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CASE STUDY

Fiber reinforced direct composite for endodontic treated tooth in one year follow-up

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ABSTRACT

After root canal treatment, tooth will be more fragile due to loss of tooth structure integrity as a result of the caries process, access preparation, reduced water, and or tooth fracture. This is the main consideration for determining the material and restoration technique for endodontic treated tooth (ETT). Fiber reinforcement direct composite can maintain the remaining tooth structure and increase fracture resistance. This case report aims to evaluate the 1-year follow-up of fiber reinforcement direct composite in molar tooth after root canal treatment. The first case was a 28-year-old man, who came to RSGM to maintain his left lower right molar which had been filled for about 10 years. On the radiograph, there was a radiopaque filling to the pulp and apical radiolucency. The results of clinical examination obtained previously initiated therapy, asymptomatic apical periodontitis. The second case, a 27-year-old woman, complained pain on biting in the lower left molar for a week. On the radiograph, there was a radiopaque filling at the occlusal side, a non-hermetic obturation material in the root canals, and apical radiolucency. From the clinical examination, previously treated, symptomatic apical periodontitis was obtained. One-visit endodontic treatment was given followed by a direct restoration with composite resin, short-fiber filler, and fiber ribbond. The endodontic treated tooth restored with fiber reinforcement direct composite obtained good results after 1 year follow-up.

Keywords*:* direct composite; endodontic treated tooth; fiber reinforced; fiber ribbond

INTRODUCTION

Endodontic treated tooth have been structurally compromised by caries, trauma, large restoration, access preparation and subsequent restorative procedures, leading to further weakening of tooth.[1,2] Restorations of endodontically treated teeth (ETT) are designed to (1) protect the remaining tooth from fracture, (2) prevent reinfection of the root canal system, and (3) replace the missing tooth structure.[3] The success rate of root canal treatment is high, but if the coronal restoration is not appropriate, the endodontically treated teeth have to be extracted. Research shows that 59.4% of ETT have failed due to inappropriate coronal restoration, whereas only 8.6% fail because of poor quality of endodontic treatment.[4]

Appropriate treatment planning for coronal restoration should be based on the remaining tooth structure, cavity wall thickness, tooth position in the arch, and load applied to the tooth.[5,6] ETT are commonly reconstructed with post and core and full crown. However, this treatment plan has many risks, such as root perforation, sacrificing a considerable amount of sound tooth structure, and tooth fracture.[6,7] Furthermore, the need for mechanical retention or resistance forms, such as boxes, grooves, slots, pins, and posts, creates regions of great stress concentrations that dramatically weaken the residual tooth structure and increase the potential for crack formation.[7] Through modern adhesive dentistry, some alternative methods are proposed for ETT restoration in accordance with minimally invasive dentistry.[6,7]

Composite improvements regarding physical and mechanical properties, besides esthetic appearance, lead to the progressive use of these dental materials and more tooth tissue preservation.[6,7] This is ideal for patients who

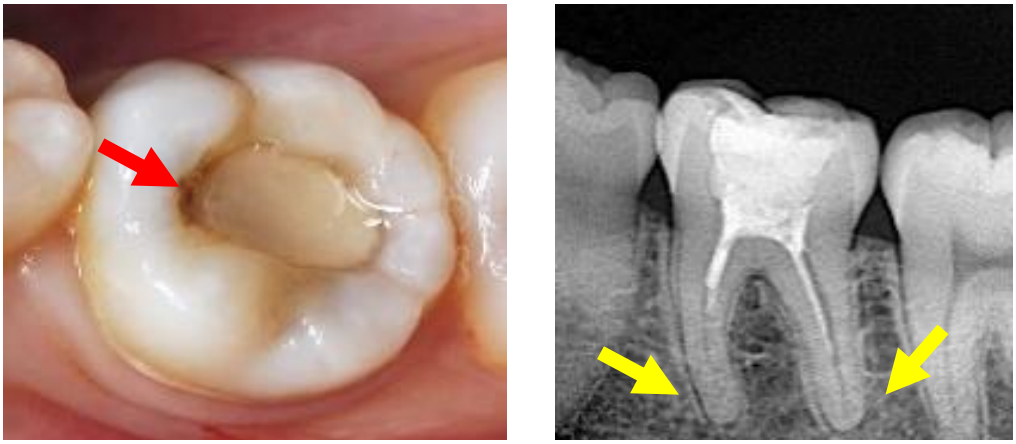
cannot afford the cost of indirect restorations. Conventional resin composites have a significantly lower fracture toughness compared to dentine.[7,8] Short Fiber-reinforced composite (SFRC) restoration has been introduced to increase durability in composite restoration, enhance composite stiffness, and provide better force distribution along fibers. SFRC may become an appropriate material to compensate the dentin loss due to mimic dentin's stress absorption capacity, prevent crack formation and propagation, and limit the risk of fractures.[6,7,8,9]

