CASE REPORT

DIRECT PULP CAPPING PROCEDURE USING BIODENTINE OR PLATELET RICH FIBRIN WITH OR WITHOUT DIODE LASER APPLICATION: A CASE SERIES

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ABSTRACT

Direct pulp capping is a procedure in which exposed vital pulp due to caries excavation or trauma is covered with a protective capping material in an attempt to preserve pulp vitality. Diode laser used for multiple applications in dentistry may expedite the repair of the pulp.

Deeply carious four permanent teeth with reversible pulpitis were selected. Sensibility of tooth was assessed using cold test and digital electric pulp tester.

Under local anaesthesia and rubber dam isolation caries was removed. The exposed pulp was capped with biodentine in 1st case which was also used in 2nd case after laser irradiation. In 3rd case autologous PRF membrane was used as capping agent while in the rest laser irradiation followed the same. In all 4 cases RMGIC liners was given and were restored with composite.

On follow-up visits teeth were asymptomatic, sensitive to the vitality test and dentinal bridge thickness measured from IOPAR revealed gradual increase in thickness upto the follow-up period of 12 months. In laser irradiation cases it was thicker than otherwise and that with the biodentine was maximum.

KEY WORDS

Direct pulp capping, Diode LASER, Biodentine, Platelet Rich Fibrin

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INTRODUCTION

The dentin is considered a living tissue with the capability to react to physiologic and pathologic stimuli. Such stimuli can result in formation of secondary dentin, reparative dentin, sclerotic dentin and dead tracts.

Reparative dentin (tertiary dentin) is formed by the replacement odontoblasts which are differentiated from the mesenchymal cells of the pulp and these replacement odontoblasts lay down the reparative dentin. Reparative dentin is confined to the localized irritated area of the pulp cavity wall, which becomes apparent microscopically about one month from the inception of the stimulus. It is structurally and chemically different from the primary and secondary dentin, being highly atubular, impervious to most irritants.[1] It is a defensive reaction of pulp to an area of assault. Clinicians are always alert in maintaining the pulp in health.

Vital pulp therapy is aimed at preserving and maintaining pulpal health in teeth in which pulp exposure has occurred due to trauma, caries, or restorative procedures.[10] The treatment options for a pulp-exposed permanent tooth include direct pulp capping (DPC), partial pulpotomy and pulpotomy. DPC is defined as "a procedure in which the exposed vital pulp is covered with a protective dressing or base placed directly over the site of exposure in an attempt to preserve pulpal vitality through the formation of reparative dentin".

The lack of predictability of the outcome of DPC procedures following carious pulp exposure has been stated based on traditional protocols and materials such as calcium hydroxide that did not generate much favourable environment for hard tissue formation.[3-8] The introduction of MTA, Biodentine and other bioceramic or calcium silicate–based cements (CSCs), along with advanced treatment strategies, have markedly changed the long-held concept that pulp capping after carious pulp exposures should be avoided.[9-11]

Previous ex vivo histologic studies in animals as well as histologic and radiographic studies in humans have demonstrated favourable results of Biodentine over MTA used as a DPC agent.[19]

Recently, the platelets concentrates like Concentrated Growth Factor (CGF) and Platelet Rich Fibrin (PRF) are being used in various fields in dentistry due to their regenerative properties. They can be used as pulp capping agents, as the growth factors released from them are known to play a crucial role in hard and soft tissue repair mechanisms, by exhibiting chemotactic and mitogenic properties that promote and modulate cellular functions. They differentiates dental pulp cells into odontoblast like cells, leading to reparative dentin formation.

A review of the pertinent literature indicated that success in the procedures of vital pulp therapy, basically depends on the degree to which the wound area can be maintained free of bacteria in short-term and in long-term.[22]

It is known that different types of lasers possess antibacterial effects. In particular, diode and erbium lasers produce antibacterial effect on carious tissue with a minimal amount of thermal severance to the rest[12].

Apart from this decontamination property, hemostatic and biostimulation effects are of great help.

Many authors (12,13) have emphasized the importance of a sterile field as a crucial phase of the pulp capping anti microbial affect, and confirmed superiority of laser-assisted antimicrobial effect over conventional, antibacterial agents.

Hemorrhage control at the exposure site of the pulp is critical for the success of the pulp-capping treatment as increased bleeding may result in diminished capacity of repair and the moisture contamination of the dentin adjacent to the exposure site makes it more difficult to obtain an adequate seal that will prevent subsequent bacterial exposure[14].

The hemostatic effect of lasers especially Diode Laser is due to the significant absorption of laser light by hemoglobin and melanin, which assures that the treated area will be dry in the least possible time. The fine area of hemostasis created by the Diode Laser includes a thin layer of necrosis layer below which there is an area where the injury can be reversed, i.e., a place for the migration of inflammatory cells and fibroblasts that contribute to the formation of the dentinal bridge.

