ORIGINAL RESEARCH

Comparative Evaluation of Effect of Lasers and Biodentine in Dentine Regeneration: A Clinical Study

Naren Sharma[1], Nitin Malik[2], Yogesh Garg[3], Harpinder Singh[4], Kamal Garg[5], Anmol Bagaria[6]

Abstract

Aim: To compare and evaluate the effect of different liners separately and in combination with lasers that is resin modified glass-ionomer cement (RMGIC), Laser+RMGIC, Biodentine, Laser+Biodentinein the treatment of deep carious lesions.

Materials and methods: Forty patients with deep caries indicated for pulp capping were selected. Curative procedure including the cavity preparation with maximal removal of softened dentine using spoon excavator, slow speed handpiece with round burs was performed. Patients were divided into four groups with 10 patients in each group

In group A RMGIC liner, group B laser biostimulation followed by RMGIC liner, group C biodentine liner, group D laser biostimulation followed by Biodentine liner were placed in the cavity after caries removal. Cavities were temporarily restored with IRM for 8 weeks.

After 8 weeks, liners in each group were removed, and cavities were permanently restored lower half of the cavity with a layer of flowable Z350 XT composite, and then the remaining half of the cavity with P60 filled composites (3 M ESPE, USA) in all the groups. The observation period was 12 months.

Results: All the patients showed a positive response to cold test and electric pulp test at 3 months, 6 months, 12 months follow-up.

In group A (RMGIC) two patients and in group B (Laser+Biodentine) three patients did not return back for the follow-up.

To standardize the samples, seven patients were selected from each group with a total of 28 samples included in the study (n = 7) and statistical analysis was done using analysis of variance (ANOVA) test.

The mean for the total amount of dentine deposited after 12 months was highest in:

Group D–(Laser+Biodenitne) 0.32 mm > Group C–(Biodentine) 0.25 mm > Group B–(Laser+RMGIC) 0.10 > Group A–(RMGIC) 0.07 mm

Conclusion: Within the limitation of the present study the following conclusion was drawn:

- Lasers and biodentine are good indirect pulp capping agents
- Laser has an additional effect on the tertiary dentine formation.

Clinical significance: Lasers with antibacterial effect penetrate into dentinal tubules and accelerate the rate of dentin bridge formation in deep carious lesions.

Keywords: Biodentine, Deep carious lesions, Dentine regeneration, Indirect pulp therapy, Laser biostimulation.

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Introduction

Dental caries is a disease which after enamel demineralization progresses slowly into the dentine. The lesion is expressed by an advancing zone of demineralization underneath which there is a bacteria affecting zone of partially demineralized dentine.

Clinically the differentiation of these two zones and the removal of the contaminated dentine alone is challenging. Consequently, a considerable amount of sound but demineralized tooth structure gets eradicated during cavity preparation.[1]

However, even after the elimination of the infected layer, viable bacteria have been routinely found in the remaining affected dentine. Therefore, liners providing the antibacterial activity in order to uphold a more immediate inactivation of the remaining viable microorganisms would be much profitable.

With indirect pulp therapy, carious dentin near the pulp is conserved to avoid pulp exposure and is covered with a biocompatible material. Pulpal inflammation is inescapable once the dentin is affected. Subjacent to deep carious lesions, the pulp presents chronic inflammatory exudates, including lymphocytes, macrophages, and plasma cells, signaling that pulpitis has been developed even in the absence of unprovoked pain.

The remaining dentin thickness has been admitted widely as the main factor in determining the long-term success of the treatment in the absence of bacteria, whereas material toxicity has been implicated with a pulpal injury and subsequent pulpal healing.[2]

For many years calcium hydroxide and glass ionomer have been considered a choice of material for pulp protection and deep dentinal caries.

[1]Department of Conservative Dentistry, Shree Bankey Bihari Dental College, Ghaziabad, Uttar Pradesh, India

[2,6]Private Practioner, India

[3]Department of Public Health Dentistry, Surendera Dental College and Research Institute, Sriganganagar, Rajasthan, India

[4]Department of Orthodontics, Shree Bankey Bihari Dental College, Ghaziabad, Uttar Pradesh, India

[5]Department of Periodontics, Surendera Dental College and Research Institute, Sriganganagar, Rajasthan, India

Corresponding Author: Naren Sharma, Department of Conservative Dentistry, Shree Bankey Bihari Dental College, Ghaziabad, Uttar Pradesh, India, Phone: +918860896603, e-mail: naresharma0890@gmail.com

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Recently, the popularization of calcium silicate-based cements as restorative materials have been received. Biodentine is indicated for use in permanent deep dentinal cavity restorations and temporary enamel restorations for periods less than 6 months.

However, the safety of its use in deep dentinal cavities without any pulp protection measure has not been scrutinized, and biodentine capability to induce transdentinal dentinogenic effects is still ambiguous.

A number of studies determining that different types of lasers have antibacterial effects on different microorganisms. In particular, diode and erbium lasers can produce an antibacterial effect on enamel, dentin, and carious tissue with a minimal amount of thermal severance to the remaining tooth.

To remove residual caries thoroughly and efficiently, it is important to know the possible antibacterial effect of diode lasers on the microorganisms related to dental caries.[3]

The apparent unanimity is that diode laser irradiation has a potential antibacterial effect. In most cases, the effect is analogous to the amount of energy delivered.[4]

Aim

To compare and evaluate the effect of different liners separately and in combination with lasers that is RMGIC, laser+RMGIC, Biodentine, Laser+Biodentine in the treatment of deep carious lesions.

Materials and Methods

Study Set-up

The present study was conducted in the Department of Conservative Dentistry and Endodontics, ITS dental college and hospital, Greater Noida in collaboration with Department of Oral and Maxillofacial Radiology. The study evaluated the effect of Lasers and Biodentine in Dentine regeneration in a patient with deep carious lesions using Radio visual graph software.

