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# Conservative aesthetic approach in reinforcing severely discoloured root-canal retreated permanent central incisors- A case report

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## Abstract

**Objective:** Endodontically retreated tooth has increased chance to fracture when compared to a vital and primary endodontically treated teeth. Literature advices to reinforce tooth with custom cast, prefabricated metallic or fibre reinforced post. The longevity of the post restoration is mainly dependent on the amount of peri-cervical radicular dentin and remaining thickness of the coronal tooth structure. Since their introduction in 2013, short fibre reinforced composite (S-FRC), has shown enhanced reinforcing properties when compared to conventional particulate filled composite resin.

**Clinical considerations:** This report presents a clinical case of reinforcing extensively damaged, root-canal retreated central incisors with S-FRC and restoring the teeth with indirect composite veneer, up to the patient's aesthetic satisfaction.

**Conclusions:** Reinforcing, retreated endodontically anterior teeth with short fiber reinforced composite has proved to be an efficient and conservative option. Indirect composite veneer, if done well, presents with a viable aesthetic option in restoring compromised tooth structure and provides an alternative treatment option in achieving optimum aesthetic satisfaction.

**Clinical significance:** With S-FRC as a core material, the remaining cervical radicular dentine when extensively lost, could be preserved. Preventing the catastrophic failure that occurs with post-endodontic

restorations and providing the patient with pleasing aesthetic by restoring it with indirect composite veneer.

**Keywords:** short fiber reinforced composite, composite veneer, structurally compromised tooth, ever X Posterior, peri cervical dentin, indirect composites.

**Introduction**

One of the important reasons affecting the outcome of the endodontic treatment is microbial contamination. Hence, apical and lateral seal are necessary from preventing the entry of microbes from entering the canal space.[1,2] There are four methods documented in the literature for bacteria and tissue fluids to enter the root canal: through the access cavity; through exposed cementum, secondary and accessory canals/ defects on surfaces; through the root filling materials and root wall; and through the apical foramen by infusion into the material.

For many years, apical leakage was thought to be a primary contributory factor for treatment failure.[3] However, Marshall and Masseler[4] reported the influence of coronal-leakage on endodontic treatment failure, as well as microbial products at apex of root-filled teeth 3-months after coronal filling was removed. Several studies have demonstrated that a well-made coronal restoration greatly influence the periradicular condition than the quality of endodontic treatment.[1,5]

Root canal treated tooth could be restored directly with composite or indirectly with cast metal/ ceramic restoration.[6] A post may be required in circumstances when retention is required for final restoration. Root-filled teeth are difficult to restore, regardless of technique, because they lose strength and are prone to failure than vital tooth. Restorative procedures primarily increase the tooth stiffness, where endodontic procedures only contribute 5% to the fracture toughness. Remaining tooth structure after an endodontic treatment determines the ability of the tooth to resist fracture. When there is excessive loss of dentin at root and/ coronal level it hinders the ability to uniformly distribute stress and strain in endodontically treated teeth.[7,8,9,10]

By reinforcing unsupported tissues, resin-based materials enhance stiffness and boost fracture resistance of a non-vital tooth. Ever X Posterior (GC Corporation, Tokyo, Japan) is a sculp table variation of previous material. According to the manufacturer, the short fibres in Ever X posterior prevents the propagation of fracture line, thereby preventing the failures and reinforcing large cavities.[11]

Reconstruction of the tooth with full coverage crown though a viable option, sacrifices a large amount of tooth structure. Introduction of adhesive system has paved way for more conservative treatment options. Composite laminate veneers are one such conservative option that provides advantages over ceramic restoration in lower cost, inherently less brittleness and allows repair to a certain extent.

In the following case report, indirect composite veneer along with fiber reinforced composite was used to reinforce/reconstruct an endodontically treated tooth with severe loss of dentine.

**Case Report**

28-yr old, female patient reported to out-patient department of endodontics, with a chief complaint of occasional dull throbbing pain for past 1 week and discoloured teeth in maxillary right and central incisors (#11, #21). Patient provided a history of root canal treatment completion 10-years back. Patient noticed the change in teeth colour 1yr after the treatment with displacement of restoration over the years (Fig. 1a & 1b). There was no clinically relevant medical history when root canal therapy was performed. The tooth was discoloured and tender to percussion during intraoral

inspection. Pulp sensibility test revealed negative responses.