The bio-stimulation effect of Diode Laser provides reduction of inflammation and pain, cell proliferation and migration, cytodifferentiation of odontoblast-like cells, synthesis of dentin extracellular matrix, and formation of reparative dentin in the injured pulp tissue[15,16,17].

Having understood above mentioned advantages of Diode laser, Biodentine (Septodont, France) and autologous PRF were used as pulp capping agents with or without the application of this laser and its usefulness in DPC procedure was assessed in the following case series.

MATERIALS AND METHODS:

Four teeth in four patients with a deep carious lesion approximating the pulp and sensitivity and mild pain to cold beverages having no tenderness or signs and symptoms of irreversible pulpitis or any periapical pathosis, attending the OPD of Department of conservative dentistry & endodontics of Dr. R. Ahmed Dental College & Hospital, were selected. All the teeth were thoroughly examined clinically and radiologically. Pulp Sensibility test- Cold spray (Roeko Endofrost, Coltene Whaledent, Switzerlnd) and digital Electrical Pulp Tester (EPT) was done and recorded. Informed consent was taken and clearance from the institutional ethics committee was obtained. In this study the Diode laser (DPI, India, Model no.- Diode Laser 4 Watt Expert 04D980) with the parameters of 980nm wavelength, 1.5W power, continuous wave mode, 400 micrometer diameter of fiber tip emitting laser beam, 2 seconds tissue contact time was used.

CASE NO. -1 (biodentine) :

A 28 yrs old female patient reported with the complaint in upper right back tooth. On clinical examination, deep carious lesion disto-proximally on #16 was found. IOPAR showed carious lesion was close to distal pulp horn (Fig.1.A) and gave positive response to both cold test & EPT. With the provisional diagnosis of reversible pulpitis, treatment plan of direct pulp capping was made. The tooth was anesthetised with 2% Lignocaine with adrenaline (1:80000) and rubber dam isolation, was achieved (Fig.1.B). Caries was excavated (Fig.1.C) by spoon excavator along with high speed sterile round diamond bur. Bleeding of exposed pulp was controlled within 30- 40 seconds by a pellet of cotton soaked with 2.5% sodium hypochlorite (Fig.1.D). After achieving haemostasis, DPC procedure was performed.

Biodentine was then mixed with the liquid as per manufacturer's direction. 2 mm thickness of biodentine was placed as capping agent (Fig.1.E). Resin-modified glass ionomer cement (RMGIC; GC Gold Label 2 LC) was placed over it as liner (Fig.1.F) and final restoration was done with composite resin (Te-Econom Plus composite, Ivoclar) (Fig.1.G). Immediate post-op IOPAR was taken (Fig.1.H). The patient was called for follow-up visits for clinical and radiological evaluation. She was asymptomatic. There was no complaint of pain, tenderness on percussion or palpation or discharging sinus and the patient gave positive response to both cold test and EPT, and functioning normally. IOPAR were taken. Using straight line tool of IMAGE J software, the dentinal bridge thickness (DBT) was measured at the time of 3 months (Fig.1.I), 6 months (Fig.1.J), 9 months (Fig.1.K) and 12 months (Fig.1.L) visits.