Another important drawback of resin composites is the polymerization shrinkage-related stress that increases with the cavity depth due to an increase in the C-factor, leading to greater stress on the cavity walls.[9,10,11] The use of polyethylene fiber ribbond on the wall connects the remaining tooth structure to decrease the stress generated by the polymerization shrinkage on the hybrid layer, thus increasing bond strength.[7,8,9,10] The transcoronal splinting fiber ribbond of the remaining walls of ETT is a technique described in recent publication known as wallpapering technique.[7,8,12] However, none of the restorative techniques used so far have been able to increase the fracture resistance of endodontically treated teeth to the level of intact teeth.[12] This study aims to evaluate fiber reinforcement direct composite in the first molar after root canal retreatment in 1 year follow-up.

METHODS

The first case was a woman, 27 years old, presenting to the Department of Conservative Dentistry of Prof. Soedomo Dental Hospital, Yogyakarta to have her left lower first molar tooth treated because of bite pain. The tooth had been endodontically treated about 1 year ago. In the objective examination, there was composite filling on the occlusal part of tooth 36 (Figure 1A). There was no response to the thermal test, the percussion test was positive, the palpation test was negative, and there was no tooth mobility. On the radiograph, there was a radiopaque filling to the pulp, non-hermetic obturation, and widening of periodontal ligament along the mesial and disto apical roots (Figure 1B). The results of the clinical examination obtained a diagnosis of previously treated, symptomatic apical periodontitis.

The second case was a man, 28 years old, presenting to the Department of Conservative Dentistry of Prof. Soedomo Dental Hospital, Yogyakarta to have treatment for his right lower first molar tooth which was filled about 10 years ago. Currently, the patient did not feel any pain. In the objective examination, there was an open



(A) (B)

Figure 1. First Case. (A) Pre-operative clinical picture show old restoration leakage in occlusal surface (red arrow : composite margin degradation); (B) Preoperative radiographic show non-hermetic obturation (yellow arrow : widening periodontal ligament on apical third of the mesial and distal root)

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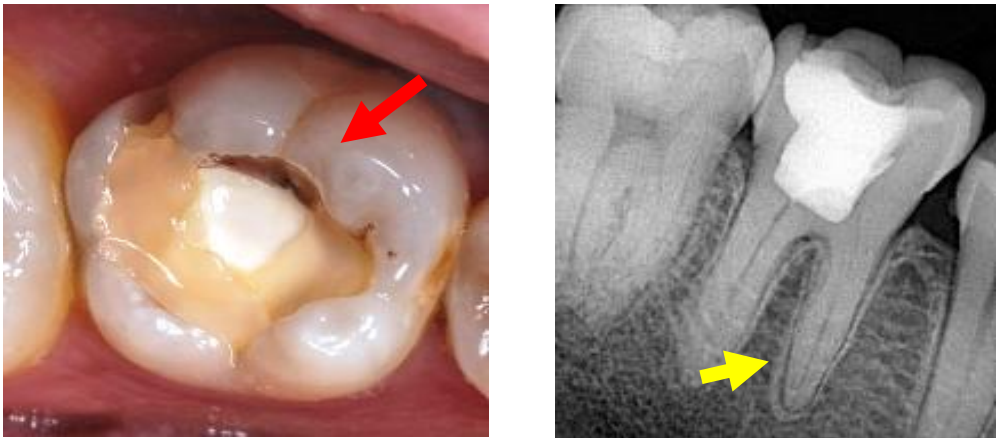

(A) (B)

Figure 2. Second Case (A) Pre-operative clinical picture showing old restoration leakage (red arrow: composite margin degradation); (B) Pre-operative radiographic showing widening periodontal ligament on *apical* third of the *mesial* root (yellow arrow) and untreated root canals

GIC filling on the occlusal part of tooth 46 (Figure 2A). There was no response to the thermal test, the percussion test was negative, the palpation test was negative, and there was no tooth mobility. On the radiograph, there was a radiopaque filling at the occlusal to the pulp and widening of the periodontal ligament along the mesial and apical roots of the distal root (Figure 2B). The results of the clinical examination obtained a diagnosis of previously initiated therapy, asymptomatic apical periodontitis.