Patients with deep caries indicated for pulp capping were selected from the Department of Conservative Dentistry and Endodontics, ITS Dental College and Hospital and Research Center, knowledge park III, Greater Noida, Uttar Pradesh, India.

Inclusion Criteria

- Permanent molars with class I caries with soft dentin thickness on the pulpal floor between 1.5–2 mm.
- Vital teeth as determined by using cold test with the help of Endo Ice spray and electric pulp test.

Exclusion Criteria

- *Symptoms:* Pain on percussion/palpation, sensitivity to hot.

Method of Pulp Capping

Forty patients with deep carious lesions indicated for indirect pulp capping were chosen. Patients acquiescence was taken and explanation regarding the study protocol, clinical procedure and possible complications of the procedure was meticulously done.

The clinical study was done on 40 molar teeth with deep caries of both genders with diagnosed caries profunda using clinical and radiographic cross-examination.

Caries profunda was studied as a carious lesion with soft dentin causing sensitivity to thermal stimuli and affecting more than 3/4th of the tooth crown with healthy gingiva around the tooth.

Preceding to the treatment a radiograph of each tooth was taken to check if there is possible micro-perforation of the pulp. Dentin thickness between the bottom of the cavity and the pulp was recorded using a ruler on RVG software.

The tooth was isolated under a rubber dam. Curative procedure including the cavity preparation with maximal removal of softened dentine using spoon excavator, slow speed handpiece with round burs was performed.

The samples were divided into four groups with 10 samples in each group:

- *Group A*–RMGIC Liner
- *Group B*–Laser+RMGIC
- *Group C*–Biodentine
- *Group D*–Laser+biodentine
- *Group A*–Resin-modified glass ionomer cement (RMGIC) (Vitrebond-3M) light hardening paste was implanted gently as a liner on the floor of the cavity (Fig. 1).

The Vitrebond liner was cured by exposing it for 30 seconds to light from a 3M ESPE light curing unit

- *Groups B and D*–The parameters for the cavity decontamination by the diode laser 980 nm assisted procedure were as follows—decontamination of the cavity–1 W, Continuous Wave, the fiber diameter of 400 µm, in contact, 2 mm per second, circular motion for 10 seconds. It was repeated three times with a 5 seconds interval with the use of safety glasses for the operator, assistant, and the patient.

After cavity decontamination, resin-modified glass ionomer cement (RM-GIC) (Vitrebond) (3M ESPE, St. Paul, MN, USA) light-hardening paste was implanted as a liner on the floor of the cavity in group B (Fig. 2).

After cavity decontamination, Biodentine was collected with an amalgam carrier and implanted as a liner on the floor of the cavity in group D (Fig. 3).

Group C–Biodentine was placed gently as a liner on the cavity floor (Fig. 4).

All cavities were temporarily restored using IRM cement for 8 weeks with periodic supervision every 2 weeks during which

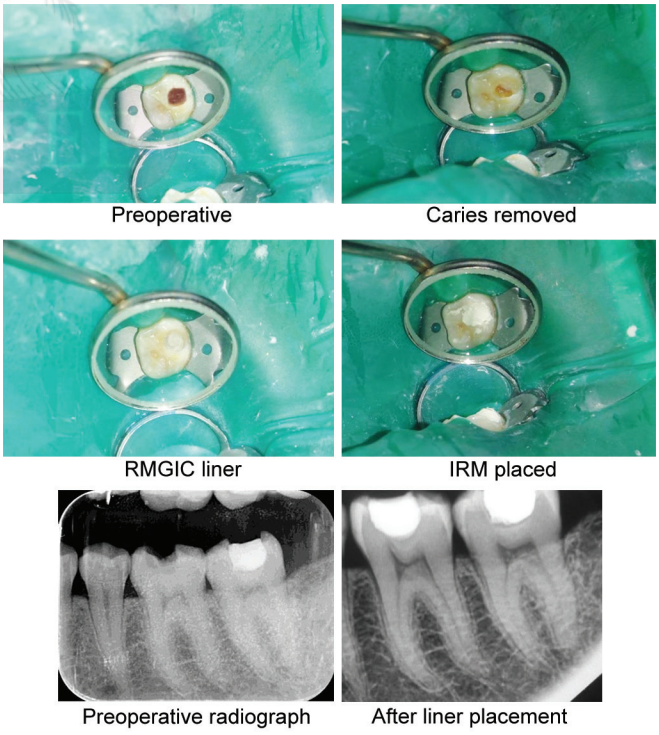


Fig. 1: Group A case (RMGIC)