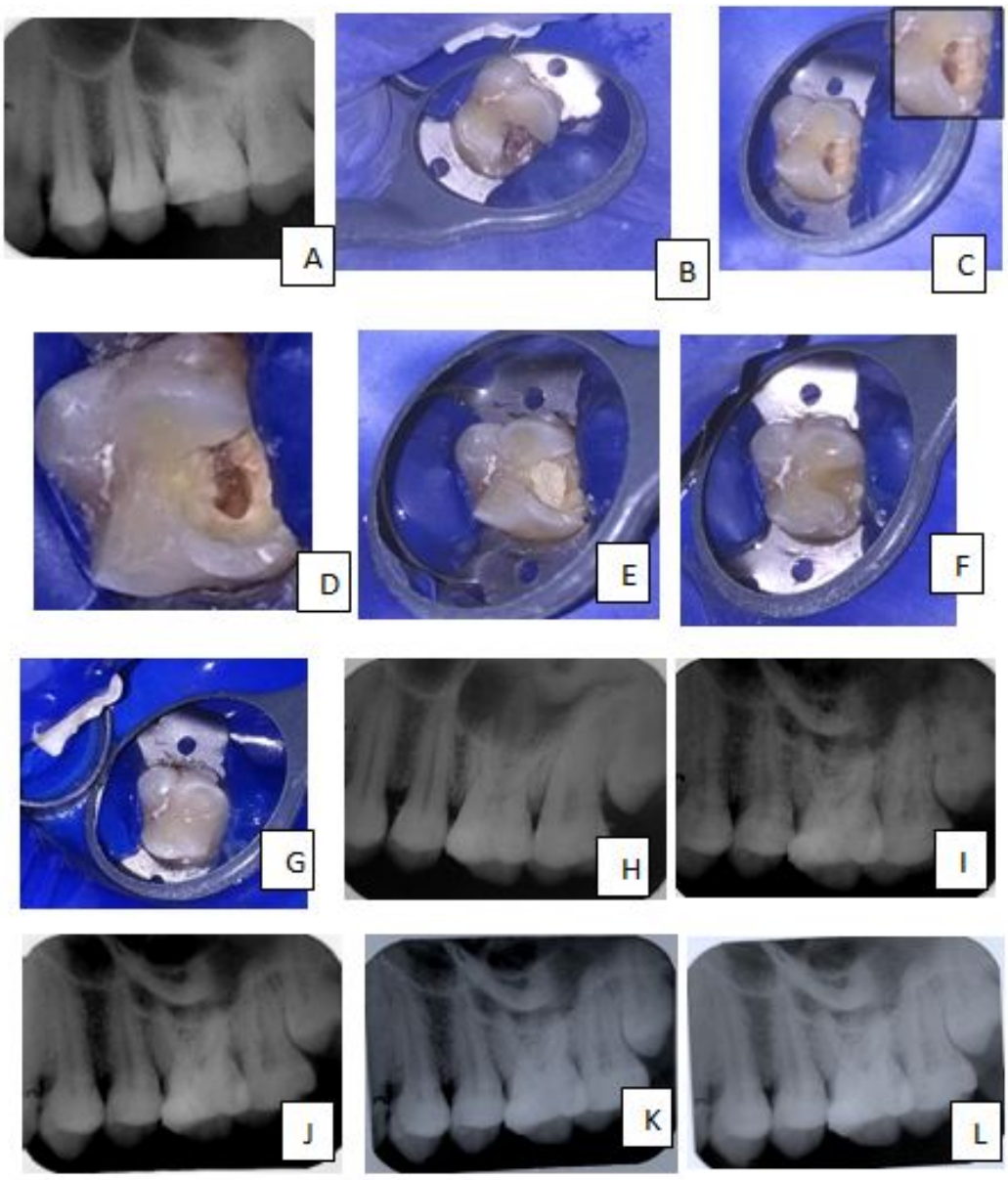

Fig. 1: A & B --Pre-OP, C. After caries excavation, D. Pulp exposure, E. Biodentine placed, F. RMGIC over biodentine G. Post-OP restoration with composite, H. Imm. Post-OP IOPAR, I. 3 mon IOPAR **(DBT-0.361mm)**, J. 6 mon IOPAR **(DBT-0.457mm)**, K. 9 mon IOPAR **(DBT- 0.714mm)**, L. 12 mon IOPAR **(DBT-0.936mm)**

CASE NO. -2 (laser + biodentine) :

A 24 yrs old male patient reported with the complaint in upper back tooth. On clinical examination, deep carious lesion occlusally on #16 was revealed and IOPAR showed carious lesion was very close to pulp (Fig.2.A). It was positive to the both pulp sensibility tests and was diagnosed reversible pulpitis.

Similar to case 1, anaesthesia was achieved; caries excavation was done after rubber dam isolation (Fig.2.B). The bleeding from the exposure site (Fig.2.C) was controlled with the irradiation of the Diode laser (Fig.2.D). Then the same biodentine was placed on exposure site as pulp capping agent (Fig.2.E) which was covered by the RMGIC liner and restored with composite (Fig.2.G). Immediate post-op IOPAR (Fig.2.H) was taken and was asked for follow-up visits. It was seen that the patient was asymptomatic, gave positive response to both cold test and EPT. Through IOPAR at the time of 3 months (Fig.2.I), 6 months (Fig.2.J), 9 months (Fig.2.K) and 12 months (Fig.2.L) visits, it was revealed gradual increase in formed DBT.