The treatment plan for both cases was the same, root canal treatment and fiber reinforced direct composite. The prognosis of these cases was good because there were no large lesions and there was still a lot of healthy tooth hard tissue structure remaining. There was no systemic history, and the patients were cooperative.

On the first visit, both patients signed an informed consent before starting the treatment. Anesthesia was administered to the tooth. A rubber dam isolator was installed to create a sterile area (Figure 3A). Filling removal and caries cleaning were performed with a diamond bur. A cavity access was made using an endo access bur (Figure 3B).

The endodontic treatment was performed in a single visit. After the root canal preparation was complete, the root canal was irrigated with 2.5% NaOCl solution, 17% EDTA solution, and chlorhexidine digluconate, and then activated with ultrasonics. A saline solution was used as an intermediate irrigation solution. The root canal was dried using paper points (Figure 3B, 4A). A gutta percha trial was carried out with F2 size gutta percha. Gutta percha was sterilized in NaOCl then washed with 70% alcohol. The obturation used a single cone technique with an epoxy resin sealer (AH Plus, Dentsply) (Figure 3C, 4B). The cavity was cleaned of residual siler and filled temporarily.

On the second visit, two weeks after obturation, subjective and objective examinations were performed. The patients had no complaints, and the coverage was still good. Percussion was negative, Palpation was negative, and Mobility was at grade 0. Fiber reinforced direct composite would be performed on the second visit. A rubber dam isolator was installed to make the area sterile. Temporary filling removal was done with a diamond bur and ultrasonic scaler. Caries removal was carried using diamond burs and tungsten carbide burs and confirmed using caries dye indicator (Kuraray).

The cavity was disinfected with 2% Chlorhexidine digluconate for 1 minute. Selective etch was carried out with 37% phosphoric acid on

the enamel surface. It was rinsed with water, the tooth cavity was dried, and the dentin was dried with cotton pellets. Universal bonding was applied (Scothbond Universal, 3M) on tooth cavities with rubbing movements for 20 seconds. It was then flattened with a three-way syringe blowing air for 5 seconds. Polymerization were carried out with an LED curing light power of 800 mW/cm^2, 10 second from the occlusal surface. Double application of bonding was carried out on the surface of the dentin and tooth enamel using the same procedure. The timer was turned on to wait for maturation of the bonding with dentin (Decoupling with Time). Within 5 minutes, no more than 1.5 mm bulk fill of composite resin was applied.

Flowable low shrinkage composite resin was applied on the dentin surface with a thickness of 0.5 mm (Resin Coating) (Figure 3C), and polymerization was applied for 20 seconds with LED curing light of 800 mW/cm^2 in a progressive mode to protect the hybrid layer. The length of the base and circumference of the cavity were measured with a probe, and Leno weaved ultra-high-molecular-weight hpolyethylene (LWUHMWPE) ribbond fiber (Ribbond THM, Ribbond Inc) was cut with a width of 3 mm, length of 5 mm for the base of the cavity, and length of 12 mm for the perimeter of the cavity wall. The fiber ribbond was wetted with composite wetting resin.

The fiber reinforcement composite (Ever-X, GC) was applied at the base of the cavity, then adaptation of the fiber ribbond was allowed until an adaptation homogeneous and tight to the surface was obtained (Figure 3D, 4C). The same procedure was done around the cavity wall with the application of Ever-X and fiber tape (Fiber wallpapering) (Figure 3D, 4D). Polymerization was carried out for 20 seconds with LED curing light 800 mW/cm2 in progressive cure mode on the occlusal, buccal, and lingual surfaces.