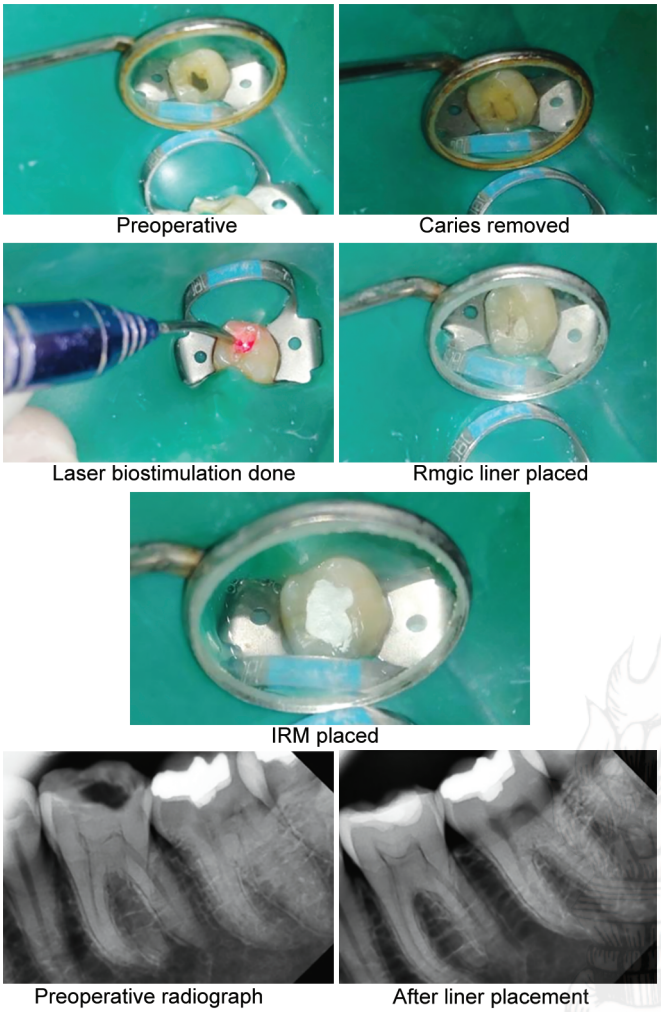


Fig. 2: Group B case (laser + RMGIC)

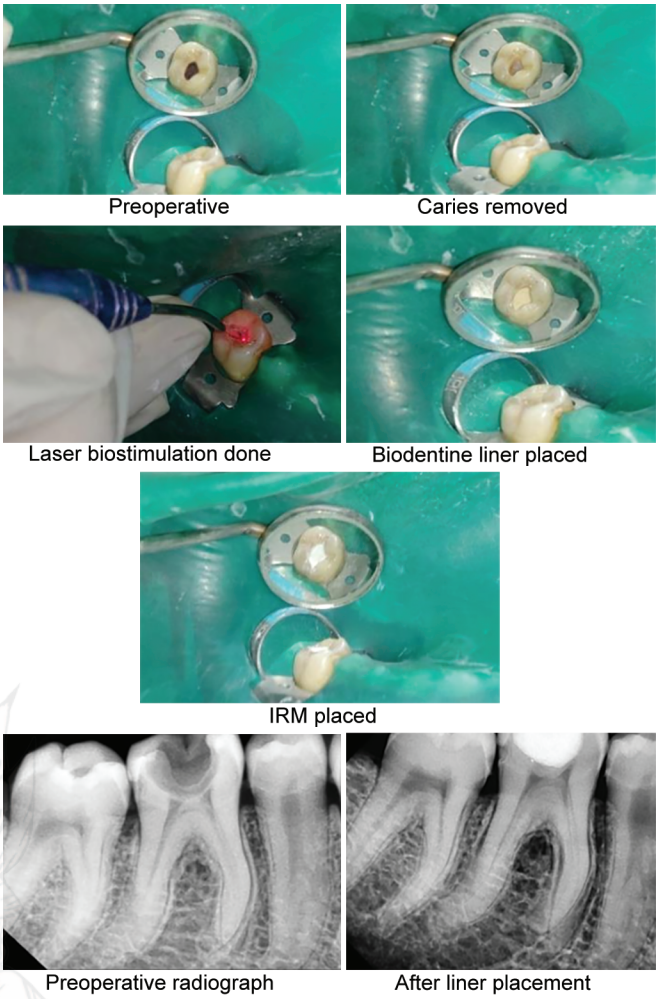


Fig. 3: Group D case (laser + biodentine)

new clinical and radiographic evidence of tooth were taken such as any spontaneous pain, any response to cold and hot stimuli. Any signs of apical radiolucency or dentin resorption were also noticed.

After 8 weeks, liners in each group were removed and cavities were permanently restored lower half of the cavity with a layer of flowable Z350 XT composite, and then the remaining half of the cavity with P60 filled composites (3 M ESPE, USA) in all the groups. The observation period was 12 months with mandatory check-up after 3 and 6 months.

The resulting assessment of different treatments including clinical and radiographic observation was done based on the following criteria's:

Clinically

- Symptoms such as pain on percussion and percussion test to outlook the periradicular involvement of the tooth and to check the extent of periradicular bone involvement.
- Response to thermal stimuli, i.e., Cold test by using Endo ice spray on the cotton pellet, the excess was soaked out and the pellet was placed immediately on the intact buccal surface in the middle third area of tested teeth and vitality was also checked by using electric pulp test

Radiographically

- Periapical radiographic changes
- Radiographic-verified "bridge" formation

The distance between two points i.e base of the cavity and highest point of the pulp horn were measured at different time intervals—3 months, 6 months, 12 months to assess the increase in dentin bridge formation using a ruler in the RVG software and values were recorded (Fig. 5).

Results

In this study, 40 patients were selected for indirect pulp capping

Patients were divided into 4 groups (n = 10)

In group A (RMGIC) 2 patients and in group B (Laser + Biodentine) 3 patients did not return back for the follow-up.

To standardize the samples, 7 patients were selected from each group with a total of 28 samples included in the study (n = 7) and statistical analysis was done using ANOVA test.

All the teeth showed a positive response to cold test and electric pulp test at 3 months, 6 months, 12 months follow-up.

Remaining dentin thickness value immediately after liner placement, at 3 months, 6 months and 12 months for group A are shown in Table 1.

The highest mean for the remaining dentine thickness was observed at 12 months follow-up (1.81 mm) for group A (RMGIC)–Table 2 and Graph 1.

Highest standard deviation was observed at 6 and 12 months (0.23mm) follow up for group A (RMGIC) (Table 2 and Graph 2).

Remaining dentin thickness value immediately after liner placement, at 3 months, 6 months and 12 months for group B is shown in Table 3.

The highest mean for remaining dentine thickness was observed at 12 months follow up (1.72 mm) in group B (laser+ RMGIC) (Table 4 and Graph 3).

The standard deviation for group 2 was highest at 12 months follow-up (0.18mm) in Group B (Table 4 and Graph 4).