Radiographically, both teeth showed separated gutta-percha fragment that was seen displaced beyond the apex, widened PDL space and well-defined periapical radiolucency in #21 (fig. 2). The surrounding soft tissues were healthy with no lesions and was diagnosed as non-vital teeth with apical periodontitis in #11 and chronic periapical abscess in #21. Before starting the procedure, intraoral images were taken (fig. 3, a-e).

Re-treatment was initiated in teeth #11and 21 under local anesthesia (Lignox 2%, Indoco Ltd, Mumbai, India), rubber dam isolation (Coltene Hy genic Dam Kit, Coltene, India) and microscope. Secondary caries was excavated using a size #6 tungsten-carbide round bur attached to slow speed electric handpiece and a spoon excavator. Re-treatment was completed in two appointments. In the 1st appointment, except for the apically dislodged fragment, all the gutta-percha was retrieved using H- file (Mani Inc., Japan) and Chloroform as a GP solvent (fig. 4). In the 2nd visit, the apically displaced fragments were retrieved (fig. 5). The working length was confirmed radiographically. Teeth were biomechanically prepared so as to remove any remnants of previous gutta-percha and sealers, irrigated with 2.5% sodium hypochlorite and 17% EDTA. Calcium-Hydroxide (RC Cal, Prime Dental, India) intracanal medicament was placed followed by a temporary filling (Cavit™, 3 M ESPE) for 14days.

Because the patient was asymptomatic after two weeks, apexification and obturation were performed. Bio dentine (Septodont, Saint Maur des Fosses, France) was used as a root end filling material, mixed according to manufacturer's instruction and delivered to the apical portion using MTA carrier in order to achieve a periapical plug of about 4 mm thickness. Condensation of Bio dentine at the apex was carried out using an appropriately sized endodontic plugger and subsequent intraoperative radiograph was taken to confirm its apical position (fig. 6). After 24 hrs., hard set of Bio dentine was verified using an endodontic file K file. The remaining portion of the canal was obturated using an epoxy sealer (AH Plus, De Trey, Konstanz, Germany) and injectable Thermoplasticised gutta-percha, up to the cemento-enamel junction. The access cavity was cleaned and sealed with Glass Ionomer Cement (fig. 7).

Prior to the beginning to non-vital bleaching, mesial walls of both the incisors were built using composite resin (spectrum, Dentsply). Non-vital bleaching was performed with 40% hydrogen peroxide gel (Opalescence Boost in-office power, Ultra dent) under rubber dam isolation. Activation of bleaching agent was does as per the manufacturer's instruction. Bleaching agent was deposited in the pulp-chamber and the access-cavity was restored with temporary material (Cavit; 3 M, St. Paul, MN, USA). Patient was recalled after 72hrs to evaluate change in the colour. Baseline colour (Vita shade guide) was set to B2, as per shade of lateral incisor. The shade appeared to have reduced from C4-C2 after 2 visits (6 days) of non-vital bleaching (fig. 8). Patient however wasn't willing to continue with the seating of non-vital bleaching, hence, prosthetic rehabilitation was planned. Calcium hydroxide paste was placed in the chamber for 21days, then restored with fiber reinforced composite resin (ever X Posterior, GC Corporation, Tokyo, Japan) 21 days after the 2nd visit of non-vital bleaching (fig. 9), and the missing surfaces were built using micro hybrid composite of B2 shade (spectrum, Dentsply) (fig. 10).

