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Case report

Endodontic treatment of severely curved root canals – A case series

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ABSTRACT

Background: *It is not uncommon for a dentist to encounter endodontic cases of severely curved root canals. Performing endodontic treatment on severely curved root canals can be a daunting task due to the notable risk of creating an iatrogenic error including a ledge, perforation, or even instrument separation. Therefore, radiograph image analysis, proper endodontic treatment planning, and selection of appropriate instruments and techniques are essential to ensure success in the endodontic treatment of severely curved root canals.* ***Purpose:*** *This case series aims to elaborate on the instruments and techniques necessary to safely negotiate, clean, shape, and seal root canals with severe curvature.* ***Cases:*** *Three patients came to Universitas Airlangga Dental Hospital due to severe toothaches. After anamnesis and examination, diagnosis was established, and endodontic treatments were deemed necessary. Severe curvatures were visible in the root canals during radiographic image analysis.* ***Case Management:*** *Access openings were performed to allow straight-line access, orifices were preflared, root canals were negotiated, and glide paths were established. Then, shaping, cleaning, and sealing could be performed conveniently into the root canal terminus. Subsequently, coronal restorations were fabricated to restore function and esthetics.* ***Conclusion:*** *With proper knowledge, case analysis, and appropriate instruments and techniques, severely curved root canals can be safely and accurately negotiated, cleaned, shaped, and sealed.*

Keywords: *glide path; negotiation; root canal curvature*
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INTRODUCTION

A severely decayed and infected tooth can be brought back into a healthy state and its integrity, function, and esthetics can be restored. This can be realized through root canal treatment and subsequent coronal restoration.[1] A quality root canal treatment can be achieved by removing the infected tissue, shaping the root canals to generate sufficient space for disinfection, cleaning the root canals of their necrotic components and microorganisms, and sealing the root canals to prevent reinfection.[1,2]

To perform successful root canal treatment, understanding the root canal morphology is necessary.[3] There is a high degree of variation in root canal anatomy. Root canals may be short or long, wide or narrow, and straight or curved. The unique characteristics of a root canal will determine the difficulty in performing root canal treatment. A short, wide, and straight root canal can be treated easily. On the other hand, a long, narrow, and curved root canal can be a significant challenge to treat.[3,4]

It is not uncommon for dentists to perform root canal treatments on curved root canals. According to Hartmann et al.[4] study in 2019, as many as 84% of human teeth present with a noticeable curvature. Treating a narrow and curved root canal can be a daunting task due to the risk of creating iatrogenic mishaps such as ledges, transportations, perforations, and instrument separations.[3–5] Therefore, this case series aims to elaborate on the instruments and methods necessary to perform successful root canal treatments in severely curved root canals.

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CASE 1

A 52-year-old female patient came to the Conservative Dentistry Department in the Universitas Airlangga Dental Hospital complaining of pain in a lower left tooth. The pain was spontaneous, lingering, and very intense. Clinical examination revealed that tooth number 36 had a large restorations, was tender to percussion, and was very sensitive during the cold test. A periapical radiograph confirmed that the tooth was heavily restored. It had a curvature on the mesial root, and the periapical tissue was normal (Figure 1A). A diagnosis of symptomatic irreversible pulpitis was established.[6] A treatment plan was discussed and the patient agreed to have a root canal treatment with subsequent restoration.

CASE 2

A 65-year-old male patient came to the Conservative Dentistry Department in the Universitas Airlangga Dental Hospital complaining of pain in an upper left tooth and in his cheek. The pain was intense and radiated to the surrounding areas when it was triggered by pressure. Clinical examination revealed that tooth number 26 was heavily restored and tender to percussion, though not sensitive to the vitality test. The periapical radiograph showed that the tooth had a large composite and amalgam filling. There was also significant curvature on the mesiobuccal root, and a periapical radiolucency surrounding the apex of tooth number 26 (Figure 1B). A diagnosis of necrotic pulp with symptomatic apical periodontitis was established.[6] The patient did not want to lose his tooth. Hence, he chose to have a root canal treatment with subsequent restoration.

CASE 3

A 24-year-old female patient came to the Conservative Dentistry Department in the Universitas Airlangga Dental Hospital complaining of pain in an upper right tooth. The pain was spontaneous and sharp, and intensified with hot food and beverages. An intraoral examination was performed, and tooth number 17 was found to have a large composite restoration with a significant secondary decay. A periapical radiograph confirmed the substantial decay under an old resin composite restoration. The mesiobuccal root of tooth number 17 had a significant curvature. The periapical tissue was normal (Figure 1C). A diagnosis of symptomatic irreversible pulpitis was established.[6] The patient was in intense pain and agreed to have a root canal treatment to relieve her symptoms.