DPC WITH BIODENTINE AFTER LASER APPLICATION

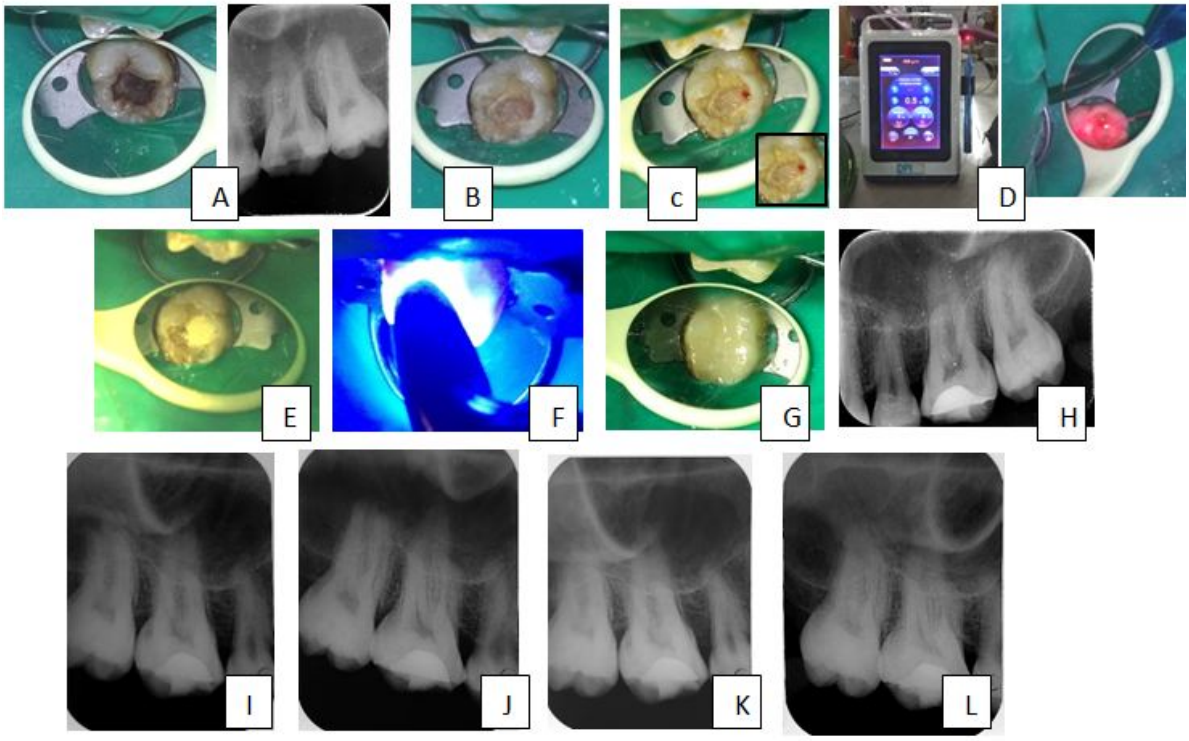

Fig. 2: A. Pre-OP, B. After caries excavation, C. Pulp exposure, D. LASER irradiation(DPI,India,Model no.-Diode Laser 4Watt Expert04D980), E. Biodentine placed, F. Composite restoration, G. Post-OP restoration, H. Imm. post-OP IOPAR I .3 mon IOPAR(DBT-0.674mm), J. 6 mon IOPAR **(DBT-0.946mm)**, K. 9 mon IOPAR **(DBT-1.003mm)**, L. 12 mon IOPAR **(DBT-1.274mm)**

CASE NO. -3 (PRF) :

A 53yrs old male patient reported with complaint of fractured occlusal amalgam restoration done 20 yrs back on lower back tooth. IOPAR showed secondary carious lesion very close to mesial pulp horn of #36 (Fig.3.A).

After anaesthesia and isolation under rubberdam (Fig.3.B), the old restoration was removed (Fig.3.C). Bleeding after caries excavation from exposed pulp was controlled similarly as in case no.-1.

PRF was prepared from patient's own blood as per protocol of Choukroun et al. 10ml of blood was drawn from antecubital vein(Fig.3.D) and immediately transferred to a sterile test tube without anticoagulant (Fig.3.E) and centrifuged for 2700 rpm for 12 minutes in a centrifuge machine (Remi R-8C centrifuge, India) (Fig.3 .F & G).

DPC WITH PRF

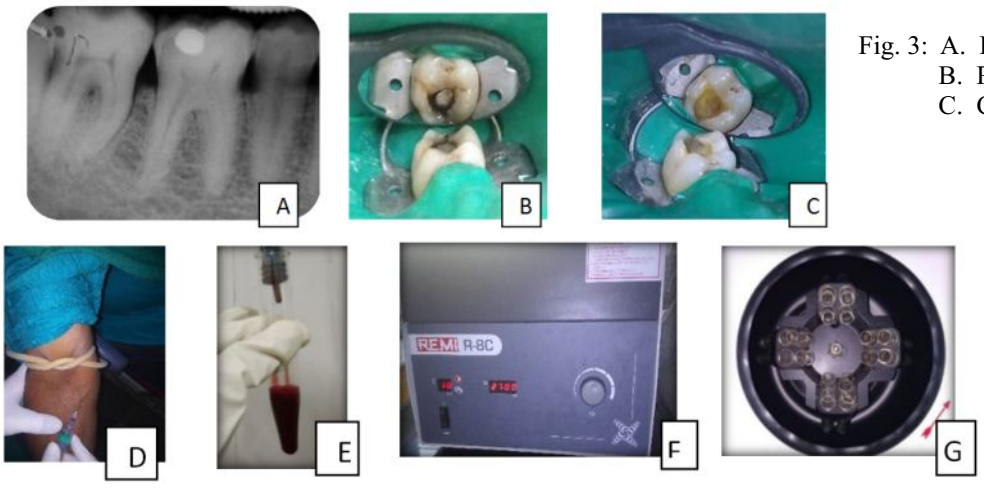

Fig. 3: A. Pre-op IOPAR,
B. Pre-op,
C. Caries excavation

Fig. 3: (contd.): D. Blood collected from antecubital vein, E. Collected blood in test tube, F. & G. Centrifuge machine

