A novel technique of sculpting Biodentine in the restoration of iatrogenic dentin loss

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Abstract
Excessive tooth structure loss is a common iatrogenic error encountered during endodontic practice. Conservative treatment planning is essential to maintain the structural integrity in such teeth. This case report elucidates a novel approach in sculpting Biodentine as a dentin substitute followed by internal bleaching and restoration with fiber-reinforced composite.

Keywords: Fiber-reinforced composite; internal bleaching; sculpting Biodentine

INTRODUCTION
Iatrogenic errors or procedural accidents are unfortunate incidences that can occur during root canal treatment. They can be attributed to failure to grasp the rationale behind cleaning and shaping concepts. Among the complications, most commonly observed during root canal instrumentation is a deviation from the original canal curvature without communication with the periodontal ligament, resulting in excessive loss of tooth structure and consequently weakening the entire tooth structure. Because of its conspicuous occurrence during root canal procedure, it is necessary to recognize and manage it with the most conservative options, thus preventing any further jeopardy to the overall tooth apparatus.

Recent studies have substantiated the use of Biodentine as a dentin substitute. Due to its superior handling characteristics, it can be sculpted into the desired shape using appropriate technique. In this case, excessive dentin loss was restored using a novel approach of Biodentine sculpting called as circumferential uncovering technique. Following which, it was treated for tooth discoloration using internal bleaching and finally restored with fiber-reinforced composite to improve its stress-bearing capacity, all which constituted a conservative treatment plan for maximum efficiency.

CASE REPORT
A 22-year-old female patient reported to the department of conservative dentistry with a chief complaint of pain and discoloration in relation to an upper front tooth. On examination, it was seen that tooth #11 presented with severe discoloration and considerable tooth structure loss on the palatal aspect. The patient gave a history of prior attempted endodontic treatment a year back, and she could not follow up the treatment with the dentist as she had relocated. The onset of pain prompted her to seek immediate dental treatment.

Clinical examination revealed significant tooth structure loss in a failed attempt to gain access to the root canal resulting in thinning of dentin on the labial and palatal aspect of the crown and subsequent discoloration due to incomplete root canal treatment. The tooth was mildly tender to percussion, absence of any swelling, and exhibited physiologic mobility. The radiograph revealed the presence of periapical periodontal widening along with dentin loss extending from middle third of the crown till the junction of the cervical and middle third of the root around the root canal.

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After examining the case, the patient was informed regarding the present condition and the treatment plan was explained, with which she complied. The procedure comprised of root canal treatment, followed by restoration of iatrogenic tooth structure loss with a dentin substitute and intracoronal bleaching.

At the first appointment, the dentinal floor was explored to locate the root canal orifice, which had been obscured due to lodgment of debris since the access opening was exposed to the oral environment for a considerable time. After the canal orifice was located, a no. #15 K-file was used to scout through the canal to reach the apex. The working length was established at 21 mm using no. 30-K file and confirmed using an apex locator and radiograph. The cleaning and shaping was initiated, and thorough irrigation was achieved using sodium hypochlorite 5.25%. The canal was enlarged to size #50 using K-files only. After irrigation and drying of the canal, calcium hydroxide (UltraCal XS, Ultradent Products, Inc.) intracanal medicament was placed and secured with a cotton pellet and temporary restoration.

The subsequent appointment was a week later. There was no tenderness to percussion and patient-reported absence of pain. After removal of the temporary restoration, the canal was further irrigated with sodium hypochlorite 5.25%, normal saline, and final irrigation with chlorhexidine 2%.

The canal was dried and prepared for obturation. AH plus sealer and gutta-percha were used for obturation using a lateral condensation method.

At the same appointment, the tooth was prepared for restoration of the lost tooth structure using Biodentine. The access cavity was flushed with saline and dried to remove any sealer and particles of gutta-percha. Biodentine was mixed in a triturator as per instructions and placed in the access cavity. Following this is a crucial step, which was carried out using an anterior Schilder plugger size 11 (1 mm diameter). The plugger was inserted into Biodentine projecting exactly above the coronal end of gutta-percha. It was moved in a circumferential motion to create a short groove of approximately 4-mm length uncovering the coronal portion of gutta-percha. The plugger was continuously moved making a circle of 2-mm diameter along with lateral flaring to form a triangular shape to simulate the pulp chamber. This was done to sustain the artificially sculpted orifice until the Biodentine had set (setting time: 12 mins) eventually replacing the lost dentinal structure as well as maintaining the natural canal anatomy [Figure 1c] [Figure 1f].

