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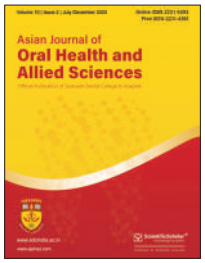

Case Report

Endodontic management of complex root canal curvatures: A case report

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ABSTRACT

Managing curved root canals in endodontics poses considerable challenges due to their complex anatomy and increased risk of complications during treatment. Successful outcomes depend on accurate diagnosis, detailed planning, and the use of advanced instruments and techniques. Pre-operative imaging, including periapical radiographs and cone-beam computed tomography, plays a vital role in identifying the degree and direction of canal curvature, allowing for appropriate treatment planning. The introduction of heat-treated nickel-titanium instruments with enhanced flexibility and shape memory has greatly improved the ability to shape curved canals while minimizing procedural errors. Effective irrigation using advanced techniques such as ultrasonic or sonic agitation ensures better cleaning of areas that instruments cannot reach. Obturation in curved canals is often difficult, but the use of flowable and biocompatible sealers, such as resin-based or bioceramic types, enhances sealing ability and long-term success. A thorough understanding of root canal morphology, along with the use of modern tools and techniques, is key to achieving predictable and successful outcomes in curved canal cases.

Keywords: Canal shaping, Cone-beam computed tomography, Curved canals, Nickel-titanium instruments, Procedural errors

INTRODUCTION

Endodontic therapy is a critical procedure aimed at preserving teeth that have been compromised by pulpal disease, trauma, or deep dental caries. This procedure involves cleaning and shaping the root canal system to eliminate infection, followed by obturation to preserve the form and function of natural teeth.[1] One of the most challenging aspects of root canal therapy is managing curved canals. The presence of curved canals is more common in third molars, with reported prevalence ranging from 3.3% to 30.92% in mandibular molars and 1.33% to 8.46% in maxillary molars.[2]

Adequate understanding of root canal morphology is vital for effective treatment. A thorough pre-operative evaluation, including radiographic imaging techniques such as radiovisiography (RVG) and cone-beam computed tomography (CBCT), can provide a three-dimensional understanding of the root canal system, which is particularly valuable in complex cases.[3] Complex root canal anatomy increases the risk of complications such as ledge formation, canal transportation, instrument separation, perforation, and internal distortion, and also presents challenges in maintaining working length and achieving apical patency. Moreover, effective irrigation in such canals is often limited unless enhanced by techniques such as passive ultrasonic activation or apical negative pressure systems.[4]

The selection and use of appropriate instruments for chemo-mechanical preparation of curved root canals is critically important as it helps to navigate through the curvature while maintaining the original path of the canal and ensuring thorough debridement.[5] The introduction of flexible nickel-titanium (NiTi) rotary and reciprocating systems, which exhibit properties such as shape memory, enhanced flexibility, and resistance to cyclic fatigue, has significantly enhanced clinicians' ability to manage complex anatomies with improved safety and efficiency.[6]

Therefore, the curvature of root canals presents a significant anatomical challenge that profoundly influences both the quality and outcome of endodontic treatment. Sharp or complex curvatures increase the risk of procedural errors, all of which can compromise the integrity of the root canal system and reduce the likelihood of long-term success. Hence, identification of canal curvature through careful radiographic assessment or advanced imaging modalities during diagnosis is critical for an appropriate and effective treatment plan.

The following case report of two clinical cases adheres to CARE guidelines and showcases successful endodontic management of teeth with pronounced root canal curvatures. It highlights the importance of accurate diagnosis, detailed radiographic evaluation, and the skilled use of advanced instruments supported by thorough knowledge, to effectively manage complex canal anatomy and achieve predictable treatment outcomes.

CASE REPORT 1

A 20-year-old male patient reported to the department of conservative dentistry and endodontics with the chief complaint of pain and food lodgement in the upper right back teeth region. There was no relevant medical history. Clinical examination and testing revealed extensive occlusal caries involving the pulp of tooth #28 [Figure 1]. On the electric pulp test, the tooth showed an exaggerated response to the stimulus and a normal response to percussion. No abnormal findings were seen during extraoral examination. Pre-operative intraoral periapical radiograph showed coronal radiolucency involving pulp of tooth #28 with severe apical curvature in mesial root (Schneider angle of 27°) [Figure 2]. Hence, after clinical and radiographic examination, a diagnosis of symptomatic irreversible pulpitis was made, and the patient was advised to undergo root canal treatment of tooth #28. Informed consent, as per Form No. 574346/24, was obtained from the patient before the commencement of treatment.