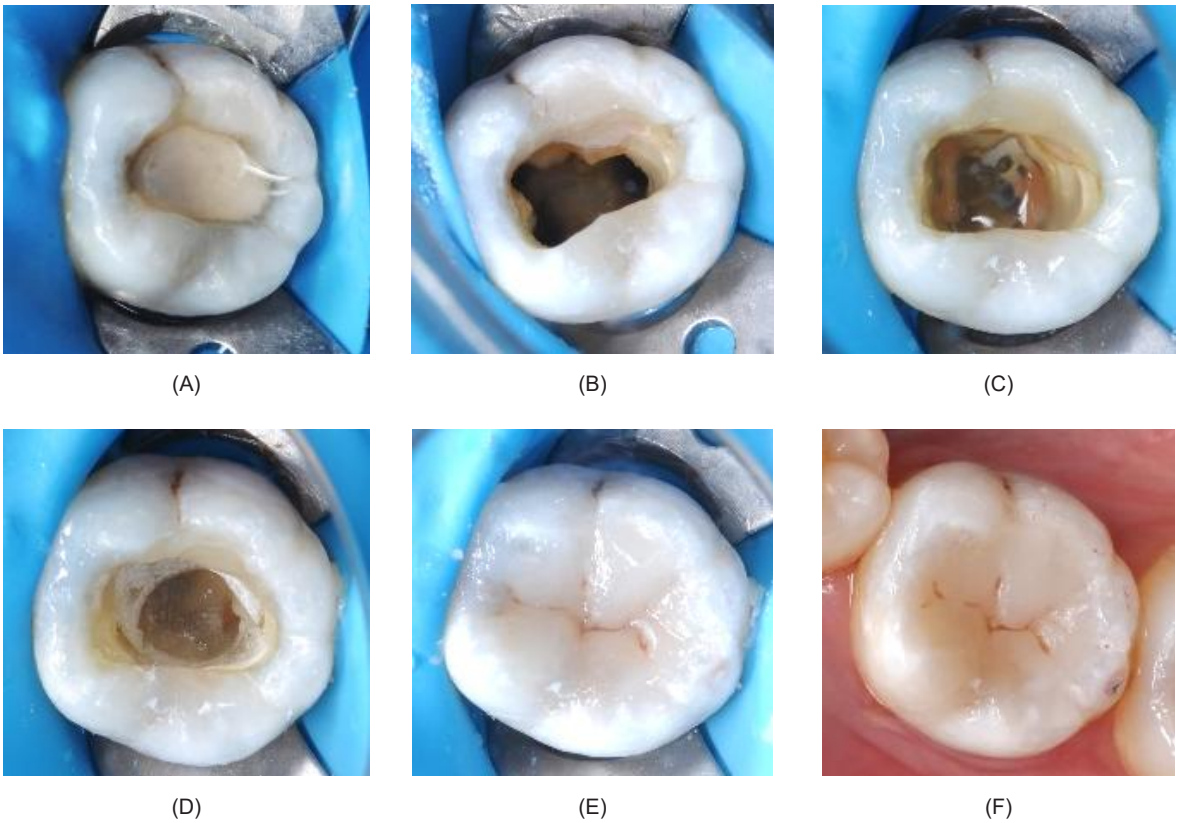

Figure 3. (A) Application of rubber dam; (B) Clinical view after cleaning and shaping; (C) Application of resin coating with low shrinkage flowable; (D) Application of ribbond fiber (fiber wallpapering) and Ever X posterior; (E) Clinial view after composite layering; (F) Clinial view after finishing and polishing

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(A) (B) (C)

(D) (E) (F)

Figure 4. Second Case Workflow (A) Clinical view after cleaning and shaping; (B) Clinical view after obturation; (C) Application of ribbond fiber on the cavity floor (fiber carpeting); (D) Application of ribbond fiber (fiber wallpapering) and Ever X posterior; (E) Clinial view after composite layering; (F) Clinial view after finishing and polishing

(A) (B) (C)

Figure 5. One year clinical and radiographic follow-up of the first case (A) No marginal leakage and discoloration on tooth 36 (B) Post-*obturation radiograph on tooth 36;* (C) Radiographic showing apical healing and no coronal leakage in 1 year follow-up

Ever-X was used for dentin replacement with a horizontal layering application technique 1-1.5 mm thick, and Polymerization was carried out for 20 seconds with LED curing light 800 mW/cm2 in progressive cure mode on the occlusal, buccal, and lingual surfaces. We left some room for application of 1-1.5 mm thick enamel composite resin. To reduce stress from polymerization shrinkage, enamel layered cusp by cusp and polymerization with pulse cure mode were applied for 20 seconds with LED curing light 800 mW/cm^2 (Figure 3E, 4E). Glycerin gel was applied to the entire tooth surface

(A) (B) (C)

Figure 6. One year clinical and radiographic follow-up of the second case (A) No marginal leakage and discoloration on tooth 46 (A) Post-*obturation radiograph on tooth 46;* (B) Radiographic showing apical healing and no coronal leakage in 1 year follow-up

and a final irradiation of LED curing light 1200 mW/cm2 was applied for 20 seconds on the occlusal, buccal, and lingual areas. The bite and occlusal adjustments were checked with a finishing bur. Polishing was carried out with a spiral rubber disc (Diacomp Eve) (Figure 3F, 4F).