CASE MANAGEMENT 1

A periapical radiograph was analyzed to determine the case difficulty. The root canal curvature was measured using Weine's method;[4] this revealed that the mesial root of tooth 36 had a 60° curvature (Figure 2).[4] Therefore, this case was considered difficult.[1]

Anesthesia was delivered, and the tooth was isolated with a rubber dam and a soft clamp (Kerr, Switzerland) (Figure 3A). An access opening was performed, allowing straight-line access to the root canal orifices. The orifices were preflared with an orifice opener rotary instrument (V-Taper Gold, Fanta, China). Root canals were negotiated with precurved D-finders, numbers 08 and 10 (Mani, Japan), with the help of 17% ethylenediaminetetraacetic acid (EDTA) (Onemed, Indonesia) and 2.5% sodium hypochlorite (NaOCl) (Onemed, Indonesia) dispensed alternately as the irrigation solution. Apical patency was

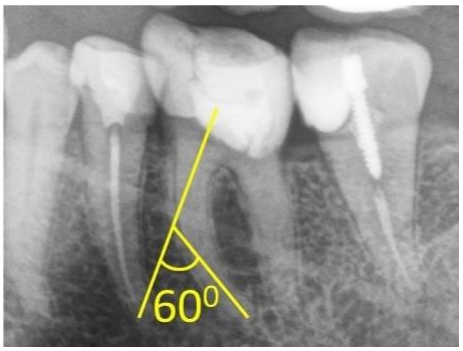

Figure 2. Measurement of tooth number 36's mesial root canal curvature.

Figure 1. (A) Case 1; (B) Case 2; (C) Case 3.

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established, and the working length was measured with an electronic apex locator (Root ZX, Morita, Japan). The working length was confirmed with a periapical radiograph (Figure 3B).

To prevent iatrogenic mishaps, the D-finders, numbers 08 and 10, and K-files, numbers 15, 20, and 25 (Mani, Japan), with frequent irrigation were used to establish a glide path. The D-finders and K-files had a 2% taper. After reaching the working length, a K-file was pulled and pushed repeatedly until loose. Subsequently, root canals were gently shaped with a V-Taper Gold (Fanta, China), using the crown-down technique. The maximum torque value for each endodontic rotary instrument was set below company recommendations. Root canals were flushed with 17% EDTA, 2.5% NaOCl, and sterile water. The root canals were then dried with sterile paper points. Calcium hydroxide ($Ca(OH)_2$) dressing (Any-Paste, Mediclus, South Korea) was applied to the root canals. The access cavity was then temporized.

After one week, the patient returned and reported no symptoms. The tooth was isolated, and the temporary filling material and the $Ca(OH)_2$ dressing were removed. Then, a gutta-percha cone fit trial was performed and a periapical radiograph was taken (Figure 3C). Root canals were cleaned with 17% EDTA and 2.5% NaOCl, dispensed with an Irriflex tip (Produits Dentaires, Switzerland). The irrigant was then activated with an Endoactivator (Dentsply, USA) for 60 seconds. This irrigation cycle was repeated three times for each root canal. Afterwards, the root canals were dried with sterile paper points and sealed with the single gutta-percha cone technique and the AH Plus sealer (Dentsply, USA). After sealing the root canals, the access cavity was restored with resin composite (Filtek Z350XT, 3M, Germany) (Figure 3D). After the completion of the root canal treatment, the patient was scheduled for prosthetic rehabilitation with a zirconia crown. The management of the curved root canals in this first case can be summarized sequentially in Figure 4.

