Case Report

Management of a mandibular second molar with vertucci type ii (root canal) configuration using fiber-reinforced direct composite: a case report

Blofoma Mohentaeses Veransa[1]
Margareta Rinastiti[2]*

[1]Specialist program of Endodontics and Conservative Dentistry, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia.
[2]Department of Conservative Dentistry, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia

* Correspondence:
rinastiti@ugm.ac.id

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ABSTRACT

Introduction: Vertucci Type II (root canal) configurations in mandibular second molars are rare. These anatomical variations complicate root canal preparation, irrigation, and obturation. The use of fiber-reinforced direct composite contributes to reinforcing teeth post-endodontic treatment, enhancing fracture resistance, and improving the long-term success of restorations, particularly in posterior teeth subjected to significant masticatory forces. This case report aims to present the management of root canal treatment procedures for a mandibular second molar with a Vertucci Type II configuration, and fiber-reinforced composite restorations through carpeting, and wallpapering techniques. **Case Report**: A 23-year-old female patient presented to the Conservative Dentistry Clinic, RSGM UGM-Prof Soedomo Yogyakarta, for treatment of her lower left second molar. She reported discomfort in the tooth, which had been previously restored two years prior. Six months before the examination, the restoration fractured causing pain. Although the pain has subsided, food debris often accumulated in the resulting cavity. Root canal treatment was performed using single-cone obturation technique with gutta percha and bioceramic sealer to achieve a hermetic sealing. In addition, restoration utilized polyethylene fiber reinforcement applied with wallpapering and carpeting techniques, combined with short fiber reinforced composite (SFRC) for dentin replacement, to enhance structural integrity and fracture resistance. The patient was monitored for one year. **Conclusion**: Root canal treatment of mandibular second molars with Vertucci type II configuration emphasizes the importance of understanding root canal anatomy, using CBCT for accurate evaluation. Optimal irrigation and hermetic obturation with a single-cone technique with a bioceramic sealer are crucial for treatment success. Post-endodontic restoration with polyethylene fiber-reinforced composite, incorporating short fiber-reinforced composite for dentin replacement, improves fracture resistance and maintains bond integrity.

KEYWORDS

Vertucci type II, root canal treatment, direct composite, fiber reinforced

INTRODUCTION

Root canal treatment addresses infected pulp tissue by removing it, cleaning, shaping the root canal, and treat infection. This process aims to restore tooth function, relieve pain, prevent the spread of infection to surrounding tissues, including bone and gingiva, and maintain the structural integrity of the tooth. In root canal treatment, knowledge about root canal morphology and proper preoperative radiographic evaluation are the key to successful root canal

treatment. Variations in root canal shape frequently complicate the treatment process. Hence, failure to properly analyze these variations can lead to treatment failure and reduce the long-term success.[1–3]

Vertucci classified root canal morphology into eight types. Type I is characterized by a single root canal with one apical foramen. Types II to VIII represent more complex configurations involving multiple canals, which may exist as one or more apical foramen. Mandibular second molars are more frequent and more complex forms of root canal systems. The Vertucci Type II configuration, found in mandibular second molars, involves two separate canals that merge into a single canal and one apical foramen. This anatomical variation is considered relatively rare. The prevalence of this anatomical variation in the Middle Eastern ethnic populations ranges from 3.3% to 28%, while in Asian ethnic populations, the prevalence ranges from 0.68% to 28.9% in mandibular second molars. This data shows that this root canal anatomy is not commonly found in most individuals and this variation adds complexity which presents challenges in root canal treatment. [3–7]

The success of root canal treatment is linked to the planning of the final restoration and the selection of appropriate restorative materials, both of which play an important role in restoring tooth function. Proper treatment planning for coronal restorations requires consideration of several things, including the remaining tooth structure, cavity wall thickness, tooth position within the jaw arch, and the load applied to the teeth. Post-root canal tooth treatment generally uses indirect restoration and post core systems. However, this treatment will remove a large amount of healthy tooth structure. Adhesive techniques can provide an alternative in restoring teeth after root canal treatment.[8–10]