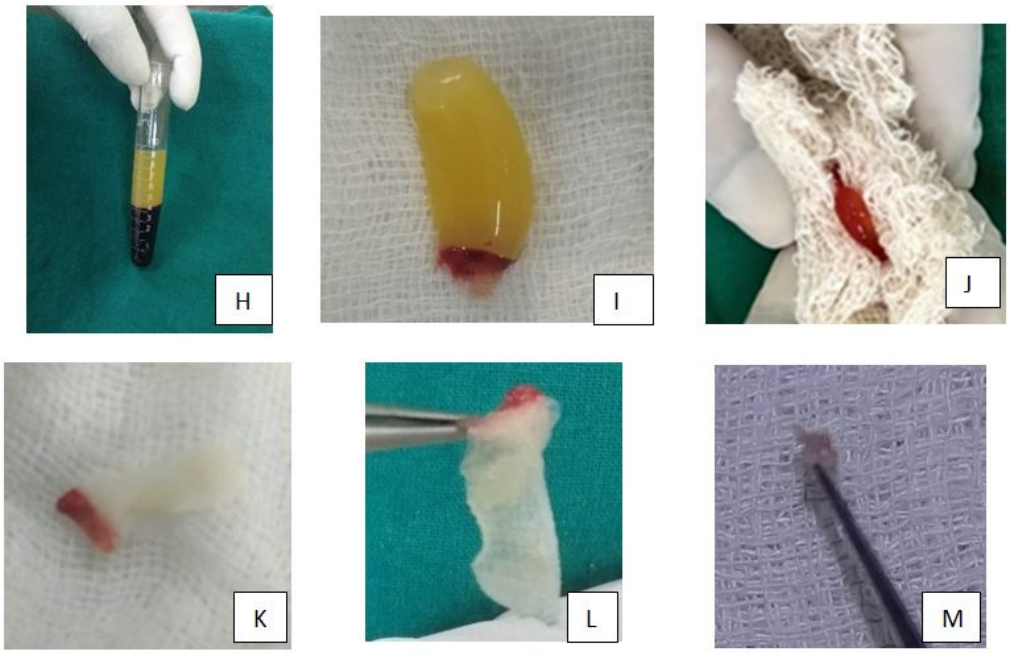

Fig 3(contd.): H. Blood after centrifugation, I. PRF gel after separated from blood clot, J. PRF gel squeezed in between sterile gauge, K & L. PRF membrane on sterile gauge & held with tweezers, M. Small piece of PRF membrane held with tips of tweezers.

