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Endodontic Management of Symptomatic Irreversible Pulpitis Using Crown-Down Technique with Porcelain-Fused-to-Metal Crown

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Abstract— *Symptomatic irreversible pulpitis is an irreversible inflammatory condition of the dental pulp and remains one of the primary indications for non-surgical root canal treatment in permanent teeth. Successful treatment depends on accurate diagnosis, effective biomechanical preparation, adequate disinfection, and definitive post-endodontic restoration. A 44-year-old woman presented with spontaneous lingering pain in the left maxillary first premolar for one month. Clinical examination revealed deep caries with a positive percussion response and a positive electric pulp test. Periapical radiography demonstrated two distinct root canals without periapical radiolucency, and the tooth was diagnosed with symptomatic irreversible pulpitis. Endodontic treatment included access cavity preparation, working length determination, crown-down biomechanical preparation using ProTaper hand files, irrigation with 2.5% sodium hypochlorite, intracanal medication with calcium hydroxide, single-cone obturation with Endomethasone sealer, fiber post placement, composite resin core build-up, and definitive rehabilitation with a porcelain-fused-to-metal (PFM) crown. At the one-week follow-up, the patient reported complete resolution of spontaneous pain. Clinical examination showed negative percussion and palpation responses, while the definitive restoration restored tooth function and provided an adequate coronal seal. This case demonstrates that the crown-down technique combined with evidence-based post-endodontic rehabilitation can provide favorable short-term clinical outcomes in maxillary premolars with symptomatic irreversible pulpitis and complex root canal anatomy. Long-term clinical and radiographic follow-up is recommended to evaluate periapical healing and restoration longevity.*

Keywords— *Crown-down technique; porcelain-fused-to-metal crown; root canal treatment; symptomatic irreversible pulpitis.*

I. INTRODUCTION

Pulpal diseases remain among the most prevalent oral diseases requiring endodontic treatment worldwide and represent a major cause of dental pain and emergency dental visits. When pulpal inflammation progresses beyond the tissue's capacity for repair, it develops into symptomatic irreversible pulpitis, an irreversible inflammatory condition characterized by spontaneous pain, prolonged pain following thermal stimulation, and persistent pain even after the stimulus has been removed. Recent evidence indicates that symptomatic irreversible pulpitis remains one of the leading indications for nonsurgical root canal treatment in permanent teeth [1][2].

Recent advances in endodontic instruments, irrigation protocols, and restorative materials have significantly improved the predictability and success of root canal treatment while expanding the indications for vital pulp therapy in selected clinical conditions. Nevertheless, nonsurgical root canal treatment remains the treatment of choice for permanent teeth diagnosed with symptomatic irreversible pulpitis when vital pulp therapy is no longer clinically indicated [3].

The primary objective of root canal treatment is to eliminate infected pulp tissue and microorganisms from the root canal system, achieve effective canal disinfection, and establish an apical seal that prevents reinfection. Treatment success is indicated by the resolution of clinical symptoms, restoration of tooth function, and the absence of pathological findings during clinical and radiographic follow-up [4]. These objectives are achieved through a systematic sequence of procedures, including accurate diagnosis, biomechanical preparation, effective irrigation, intracanal medication when indicated, and hermetic obturation to prevent reinfection of the root canal system [5].

A comprehensive diagnosis based on patient history, clinical examination, pulp vitality testing, and radiographic assessment is fundamental for accurately diagnosing pulpal disease and selecting the most appropriate treatment approach [6]. Among the available instrumentation techniques, the crown-down technique remains widely recommended because it begins with enlargement of the coronal third using larger instruments before progressively preparing the middle and apical thirds with smaller instruments. This approach reduces coronal interference, enhances irrigant penetration into the apical region, facilitates accurate working length determination, minimizes apical extrusion of debris, and preserves the original canal curvature and anatomy [7].