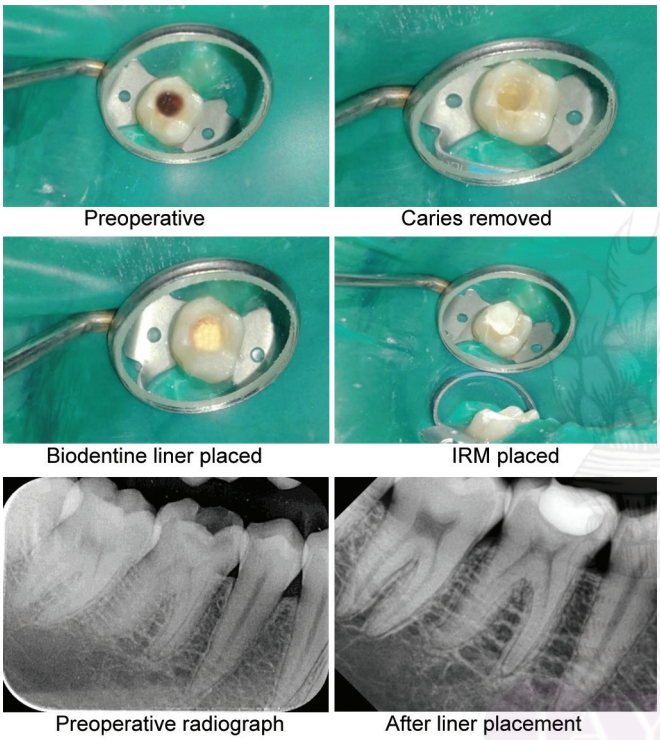


Fig. 4: Group C case (biodentine)

Remaining dentin thickness value immediately after liner placement, at 3 months, 6 months and 12 months for group C is shown in Table 5.

The highest mean for remaining dentine thickness was observed at 12 months follow-up (1.95 mm) for group C (biodentine) (Table 6 and Graph 5).

Standard deviation observed was highest at 12 months (0.25mm) in group C (Biodentine) (Table 6 and Graph 6).

Remaining dentin thickness value immediately after liner placement, at 3 months, 6 months and 12 months for group D is shown in Table 7.

The highest mean observed was at 12 months follow-up (1.98 mm) in group D (laser + biodentine) (Table 8 and Graph 7).

The highest standard deviation observed was at 6 months follow-up (0.23 mm) in group D (laser + biodentine) (Table 8 and Graph 8).

The mean for total amount of dentine deposited after 12 months was highest in:

Group D–(laser+biodenitne) 0.32 mm> group C–(biodentine) 0.25 mm > group B–(laser+RMGIC) 0.10 > group A–(RMGIC) 0.07 mm (Table 9 and Graph 9).

Discussion

Dental caries is usually a slow, periodic microbial disease which causes demineralization of the enamel and dentine, as well as proteolytic digestion of the collagen matrix of the dentine.[5]

Whereas, deep carious lesions are defined as lesions encompassing more than two-thirds of the dentin thickness. Either pre- or post-operative radiographs are used to assure the lesion depth.

Two important factors could have altered the residual bacteria reduction: (1) the acceptable cavity sealing, which limited the extent and the intricacy of nutrients available, and (2) the antibacterial activity of the liner materials.[6]

The purpose of this study was to compare and evaluate the effect of lasers and biodentine in dentine regeneration. The null hypothesis was that there is no significant effect of laser and biodentine on dentine regeneration.

The liners were placed after caries removal and restored with IRM for 8 weeks with periodic surveying done every 2 weeks. In 2 weeks follow-up, the vitality test (cold test and electric pulp test) were done and a radiograph was taken to evaluate the dentine bridge formation and to look for the periapical changes.

Fig. 5: Screenshots showing increase in RDT

Fig. 6: Zolar photon plus diode laser

After 8 weeks, liners in each group were removed and cavities were permanently restored with a layer of flowable Z350 XT and then P60 filled composites (3 M ESPE, USA) in all the groups. The observation period was 12 months with mandatory check-ups after three and six months.

In groups B and D, diode laser was being used (Fig. 6) for cavity fumigation after caries removal which showed a slight but non-significant increase in RDT when compared with RMGIC and biodentine group. Group D (laser+ biodentine) showed a maximum increase in RDT among all the groups.

Santucci, Jayawardena, Moritz, Iaria, Olivi stated that laser-assisted pulp capping has considerable advantages compared to traditional methods.[7]

Effect of lasers can be as follows:

- Decontaminant effect
- Hemostatic and coagulant effect
- Limited increase in pulp temperature
- Reduction of intracavitary pressure
- Dentinal melting
- Biostimulating effect

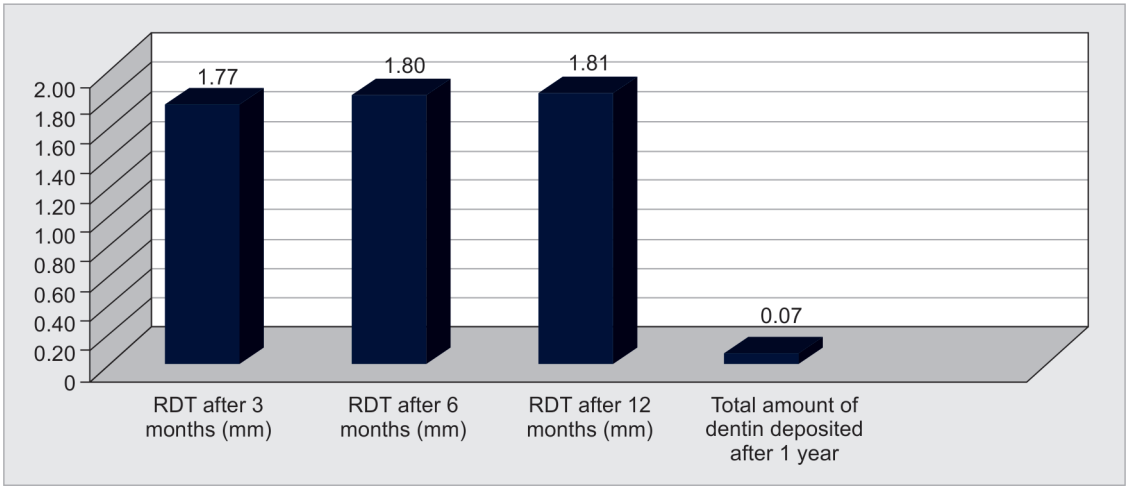
Table 1: Group A (RMGIC) RDT at 3 months, 6 months, and 12 months