The treatment was performed under magnification of ×2.5 loupes (Orikam, Eighteeth Brilliance Dental Loupes, China). Following the administration of local anesthesia 2% lidocaine with 1:80,000 epinephrine (Indoco Remedies Ltd, India), a rubber dam (Hygienic Dental Dam, Coltene, USA) isolation was performed in #28 to ensure an aseptic working environment. An access cavity was prepared under sufficient water cooling using a high-speed air-rotor handpiece with an Endo-access and an Endo-Z bur (Dentsply Maillefer, Switzerland) to achieve a straight-line access. Four canals were located, namely, Mesiobuccal 1 (MB1), Mesiobuccal 2 (MB2), Distobuccal (DB), and Palatal canal using a DG-16 endodontic explorer (Dentsply, Switzerland).

Figure 1: Pre-operative radiograph # 28.

Canal patency was obtained after working length estimation using an electronic apex locator (Orikam, Eighteenth E-Pex Pro Apex Locator, China) with pre-curved #10 K-files in all the canals, including the mesiobuccal canal, where a sharp apical curvature was seen, which was later verified by RVG [Figure 3]. A glide path was established using Hyflex EDM (Coltene Whaledent, USA) ISO size 15, 3% taper.

Root canal cleaning and shaping was performed using rotary NiTi Hyflex® CM file system (Coltene Whaledent, USA) with final preparation size 0.04/30 for MB1, MB2, and DB canals and upto size 0.06/40 for Palatal canal along with 5% sodium hypochlorite (Parcan, Septodont Healthcare India Pvt Ltd) and 17% ethylenediaminetetraacetic acid (EDTA) (Coltene Whaledent, USA) irrigation throughout instrumentation with activation using passive ultrasonic irrigation for enhanced smear layer removal and improved disinfection. Final irrigation was done with normal saline.

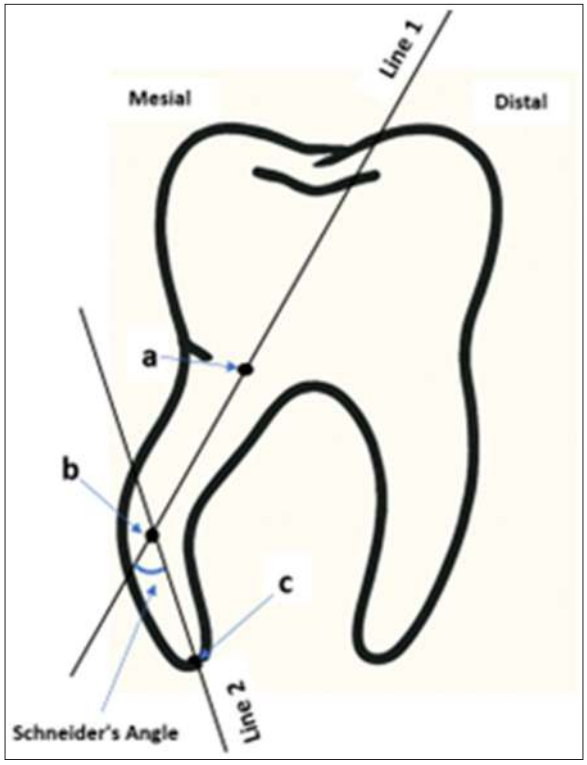

Figure 2: Schematic diagram representing Schneider angle Point "a:" The canal orifice. Point "b:" The point where the canal begins to curve. Point "c:" The apical foramen. Line 1: From point a to b, following the initial straight portion of the canal. Line 2: From point b to c, following the curved portion to the apex, and the angle between these two lines is the Schneider angle that reflects the degree of canal curvature.

