in Class II adhesive restorations. *J Adhes Dent*. 2007;9(2):175–81.
15. Dietschi D, Spreafico R. Current clinical concepts for adhesive cementation of tooth-colored posterior restorations. *Pract Periodontics Aesthet Dent*. 1998;10(1):47–54.
16. Samartzi TK, Papalexopoulos D, Ntovas P, Rahiotis C, Blatz MB. Deep Margin Elevation: A Literature Review. *Dent J (Basel)*. 2022;10(3):48. doi:10.3390/dj10030048.
17. Magne P. deep margin elevation: aparadigm shift. *Amer J Estht Dent*. 2012;2(2):86–96.
18. Iida K, Inokoshi S, Kurosaki N. Interfacial gaps following ceramic inlay cementation vs direct composites. *Oper Dent*. 2003;28(4):445–52.
19. Alleman N, Alleman. The Protocols of Biomimetic Restorative Dentistry: 2002 to 2017. *Inside Dent*. 2017;13(6):64–70.

Author biography

Rishu Mittal, Dental Surgeon

Shivani Hooda, Deputy Civil Surgeon

Cite this article: Mittal R, Hooda S. Managing the deep carious lesion biomimetically without pulpal involvement. *IP Indian J Conserv Endod* 2024;9(1):53-57.