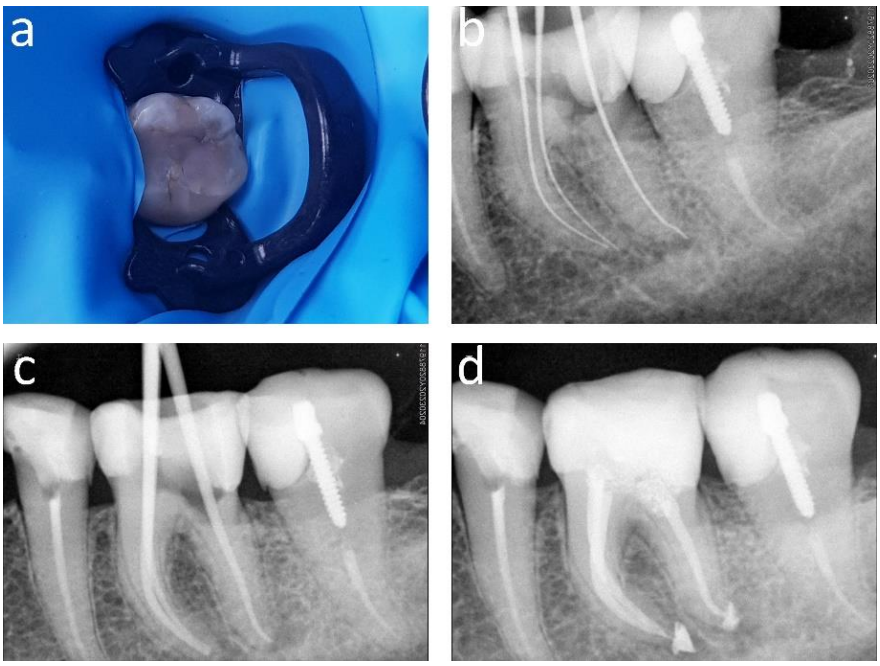

Figure 3. (A) Isolation; (B) working length x-ray; (C) gutta-percha trial; (D) obturation.

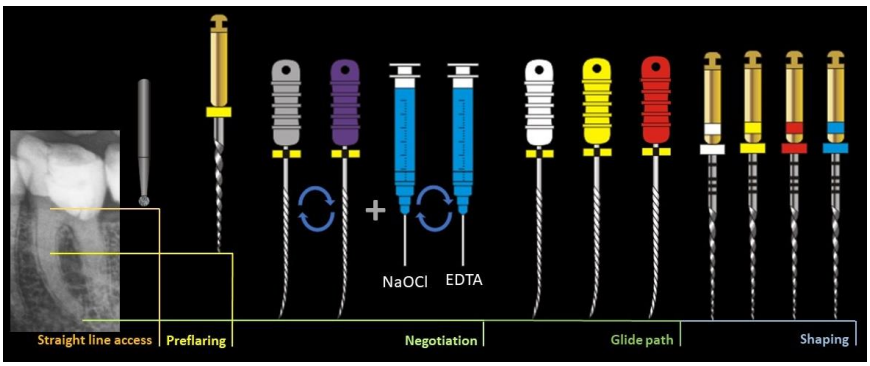

Figure 4. Management of curved root canals.

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CASE MANAGEMENT 2

A periapical radiograph analysis was carried out to assess the case difficulty. The mesiobuccal root canal curvature of tooth number 26 was measured to be 75° (Figure 5).[4] It was considered to be a difficult case.[1]

A rubber dam and a soft clamp were used to isolate tooth number 26 (Figure 6A). An access opening procedure was done, allowing straight-line access to the root canal orifices. The orifices were preflared, and the root canals were gently negotiated using precurved D-finders, numbers 08 and 10, with the help of 17% EDTA and 2.5% NaOCl, dispensed alternately. Apical patency was achieved, and the working length was measured (Figure 6B).

To lessen the risk of iatrogenic mishap, pre-curved D-finders, numbers 08 and 10, and K-files, numbers 15, 20, and 25, were used sequentially to establish a glide path. After establishing a smooth pathway for the K-file 25 into the root canal terminus, shaping could be performed safely with the crown-down technique. The maximum torque value for each rotary instrument was set below company recommendations. The root canals were then cleaned and subsequently dried. $Ca(OH)_2$ medication was applied, and the access cavity was temporized.

After one week, the patient returned without any symptoms. The tooth was isolated with a rubber dam. Then, the temporary filling material and the $Ca(OH)_2$ dressing were removed, and the gutta-percha cone fit trial was performed (Figure 6C). Afterward, the root canals were cleaned, dried, and sealed with the single cone technique (Figure 6D). The access cavity was restored with resin composite, and the patient was scheduled for prosthetic rehabilitation.

Figure 5. Measurement of tooth number 26's mesial root canal curvature.