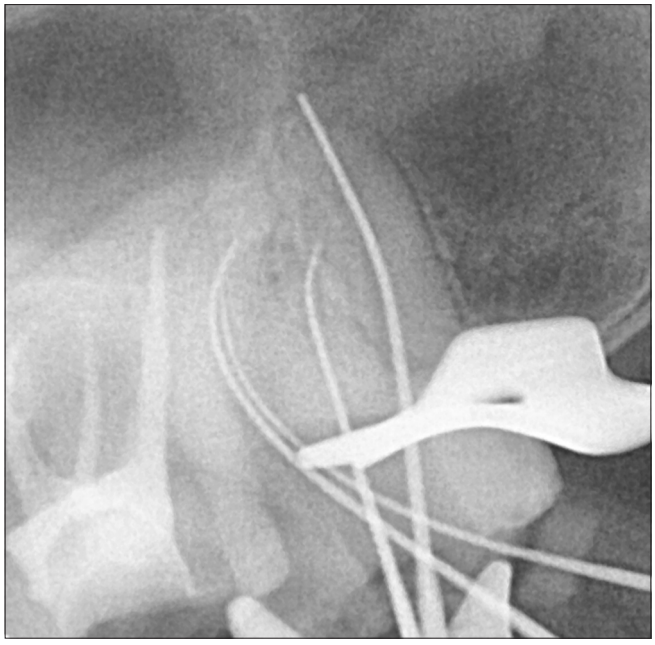

Figure 3: Working length determination radiograph #28.

The canals were dried using sterile paper points and obturated using warm vertical compaction of gutta-percha points corresponding to the final canal preparation size, in conjunction with AH Plus resin sealer (Dentsply, Germany) [Figures 4 and 5]. Post-endodontic restoration was done using composite resin Z 350 (3MESPE AG, Germany). A follow-up check-up was done after 3 months, and no fresh complaint was noted [Figure 6].

CASE REPORT 2

A 35-year-old female patient reported to the Department of Conservative Dentistry and Endodontics with the chief complaint of pain in the upper right posterior region. Clinical examination revealed deep caries in the right maxillary second premolar #25, with tenderness on percussion. Pre-operative intraoral periapical radiograph showed coronal radiolucency involving pulp of tooth #25 [Figure 7] and an S-shaped root canal morphology (Schneider angle of 30°). Based on clinical and radiographic findings, tooth #25 was diagnosed with symptomatic irreversible pulpitis, and root canal therapy was recommended. A diagnosis of symptomatic irreversible pulpitis was made, and the patient was advised to undergo root canal treatment of tooth #25. Informed consent, as per Form No. 536481/24, was obtained from the patient before the commencement of treatment.

The treatment was performed under magnification of ×2.5 loupes. After administration of local anesthesia, rubber dam isolation for the tooth was done, and an access cavity was prepared, and buccal and palatal canal orifices were located using DG 16 endodontic explorer. Working length was estimated using #10 K flex files, which were later confirmed with an apex locator and RVG [Figure 8]. A glide path was established using Hyflex EDM ISO size 0.03/15. The canals were then shaped using HyFlex CM rotary files up to a final preparation size of 0.04/30 for buccal and palatal canals [Figure 9].

Copious irrigation with 5% sodium hypochlorite, followed by 17% EDTA, was used throughout the instrumentation process, with ultrasonic agitation to enhance debris removal. After thorough drying, the canal was obturated using a warm vertical compaction technique with AH plus sealer. The access cavity was later sealed with composite resin Z350 [Figure 10]. A follow-up evaluation was conducted three months later, and no new complaints were reported [Figure 11].

DISCUSSION

Managing a curved canal in a posterior tooth presents unique challenges in endodontic treatment due to the tooth's complex anatomy, limited access, and potential for