Owing to the overall thickness of the remaining tooth structure, providing an indirect composite veneer was considered a viable option. The teeth were prepared to

receive full veneer with incisal lapping preparation design. Reduction was done in 3-plane with depth cuts of thickness 0.5mm in gingival third, 1mm in middle and 1.5mm in the incisal third. Preparation was done using a flat and tapered bur; finishing discs (Super Snap, Shofu Dental Asia-pacific Pte. LTD) were used to ensure the labioincisal angles were smooth and did not have sharp edges (fig. 11). Considering the patients gingival biotype, '000' knitted, cotton (Ultra dent Ultra Pak) retraction cords, soaked in adrenaline was used for gingival retraction. Impression was made using polyvinyl siloxane impression material, one step technique and was sent to the lab for the fabrication of indirect composite veneer.

The fabricated composite veneers (Adoro Ivoclar) (fig. 12) were evaluated for the fit and shade in the patient's mouth. Bonding of the composite veneer was done under rubber dam isolation. Etching of the teeth surfaces were done as follows, etching of the residual enamel; and composite surfaces were done with 37% phosphoric acid for 15 seconds followed by application of universal bonding agent, dentine was conditioned with two layers universal adhesive (Prime and Bond universal, Dentsply), and silane coupling agent was applied on the surface of the composite resin. Intaglio surface of composite resin was etched with 5% hydrofluoric acid, for 10 seconds, followed for application of silane coupling agent. The composite veneers were cemented on the tooth surface using dual-cure resin cement (variolink, Ivoclar Vivadent), gross excess cement was removed and light cured for 40 seconds. Polishing of the veneers were done 24hrs after the cementation of the veneer, radiographs were obtained (fig. 13 a-c), and the patient was followed for a year (fig.14). Fig.15 represents changes in the aesthetics of the patients at three different intervals i.e., first visit, after non-vital bleaching and 12months follow-up. Fig.16 represents change in patient profile after the cementation of the indirect composite veneer at 12-months follow-up period.

**Figures**

Figure a

Figure b

Figure 1: (a & b), images taken at 1st visit, extensively discoloured, carious central incisors.

Figure 2: RVG reveals, improper obturation, with fractured gutta-percha fragment displaced beyond the apex, ledge was created in the cervical region with widened PDL space and well-defined radiolucency in tooth #21.

Figure 3: intra-oral images; front view.

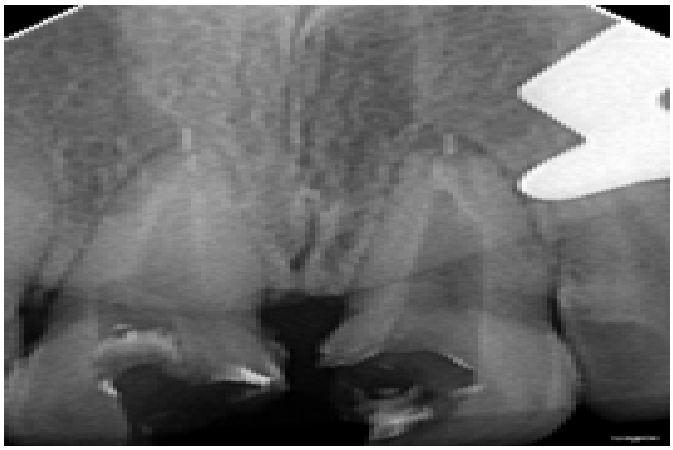

Figure 4: gutta-percha was removed using chloroform as gp solvent.

Figure 5: Apically displaced fragments were removed using H files (Mani Inc., Japan), working length was determined.

Figure 6: 4mm of apical Bio dentine (Septodont, Saint Maur des Fosses, France) plug was placed

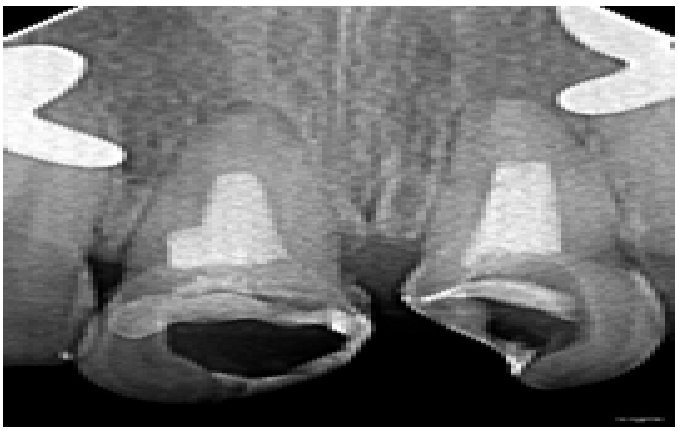

Figure 7: obturation was done using Thermoplasticised gutta-percha.