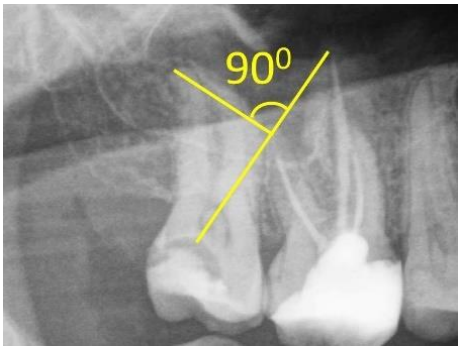

Figure 7. Measurement of tooth number 17's mesial root canal curvature.

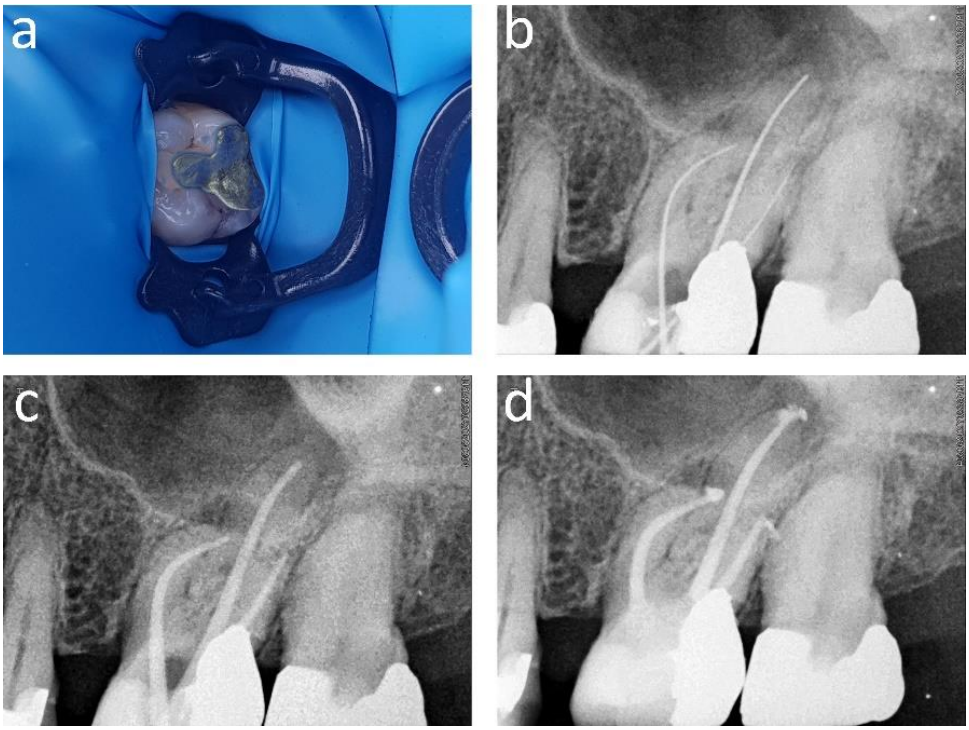

Figure 6. (A) Isolation; (B) working length x-ray; (C) gutta-percha trial; (D) obturation.

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CASE MANAGEMENT 3

Before treatment, the case difficulty was assessed by measuring the root canal curvature of tooth number 17. The mesiobuccal root of tooth number 17 was found to have a 90° curvature (Figure 7).[4] Hence, it was considered a difficult case.[1]

Anesthesia was administered, and the tooth was isolated with a rubber dam and a soft clamp (Figure 8A). An access opening was carried out, allowing straight-line access to all orifices. The orifices were preflared, and the root canals were gently negotiated with precurved D-finders, numbers 08 and 10, with the help of 17% EDTA and 2.5% NaOCl, dispensed alternately. Apical patency was achieved and the working length was measured (Figure 8B). Subsequently, precurved K-files, numbers 15, 20, and 25, were used to establish a glide path. Afterwards, shaping could be carried out safely. The maximum torque value for the rotary instruments was set below company recommendations. Finally, $Ca(OH)_2$ was used as the root canal dressings, and the access cavity was temporized.

After one week, the tooth was asymptomatic. The tooth was isolated with a rubber dam, and the temporary filling and $Ca(OH)_2$ dressings were removed. Gutta-percha cones were tried inside the root canals (Figure 8C), and the root canals were cleaned, dried, and sealed with the single cone technique (Figure 8D). The access cavity was then filled with a resin composite restoration. The patient was then scheduled for prosthetic rehabilitation.