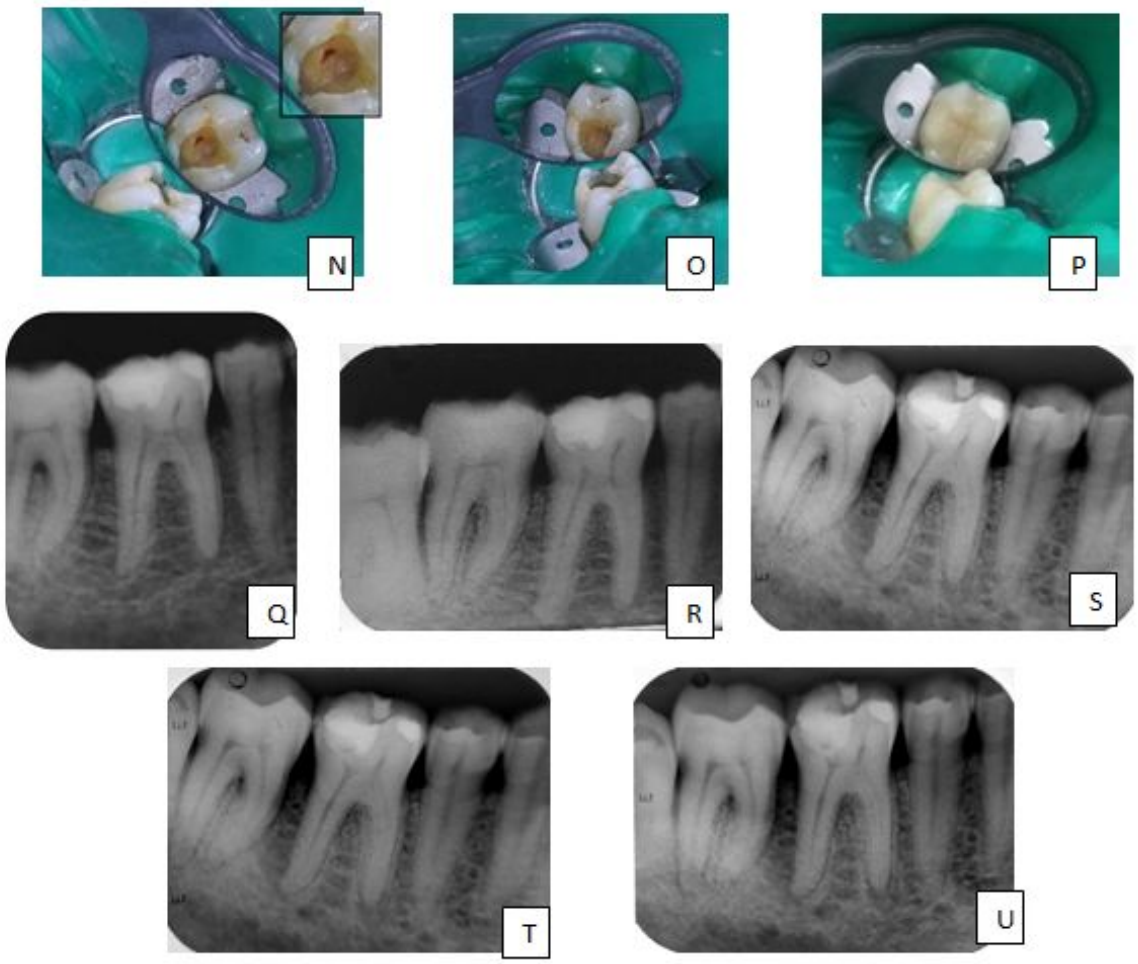

Fig. 3(contd.): N. Pulp exposure, O. PRF placed, P. Post-OP composite restoration over PRF & RMGIC, Q. Imm. post-OP IOPAR, R. 3 mon IOPAR (DBT-0.159mm), S. 6 mon IOPAR (DBT-0.366mm), T. 9 mon IOPAR (DBT-0.710mm), U. 12 mon IOPAR (DBT-0.843mm)