This case report presents the nonsurgical management of symptomatic irreversible pulpitis in a maxillary first premolar with two distinct root canals using the crown-down instrumentation technique with ProTaper hand files. The treatment protocol was performed systematically, including comprehensive diagnosis, identification of root canal anatomy, working length determination, biomechanical preparation, irrigation, intracanal medication, obturation, post-endodontic restoration, and clinical evaluation. Each stage was conducted in accordance with evidence-based endodontic principles to achieve effective canal disinfection, preserve tooth structure, establish a hermetic apical seal, and minimize the risk of root canal reinfection. Demonstrates the integration of evidence-

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based endodontic and restorative management, including fiber post-supported rehabilitation and a porcelain-fused-to-metal (PFM) crown, to restore the biological, functional, and structural integrity of an endodontically treated tooth with extensive coronal destruction. The findings provide a practical clinical reference for managing anatomically complex root canal cases and highlight the role of meticulous endodontic procedures in achieving favorable treatment outcomes.

II. Case

A 44-year-old woman presented to the Department of Conservative Dentistry, Faculty of Dentistry, Universitas Muhammadiyah Surakarta, Indonesia, with a chief complaint of spontaneous pain associated with a cavitated lesion in the left maxillary first premolar. The pain had persisted for approximately one month and had progressively worsened, interfering with daily activities and mastication. The patient described the pain as spontaneous, lingering for a prolonged period, and not significantly relieved after the removal of the provoking stimulus, which was consistent with the clinical presentation of symptomatic irreversible pulpitis. Before seeking professional dental care, the patient attempted self-medication using garlic and locally available herbal oil; however, these measures did not provide meaningful pain relief. The patient had not previously received restorative or endodontic treatment for the affected tooth.

Based on the patient's medical history, she had no history of systemic diseases, including diabetes mellitus, hypertension, cardiovascular disease, or other medically significant conditions, no allergies to medications, foods, or environmental allergens and was not receiving any long-term medical treatment. The patient had no previous history of restorative or endodontic treatment and reported that the affected tooth had only been managed with self-administered traditional remedies before seeking professional dental care.

Extraoral examination revealed no facial swelling, lymphadenopathy, or other abnormalities. Intraoral examination demonstrated a deep cavitated lesion on the mesiobuccal surface of tooth #24 extending into the pulp chamber. Clinical examination showed a positive response to probing and percussion, a negative response to palpation, and a positive electric pulp test (EPT) response at a reading of 31, indicating a vital but inflamed pulp. According to the Mount and Hume classification, the lesion was categorized as Site 3 Size 4, indicating extensive proximal caries with pulpal involvement. Based on the International Caries Detection and Assessment System (ICDAS), the lesion was classified as ICDAS score 6, consistent with an extensive cavitated lesion with visible dentin involvement and pulpal exposure [Fig.1].

Preoperative periapical radiography revealed a deep carious lesion extending into the pulp chamber of tooth #24 with two distinct root canals, namely the buccal and palatal canals. The working length for both canals was determined to be 19 mm during the first radiographic evaluation. Following the conventional working length determination protocol, a provisional working length of 18 mm was established by subtracting 1 mm from the radiographic estimate before clinical verification.

Fig. 1. Clinical photograph of tooth 24

Based on the patient's history, clinical examination, pulp vitality testing, and radiographic findings, symptomatic irreversible pulpitis involving a maxillary first premolar with two root canals was diagnosed in tooth #24. As the definitive therapy for the tooth that was affected, the radiographic and clinical data corroborated the need for nonsurgical root canal therapy.

III. Case Management

Before treatment, the patient was informed about the diagnosis, proposed treatment procedures, potential benefits and risks, expected prognosis, and available treatment alternatives, and written informed consent was obtained. The diagnosis of symptomatic irreversible pulpitis with two different root canals (buccal and palatal) was determined by clinical examination, pulp vitality testing, and periapical radiography of tooth #24. After local infiltration anesthesia with 2% lidocaine and 1:100,000 epinephrine, the tooth was isolated with a rubber dam. Carious tissue was removed, and an ovoid access cavity was prepared in the buccopalatal direction with slight occlusal divergence. Coronal pulp tissue was removed until both canal orifices were clearly identified using a endodontic explorer and a smooth broach. Canal negotiation was performed with size #8 and #10 K-files to establish the glide path, followed by pulp extirpation using a sterile barbed broach with continuous irrigation using 2.5% sodium hypochlorite (NaOCl).