Direct composite restoration offers a minimally invasive approach to restoring posterior teeth, effectively strengthening the tooth structure and restoring aesthetics.[11,12] The advantages of direct composite restorations include reversibility, cost efficiency, ease of placement, and, most importantly, an additive approach that utilizes the ability to bond composite material to the tooth structure.[13] In cases involving large cavities, the addition of fiber bands with the wallpapering and carpeting technique can increase tooth strength and fracture resistance. This is particularly beneficial in molars, which experience greater masticatory forces than other teeth.[9,14]

Fiber-reinforced composites create a polymer matrix structure with embedded fibers. This design allows pressure applied to the matrix structure to be transmitted to the fibers, mitigating the risk fractures in both the restoration and the tooth.[15,16] Consequently, the incorporation of fibers can improve the mechanical properties of teeth after root canal treatment, provide better load distribution, and prevent restoration failure, particularly in high-stress areas like posterior teeth. [9,17]

This paper presents a case of a mandibular second molar with a Vertucci Type II canal configuration. This configuration complicates comprehensive cleaning, shaping, and obturation procedures. Restorations of endodontically treated teeth using fiber-reinforced direct composite with wallpapering and carpeting techniques, combined with short fiber-reinforced composite, aims to enhance the fracture resistance of the teeth. The case report describes a method for managing the complexities of Vertucci type II canals while integrating these restorative techniques to achieve durable functional and aesthetic outcomes.

Case Report

A 23-year-old female patient presented to the Dental Conservation Clinic, RSGM UGM-Prof. Soedomo Yogyakarta for treatment for her lower left second molar (tooth 37). The subjective examination revealed that the tooth had been filled approximately 2 years ago, and the restoration fell out 6 months before the patient's examination, resulting in pain. Currently, Although the pain has subsided,

the patient reports frequent food debris accumulation in the resulting cavity. Objective examination revealed tooth 37 had a cavity in the occlusal extending to the pulp (Figure 1A). The percussion test was positive, the palpation test was negative, the mobility test showed no mobility, and the patient's oral hygiene was good.

Radiographic examination of tooth 37 demonstrated that a radiolucency extending to the pulp and widening of the periodontal ligament at the apical end of the tooth (Figure 1B). The CBCT results confirmed two canals in the mesial root-mesiobuccal and mesiolingual - merging in the apical third (Figure 1C). The diagnosis of this case was pulp necrosis with symptomatic apical periodontitis.

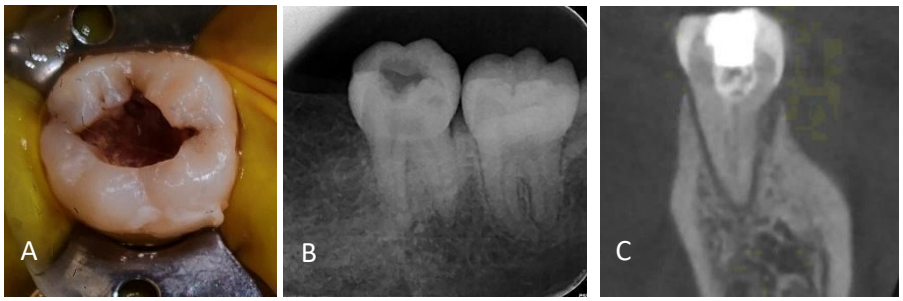

Figure 1. A Preoperative image shows a cavity on the occlusal part of the tooth. B Preoperative X-ray shows a cavity in the pulp depth and a widening of the periodontal membrane. C CBCT radiography results show the mesiobuccal and mesiolingual canals merging into one canal in the apical third of the tooth, in accordance with the Vertucci type II configuration

The treatment plan consisted of root canal treatment and fiber-reinforced direct composite restoration. At the initial visit, the treatment plan, procedures, costs, and estimated treatment time were explained to the patient, who provided informed consent. The prognosis of this case was good because there were no extensive lesions, adequate hard tooth tissue, no history of systemic disease, and good patient cooperation. The treatment the first visit began with the installation of a rubber dam to create a sterile area on tooth 37, followed by carious removal using a diamond bur and access cavity preparation using an endodontic access bur (Figure 2A). The root canal was explored and the working length was measured using an apex locator (Tri Auto ZX2, Morita) and confirmed with periapical radiography (Figure 3A).