Sample no.	RDT immediately after liner placement (mm)	RDT after 3 months (mm)	RDT after 6 months (mm)	RDT after 12 months (mm)	Total amount of dentin deposited after 1 year
1	1.52	1.54	1.54	1.55	0.03
2	1.88	1.92	1.95	1.99	0.11
3	1.94	2.05	2.12	2.12	0.18
4	1.5	1.5	1.5	1.5	0
5	1.93	1.96	2.06	2.06	0.13
6	1.67	1.7	1.71	1.71	0.04
7	1.69	1.7	1.7	1.72	0.03

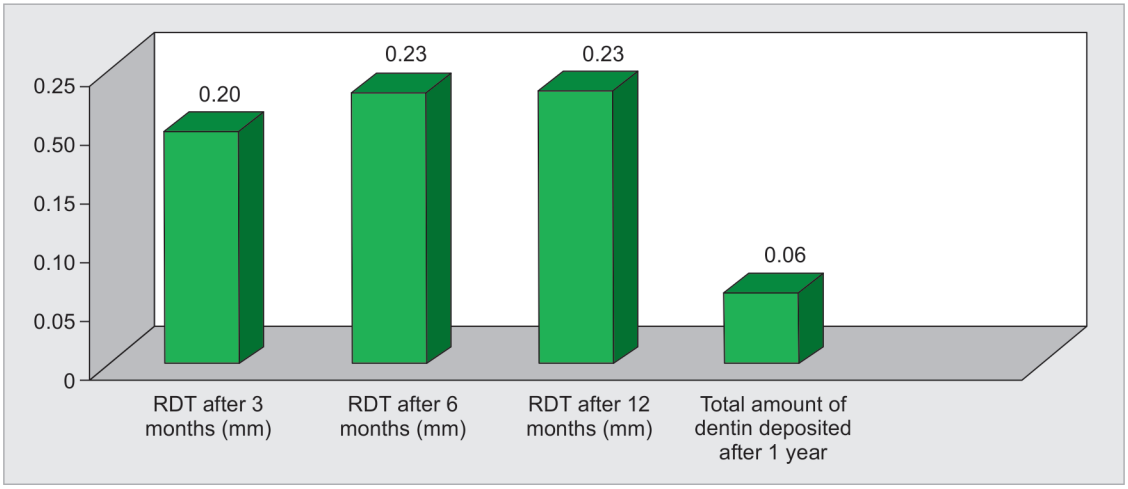
Source of variation	*SS*	*df*	*MS*	*F*	*p value*	*F crit*
Between groups	16.24151	4	4.060379	97.57845	0.00	2.689628
Within groups	1.248343	30	0.041611			
Total	17.48986	34				

Table 2: Mean and standard deviation values of group A at 3 months, 6 months, and 12 months

RDT (mm)	*Mean*	*Standard deviation*
RDT after 3 months (mm)	1.77	0.20
RDT after 6 months (mm)	1.80	0.23
RDT after 12 months (mm)	1.81	0.23
Total amount of dentin deposited after 1 year	0.07	0.06



Graph 1: Mean of group A at 3 months, 6 months, and 12 months



Graph 2: Standard deviation of group A at 3 months, 6 months, and 12 months

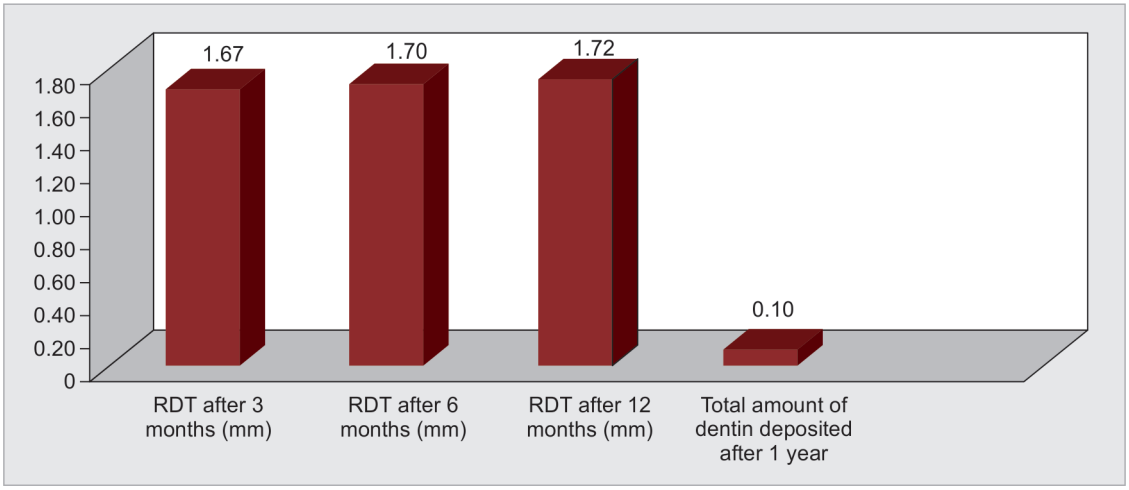
Table 3: Group B (laser+ RMGIC) RDT at 3 months, 6 months, and 12 months

Sample no.	*RDT immediately after liner placement (mm)*	*RDT after 3 months (mm)*	*RDT after 6 months (mm)*	*RDT after 12 months (mm)*	*Total amount of dentin deposited after 1 year*
1	1.87	1.92	1.93	1.96	0.09
2	1.51	1.54	1.58	1.6	0.09
3	1.5	1.53	1.56	1.59	0.09
4	1.89	1.99	2.01	2.04	0.15
5	1.52	1.54	1.56	1.59	0.07
6	1.59	1.61	1.66	1.66	0.07
7	1.51	1.54	1.6	1.62	0.11