Fig. 2. Measurement of actual working length using periapical radiography

The working length was first determined radiographically, then verified with periapical radiography and a size #10 K-file, setting the final working lengths for the buccal and palatal canals at 20 mm and 18 mm, respectively [Fig.2]. The canals were irrigated with 2.5% NaOCl and sterile saline, dried with paper points, medicated with chlorophenol camphor menthol (ChKM), and temporarily sealed with zinc phosphate cement. At the following visit, biomechanical preparation was performed using the crown-down technique with the ProTaper Hand file system. Coronal flaring was completed with SX, S1, and S2 files, followed by apical preparation with S1, S2, F1, and F2 files to the established working lengths [Fig.3].

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Recapitulation with a size #15 K-file and irrigation with 2.5% NaOCl and sterile saline were performed after each instrumentation step to maintain canal patency and remove dentinal debris.

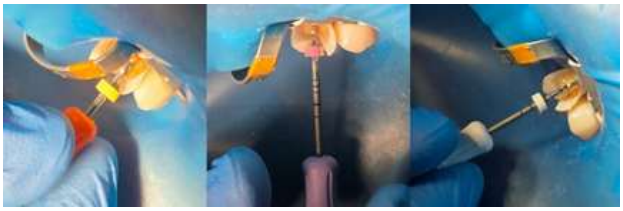

Fig. 3. The canals were prepared using ProTaper hand files with the crown-down technique

Before obturation, a master cone fitting was performed using ProTaper F2 single-cone gutta-percha. Adaptation was verified clinically by a distinct tug-back sensation and radiographically at the established working lengths. Calcium hydroxide paste mixed with iodoglycerin was then placed as an intracanal medicament using a Lentulo spiral, and the access cavity was temporarily sealed [Fig.5]. At the subsequent appointment, clinical examination demonstrated complete resolution of symptoms, negative percussion and palpation responses, and no signs of persistent infection. After removal of the temporary restoration and intracanal medicament, the canals were irrigated, dried, and obturated using the single-cone gutta-percha technique with Endomethasone sealer. Post-obturation radiography confirmed satisfactory three-dimensional obturation, excess gutta-percha was removed approximately 2 mm below the canal orifices, and the orifices were sealed with Type III glass ionomer cement.

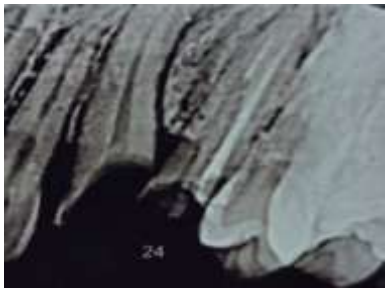

Fig. 4. A periapical radiograph verified the remaining apical gutta-percha after post space preparation

Following successful root canal treatment, the tooth was prepared for definitive post-endodontic restoration. A direct composite resin core build-up was planned, and the palatal canal was selected for fiber post placement because of its favorable anatomical configuration. Post space preparation was performed by removing coronal gutta-percha while preserving 4–5 mm of the apical seal. Peeso reamers sizes 1 and 2 were used to prepare a post space approximately 9.1 mm deep, and a 1.3 mm fiber post was selected according to the root diameter. The fiber post was cemented, and the composite core was anatomically reconstructed to restore the remaining coronal tooth structure and provide adequate retention and resistance for the definitive restoration [Fig.4].

Fig. 4. The canals were obturated using the single-cone gutta-percha technique with Endomethasone sealer. Excess gutta-percha was severed approximately 2 mm below the canal orifice.

Tooth preparation for a porcelain-fused-to-metal (PFM) crown included occlusal reduction of approximately 1.0–1.5 mm, buccal and palatal reduction with chamfer finish lines, proximal preparation with convergent axial walls, and rounding of all internal line angles. Finishing and polishing were completed before making a one-step double-mix elastomeric impression with putty and light-body materials, and a Type IV dental stone working cast was fabricated for laboratory construction of the PFM crown. At the insertion appointment, gingival retraction was performed, and the PFM crown was evaluated for marginal adaptation, proximal contact, cervical adaptation, shade matching, and occlusion. The crown was cemented with dual-cure resin cement, excess cement was removed, light curing was performed for approximately 20 seconds on each accessible surface, and final occlusal adjustment, finishing, and polishing were completed [Fig.6]. The final clinical evaluation demonstrated satisfactory marginal adaptation, harmonious occlusion, healthy surrounding soft tissues, and absence of pain, sensitivity, or functional discomfort after definitive crown placement.

Fig. 5. The definitive porcelain-fused-to-metal (PFM) crown was seated, adjusted for occlusion, and permanently cemented.