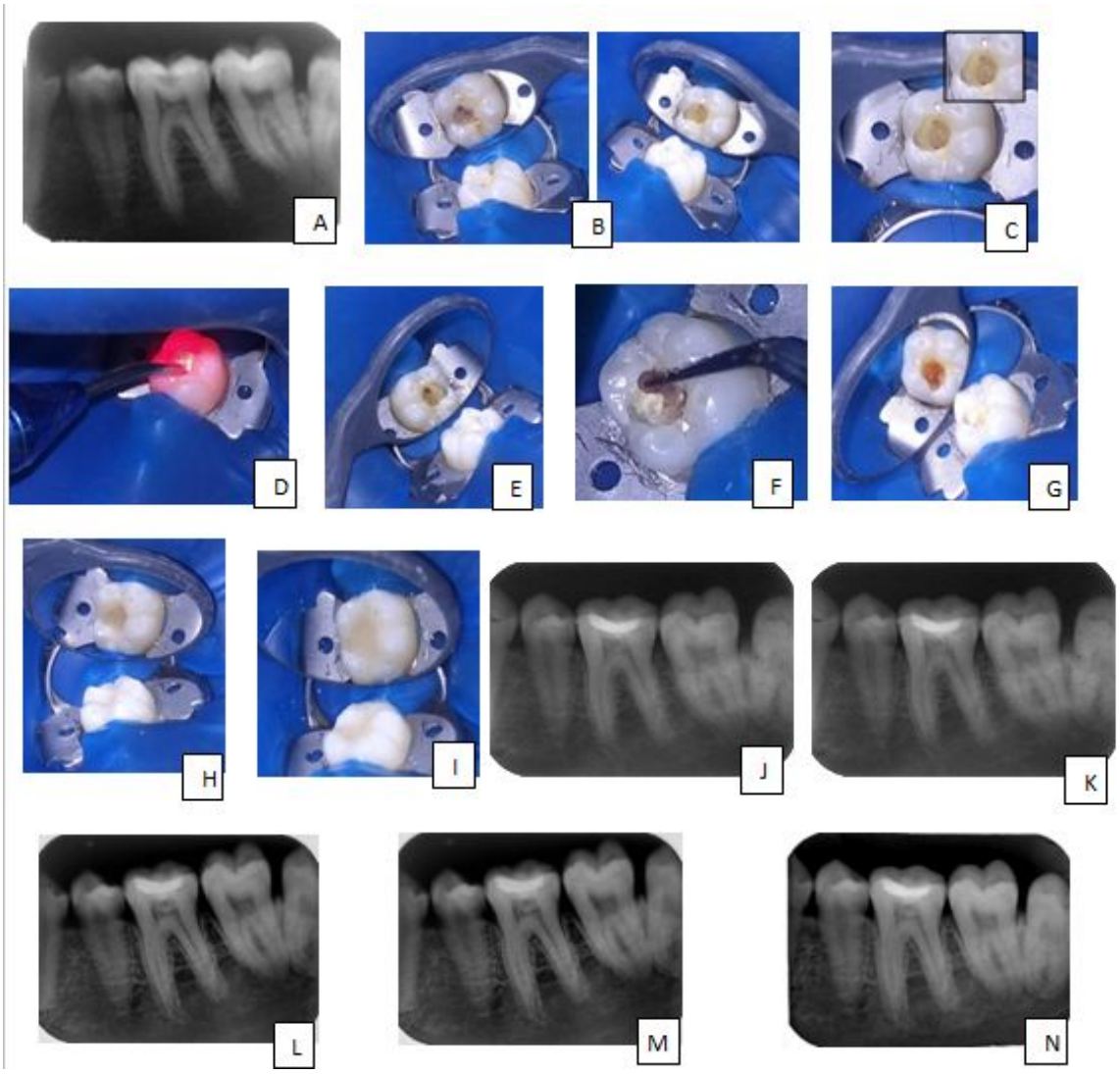

Fig. 4: A. Pre-OP IOPAR, B. After caries excavation, C. Pulp exposure, D. LASER application, E. After LASER irradiation, F. PRF carried, G. PRF placed properly, H. RMGIC liner placed, I. Composite restoration, J. Imm. post-OP IOPAR, K. 3 mon IOPAR **(DBT-0.292mm)**, L. 6 mon IOPAR **(DBT-0.473mm)**, M.9 mon IOPAR **(DBT-0.869mm)**, N.12 mon IOPAR **(DBT-0.915mm)**

The centrifuged blood separated into 3 layers with Platelet Poor Plasma (PPP) at the top, RBC at the bottom and Platelet Rich Fibrin (PRF) gel in the middle (Fig.3.H). The PRF was taken out from the test tube with a sterile tweezers (Fig.3.I). It was then compressed in between sterile gauge with fingure pressure to get a thin membrane which was cut into small pieces (Fig.3. J, K, L, M).

A small piece of PRF was placed over the exposure site (Fig.3.N &O) carefully. After covering it with a layer of the RMGIC, composite restoration was done (Fig.3.P). Immediate post-op IOPAR (Fig.3.Q) was taken. Like case no. 1 & 2 similar results were obtained through clinical and radiological evaluation at the time of 3 months (Fig.3.R), 6 months (Fig.3.S), 9 months (Fig.3.T) and 12 months (Fig.3.U) visits. He was asymptomatic all along.

CASE NO. -4 (laser + PRF) :

A 25 yrs old female patient complaint of food lodgement in chewing surface of lower back tooth. On clinical examination, a deep carious lesion was seen occlusally on #36 with IOPAR showing carious lesion close to mesial pulp horn (Fig.4.A).

Similar to the other three cases, after anaesthesia and rubberdam application caries excavation was done (Fig.4.B&C). The bleeding from the exposure site was controlled with the application of the Diode Laser with same parameter as in case no. 2 (Fig.4. D & E).

Autologous PRF membrane was obtained in the same way as in case 3. The laser irradiated exposure site was capped with a piece of the membrane with the help of a sterile tweezers (Fig.4. F & G) followed by

application of a layer of the RMGIC as liner (Fig.4.H) and final restoration was done with the composite (Fig.4.I). Immediate post-op IOPAR (Fig.4.J) and that in subsequent follow-up visits were recorded and DBT was calculated at the time of 3 months (Fig.3.K), 6 months (Fig.3.L), 9 months (Fig.3.M) and 12 months (Fig.3.N) visits. She was asymptomatic all throughout.

RESULTS:

In this case series, treated teeth showed positive response to cold test and EPT and no sign and symptoms to percussion and palpation and were subserving normal function till the last follow-up period of one year. This indicates favourable outcome of direct pulp capping procedure which was undertaken differently in four cases.

The value of formed DBT measured (Fig 5) using straight line tool of IMAGE J software was different in four teeth (Table no.-1). Through the follow-up visits it was revealed that there was gradual increase in DBT and the diode laser assisted DPC performed better both in case of biodentine and PRF as capping agent. An important finding was that among four procedures, in laser assisted DPC with biodentine DBT was seen maximum in all the follow-up visits. The order of DBT formed in four teeth with four different DPC procedure may be depicted -----

Laser +biodentine > biodentine> Laser +PRF> PRF.

DISCUSSION:

With better understanding and expanding knowledge of pulp physiology, microbiology, caries progression, and with identification of new bioactive materials along with physiological mediators that consistently stimulate reparative dentine formation, protection of pulp against microbial ingress has become easier. Vital pulp therapy is recommended for all teeth diagnosed with reversible pulpitis or partially inflamed pulps in which the remaining healthy tissue can be conserved to generate a hard tissue barrier that seals and protects the pulp from future microbial insult.