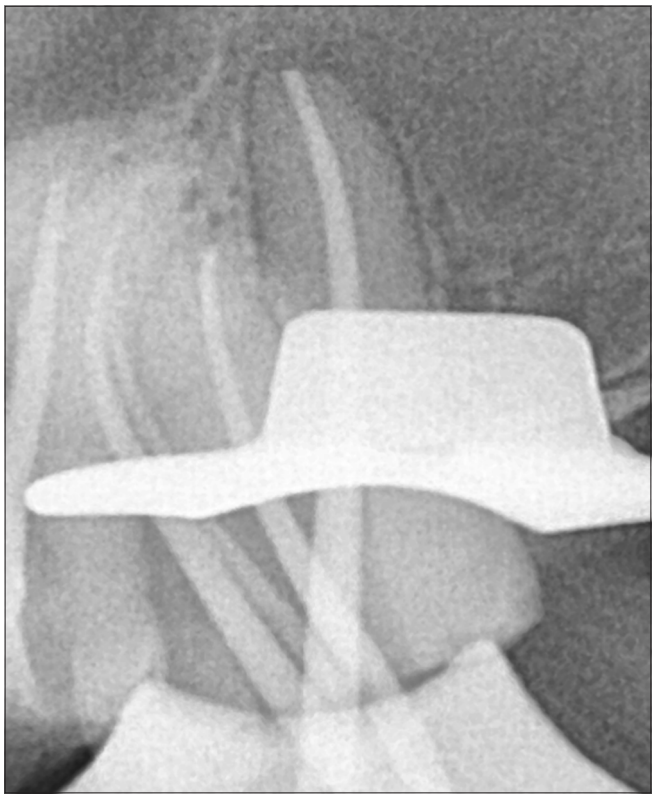

Figure 4: Master apical cone radiograph #28.

Figure 5: Post-obturation radiograph #28.

Figure 6: Follow-up radiograph #28.

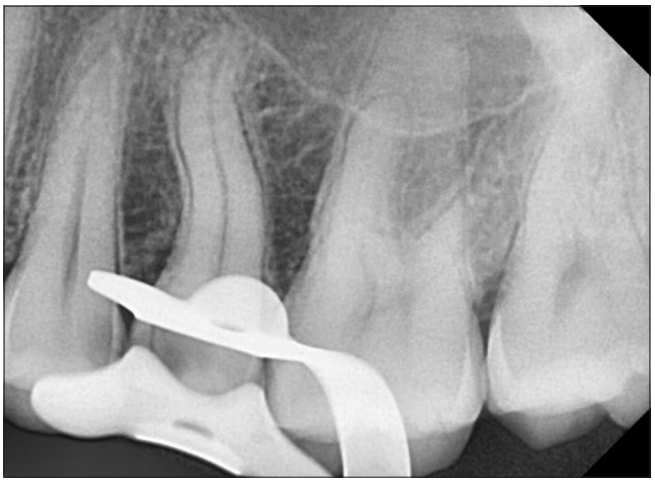

Figure 7: Pre-operative radiograph #25.

procedural errors.[2,7] A systematic approach encompassing thorough diagnosis, meticulous instrumentation, and effective obturation is essential for successful treatment.

Accurate diagnosis plays a pivotal role in the effective management of curved root canals. Obtaining a periapical

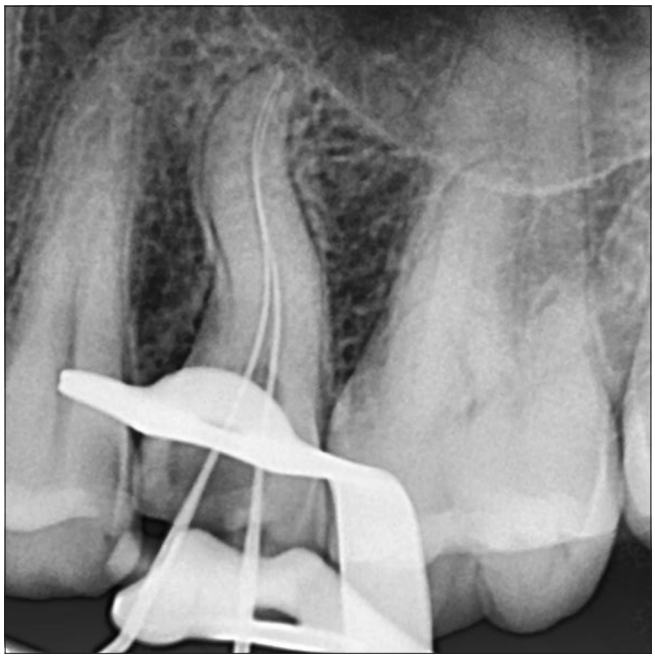

Figure 8: Working length determination radiograph #25.