IV. Discussion

The diagnosis of symptomatic irreversible pulpitis in tooth #24 was established through a comprehensive interpretation of the patient's history, clinical examination, pulp vitality testing, and radiographic findings in accordance with the diagnostic criteria of the American Association of Endodontists (AAE). Endodontic diagnosis should not rely on a single clinical finding; instead, it requires integration of subjective symptoms with objective clinical and radiographic assessments to accurately determine pulpal and periapical status [8][9].

In the present case, the patient reported spontaneous lingering pain for approximately one month, accompanied by a positive response to percussion and a positive electric pulp test

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(EPT), indicating that the pulp remained vital despite irreversible inflammation. Periapical radiography demonstrated a deep carious lesion extending into the pulp chamber without evidence of periapical radiolucency, supporting the diagnosis of symptomatic irreversible pulpitis rather than pulpal necrosis or symptomatic apical periodontitis. The clinical presentation was also differentiated from reversible pulpitis because the pain was spontaneous, prolonged after stimulation, and did not resolve despite self-medication, indicating irreversible pulpal damage [8][10].

Based on these findings, nonsurgical root canal treatment was selected as the definitive therapeutic approach. In this patient, the extensive carious lesion with pulpal involvement made root canal treatment the most appropriate strategy to eliminate intracanal infection, relieve pain, preserve the tooth within the dental arch, and prevent progression to pulpal necrosis and apical periodontitis [10].

Successful nonsurgical root canal treatment depends on the identification, cleaning, shaping, disinfection, and obturation of the entire root canal system. In the present case, careful exploration of the pulp chamber revealed two distinct canal orifices corresponding to the buccal and palatal canals of the maxillary first premolar. This finding is clinically significant because untreated or missed canals remain one of the most common causes of persistent intracanal infection and long-term endodontic failure, particularly in maxillary premolars with complex root canal anatomy [11].

Determination of the working length represents one of the most critical stages of root canal treatment because it establishes the apical limit for instrumentation, irrigation, and obturation within the biological boundaries of the root canal system. Periapical radiographic verification established the final working lengths as 20 mm for the buccal canal and 18 mm for the palatal canal.

According to the American Association of Endodontists, canal preparation should terminate approximately 0.5–1.0 mm short of the anatomical apex, corresponding to the apical constriction, to maintain the biological seal and minimize the risk of apical extrusion of debris and irrigants [12][8]. Recapitulation after each instrument change is an essential component of biomechanical preparation because it maintains apical patency, preserves the original canal pathway and prevents canal blockage, ledge formation, and apical transportation. In the present case, recapitulation was consistently performed with a size #15 K-file after each ProTaper instrument to maintain the original canal pathway and ensure that subsequent instruments reached the predetermined working length [12].

In addition to maintaining canal patency, recapitulation enhanced the effectiveness of irrigation by preserving an unobstructed pathway for irrigating solutions to reach the apical third of both canals. Maintaining apical patency throughout instrumentation improves irrigant exchange and promotes the removal of dentinal debris and residual organic tissue from areas that are inaccessible to mechanical instruments. Recapitulation contributed to the overall effectiveness of canal debridement and disinfection in this case [12].

The crown-down instrumentation technique used in this case provided several biological and mechanical advantages during root canal preparation. Initial enlargement of the coronal third created sufficient space for dentinal debris, necrotic tissue remnants, and microorganisms to be displaced coronally rather than extruded through the apical foramen during subsequent instrumentation [13]. According to the American Association of Endodontists (AAE), the primary objective of root canal preparation is to create a continuously tapered canal that allows effective mechanical debridement, adequate antimicrobial irrigation, and three-dimensional obturation while preserving as much sound radicular dentin as possible [8]. In this case, the sequential use of ProTaper SX, S1, S2, F1, and F2 files produced a tapered canal configuration that facilitated effective cleaning and shaping while maintaining the original canal anatomy.