DISCUSSION

An investigation of the root canal morphology is essential for preparation before commencing root canal treatment. According to the American Association of Endodontists,[1] a root canal with more than 30° curvature is classified a highly difficult case. Therefore, extra caution needs to be exercised.[1]

An access opening procedure is the first step in a root canal treatment and needs to be carried out with a thorough knowledge of tooth anatomy. The shaping, cleaning, and sealing phases might be jeopardized if the access opening procedure is not performed appropriately.[7] The access opening must be wide enough to allow straight-line access into root canal orifices.[7] This traditional, or conventional, method of access opening removes remaining necrotic pulp and dentine interferences; thus, it enables a smooth, convenient, and unimpeded entry and pathway of endodontic instruments into the apex. According to Silva and colleagues' study in 2022, straight-line access into root canal orifices reduces the risk of root canal instrument separation.[7]

The second important step for the management of curved root canals is coronal preflaring, also known as cervical preflaring, coronal early flaring, or coronal pre-enlargement.[5] Coronal preflaring removes impediments and also enlarges the cervical third to the middle third of the root canal. This phase is carried out using a specifically designed root canal rotary instrument called an orifice

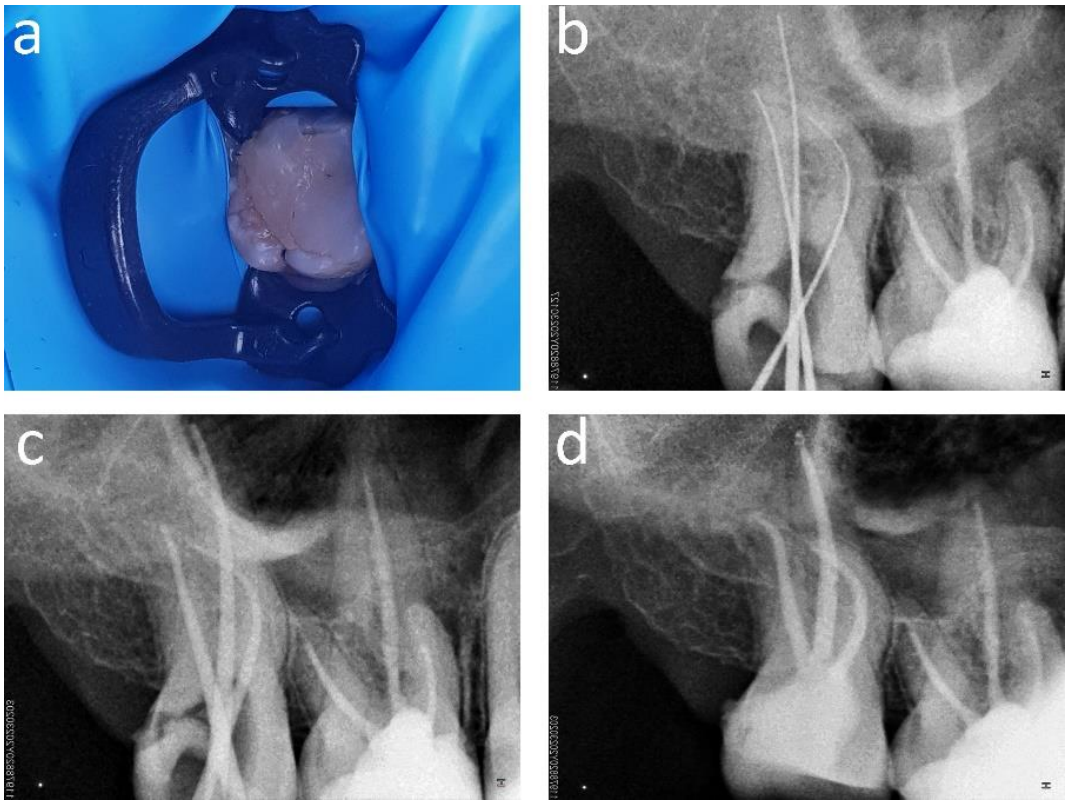

Figure 8. (A) Isolation; (B) working length x-ray; (C) gutta-percha trial; (D) obturation.