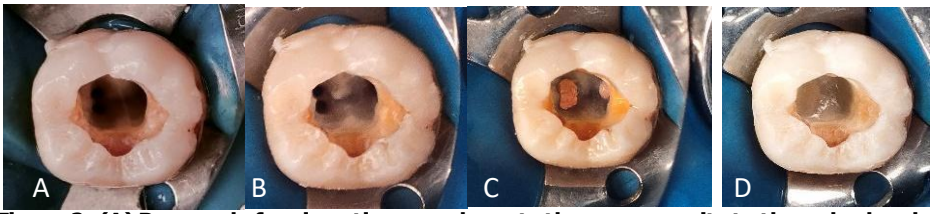

Figure 2. (A) Removal of carious tissue and create the access cavity to the pulp chamber. (B) Clinical picture after root canal preparation. (C) Clinical picture of root canal obturation. (D) Application of resin modified glass ionomer (RMGIC) on the base of the cavity

Root canal preparation was performed using E-flex Blue rotary files (Eighteeth) (Figure 2B). The root canal was irrigated with 2.5% NaOCl, 17% EDTA, and 2% chlorhexidine digluconate, interspersed with saline solution. The irrigation fluid was agitated using Endo Activator Ultra-X (Eighteeth), and the root canal was then dried with paper points. The intracanal medicament was using Ca (OH)2 (Ultracal, Ultradent), and temporary filling was placed. At the second visit, both subjective and objective examinations revealed no abnormalities.

Treatment continued with removal of the intracanal Ca (OH)2 using 2.5% NaOCl irrigation. A gutta-percha cone fitting was, and periapical photos were

taken to confirm proper adaptation of root canal shape and gutta percha according to the working length (Figure 3B). Root canal filling was performed using gutta percha and bioceramic sealer (CeraSeal, Meta-Biomed) then covered with modified glass ionomer resin and followed with a temporary filling (Figure 2C). Post-operative radiographic examination was performed and hermetic obturation results were obtained in the entire root canal (Figure 3C, D).

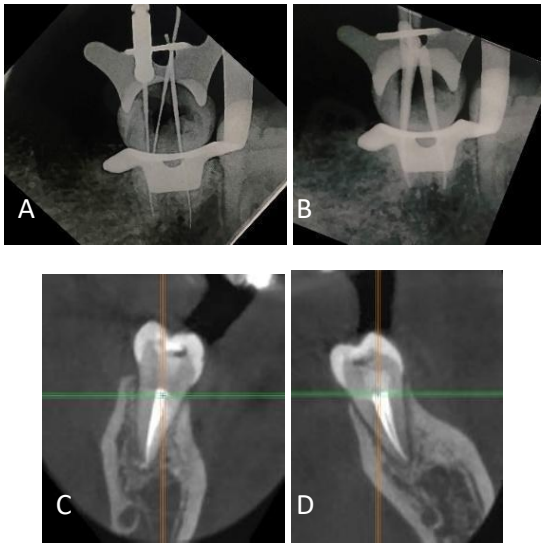

Figure 3. A Measurement of working length. B Gutta-percha trial, gutta-percha is seen to be in accordance with the working length. C Coronal CBCT image section of the distal root canal obturation D Coronal CBCT image section of the mesiobuccal and mesiolingual root canal obturation.

At the third visit, subjective objective examinations of both percussion and palpation tests showed no abnormalities. The tooth was restored using fiber reinforced direct composite. Rubber dam isolation was installed to keep the area sterile (Figure 4A), temporary filling was removed using an ultrasonic scaler, and any remaining carious tissue was cleaned with a diamond bur.

The cavity was disinfected with 2% Chlorhexidine digluconate for one minute. Selective enamel etching was performed using 37% phosphoric acid, followed by rinsing and drying with cotton pellets. Universal adhesive (Scotchbond Universal, 3M) was applied with a rubbing motion for 20 seconds and then air-thinned using a tri-way dental syringe for 5 seconds.