The tapered canal configuration achieved through crown-down preparation also improved the effectiveness of irrigation. Coronal enlargement increased irrigant penetration and circulation within the middle and apical thirds of the canals, allowing sodium hypochlorite (NaOCl) to contact areas that were not directly instrumented. Effective irrigation plays a fundamental role in dissolving organic tissue, removing dentinal debris and the smear layer, and disrupting microbial biofilms. The combination of crown-down biomechanical preparation and adequate irrigation provided a complementary strategy for achieving effective disinfection of the root canal system in this case [8]. Studies have shown that endodontic instruments contact only approximately 40–60% of the canal wall surface, leaving substantial areas that rely on irrigating solutions for debridement and disinfection. Therefore, irrigation plays a critical role in eliminating microorganisms and disrupting biofilms in regions inaccessible to mechanical instruments [14][15].

In the present case, 2.5% sodium hypochlorite (NaOCl) was used as the primary irrigating solution throughout biomechanical preparation, followed by sterile saline irrigation after each stage of instrumentation. This irrigation protocol was intended to remove organic tissue remnants and dentinal debris generated during instrumentation while improving canal cleanliness before subsequent file progression. The sequential use of NaOCl and saline also facilitated removal of residual irrigant and debris from the root canal system before drying the canals with sterile paper points.

Sodium hypochlorite remains the gold-standard irrigant in endodontic treatment because of its unique ability to dissolve organic tissue while providing broad-spectrum antimicrobial activity against bacteria, fungi, and microbial biofilms. A concentration of 2.5% was selected in this case because it provides an appropriate balance between antimicrobial effectiveness and biological safety, reducing the potential for cytotoxic effects while maintaining satisfactory tissue-dissolving capacity. The antimicrobial effectiveness of NaOCl is influenced not only by its concentration but also by the volume delivered, duration of contact with the canal walls, frequency of irrigant replenishment, and its ability to penetrate the anatomical complexities of the root canal system [14][15].

Sodium hypochlorite (NaOCl), sterile saline was used as an adjunct irrigating solution after each stage of instrumentation. Although saline has no significant antimicrobial activity or tissue-dissolving capability, it functions as a flushing solution that removes dentinal debris, pulp tissue remnants, and residual irrigants from the root canal system. Throughout biomechanical preparation, sequential saline irrigation helped maintain canal patency, reduced debris accumulation within the apical third, and facilitated penetration of subsequent instruments and irrigating solutions into the full working length of the canals. The use of saline between irrigation steps also supports the principle of sequential irrigation in endodontic therapy, in which irrigating solutions are applied according to their specific biological functions. In this case, saline served primarily to flush residual NaOCl and instrumentation debris from the canals before the next procedural step, thereby improving canal cleanliness and reducing the potential for accumulation of chemical residues. This irrigation strategy contributed to a cleaner canal environment before intracanal medication and obturation [16].

Following completion of biomechanical preparation, calcium hydroxide ($Ca(OH)_2$) was placed as an intracanal medicament in accordance with contemporary endodontic treatment principles for primary endodontic infections. Intracanal medication is recommended when additional antimicrobial control is required between treatment visits to further reduce residual intracanal microorganisms before definitive obturation. Calcium hydroxide was selected because of its well-established antimicrobial properties and its ability to create an alkaline environment that is unfavorable for the survival of residual microorganisms within the root canal system. The iodoglycerin vehicle facilitated placement of the medicament and helped maintain intimate contact between the paste and the canal walls. After placement of the intracanal medicament, the pulp chamber was covered with a sterile cotton pellet and the access cavity was temporarily sealed with zinc phosphate cement to prevent coronal microleakage and recontamination of the root canal system during the interappointment period [16]. Calcium hydroxide has a high alkaline pH of approximately 12.5, which promotes the release of hydroxyl ions (OH^-) capable of disrupting the cytoplasmic membrane of microorganisms, denaturing bacterial proteins, inactivating essential enzymes, and damaging microbial DNA. These mechanisms contribute to substantial reduction of residual intracanal microorganisms following biomechanical preparation [17]. Calcium hydroxide also possesses bioactive properties that support periapical tissue healing. The release of calcium ions stimulates mineralized tissue formation by promoting the activity of cementoblasts and osteoblasts, thereby facilitating repair of damaged periapical tissues and contributing to the regeneration of mineralized tissue after elimination of infection. These biological properties make calcium hydroxide an appropriate intracanal medicament in cases of symptomatic irreversible pulpitis requiring interappointment disinfection [17].

