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Endodontic Management Of Severely Curved Root Canal Systems – Case Reports

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Abstract:
Endodontic management of curved canals is posing serious challenges to the clinicians in terms of mechanical instrumentation. Most commonly it is associated with procedural errors. Continuous tapered preparation of the curved root canal from the cervical orifice to the apical terminus necessitates proper preoperative clinical and radiographic evaluation, assiduous glidepath management with smaller files and judicious use of flexible Ni- Ti rotary or reciprocating files along with copious irrigation. Multiple assessment criteria were developed for preoperative judgment of the difficulty of the cases as well as numerous strategies are adopted for correct instrumentation techniques. Most of the time more than one technique is necessary for their successful management. Meticulous attention to every detail ensures successful management and long term prognosis of the endodontic treatment of the curved canals. This article presents three interesting case reports of the curved canals in posterior teeth along with a brief review of the preoperative assessment and instrumentation techniques.

Key Words: *Curved canals, Glide Path, Zone Technique, Rotary file, Reciprocation file*

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I. Introduction

Main objectives of endodontic therapy are thorough mechanical and chemical cleansing of the entire pulpal space and its complete obturation with an inert filling material to form an impermeable seal for maintenance or restoration of the health of the periradicular tissues (European Society of Endodontology, 2006),(1) (McSpadden, 2007).(2) Ideal mechanical debridement procedure not only removes the pulp tissue and infected dentin from the canal spaces but also facilitates optimal disinfection by chemicals and creates shape for subsequent three dimensional obturation without any procedural errors while preserving as much as tooth structure as possible (Hülsmann et al, 2005)(3). It is a real challenge for clinician to effectively prepare a severely curved canal while maintaining its original shape without any error. Ledge formations, blockages, perforations, transportations, instrument separations are most common undesirable accidents that are associated mechanical instrumentation of curved canals. Adaptation of correct preoperative assessment techniques and stringent protocol with efficient and safe instruments are of utmost important.

II. Case Reports

Case-1: A 29 years old male with noncontributary medical history was reported with pain in lower left posterior region. On examination it was found that the tooth #36 was having secondary caries under restotration and tender on percussion. Pulp vitality test was negative. IOPA X ray revealed carious exposure and periapical radiolucency. Diagnosis of pulp necrosis with apical periodontitis was made and Root canal treatment was planned. Preoperative evaluation revealed high degree curvature in mesial canals and exceptional curvature in distal canal. Under anaesthesia, rubber dam was applied and access was gained under Microscope (Labomed Magna) with #4 round bar. Initial negotiation was done with #8 K file and working lengths were measured with Electronic Apex Locator (Propex Pixi, Dentsply Sirona). Canals were prepared with Wave one Gold file system (Dentsply Sirona) after securing microglyde path with K Files #10 and macroglyde path with Wave One Gold Glyder (Dentsply Sirona) in conjunction with copious 5.25% Na- Hypochlorite solution. Canals were irrigated

thoroughly with 5.35% Hypochlorite and activated with Endoactivator (Dentsply Sirona). Smear layer was removed with 17% EDTA solution. Warm vertical compaction technique with AH Plus (Dentsply Sirona) sealer was used for obturation after flushing the canals with distilled water and drying with paper points. Core Build up was done with Light Cure composite (SDR and Ceram X, Dentsply Sirona).

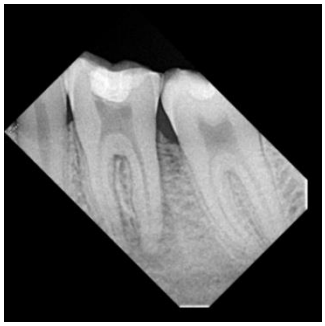

Fig 1- Pre Operative X ray

Fig 2- Master Gp X ray

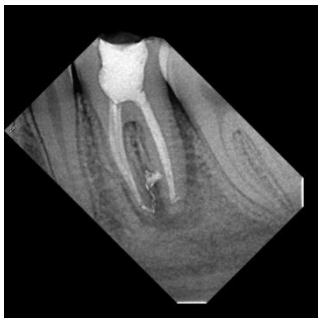

Fig 3- Post Operative X ray

Case 2: A 56 years old female with noncontributary medical history was referred for completion of RCT in tooth #16. On examination it was found that the tooth #16 was having access cavity prepared by the referring clinician. Preoperative radiographic evaluation revealed high degree curvature in mesial canal and presence of a separated instrument in MB canal. Under anaesthesia, rubberdam was applied and the access was modified with Start X ultrasonic tips (Dentsply sirona) under Microscope (Labomed Magna). Initial negotiation and bypassing of the broken instrument in MB1 canal was done with #10 K file and working lengths were measured with Electronic Apex Locator (Propex Pixi, Dentsply Sirona) for all canals (MB1, MB2, DB, P). Canals were prepared with Trunatomy File System (Dentsply Sirona) after securing microglyde path with K Files #10 and macroglyde path with Trunatomy glyder (Dentsply Sirona) with copious 5.25% Na- Hypochlorite solution. Canals were irrigated thoroughly with 5.25% Hypochlorite and activated with Endoactivator (Dentsply Sirona). Smear layer was removed with 17% EDTA solution. Canals were obturated with warm vertical compaction technique with AH Plus (Dentsply Sirona) sealer after flushing with distilled water and drying with paper points. Core Build up was done with Light Cure composite (SDR and Ceram X, Dentsply Sirona).