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opener, which should only measure 19 mm, with a high percentage of taper.[8] Coronal preflaring will allow more convenient access of subsequent root canal instruments into the apical part of the root canal. Moreover, it also lessens the root canal curvature angle, reduces root canal instrument stress, and ultimately decreases the risk of instrument separation.[9]

The third phase in the management of curved root canals is negotiation, also known as root canal scouting or root canal exploration. Negotiation aims to explore the internal anatomy of a root canal to understand its morphology; the root canal negotiation enables the operator to identify the width as well as the impediments inside a root canal. Hence, it is possible to sense if the root canal is wide or narrow, straight or curved, and smooth or constricted. Negotiation is performed with a small endodontic instrument, such as K-file number 08 or 10. However, in this case series, the operator decided to use D-finders instead of K-files, because D-finder instruments have a higher buckling resistance compared to K-files. Therefore, they have a higher capacity to negotiate a constricted and curved root canal.[5,9,10] To perform a proper root canal negotiation, especially in root canals with constriction and/or curvature, the root canal instruments need to be slightly bent to replicate the root canal morphology. It is also recommended to use root canal irrigants, especially EDTA and NaOCl; 17% EDTA can remove inorganic debris, and NaOCl can remove organic debris from root canals.[11] Therefore, both of these irrigants, used alternately, allow for a smoother passage of root canal negotiation instruments down to the apex.[11]

The fourth step following negotiation is the glide path establishment. A glide path is defined as a smooth pathway originating from the root canal orifice to the apical constriction.[9] A glide path is established by slowly and consistently moving a small root canal instrument up and down with a 1 mm amplitude to the apical constriction until it is loose. In some cases, the instrument could establish the path after only a few repetitions, in others, it could take 50 repetitions or more.[5] After that, the strokes can be performed with a higher amplitude until the glide path is established. According to many authors, a glide path is only established if a K-file number 10 can slide easily and repeatedly to the apical constriction. In this case series, the operator decided to use K-file numbers 15, 20, and 25 to further enlarge and smoothen the severely curved root canals.[5,9]

Engine-driven glide path rotary instruments are available and commonly used instead of manual files. Both engine-driven glide path instruments and manual files perform similarly.[12] However, using manual files to establish a glide path has the advantage of maintaining tactile sense throughout the procedure. Thus, the operator can exercise more caution in treating difficult root canals. The glide path is as important, as the previous phase as it decreases subsequent instrument stress, and reduces the risk of iatrogenic mishaps such as ledges and instrument separations.[13,14] Following straight-line access, coronal preflaring, negotiation, and glide path establishment, the severely curved root canals can be safely and accurately shaped until the apical constriction.

Because of current scientific investigations into root canal morphology, dentists are beginning to understand the complicated nature of root canals; as a result, they know that it is impossible for root canal shaping instruments to completely debride root canals of necrotic debris and microorganisms. Therefore, it is essential to administer root canal irrigants as well as intracanal medication following root canal shaping. EDTA and NaOCl are the most widely used root canal irrigants.[15–17] EDTA serves to remove inorganic debris inside root canals, whereas NaOCl serves to remove organic debris and eliminate microorganisms.[18] In this case series, the root canal irrigant was initially impossible to deliver near the apical constriction because the rigidity of the metal dispensing tip refused to glide along the root canal's curvature. Hence, the metal dispensing tip was replaced with an Irriflex tip. The Irriflex tip is more flexible than the metal dispensing tip; thus, the root canal irrigant was able to be delivered near the apical constriction.[19] $Ca(OH)_2$ was chosen as the intracanal medication because of its high effectiveness against root canal pathogens. In addition, $Ca(OH)_2$ can also remove remaining necrotic tissue and disrupt osteoclast activity.[19–21] After delivering adequate intracanal medication and cleaning irrigants, the root canals can be sealed whenever the patient exhibits no symptoms and the root canals are dry.

Severely curved root canals can be predictably and safely managed. However, the negotiation of severely curved root canals often requires a significant amount of time. Sometimes, it can take up to 60 minutes just to negotiate one root canal up to the apical constriction. To prevent excessive root canal instrument bending, the access opening also needs to be widened to allow more convenient access into the root canal. Consequently, a greater amount of healthy tooth structure will inevitably be removed.

Generally, negotiation, glide path establishment, and the shaping of one root canal should take place before beginning to treat other root canals. This workflow makes sure that the clinician consistently appreciates and remembers the length, narrowness, and curvature of a particular root canal. It also enables the clinician to develop the muscle memory necessary to safely negotiate, establish a glide path in, and shape the root canal. In conclusion, after case analysis, through the application of proper straight-line access, coronal preflaring, negotiation, and glide path, a severely curved root canal can be safely, predictably, and successfully shaped, cleaned, and sealed.

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