Figure 9: Master apical cone radiograph #25.

and, if necessary, CBCT images helps to assess the degree and direction of canal curvature, as well as the number and configuration of canals. Canal curvature is primarily caused by developmental irregularities during root formation, such as uneven dentin deposition and asymmetric growth of Hertwig's epithelial root sheath. Genetic predisposition, functional forces, secondary dentin deposition with age, and pathological conditions, such as trauma or infections, can further alter the canal path, leading to curvatures.[8] Recognizing the presence,

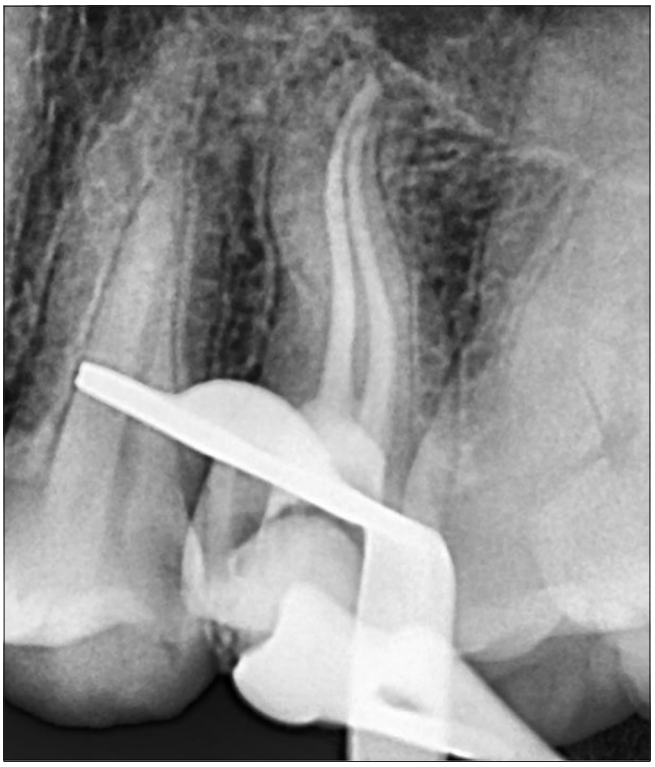

Figure 10: Post-obturation radiograph #25.

Figure 11: Follow-up radiograph #25.

severity, and direction of canal curvature at the diagnostic stage allows the clinician to anticipate these challenges and adapt their approach accordingly. This pre-operative assessment is crucial for planning the treatment approach in a complex root canal system.[9]

Further, in cases of curved canals, a precise access cavity design is critical to prevent instrument deflection, canal transportation, and ledge formation. Inadequate or overly conservative access may result in missed canals, difficulty in negotiation, or excessive force during instrumentation.[10] The design of the access cavity should be such as to achieve a straight-line path to the apical third of the root canal while conserving tooth structure and minimizing the risk of instrument separation, ledge formation, and procedural errors.[11]

Along with a straight-line access, the establishment of a glide path is essential in curved canals. A well-established glide path guides shaping files smoothly, reduces instrument stress, and preserves canal anatomy. Using small hand files (#8, #10, #15 K-files), often pre-curved, helps negotiate curvatures and enhances tactile control during instrumentation.[12]

Employing the use of flexible NiTi rotary files with controlled memory (CM), designed for curved canals, offers enhanced flexibility and resistance to cyclic fatigue, reducing the risk of instrument separation.[13] Unlike traditional NiTi files, they can be pre-bent and retain their shape, allowing them to follow the natural canal curvature.[14] Their enhanced resistance to cyclic fatigue, especially in curved canals where repeated flexing occurs at the point of curvature, reduces the risk of separation and improves procedural safety and reduces the likelihood of complications in endodontic management of complex root canal anatomy.[15]

Furthermore, root canal irrigation is crucial in curved canals, as mechanical instrumentation often fails to reach all canal surfaces due to complex anatomy. Irrigants such as sodium hypochlorite and EDTA dissolve tissue and remove the smear layer, flush out debris, and biofilm.[16] Techniques such as sonic/ultrasonic agitation and apical negative pressure enhance effectiveness. Side-vented needles aid in safe, controlled delivery. Effective irrigation ensures microbial control and treatment success.[17]

Obturation in curved canals is challenging due to the difficulty in adapting gutta-percha to canal walls. Hence, flowable, biocompatible sealers, such as resin-based or bioceramic types, are especially effective to fill voids, lateral canals, and irregularities, adapting well to complex anatomy, enhancing the seal and preventing microleakage, and improving long-term outcomes.[18]

CONCLUSION

The endodontic management of curved canals presents unique clinical challenges that require a comprehensive and skilled approach. Understanding root canal morphology, accurate diagnosis, and appropriate case selection form the foundation of successful treatment. Advances in imaging, flexible NiTi instruments, CM file systems, effective irrigation protocols, and high-performance sealers have significantly improved the clinician's ability to manage curved canals with greater precision and safety. By combining these innovations with sound clinical judgment and technique, it is possible to preserve the natural anatomy, minimize procedural errors, and enhance long-term treatment outcomes.