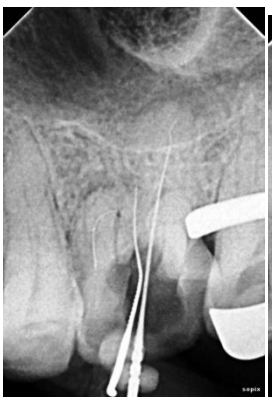

Fig 4- Initial Scouting

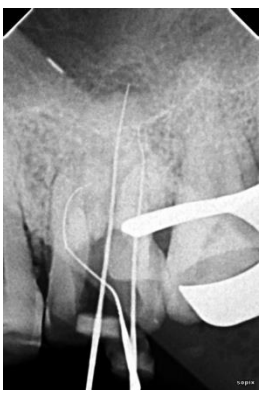

Fig 5- Bypassing of separated instrument

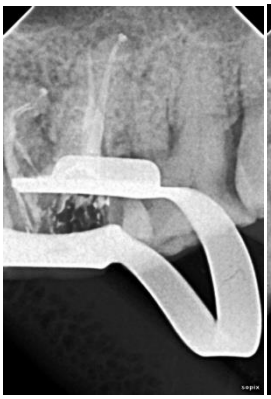

Fig 6- After obturation

Fig 7- Post Operative X ray

Case 3: A 45 years old male with noncontributary medical history was reported with pain in lower right posterior region. On examination it was found that the tooth #36 was having secondary caries under restotration and tender on percussion. Pulp vitality test was negative. IOPA X ray revealed carious exposure. Diagnosis of pulp necrosis and Root canal treatment was planned. Preoperative evaluation revealed S shaped curvature in both mesial canals and distal canals (Exceptional Curvature). Under anaesthesia, rubber dam was applied and the access was gained under Microscope (Labomed Magna) with #4 round bar. Initial negotiation was done with #8 K file and working lengths were measured with Electronic Apex Locator, (Propex Pixi, Dentsply Sirona). Canals were prepared with Reciproc Blue file system (VDW) after securing microglyde path with K Files #10 along with copious 5.25% Na- Hypochlorite solution. Canals were irrigated thoroughly with 5.25% Na-Hypochlorite with sonic activation (Endoactivator, Dentsply Sirona). Smear layer was removed with 17% EDTA solution. Canals were obturated with warm vertical compaction technique with AH Plus (Dentsply Sirona) sealer after flushing with distilled water and drying with paper points. Core Build up with Light Cure composite (SDR and Ceram X, Dentsply sirona) was done.

Fig 8 - Preoperative X ray

Fig 9- After Obturation

III. Discussion

According to Schilder (1974),[4] ideal root canal shaping should follow certain mechanical objectives, i.e. to prepare the canal following its original morphology to a continuously tapering funnel from cervical orifice to apical terminus without violating apical foramina. Although these objectives can easily be followed in straight canal, presence of curvature makes the efficient shaping a challenging one. Transportation, ledges, perforations, instrument separation, asymmetrical dentin removal, and alterations of the internal anatomy are the most common undesirable accidents associated with the instrumentation of the curved canals (Jain et al, 2008).[5] These errors may decrease the prognosis of the endodontic treatment (Lin et al, 2005). [6]

Various strategies are put forwarded by researchers to overcome the difficulties associated with the curved canals. (Abou-Rass et al, 1980; Dodds et al, 1985; Goerig et al, 1982; Mullaney, 1979; Roane et al, 1985; Weine et al, 1975).[7,8,9,10,11,12] Most commonly multiple approaches are needed to adopted due to high variability of the pulpal space anatomy.

To determine the difficulties, risk of procedural errors and specialized managements to address the curved canal, several guideline have been introduced (American Association of Endodontists, 2010, Canadian Academy of Endodontics, 2017; Essam et al, 2021; Falcon et al, 2001; Ree et al, 2003; Shah & Chong, 2018)[13, 14, 15,16,17,18] and are summarized by Antonis Chaniotis and Ronald Ordinola-Zapata (2022)[19].