Figure 8: images represent 1st and 2nd visit (indicated by arrow) of nonvital bleaching (Opalescence Boost in-office power, Ultra dent).


Figure 9: Short fibre reinforced composite (ever X Posterior, GC Corporation, Tokyo, Japan) was placed in the cavity.


Figure 10: after the placement of everX posterior, overall composite (Micro hybrid, spectrum, Dentsply) build-up was done again under rubber-dam isolation

Figure 11: preparations on the incisors were made to receive indirect composite veneer.

Figure 12: indirect composite veneers (Adoro Ivoclar).

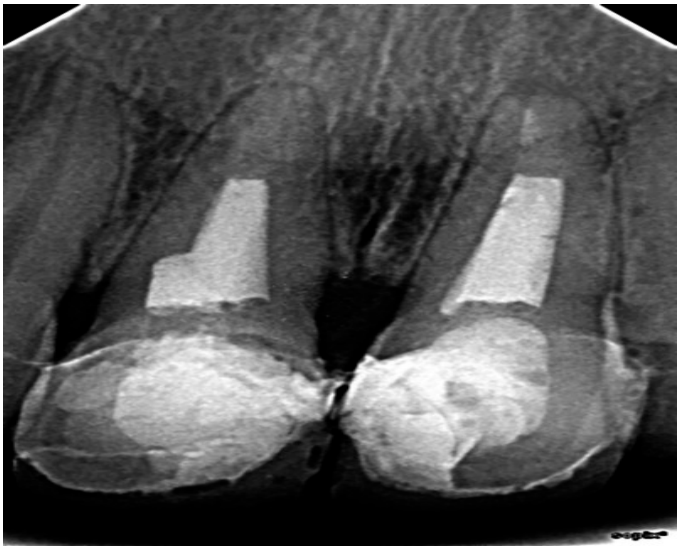

Figure 13: (a, b & c) cementation of indirect composite veneers, RVG taken immediately after cementation.

Figure 14: 12months follow-up image.

Figure 15: collage of images at 3 stages; 1st visit, after bleaching and 12months follow up image.

Figure 16: Collage of patient profile, before and after treatment.

**Discussion**

Providing a good coronal seal which satisfies the patients aesthetic needs becomes a challenging task when the overall crown-root material is compromised due to improper endodontic management. The current case report presented with management of post-endodontically retreated, severely damaged central incisors, reinforced with fiber-reinforced composites and restored with indirect composite veneers.

The goal of primary endodontic treatment is to prevent bacterial microleakage into the root canal system once it has been cleansed, shaped, and filled. Along with coronal seal, procedural errors, such as overfilling, underfilling, ledge, perforation, separation etc., affect the outcome of the endodontic therapy.[12] In the following case report, the previously treated root canal was overfilled, with a ledge created in middle third of the root #11. Longstanding dislodged coronal restoration, followed by development of secondary caries could have contributed to the failure of primary endodontic treatment.[13, 14]

Significant tooth structural loss occurs in root canal retreated teeth. In this example, subsequent caries excavation and root canal filling material retrieval resulted in significantly reduced the remaining coronal and radicular dentin. Because tooth's structural integrity is lost, root-canal treated teeth are regarded to be weaker and more prone to fracture. Hence the common understanding is that, for corono-radicular stabilization, post-endodontic restorations are indicated. However, structural integrity of the root is compromised due to excessive loss of root dentin that happens at the time of cleaning and shaping procedure or during post space preparation.[15] Inner dentine conservation is critical because it provides the tooth structure with toughness and fracture resistance. As a result, removing the inner dentin during a post-endodontic procedure puts the tooth at risk of catastrophic fracture. Ferrari et al. found that remaining coronal dentin had a substantial impact on tooth survival, and that the probability of failure was significantly higher for teeth that had lost all coronal walls. Coronal reduction of the teeth, to achieve a minimum ferrule height of 1.5-2mm sacrifices the remaining enamel and dentine that play a crucial role in bonding.[16] Hence it would be fair to state that, restoring highly damaged endodontically treated teeth poses with multiple challenges.