In the present case, calcium hydroxide was mixed with iodoglycerin as the vehicle before placement into the root canals. Iodoglycerin provides an appropriate paste consistency, allowing the medicament to be delivered uniformly throughout the canal system using a Lentulo spiral, including areas that are difficult to reach mechanically. In addition, iodoglycerin slows the release of hydroxyl ions, thereby prolonging the antimicrobial activity of calcium hydroxide during the interappointment period and enhancing its therapeutic effectiveness [18]. Recent systematic reviews indicate that calcium hydroxide achieves optimal antimicrobial activity when left inside the root canal for a minimum of seven days, enabling hydroxyl ions to penetrate dentinal tubules and eliminate residual bacteria before obturation. In this case, the intracanal medicament was retained for seven days in accordance with current evidence-based recommendations for interappointment disinfection [17].

Successful microbial elimination is achieved through the synergistic effect of adequate biomechanical preparation, effective irrigation, appropriate intracanal medication, and prevention of coronal recontamination with a well-sealed temporary restoration. Biomechanical preparation reduces the microbial load mechanically, irrigation dissolves organic tissue and disrupts biofilms, while calcium hydroxide acts against residual microorganisms that remain within dentinal tubules and anatomical areas inaccessible to endodontic instruments. The integration of these procedures creates favorable biological conditions for three-dimensional obturation and contributes to the long-term success of endodontic treatment [19].

Obturation was performed using the single-cone gutta-percha technique after successful master cone fitting demonstrated an adequate tug-back sensation and radiographic verification confirmed correct cone positioning. The presence of tug-back indicated intimate adaptation of the master cone to the apical constriction, while periapical radiography confirmed that the gutta-percha reached the predetermined working length without evidence of overextension or underfilling. Accurate adaptation of the master cone within the apical third is essential because apical sealing quality is one of the primary determinants of long-term endodontic success.

The single-cone obturation technique was selected because it is specifically designed to complement the tapered canal geometry created by the ProTaper instrumentation system. ProTaper F2 gutta-percha cones correspond to the size and taper of the F2 finishing file, allowing improved adaptation of the master cone to the prepared canal, particularly within the apical third. This anatomical compatibility facilitates effective sealing while simplifying the obturation procedure compared with conventional lateral condensation techniques. Furthermore, the single-cone technique is more reproducible, requires less chairside time, and reduces operator-dependent variability, making it a widely accepted obturation method in contemporary endodontic practice [20].

Another important advantage of the single-cone technique is the reduced application of lateral condensation forces during obturation. Conventional lateral condensation requires repeated insertion of spreaders, which may generate excessive stress on the root canal walls and increase the risk of dentinal microcracks or vertical root fracture, particularly in endodontically treated teeth with substantial loss of radicular dentin. This conservative approach is consistent with the

principles of minimally invasive endodontics and is particularly beneficial for maxillary premolars that are more susceptible to fracture because of their relatively thin root morphology [21].

The quality of the sealer is a critical determinant of the success of the single-cone obturation technique. The sealer must possess adequate flowability to penetrate anatomical irregularities, including lateral canals, isthmuses, accessory canals, and dentinal tubules, while maintaining dimensional stability during the setting process. Additional characteristics, such as radiopacity, biocompatibility, low solubility, and long-term sealing ability, are essential for achieving a durable apical and coronal seal [22].

An important consideration when using zinc oxide–eugenol sealers is the prevention of excessive sealer extrusion beyond the apical foramen because overextension may induce irritation of the periapical tissues. In this case, accurate working length determination, appropriate master cone adaptation, and careful sealer placement minimized the risk of apical extrusion while allowing the sealer to occupy irregularities within the prepared canal system. Post-obturation radiographic evaluation demonstrated satisfactory adaptation of the obturation materials without evidence of overfilling, supporting the effectiveness of the obturation procedure.

Although bioceramic sealers have recently gained popularity because of their bioactivity and superior sealing properties, zinc oxide–eugenol sealers such as Endomethasone remain a clinically acceptable option in many healthcare settings, particularly where bioceramic sealers are not routinely available. When combined with adequate biomechanical preparation, effective irrigation, accurate working length control, and proper obturation technique, Endomethasone is capable of providing a satisfactory seal and favorable short-term clinical outcomes in nonsurgical root canal treatment [23].