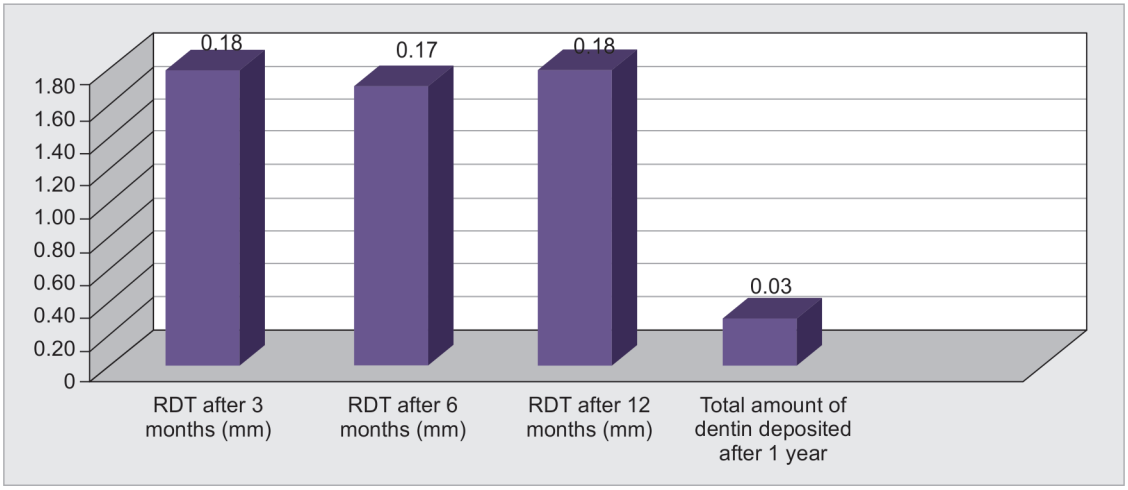
Source of variation	*SS*	*df*	*MS*	*F*	*p value*	*F crit*
Between groups	14.07947	4	3.519867	122.2459	0.00	2.689628
Within groups	0.8638	30	0.028793			
Total	14.94327	34				

Table 4: Mean and standard deviation value of group B at 3months, 6 months, and 12 months

RDT (mm)	*Mean*	*Standard deviation*
RDT after 3 months (mm)	1.67	0.18
RDT after 6 months (mm)	1.70	0.17
RDT after 12 months (mm)	1.72	0.18
Total amount of dentin deposited after 1 year	0.10	0.03



Graph 3: Mean of group B at 3 months, 6 months, and 12 months



Graph 4: Standard deviation of group B at 3months, 6 months, and 12 months

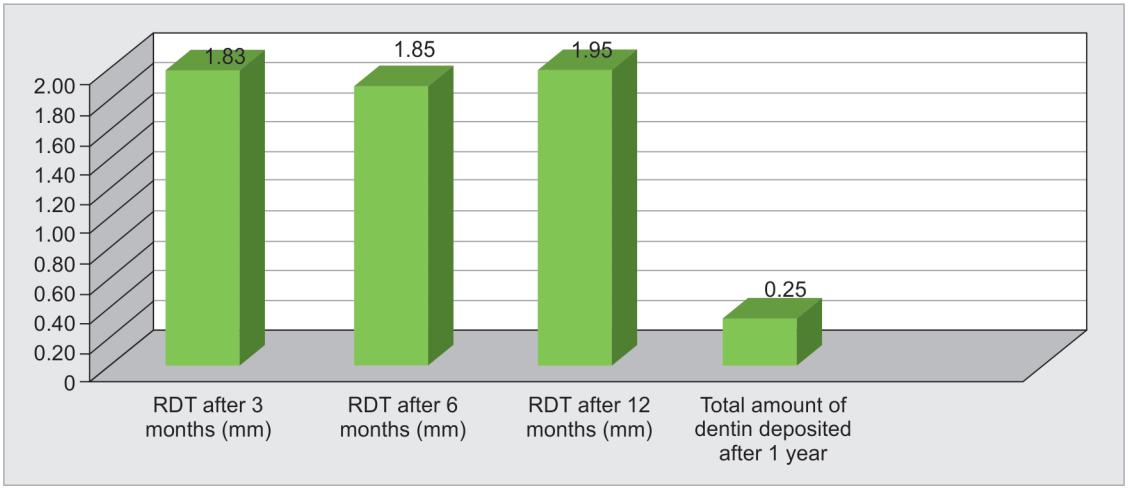
Table 5: Group C (Biodentine) RDT at 3 months, 6 months, and 12 months

Sample no.	RDT immediately after liner placement (mm)	RDT after 3 months (mm)	RDT after 6 months (mm)	RDT after 12 months (mm)	Total amount of dentin deposited after 1 year
1	1.52	1.6	1.69	1.73	0.21
2	1.76	1.85	1.93	2	0.24
3	1.56	1.6	1.66	1.74	0.18
4	1.5	1.55	1.6	1.62	0.12
5	1.79	1.83	1.93	2.06	0.27
6	1.71	2.1	2.21	2.29	0.58
7	1.96	2.08	2.16	2.22	0.26