ETT require a proper coronal seal, preservation of residual tooth, restored functionality, and satisfactory aesthetics in order to be effectively restored. Prefabricated-posts have become increasingly popular, and they are now widely utilized for ETT rehabilitation. Root fracture is one of the leading causes of tooth failure that is restored with post, emphasizing the need for a minimally invasive procedure. Intracoronal tooth strengthening is necessary to protect teeth from fracture and to reinforce the unsupported tooth structure.[21,22] Denehy and Torney in 1976, advocated the use of adhesive restorations to strengthen damaged tooth and to reinforce undermined enamel. The concept of fibre reinforcement in dentistry was introduced in 1960 so as to reinforce prosthetic dentures. [19]

Short fiber-reinforced composite (SFRC), now modified to a sculpt able form and introduced as EverX Posterior (2013) (GC, Tokyo, Japan), was aimed at mimicking stress absorbing properties of dentine, both in vital and non-vital tooth. They have shown a high reinforcing ability with good aesthetic qualities. According to krenchel, short random fibres give an isotropic reinforcing effect in multiple directions rather than one or two.

They are made up of a resin matrix made up of bisphenol-A-diglycidyl-Di methacrylate (bis-GMA), Triethylene glycol Di methacrylate (TEGDMA), and polymethylmethacrylate (PMMA), as well as randomly oriented E-glass fibres (67.7%) and inorganic particle fillers like silicon dioxide (5wt percent). This composite has seemed to provide improved bonding properties that helps in repair and improved the toughness of the material.

Fibers were suggested as a way to reinforce tooth that was structurally weak and to help prevent fractures. The effectiveness of fibre reinforced materials is dependent its length, orientation, position, resin, and its adherence to the matrix. Fibres incorporated act as a stress bearer and transfer them to the resin matrix. In laboratory mechanical testing studies these short e–glass fibers showed enhanced capacity to bear load, strength and toughness when compared to traditional particulate fillers.[26]

Garoushi et al, determined physical properties of S-FRC in comparison to different particulate filler composite, and found that short fibered composites had a higher flexural strength (124MPa), superior fracture toughness (2.9MPam$^{1/2}$) and modulus (9.5GPa) when compared to other conventional and bulk-fill composites that recorded the fracture toughness in range 0.9-1.1MPam$^{1/2}$ which is significantly lower. Similar results were seen in evaluations done by Bijelic-Donova et al and Tsuji moto et al. Garoushi et al who compared different core build-up material including everX Posterior, they concluded that everX posterior had a higher fracture toughness when compared with other short fiber reinforced materials, this result was supported by the Garlapati et a and Gurel et al who found fracture resistance of endodontically treated tooth higher when reinforced for short fiber reinforced composite.[25]

These fibres prevent the crack propagation and distribute the stresses more favorably, this prevents any catastrophic failures, and enables the tooth to remain in the clinical service for a prolonged period of time. It was also observed that, these fibres can play a significant role in reducing polymerization shrinkage, thereby reducing the marginal microleakage and preventing the initiation of failure process.[18]

The fracture-strength of compromised roots (1 mm residual dentin) treated using glass-fibre posts, composite cores, and rehabilitated with metal crowns was studied by Zogheib et al. They observed that in a