The fiber reinforced direct composite for both cases obtained good results in 1 year follow-up in this study. The anatomic form, marginal adaptation, color match, marginal discoloration, secondary caries, surface roughness, tooth integrity, and restoration integrity were clinically acceptable (Figure 5A & 6A). The radiographic showed apical healing and no coronal leakage in 1 year follow-up (Figure 5B, 5C, 6B and 6C).

DISCUSSION

Endodontically treated teeth (ETT) are currently treated with adhesive rather than non-adhesive restorations.[12,13] The stress generated from polymerization shrinkage and the lack of adequate protocols have discouraged many clinicians from selecting a direct technique for the restoration of structurally compromised vital and ETT for many years. However, fiber reinforced and stress-reducing protocol direct composite restorations have been proposed as a valid alternative to indirect resin-bonded composite restorations.[13,14] The endodontic treated teeth being restored with fiber reinforcement direct composite obtained good results in 1 year follow-up in these cases. The anatomic form, marginal adaptation, color match, marginal discoloration, secondary caries, surface roughness, tooth integrity, and restoration integrity were clinically acceptable.

A meta-analysis study comparing direct and indirect composite restorations for the short term (2.5 to 3 years) low-quality evidence suggests no difference between the direct and indirect restorations.[14] When comparing direct composite resin restoration on vital teeth with endodontically treated posterior teeth, more fractures of tooth tissue occur after a period of 8 years. However, only 34.1% of cusps were covered. In a retrospective study, the 5-year survival rate for severely compromised endodontically treated molars restored with direct composite resin was 18%. In contrast, when the maximum amount of tooth tissue was present (comparable to a class I cavity), the cumulative survival rate increased to 78%. Three possible confounding factors could be responsible for this result: restoration type, cusp coverage, and patient risk factors.[14]

The biomechanical behavior recovery of ETT through restorative procedures is still a complex issue in modern adhesive restorative dentistry. Fiber reinforced direct composite has been used in this study to preserve the remaining tooth structure. Preserving and conserving sound tooth structure with modern adhesive partial restorations (extension preservation) instead of tooth reduction

for full crowns (extension for prevention) improve prognosis for ETT.[11]

The wallpapering technique in this study was created with Leno weaved ultra-high-molecular-weight polyethylene (LWUHMWPE) ribbond fiber on the base and circumference connecting the remaining wall to decrease the stress generated by the polymerization shrinkage on the hybrid layer, thus increasing the bond strength as reported in some in vitro studies.[10,15,16] The dentin replacement made using SFRC has shown significant improvements in the load-bearing capacity, flexural strength, and fracture resistance of SFRC compared to conventional particulate filler composite resin.[10,17] The role of SRFC is to act as a crack stopping layer, superior load-bearing capacity, and a favorable fracture pattern.[9,10,17]

Combining composite stratification with small increments and polymerization with a low intensity approach is also mandatory to reduce stress in the restoration.[7,18] Multiple application of small increments allows clinicians to influence the C-factor at a micro level (micro C-factor) and decrease stress from polymerization shrinkage by reducing the composite mass (per increment) and transforming the high C-factor configuration into multiple low C-factor configurations.[7,19-21] Combination of progressive and pulse curing polymerization is used on dentin and enamel, respectively, to further decrease the stress from polymerization shrinkage.[19-21] By adopting a similar soft-start curing protocol, physical and mechanical properties of composite resin may also be improved; more time is available for composite flow into the direction of the cavity walls, resulting in stress release during polymerization shrinkage and increased crosslinking. The quality of the polymer network, which is not equivalent to the degree of conversion, is influenced by the modified curing scheme.[19-21]

CONCLUSION

Fiber reinforced and stress reduce direct composite protocol allows clinicians to not only create minimally invasive preparations but also preserve the remaining sound tooth tissues in structurally compromised teeth (ETT). Improvements in materials and techniques are paving the way to restore teeth in a less invasive way, respecting the remaining tooth structure, and attempting to restore the tooth to its original biomechanical behavior. Long-term clinical studies are required to confirm the superiority of this protocol over traditional restorative strategies. Nevertheless, endodontic treated teeth being restored with fiber reinforcement direct composite obtained good results in 1 year follow-up.

CONFLICT OF INTEREST

There is no competing interest regarding the manuscript.

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