Subsequently, the pulp chamber was sealed with temporary restoration until next visit.

After a week, the patient was scheduled for intracoronal bleaching procedure. The patient was asymptomatic, and the radiograph revealed periapical healing. The procedure
included an initial formation of an intraorifice barrier. Glass-ionomer cement (GIC) was mixed and placed in the artificially created orifice to form a 2-mm thick plug over the gutta-percha with a bobsleigh configuration [Figure 1d]. Hydrogen peroxide-based powder and liquid bleaching system (Pola Office) were used for bleaching purpose. The powder and liquid were mixed to the consistency of wet sand and packed into the pulp chamber using a plastic instrument [Figure 1e]. A cotton pellet was pressed over the bleaching agent, and a 2-mm thick plug of GIC was used to secure these contents into the pulp chamber [Figure 1f].

The next visit was scheduled after 2 weeks, at which the tooth bleaching was assessed. The patient was satisfied with the esthetic result of bleaching [Figure 1g]. Hence, the bleaching agent was carefully evacuated from the pulp chamber and copiously flushed with water. The final restoration was done with fiber-reinforced composite (EverX Posterior) and final increment of conventional composite (3M ESPE Filtek Z350) [Figure 1j].

The patient was asymptomatic when called for a follow-up visit at 2 weeks, 3 months, 6 months and 1 year [Figure 1k].

**DISCUSSION**

Dentin forms the majority of the structural component of human tooth, protecting the pulp vitality against microbial and other detrimental stimuli. The dentin microstructure and its intrinsic properties are indubitably major elements of essentially all clinical restorative procedures. Dentin also provides mechanical support to enamel and enables it to resist occlusal and masticatory forces without fracturing. The mechanical performance of dentin is considered to have major implication on the overall function of teeth. Hence, it is of utmost importance that the structural integrity of root canal-treated teeth should closely resemble that of vital teeth for its efficient performance in the oral cavity.

In the present case, the iatrogenic loss of tooth structure occurs due to a prior failed attempt at root canal treatment by overzealous access cavity preparation. The residual dentin is devoid caries and fragile, thus requiring the support of a material which is structurally and biologically similar to dentin as well as, can be integrated conveniently into an effective treatment plan, thus prompting the use of Biodentine as the suitable dentin replacement material.

Biodentine has a vast array of applications including its use as dentin substitute, pulp capping, pulpotomy, apexogenesis, apexitification, and root repair material for perforation, full canal obturation, and root-end filling.\textsuperscript{[3,4]}

It has a shear bond strength to dentin comparable to GIC but higher than that of ProRoot mineral trioxide aggregate (MTA). It has shown superior mechanical properties even after being exposed to various endodontic irrigants as compared to MTA,\textsuperscript{[5]} as well as least amount of leakage compared to MTA and GIC.

Biodentine possesses a significantly higher Vickers microhardness compared to ProRoot MTA; thus, the attribute of surface hardness qualifies it as a dentin substitute.\textsuperscript{[6]} Furthermore, when used as a dentin substitute under composite restorations in open sandwich technique, it gave satisfactory marginal adaptation values.\textsuperscript{[7]} Moreover, Biodentine has shown color stability over time, in different laboratory environments.\textsuperscript{[8]}

In addition, it has shown better adhesiveness as well as improved resistance to dislodging forces such as mechanical stresses due to tooth function or operative procedures.\textsuperscript{[9]} According to a clinical study by Kaubi et al.,\textsuperscript{[5]} the tolerance of Biodentine under posterior composite restorations showed Biodentine as an efficient and well-tolerated dentin substitute. Biodentine as a dentin substitute in cervical lining restorations or as a restorative material in approximal cavities when the cervical extent is below the cemento-enamel junction seems to perform better without any conditioning treatment.\textsuperscript{[5]}