Light polymerization was performed using an LED curing light from the occlusal surface. Cavity depth and cavity circumference were measured with a probe (Figure 4B, C, D). Polyethylene fiber (Construct, Kerr) was cut into 3 x 8 mm segments for the cavity base and 3 x 15 mm segments for the cavity walls. The polyethylene fiber segments were wetted with composite wetting resin.

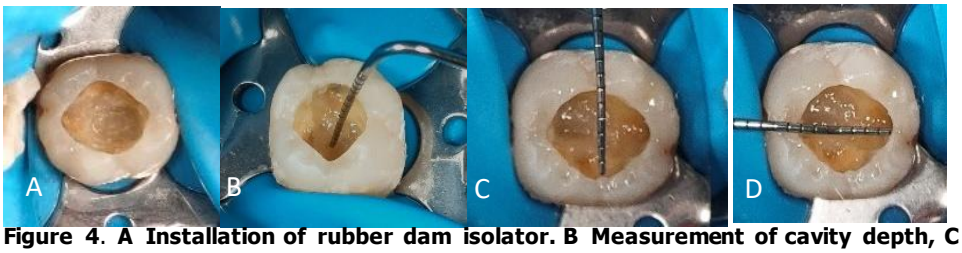

Figure 4. A Installation of rubber dam isolator. B Measurement of cavity depth, C buccolingual length, and D mesiodistal length.

Short fiber reinforced composite (SRFC) (Ever-X, GC) was applied onto the cavity floor. Polyethylene fiber was then carefully adapted to the SRFC layer to ensure a homogeneous and tight adaptation were achieved, creating fiber carpeting layer (Figure 5A). The same procedure was done on the cavity walls

with Ever-X application and polyethylene fiber (fiber wallpapering) (Figure 5B). Polymerization was performed for 20 seconds using an LED curing light. Ever-X also used for dentin replacement with a horizontal layering technique with a thickness of 1-1.5 mm, and polymerization was performed for 20 seconds with LED curing light. Sufficient space was then created for the application of packable composite resin, also measuring 1-1.5 mm in thickness (Figure 5C).

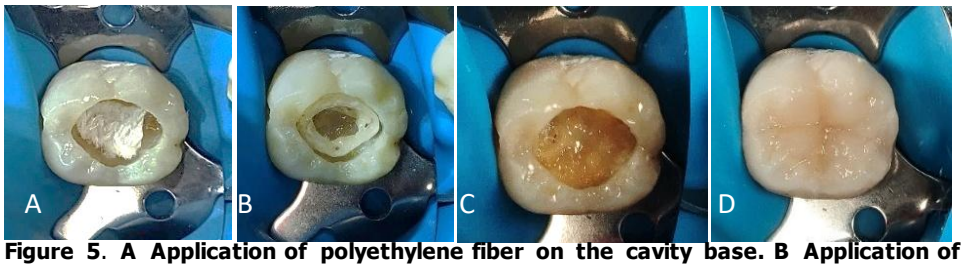

Figure 5. A Application of polyethylene fiber on the cavity base. B Application of polyethylene fiber circumferentially on the cavity walls. C Addition of Ever-X to the cavity and leaving a space of 1-1.5 mm thick for placement of packable composite. D Application of packable composite on the occlusal part

Packable composite was applied to the occlusal surface and polymerized using an LED curing light (Figure 5D). Occlusal adjustments were made using finishing bur, and polishing was performed with a spiral rubber discs (Diacomp Eve). Root canal treatment and direct composite restoration and fiber-reinforced direct composite restoration showed satisfactory results at 1-month (Figure 6A, D), 6-month (Figure 6B, E) and 1-year (Figure 6C, F) follow up examinations. The patient has no complaints and is satisfied with the treatment result.