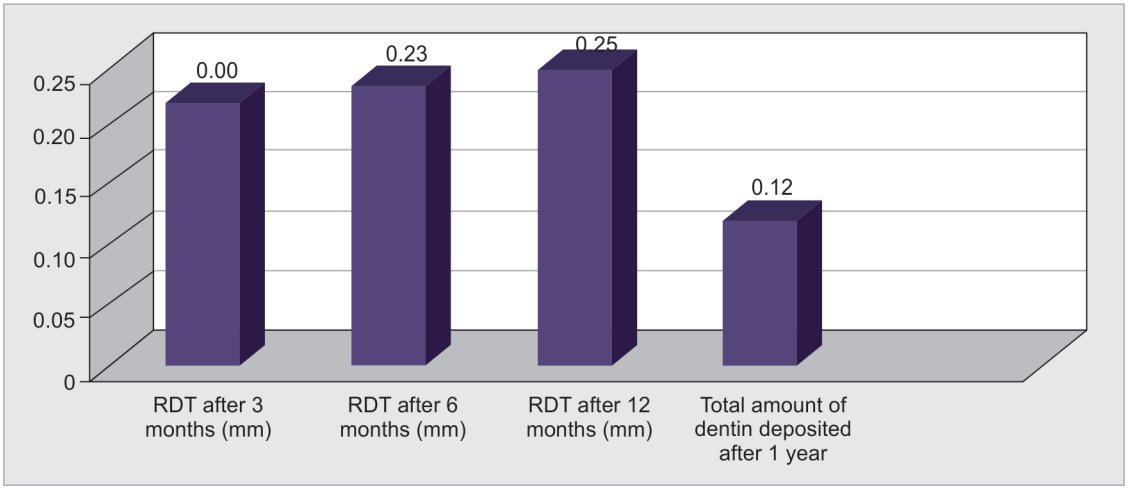
Source of variation	*SS*	*df*	*MS*	*F*	*p value*	*F crit*
Between groups	13.72658	4	3.431646	46.96412	0.00	2.689628
Within groups	2.192086	30	0.07307	–	–	–
Total	15.91867	34	–	–	–	–

Table 6: Mean and standard deviation value of group C at 3 months, 6 months, and 12 months

RDT (mm)	*Mean*	*Standard deviation*
RDT after 3 months (mm)	1.83	0.22
RDT after 6 months (mm)	1.85	0.23
RDT after 12 months (mm)	1.95	0.25
Total amount of dentin deposited after 1 year	0.25	0.12



Graph 5: Mean of group C at 3 months, 6 months, and 12 months



Graph 6: Standard deviation of group C at 3 months, 6 months, and 12 months

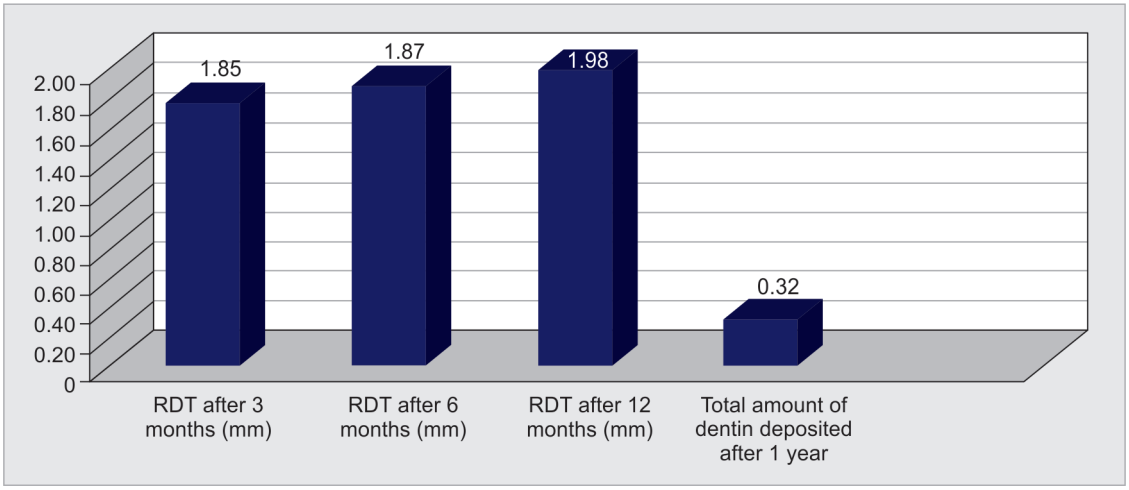
Table 7: Group D (laser+ biodentine) RDT at 3 months, 6 months, and 12 months

Sample no.	*RDT immediately after liner placement (mm)*	*RDT after 3 months (mm)*	*RDT after 6 months (mm)*	*RDT after 12 months (mm)*	*Total amount of dentin deposited after 1year*
1	1.78	2.02	2.06	2.06	0.28
2	1.61	1.67	1.71	1.75	0.14
3	1.54	1.59	1.63	1.69	0.15
4	1.97	2.08	2.16	2.22	0.25
5	1.64	1.66	1.7	1.7	0.06
6	1.51	1.59	1.69	2.14	0.63
7	1.76	2.12	2.17	2.17	0.41

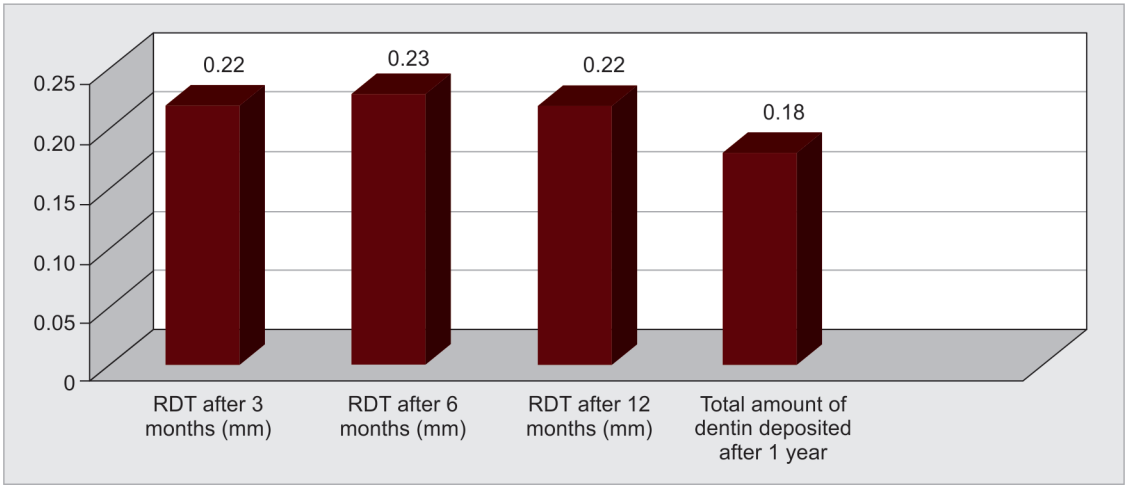
Source of variation	*SS*	*df*	*MS*	*F*	*p value*	*F crit*
Between groups	13.9245	4	3.481124	73.29417	0.00	2.689628
Within groups	1.424857	30	0.047495			
Total	15.34935	34				