The straight-line tool was used to measure the thickness of the dentinal bridge thus formed by drawing a point from the base of the pulp-capping material, as seen radiographically; till the pulp chamber roof/ pulpal horn.

Months	Area	Mean	Min	Max	Angle	Dentin bridge length
3	0.036	125.423	124.721	125.965	-39.806	0.242
6	0.096	165.156	154.183	175.214	-73.072	0.74
12	0.108	170.319	154.111	187.333	-90	0.913

Fig. 5: An example(case no.-4) of DBT measurement

TABLE No. 1: Formed dentin bridge thickness (in mm)

CASES	AGE/SEX	TOOTH No.	3 MONTHS	6 MONTHS	9 MONTHS	12 MONTHS
CASE 1 (BIODENTINE)	28/F	16	0.361	0.457	0.714	0.936
CASE 2 (LASER+BIODENTINE)	24/M	26	0.674	0.946	1.003	1.274
CASE 3 (PRF)	53/M	46	0.159	0.366	0.710	0.843
CASE 4 (LASER+PRF)	25/F	36	0.292	0.473	0.869	0.915

The direct pulp capping procedure using Biodentine is a standard practice. Previous studies by various investigators (Jong Ryul et al.,2015[19]; Imad About, 2016[20]; N A Taha et al.,2020[21]) had reported that in vitro and in vivo studies demonstrated that the interactions of Biodentine with both hard and soft tissues provide a hermetic seal protecting the dental pulp by preventing bacterial infiltration. These studies demonstrated that, through its interactions with the hard tissues, Biodentine provides a micro-mechanical retention by infiltrating the dentin tubules. On the other hand, it induces the target tissue specific functions by inducing tertiary dentin synthesis which provides further protection to the pulp. These two combined effects might be responsible, at least in part, for the absence of post-operative pain and hypersensitivity. More importantly, when applied on odontoblast-like cells Biodentine decreases pro-inflammatory TNF-α secretion. This indicates that, in addition to the above-mentioned roles of Biodentine, its application onto the dentin/pulp reduces the inflammation and consequently the post-operative pain[20].

PRF belongs to the second generation of platelet concentrate products, named Choukroun's PRF after its inventor. It has favourable properties, which include osteogenic ability, simple preparation, requiring no reagents or biological agents. PRF was demonstrated to promote cell proliferation and osteogenic differentiation in Human Dental Pulp Cells (HDPCs).[22,23]

PRF looks like a fibrin network, contains platelet growth factors and cytokines that enhance the healing potentials of both soft and hard tissues.

Many growth factors such as PDGF( ) and TGF-β( ) are demonstrated to release from PRF, within its biological scaffold for wound healing process that lead to the idea of PRF membrane as a capping agent for reparative dentin formation.[23] Moreover PRF exhibited no cytotoxic effect to Dental Pulp Cells. Taken together, PRF acts as a biomaterial which can increase its proliferation and differentiation, suggesting potential application of PRF as biological molecule to promote the regeneration of lost or injured pulp tissue and stimulate reparative dentinogenesis. [24]

The use of PRF as a capping agent in direct pulp capping has gained popularity (Shekar Shobana et al., 2022[25]; Rijin Raj J R, Adhikari H D et al. (2021)[26]; Agrawal A et al. (2020)[27]; Tikku A P et al., (2018[28]). But whether Laser assisted direct pulp capping using those capping material is more effective in terms of producing dentinal bridge is the concern of the present case series.

After mechanical excavation of carious lesion, haemostasis of exposed pulp tissue irradiated with the laser is associated with the advantage of decontamination and biostimulation effects which can accelerate the growth of fibroblasts and osteoblasts and stimulate the proliferation, migration, and cytodifferentiation of odontoblast like cells to promote the formation of reparative dentin in the injured pulp tissue.[12]

The biostimulation effect is a common characteristic of lasers, that of diode laser, is especially advantageous in the healing processes of the pulp tissue and thus showed promising result for DPC treatment.[12]

In the present case series, the formed dentinal bridge after DPC showed highest thickness in laser with biodentine case followed by biodentine, then laser with PRF case and lowest in case with PRF only, which is indicative of the fact that laser improves the outcome of DPC with biodentine and PRF as capping material. Therefore, the conclusion of the present case series was that the diode laser irradiation with biodentine capping might be considered suitable option for DPC.

The use of diode laser in conjunction with direct pulp capping agents such as biodentine and PRF had not been reported in literature yet, so report of this case series might be the first of its kind in DPC procedure.

CONCLUSION:

Within the limitation of the study, it can be concluded on the basis of clinical and radiological observation that PRF could be considered as one of the pulp capping agents. The diode laser irradiation prior to placement of pulp capping agent – biodentine / PRF may carry significant role in increasing the thickness of formed dentinal bridge particularly in case of the former. However, more number of studies with greater sample size and longer follow-up period are required to validate it.

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