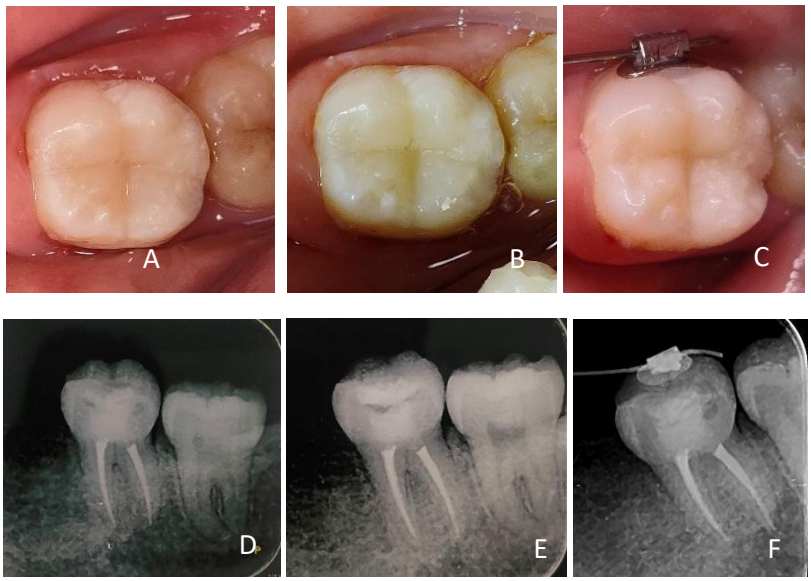

Figure 6. A Clinical picture of teeth during 1 month follow up. B Clinical picture of teeth during 6 month follow up. C Clinical picture of teeth during 1 year follow up. D Periapical radiograph of teeth during 1 month follow up. E Periapical radiograph of teeth during 6 month follow up. F Periapical radiograph of teeth during 1 year follow up

DISCUSSION

The Vertucci Type II configuration is a complex root canal anatomy that presents challenges in endodontic treatment. .[18] This configuration is relatively rare in mandibular second molars. Proper inspection of this canal merging pattern is essential for thorough cleaning, shaping, and obturation of the root canal system. Understanding Vertucci configurations helps clinicians anticipate anatomical variations and improve treatment outcomes.[19–21]

The accuracy of root canal shape analysis before root canal treatment can be achieved through periapical radiography; however, its two-dimensional limitations may prevent complete detection of anatomical variations. Cone-beam computed tomography (CBCT), on the other hand, provides high-resolution three-dimensional images, allowing for more precise evaluation of the tooth anatomy and surrounding tissues compared to conventional radiographs.[22,23] Thorough assessment of root canal anatomy helps prevent procedural errors, such as ledges and perforations. In this case, CBCT revealed Vertucci Type II canal configuration in the left mandibular second molar.

The Vertucci Type II configuration requires meticulous canal exploration and optimal irrigation to ensure all canal pathways are adequately addressed.[24] In this case, ultrasonic agitation was used to enhance irrigant delivery. Ultrasonic agitation can improve the root canal cleanliness, as evidenced by comparisons with similar cases that do not employ this method. Studies indicate that ultrasonic activation significantly improves debris removal from anatomically challenging areas such as isthmuses, lateral canals, and the apical delta. Irrigation activation techniques using ultrasonic devices enhance the effectiveness of root canal cleaning through cavitation and acoustic streaming mechanisms. Acoustic streaming or microstreaming involves rapid, circular movement of irrigant solution around the agitating tip.[24-26]

This case shows the benefit of combining irrigation strategies, including 2% chlorhexidine digluconate as a final irrigant and calcium hydroxide as intracanal medicaments between visits. This combination can further support root canal disinfection, particularly in areas with complex anatomy.[26] Additionally, post-treatment improvement during the first visit was observed at the first follow-up visit, with the tooth and surrounding tissues exhibiting signs of healing and no periapical lesion expansion. Achieving a hermetic obturation is a critical factor for the long-term success of root canal treatment, as it prevents leakage of fluids and materials from the periradicular tissue into the root canal system and vice versa.[27] In other cases, warm obturation techniques are often used for root canals with complex configurations. However, in this case, obturation was performed using the single cone technique combined with a bioceramic sealer to achieve hermetic sealing in a mandibular second molar with a Vertucci Type II root canal configuration. Despite ongoing discussion regarding the efficacy of a single-cone technique in such complex cases, the favorable outcome observed in this instance suggest that this approach, when combined with a bioceramic sealer, can yield satisfactory outcomes and support the success of root canal treatment.