severely weakened tooth, glass-fibre posts do not improve fracture resistance as it does in non-weakened tooth.[12]Thus, taking all these factors under consideration, fiber reinforced composites were chosen as a material of choice for reinforcing the weakened coronal tooth structure. Discoloration in the anterior region is a cosmetic problem that poses an immediate concern to the patient. Nonvital tooth undergoes discoloration as a result of hemolytic byproducts penetrating to dentine that combine with the bacterial by-products leading to yellow-brown discoloration. Nonvital bleaching was first proposed by Truman in 1864, for the bleaching of the discoloured pulp less teeth. Today's bleaching systems are based on hydrogen-peroxide, sodium-perborate or carbamide-peroxide. In this case report, 40% hydrogen peroxide was used for nonvital bleaching. Along with cervical root resorption, recurrence and efficiency of the bleaching process is an important factor for success. After a 5-year clinical follow-up, Deli peri discovered recurrence of stains in 15 of 25 teeth treated with intracoronal bleaching; the recurrence for teeth lightened by up to 6 shades on the VITA colour scale. Deli peri and Bardwell (2005) reported a comparable recurrence rate of about half of the 26 bleached teeth that had been lightened by up to four shades. In the following case report, nonvital bleaching was performed for 2 seating (6 days), where the colour changed from C4 to C3 (as per vita shade guide). However, since the patient showed unwillingness in continuing the bleaching process, a prosthesis that conserves the tooth and also masks the tooth discolouration was necessary.[27, 28, 29]

Conservative repair has become a viable option thanks to developments in adhesive technology over the last few decades. To mitigate further loss of healthy tissues, bonded restorative options are favored over an invasive full-coverage preparations, as adhesion provides adequate retention of the material and nullifies the necessity for extensive macro retentive characteristics, resulting in a more cost-effective and time-saving solution. Veneers have become an increasingly popular procedure for restoring aesthetics over the last decade as a cost-effective alternative to dental crowns. In this case, the use of adhesive techniques makes the therapy less invasive while also meeting the patient's aesthetic criteria. Particulate-filled resin composites or ceramics are commonly used to make laminate veneers.[19]

In the following case report, maximum portion of the central incisor was covered with resin composite, moreover, due to pulpal necrosis, the remaining tooth tissue was noticeably discolored. Hence, restoration of choice should not only mask the tooth discoloration but should also provide a sound bonding to composite resin substructure and to restore function and aesthetic up to the patient's satisfaction.[20]

After 78 weeks of clinical examination, it was discovered that ceramic laminate veneers crossing existing composite restorations had a shorter lifespan than those that didn't. The current composite restoration in the cervical area was discovered to be attached to the composite laminate's cementation surface when the bond strength was compared. This could indicate that the composite-cement bond's adhesive strength was higher than the dentin-cement bonds. Resin composites outperformed ceramic laminate veneers in terms of colour matching. For indirect composite and ceramic veneer, there was no significant difference in survival rates up to 36 months. The composite veneer material, on the other hand, showed more frequent surface quality changes, which may necessitate more maintenance over time.[24] As a result, composite veneers were selected as the preferred ultimate repair.

In the following case report Bio dentine was used for apexification. Bio dentine is a calcium silicate-based material, introduced in 2008 as dentine replacement material. Bio dentine, unlike MTA, has characteristics that are similar to those of natural dentine. Studies have shown that Bio dentine attains compressive strength of 200mpa at 24hrs which reaches up to 300mpa by one month. This value of compressive strength is similar to that of the natural dentine (297mpa). It also provides a bacterial tight seal, by forming micro tags, at the dentine-material interface due to re-crystallization of the minerals in the dentinal tubules.[20] The material is stable, non-resorbable, hydrophilic, easy to process and place, takes less time to set, seals better, and has radiopacity comparable to dentine.[13] Though composite veneers delivered in this case report were not aesthetically similar to porcelain laminate veneer the patient was satisfied with the final outcome. The process being highly technique sensitive relies on highly skilled technicians for delivering a restoration similar to porcelain laminate veneer, which is limitation of this study. Nevertheless, since composite made up bulk of remaining tooth structure, and due to similarity in the material composition bonding of indirect composite veneer to the composite substructure would be more reliable.

**Conclusion**

Managing an endodontically retreated teeth has been a challenging task. Restoring a compromised teeth with post restoration presents with a risk of catastrophic failure. Short fibre reinforced composites present with improved physical properties when compared to conventional particulate filled composite, which has shown its benefit in this case report. Patient presents with a sense of satisfaction to the type of aesthetic restoration provided.

**Abbreviations**

1. S-FRC: Short Fibre Reinforced composite.

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