An additional consideration in post-endodontic rehabilitation is the preservation of an adequate ferrule effect. Maintaining circumferential sound tooth structure around the cervical portion of the tooth improves fracture resistance, enhances retention of the definitive restoration, and contributes to the longevity of endodontically treated teeth. The composite resin core build-up in this case was designed to provide sufficient coronal support for the definitive crown while preserving the remaining healthy tooth structure and creating favorable conditions for crown retention. A porcelain-fused-to-metal (PFM) crown was selected as the definitive restoration because it provides complete cuspal coverage and adequate mechanical strength for posterior teeth subjected to substantial occlusal loading. Compared with direct composite resin restorations, full-coverage crowns distribute occlusal forces more evenly across the remaining tooth structure and reduce cuspal flexure during mastication. This consideration is particularly important for maxillary first premolars, which are exposed to combined axial, lateral, and torsional forces during function and are therefore more susceptible to fracture after extensive coronal tissue loss [24].

Clinical studies have demonstrated that full-coverage restorations significantly improve the fracture resistance and survival of endodontically treated premolars with extensive coronal destruction compared with restorations that do not provide cuspal protection. By providing complete coronal coverage, PFM crowns reduce stress concentration within the remaining tooth structure and help maintain the integrity of the underlying endodontic treatment over time [24].

The chamfer finish line is widely recommended for PFM restorations because it provides sufficient material thickness with a more conservative reduction of cervical tooth structure than a shoulder finish line. In addition, rounding all internal line angles reduces stress concentration within the restoration, improves internal adaptation of the crown, and decreases the likelihood of marginal discrepancies or ceramic fracture. Conversely, sharp preparation angles may increase stress concentration within the restorative material and compromise marginal adaptation and long-term restoration durability [25][26].

The favorable early clinical outcome observed in this patient suggests that adherence to evidence-based prosthodontic preparation principles, combined with appropriate endodontic treatment and definitive full-coverage restoration, contributed to restoration of function, preservation of the coronal seal, and improvement of the long-term prognosis of the endodontically treated maxillary first premolar. However, long-term success of endodontic treatment depends not only on successful root canal disinfection and obturation but also on the quality of the definitive coronal restoration.

Preservation of the coronal seal is essential to prevent bacterial microleakage and reinfection of the root canal system after endodontic treatment. Consequently, definitive restorative rehabilitation should restore tooth function, protect the remaining tooth structure from fracture, and maintain the biological seal established during root canal treatment [20]. The favorable short-term clinical outcome observed in this patient reflects the successful integration of evidence-based endodontic and restorative treatment principles.

This treatment strategy is consistent with the concept of the endodontic-restorative, which emphasizes that the long-term prognosis of endodontically treated teeth is determined by the combined quality of infection control, biomechanical preparation, obturation, and definitive coronal restoration rather than by any single treatment stage alone [20]. Despite the favorable early outcome, continued clinical and radiographic follow-up is recommended at approximately 6 and 12 months to evaluate maintenance of the coronal restoration, periapical healing, and long-term functional stability of the treated tooth.

V. Conclusion

This case demonstrates that nonsurgical root canal treatment using the crown-down instrumentation technique can achieve favorable early clinical outcomes in a maxillary first premolar with symptomatic irreversible pulpitis and two root canals. Successful management was achieved through a systematic, evidence-based treatment protocol that integrated accurate diagnosis, careful identification of root canal anatomy, precise working length determination, crown-down biomechanical preparation with ProTaper hand files, sequential irrigation with 2.5% sodium hypochlorite and saline, interappointment intracanal medication with calcium hydroxide, and three-

dimensional obturation using the single-cone technique with Endomethasone sealer. Together, these procedures established effective root canal disinfection and a satisfactory apical seal while preserving the biological integrity of the periapical tissues.

The favorable short-term clinical outcome was further supported by definitive post-endodontic rehabilitation using a prefabricated fiber post, composite resin core build-up, and a porcelain-fused-to-metal (PFM) crown, which restored structural integrity, functional occlusion, and an adequate coronal seal. This case emphasizes the importance of integrating evidence-based endodontic and restorative principles in the management of structurally compromised maxillary premolars with complex root canal anatomy to optimize clinical outcomes and preserve the tooth within the dental arch.

This report is limited by its single-case design and short-term follow-up period. Therefore, long-term clinical and radiographic follow-up at 6 and 12 months is recommended to evaluate periapical healing, maintenance of the coronal seal, periodontal health, and the long-term survival of the definitive restoration.

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