Specific properties of Biodentine which favours its use as a dentin substitute include an elastic modulus of 22.0 GPa which is similar to that of dentin which is around 18.5GPa; compressive strength of about 220 MPa is comparable to the average for dentine of 290 MPa, microhardness of Biodentine at 60 HVN is same as that of natural dentin. Biodentine also has a better sealing ability compared to ProRoot MTA; this can be attributed to its ability to construct biomimetic remineralization and deposition of calcium phosphate on the surface suggestive of a high rate of calcium release with constant formation of apatite making it a scaffold for clinical healing.\textsuperscript{[10]} To support this evidence, Kim et al. have shown that Biodentine caused deposition of amorphous calcium phosphate interfacial layer with radicular dentin and that the Ca/P ratio of this layer is comparable to MTA.\textsuperscript{[11]} MTA displays slow setting kinetics, difficult handling characteristics, discoloration potential, and increased cost whereas Biodentine is a promising restorative material (increased compressive strength, push-out bond strength, density, and porosity), with less cost and better handling properties allowing it to be sculpted into the desired form within its adequate setting time. It also possesses high wash out, low fluid uptake and resorption values, and superior mechanical properties.

Freshly mixed Biodentine has a putty-like consistency with favorable setting kinetics – about 12 min which facilitates its use directly intraorally without fear of the material deterioration, ease of manipulation, better consistency, and safety handling.
The method used in this case for Biodentine sculpting is circumferential uncovering technique which involves placement of freshly mixed Biodentine into the defect with a plastic carrying instrument followed using a plugger of appropriate size (Schilder anterior plugger 10, in this case) to carve the Biodentine to desired shape. The plugger is held exactly above the Biodentine, which is projecting over the coronal end of the obturated gutta-percha. The plugger is then moved in a circular motion to form a circle of diameter 2 mm, thus displacing the Biodentine laterally and eventually exposing the gutta-percha. Intermediately, the plugger is also moved laterally along the artificially created Biodentine walls to flush it with the residual dentin to simulate the shape of a root canal. This procedure is continued until the Biodentine sets firmly [Figure 2a]. Avoid excessive agitation of the cement mix as it can tend to increase the setting time. This technique can effectively help in restoring dentinal defects due to internal resorption, excessive tooth structure loss during root canal access, and preparation, which occur along the canal length.

Internal bleaching followed by restoration with fiber-reinforced composite was utilized in this technique as the tooth was already weakened, and postplacement with crown preparation would require tooth reduction, further subjecting the tooth to increased stress and would succumb the tooth to fracture [Figure 2b]. Hence, the entire treatment procedure was designed to increase the overall fracture resistance and provide satisfactory esthetics simultaneously.

Before bleaching, an intraorifice barrier of GIC having a bobsleigh tunnel appearance was placed above the gutta-percha. Intraorifice barrier is an efficient alternative method to decrease coronal leakage in endodontically treated teeth. Without an adequate coronal seal, long-term success remains questionable and failure to maintain the seal may expose obturated root canals to microbes that could retard healing and create infection in the periradicular, periodontal ligament or supporting osseous structures. Furthermore, the hydrogen peroxide used in bleaching procedure can penetrate and release oxygen that breaks the double bonds of the organic and inorganic compounds inside the dentinal tubules, which has also been associated with cervical resorption. Thus, sealing the root canal orifice is essential to prevent diffusion of bleaching agents from the pulpal chamber into the root canal and the cervical periodontal tissue. GIC has been able to convincingly seal the coronal portion of the canal during nonvital bleaching.

The use of fiber-reinforced composite as the reinforcing substructure beneath conventional posterior composite provides fracture toughness greater than collagen-reinforced dentin and almost double that of conventional composite. EverX Posterior is fracture resistant and designed to stop crack propagation. When used as a substructure under conventional composite, its strength is significantly improved and the fracture pattern under load is changed. If the restoration is loaded till failure, the path of a fracture changes and is deflected away from the roots. The synergistic effect of EverX Posterior and conventional composite will create a bilayered restoration that can withstand double the load of a restoration made from conventional composite alone. Load-bearing capacity of EverX Posterior as a substructure in sandwich technique is more than the maximum human biting force and significantly higher than that of conventional composite alone. The fibers minimize the polymerization shrinkage in the horizontal plane after placement. They also prevent fracture propagation in restoration and tooth structure.

The entire treatment plan was aimed at restoration of structural tooth integrity by replacing the lost tooth structure with materials, which closely resembled dentin and enamel in its mechanical and physical properties. The use of Biodentine and fiber-reinforced composite along with conventional composite helped in successfully achieving this goal and simultaneously improving the fracture resistance of the tooth while achieving satisfactory aesthetics.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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