Table 8: Mean and standard deviation value of group D at 3months, 6 months, and 12 months

RDT (mm)	*Mean*	*Standard deviation*
RDT after 3 months (mm)	1.85	0.22
RDT after 6 months (mm)	1.87	0.23
RDT after 12 months (mm)	1.98	0.22
Total amount of dentin deposited after 1 year	0.32	0.18



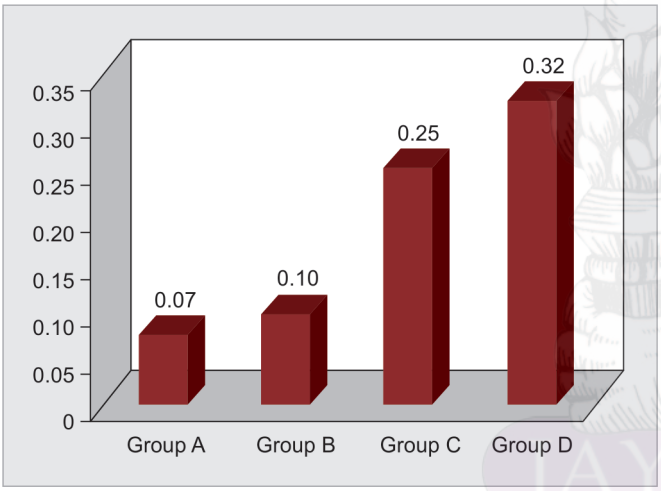
Graph 7: Mean of group D at 3 months, 6 months, and 12 months



Graph 8: Standard deviation of group D at 3 months, 6 months, and 12 months

Table 9: Total amount of dentine deposited after 12 months (mm)

	Group A	*Group B*	*Group C*	*Group D*
Total amount of dentin deposited after 1 year	0.07	0.10	0.25	0.32



All the values are in mm

Graph 9: Comparison of the total amount of dentin deposited in groups A, B, C and D at 12 months

Lethal impairment includes the destruction of the cell wall integrity and possibly the denaturation of the protein. The cell wall destruction will cease cell growth and successive cell lysis. At the same time, cellular protein is susceptible to thermal changes.[8]

Another hopeful explication could be due to the dentinal tubule occluding which results from melting of dentin that leads to the entrapping of the invading microorganisms and dentinal fluid cut back as a source of nutrition.[9]

According to Murat, using one cycle will most likely result in partly disruption of the bacterial layer and the extensive bacterial reduction was gained in all cases by repeating laser treatment with a high power diode laser.[10]

In group C Biodentine, the significant amount of dentin bridge formation was appreciated.

Atmeh et al. in 2012 and Watson et al. in 2014 stated that the Biodentine with alkaline caustic effect results into debasement of the collagenous component of the underlying dentine, leading to the formation of porosities that facilitated diffusion of high concentrations of calcium, hydroxyl, and carbonate ions, leading to increased mineral deposition.[11]

Biodentine with evidence showing zones of inhibition signifies that it has an anti-microbial effect that might be attributed to the high pH. Piyalakshmi and Ranjan stated that the deep-seated and constant alkalinity of Biodentine might be sufficient to control the *S. mutans*.[12]

The magnitude of tertiary dentine formed is directly related to the postoperative interval following cavity preparation and marginally distressed by the degree of operative trauma. It is self-evident that the formation of tertiary dentine is most rapid initially and decreases extensively after about 30 active days of production (about 48 postoperative days).[13]

Dentin sialophospho protein is considered to be a peculiar biochemical marker of functional odontoblasts, its role in dentin formation being an essential one since it initiates and regulates biomineralization.[14]

In group A, RMGIC has been used as a liner in deep cavities showed slight less amount of dentin bridge formation

Costa et al .stated that vitre bond can be applied in deep cavities in sound human dentine. Felton and Hilton have indicated that the pulp-dentin complex reaction to visible-light-activated glass-ionomer cements is quite positive when implanted as cavity liners.[15]

Costa et al. reported that the crystal plugs into the dentinal tubules might hamper vitre bond components inward diffusion from the cavity floor to reach the pulpal space which contributes to reactionary dentin.[16]

Costa et al. proclaimed that axial wall of deep cavities prepared in human teeth does not undergo any inflammatory pulpal response or tissue disorganization when tested against vitrebond, even when the RDT was 272 µm.[17]

As an after effect, bioactive molecules such as transforming growth factors (TGF-βs) could be discharged from the dentine matrix and stimulated to induce odontoblast cells to produce intratubular and reactionary dentine in order to reduce dentine

permeability and to pose a barrier against bacterial invasion via dentinal tubules.[7]

Conclusion

Within the limitation of the present study the following conclusion was drawn:

- Lasers and Biodentine are good indirect pulp capping agents
- Laser has an additional effect on the tertiary dentine formation.

However further studies are required to assess the rate of the dentine formation in the presence of lasers.

Limitation

The patient might not have strictly followed the compliance, could have altered the results as they were not under full-time monitoring, only being reviewed at different time intervals.

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