The obturation process for a Vertucci Type II root canal configuration requires high precision, particularly when adjusting the gutta-percha at the canal convergence point. In this instance, one guttapercha cone was trimmed and adjusted at the canal convergence point to ensure proper placement. Additionally, the use of a bioceramic sealer was crucial, it enhanced hermetic sealing by easily penetrating the dentinal tubules. These findings align with previous literature indicating that bioceramic sealer can form chemical bonds with dentin through hydroxyapatite synthesis during the setting process, thereby enhancing the bond strength.[27] The dimensional stability of bioceramic sealer ensures more reliable sealing, while their bioactive properties stimulate tissue repair and induce mineralization. Furthermore, the study shows their alkaline pH, which supports and provides effective antimicrobial activity against pathogenic bacteria such as *Enterococcus faecalis* and *Porphyromonas gingivalis*.[27,28]

At the control visit for this case, improvement in the periapical tissue were observed. This was indicated by the improvement in the surrounding bone structure, and the absence of clinical symptoms such as pain or discomfort. The follow-up radiograph further demonstrated increased consistency in the periapical tissue, indicating a successful healing process. These outcomes highlight the effectiveness of the treatment provided, including the management of root canal

treatment, obturation, and the selection of materials that support periapical tissue regeneration.

Post endodontic restoration is essential for ensuring long-term success. While indirect restorations are often preferred for endodontically treated posterior teeth, fiber-reinforced direct restorations can also achieve excellent results. Techniques such as "wallpapering" and "carpeting" make direct restorations an effective and practical alternative. This approach has been shown to enhance fracture resistance, as previous studies have reported that incorporating fibers into composite restorations provides additional strength and acts as a stress breaker.[29,30] Comparatively, studies have also indicated that the durability of direct composite restorations, yielding similar long-term outcomes. Additionally, direct composite restorations are a viable option for posterior teeth with extensive damage, including loss of multiple cusps and significant tooth surfaces [31,32]

In this case, the direct restoration technique, combined with the use of polyethylene fibers and short fibers, yielded excellent outcomes. This approach was simpler and more cost-effective compared to indirect composite restoration. Polyethylene fiber was used as "wallpapering" the cavity walls and "carpeting" the cavity base. In the wallpapering technique, polyethylene fiber was arranged circumferentially along the remaining hard tissue walls of the tooth. Its interlocking structure effectively transmitted pressure through the fiber tape's interwoven design. The fiber tape served to reduce stress from polymerization shrinkage and maintain the bonded interface in deep dentin, thereby increasing the restoration strength. The structure of polyethylene fibers not only reinforced the restoration but also helped prevent failure under high occlusal loads in posterior teeth [33–35] Additionally, dentin replacement with SFRC (Short Fiber-Reinforced Composite) demonstrated superior fracture resistance compared to conventional particle-filled composite resins.[36] Consequently, the incorporation of fibers, whether as SFRC or polyethylene tape, significantly contributes to the successful treatment of posterior teeth requiring extensive restorations.

Based on the evaluation at one month, six months and one year post-treatment, the patient reported no complaints or discomfort with the treated tooth and was able to use it normally for mastication. Observations after one year showed that the treatment and restoration remained successful, both functionally and aesthetically, with no signs of failure or complications. The patient's satisfaction with the outcome further underscores the effectiveness of the fiber-reinforced direct composite restoration in restoring the structural integrity and function of the tooth following root canal treatment.

While the root canal treatment of mandibular second molars with Vertucci Type II configuration yielded positive results, special attention should be given to the possibility of restoration failure. A limitation of this study is the relatively short follow-up period. Therefore, a longer follow-up period is necessary to ensure sustained success and to promptly address any potential issues that may arise over time.

CONCLUSION

Root canal treatment of mandibular second molars with Vertucci Type II configuration emphasizes the importance of understanding root canal anatomy and using CBCT for accurate evaluation. Effective irrigation and hermetic obturation with a single-cone technique, combined with the use of a bioceramic sealer, contributed to improved treatment success. Post-endodontic restoration using polyethylene fiber-reinforced composite resin, along with the addition of SFRC, enhanced fracture resistance and preserved bond integrity. This case report emphasizes the goal of achieving optimal functional and aesthetic outcomes, ultimately supporting the long-term success of the treatment for patients.

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