	Minimal Difficulty/ Avarage Risk	Moderate Difficulty /High Risk	High Difficulty/ Very High Risk	Exceptional Difficulty
AAE	Slight or no Curvature < 10º	Moderate Curvature(10º-30º)	Extreme Curvature>30º or S Shaped	
CAE	Canal curvature – I Small or no Curvature < 10º	Canal Curvature J Moderate Curvature(10º-30º)	Canal Curvature C or S Moderate Curvature (10º-30º)	
Ree et al	Score A Small or no Curvature < 10º	Score- B Moderate Curvature >10 º		
Falcon et al	Complexity I Curvature <15º	Complexity II Curvature 15º-40º	Complexity III Curvature> 40º	
Shah and Chong	Mild Curvature <15º	Moderate Curvature 15º -60º	Severe Curvature > 60º	Exceptional Curvature >60º or S Shaped
Essam et al	Small or no Curvature < 15º	Moderate Curvature 30º-45º	Severe Curvature 45º -60º	Exceptional Curvature >60º or S Shaped

These guidelines are not absolute (Faraj & Boutsioukis, 2017)[20] as multiplanar nature of curvature and diameter variability due to physiological ageing and pathological processes may increase the difficulties (Schäfer E, Diez C, Hoppe W, Tepel J2002, Vertucci 2005, Cunningham & Senia, 1992).[21,22,23] Shaping of curved canals are associated with severe torsional and bending forces on instruments that can result in transportation, ledging, apical perforation or instrument fracture (Schäfer & Dammaschke,2006)[24].

Dilaceration refers to angular relationship of a crown of a tooth to its root (Jafarzadeh & Abbott, 20007).[26] The criteria for describing root dilaceration varied amongst different authors (Hamasha et al. 2002, Malcic et al. 2006, Chohayeb, 1983).[27,28,29] According to Schneider, 1971 straight canals are presenting an angle of 5° or less, moderate between 10° and 20°, severely curved represents root canals presenting a curve greater than 25° (Schneider, 1971).[25]

The radius of curvature is defined as the radius of a circle passing through the curved part of the canal and more properly describes the abruptness of curvature (Pruett et al., 1997)[30] and subsequent difficulty in instrumentation. It is easy to instrument the canal with larger radius compared to a canal having smaller radius even if the angle remains same. Difficulty will be more for a canal representing acute angle of curvature (Al-Sudani et al., 2012).[31] Coronally presented curvatures tests the instruments more in terms of fatigue resistance (Alghamdi et al, 2020; Gao et al, 2011; Lopes et al., 2011, 2013).[32,33,34,35] Smaller radius and abrupt deviation from long axis generates severe strain in the instruments (Gao et al., 2011).[33]

Measurement of the radius and angle in a single view of IOPA X- Ray may be misleading in multiplanar curvetures and an additional angled radiograph might be helpful (Slowey, 1974).[36] CBCT imaging of the tooth provides most detailed information about the entire root canal configuration (Patel, Brown et al., 2019a; Patel, Patel et al., 2019b).[37,38] CBCT guided diagnostic plotting and design are very helpful in managing curve canals (Patel, Brown, et al., 2019a; Patel, Patel, et al., 2019b).[37,38]

Instrumentation Procedure: There are certain strategies that may be helpful for successful instrumentation of the curve canals:

1. Precurving the file (Schilder, 1974)[4] according to the canal curvature and initial negotiation with watch winding motion
2. Using large volume of irrigants and lubricants
3. Use of flexible files such as Flexo files and intermediate size files
4. Use of smaller size hand files (#6,#8,#10 sequentially) to create a microglide path and making them super loose inside the canal - facilitates unforceful placement of the larger size files in the canal (Berutti et al, 2009; West, 2010) [39,40]
5. Irrigation, reirrigation, recapitulation and proceeding towards larger file should be ideal sequence
6. No engine-driven instrument should be used before creation of microglide path by hand instruments
7. Coronal Preflaring is very helpful (Berutti et al, 2009; West, 2010)[39,40]
8. Balance force technique (Roane et al., 1985),[11] Anticurvature technique (Abou-Rass et al., 1980)[7] Crown Down technique, Zone technique (McSpadden, 2007)[2] are some of the example of instrumentation technique that are very useful
9. Use of Rotary Glide path file made from M wire or Heat treated wire with small size and less taper
10. Use of Flexible Heat Treated Ni-Ti Instruments (M wire, CM wire, Gold wire, Blue wire, Max wire) either Rotary or Reciprocal using zone technique and TCA Technique (Chaniotis & Filippatos 2017a, b)[41,42] is very useful for working near the curvature. These instruments are very flexible and can conform to the curved canal better. They are also having very high cyclic fatigue resistance in comparison to stainless steel and conventional Austenite Ni-Ti instruments. Thus preparing the canal better, maintaining its original anatomy without any iatrogenic damage and separation.

11. Progression from smaller diameter to larger diameter, smaller taper to larger taper and use of variable taper instruments (To reduce the active working area of the file, thereby reducing frictional force on the instrument and ultimately chances of failure) is an excellent strategy
12. Finer and more flexible irrigation needles (30–32 G) should be used for reaching the critical apical area
13. Activation of irrigants is very critical in a curve canal

IV. Conclusion

Proper care and attention should be taken for successful endodontic management of curved canals. Preoperative radiographic assessment of the curvature in 3 dimensions, diligent practice of glide path management and use of suitable technique with proper instruments are holding the key for properly address their endodontic management.

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