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REFERENCES

1. Urkande NK, Mankar N, Nikhade PP, Chandak M. Beyond tradition: Non-surgical endodontics and vital pulp therapy as a dynamic combination. Cureus 2023;15:1.
2. Kharkar AP, Reddy KS, Banerjee S, Maheshwari Z. Coping with complexity: Navigating severe curve canals in endodontic root canal treatment: A clinical case series. J Conserv Dent Endod 2024;27:785-8.
3. Hegde MN, Lagisetti AK, Honap MN. Negotiating the bends: An endodontic management of curved canals-a case series. Endodontology 2017;29:160-3.
4. Versiani MA, Martins JN, Ordinola-Zapata R. Anatomical complexities affecting root canal preparation: A narrative review. Aust Dent J 2023;68:S5-23.
5. Kim HC, Kim HJ, Lee CJ, Kim BM, Park JK, Versluis A. Mechanical response of nickel-titanium instruments with different cross-sectional designs during shaping of simulated curved canals. Int Endod J 2009;42:593-602.
6. Nagendrababu V, Aly Ahmed HM. Shaping properties and outcomes of nickel-titanium rotary and reciprocation systems using micro-computed tomography: A systematic review. Quintessence Int 2019;50:186-95.
7. Jordan L, Bronnec F, Machtou P. Endodontic instruments and canal preparation techniques. In: Endodontic Materials in Clinical Practice. Hoboken: John Wiley and Sons; 2021. p. 81-131
8. Estrela C, Bueno MR, Sousa-Neto MD, Pécora JD. Method for determination of root curvature radius using cone-beam computed tomography images. Braz Dent J 2008;19:114-8.
9. Khanna R, Handa A, Virk RK, Ghai D, Handa RS, Goel A. Clinical and radiographic evaluation of procedural errors during preparation of curved root canals with hand and rotary instruments: A randomized clinical study. Contemp Clin Dent 2017;8:411-5.
10. Chaniotis A, Ordinola-Zapata R. Present status and future directions: Management of curved and calcified root canals. Int Endod J 2022;55:656-84.
11. Patel S, Rhodes J. A practical guide to endodontic access cavity preparation in molar teeth. Br Dent J 2007;203:133-40.
12. Dhingra A. Glide path in endodontics. Endodontology 2014;26:217-22.
13. Tabassum S, Zafar K, Umer F. Nickel-titanium rotary file systems: What's new? Eur Endod J 2019;4:111.
14. Zevallos-Quiroz CA, Perez IE, Garcia-Rupaya CR. Efficacy of controlled memory and shape memory nickel titanium instruments in

removing filling material from severely curved root canals: An *ex vivo* study. Iran Endod J 2019;14:115.
15. Zhou HM, Shen Y, Zheng W, Li L, Zheng YF, Haapasalo M. Mechanical properties of controlled memory and superelastic nickel-titanium wires used in the manufacture of rotary endodontic instruments. J Endod 2012;38:1535-40.
16. Boutsioukis C, Arias-Moliz MT. Irrigating solutions, devices, and techniques. In: Endodontic Materials in Clinical Practice. Hoboken: John Wiley and Sons, Inc.; 2021. p. 133-80.
17. Almeida JF, Gomes BP, Ferraz CC, Souza-Filho FJ, Zaia AA. Filling of artificial lateral canals and microleakage and flow of five endodontic sealers. Int Endod J 2007;40:692-9.
18. Marciano MA, Guimarães BM, Ordinola-Zapata R, Bramante CM, Cavenago BC, Garcia RB, *et al*. Physical properties and interfacial adaptation of three epoxy resin-based sealers. J Endod 2011;37:1417-21.

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