# Management of radix entomolaris of mandibular first molar with complex root canal curvatures; A case report and mini review

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Running title: Managing Radix Entomolaris with complex root canal curvatures

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## Key Clinical Message

Radix entomolaris (RE) characterized by an extra root in mandibular molars is a rare phenotype. When this condition occurs simultaneously with complex root canal curvatures or S-shaped canals, root canal therapy (RCT) challenges arise\RL. The present study presents three cases of RE + complex root curvatures. The challenges of RCT and case management of this study are in the framework of paying attention to the access cavity according to the extra root, instrumentation with the crown down technique, sufficient irrigation, using nickel-titanium rotary systems, dense obturation with warm vertical technique and patient follow-up. Also, in the last case, the management of two broken files by loop and bypass techniques is described. \RL Adequate knowledge of the root canal system's morphology and the use of appropriate techniques and materials for root canal therapy is the background for successful RCT.

**Keywords**

Endodontic, Radix entomolaris, Root canal therapy, complex root canal curvatures, S-shaped canals

# Introduction

The success of root canal therapies requires factors such as proper irrigation and instrumentation, dense obturation, and good coronal sealing. For this purpose, knowledge about the morphology of the root canal system and its variations is essential (1). Most permanent mandibular first molars typically have 2 roots-mesial and distal with 3 root canal systems. Still, variations concerning the number of roots and canal morphology are also not occasional. Radix Paramolaris (mesiobuccally) and Radix Entomolaris (distolingually) are variations determined according to the position of the third additional root (2). In the literature review, the prevalence of RE according to race and ethnic group includes a wide range from 0.6 to 29.7% (3). Radix entomolaris (RE) is often not diagnosable because of overlapping by the distal root with orthograde radiographs and it can only be discovered by a careful correlation between clinical and radiographical examination(1). Roots that have a double curvature are called S-shaped roots(4). S-shaped canals, also known as bayonet root canals(5), are found in approximately 10% of clinical cases(4). Due to the complexity of these canals, the root treatment process in these teeth is very challenging (5, 6). complex root canal curvatures or S-shaped canals in radix entomolaris create rare circumstances. Accordingly, the current study aimed at presenting three cases of management of radix entomolaris of the mandibular first molar with complex root curvature or (s-shaped canal).

# Methodology

This case-series study presents three cases and is organized according to PRICE 2020 guidelines (7). An experienced endodontics specialist in the endodontics department of the Mashhad Dental Faculty performed all the treatment protocols conducted in the present study. Verbal and written informed consents were obtained from all patients participating, and all the Declarations of Helsinki were observed in the present study.

## Case \RL 1

A 25-year-old man who was systematically healthy had been referred to the endodontics department due to toothache. Clinical examination and the patient's history \RL showed signs of irreversible pulpitis in the mandible left the first molar. Nocturnal Toothache was also reported and pulp tenderness to cold and heat were positive. Extensive distal caries was shown in the clinic and pre-operative radiograph. Radiographic evaluation showed radix entomolaris along with S-shaped canals (Figure 1A). After a local anesthesia infiltration with 2% lidocaine and epinephrine 1:100,000 (Daroupakhsh, Tehran, Iran), the tooth was isolated with a rubber dam, and the distal access cavity was obtained with a high-speed diamond round bur No. 2 (Jota AG, Rüthi, Switzerland) with continuous water spray under a dental operating microscope (Carl Zeiss, Meditec Inc., Dublin, CA, USA). The channels were negotiated with C-file #8 \RL and K-file \RL #10. An electronic apex finder was used to inspect the working length and it was confirmed by radiography (Figure 1B)\RL. All channels except radix were filed up to k-file #25 with tipper 0.04 and radix up to #20. (M3 Gold series, Dusseldorf, Germany). Irrigation was done with a 30-gauge needle (side vent needle) up to 2 mm from the working length. Chemomechanical Irrigation and shaping was completed by crown-down technique with M3 rotary files (UDG, Changzhou, China) up to size 25/04 under copious irrigation with 5.25% sodium hypochlorite and normal saline, alternately. After taking cone-fitting confirmation radiograph, all canals were dried with sterile paper points (META, Chugbuk, South Korea) and obturated with guttapercha (META, Chugbuk, South Korea) and AH plus sealer (Dentsply DeTrey, Konstanz, Germany) using warm vertical technique by FastFill warm obturator (Fast Fill Obturation System, Eighteeth, china). Finally,

Cavit (Cavisol, Tehran, Iran) was applied as a temporary restoration (Figure 1C). Follow-up was done 18 months later and the patient did not report any pain or discomfort. Clinical examination and radiograph showed an asymptomatic tooth with successful endodontic treatment (Figure 1D) <Figure 1>.

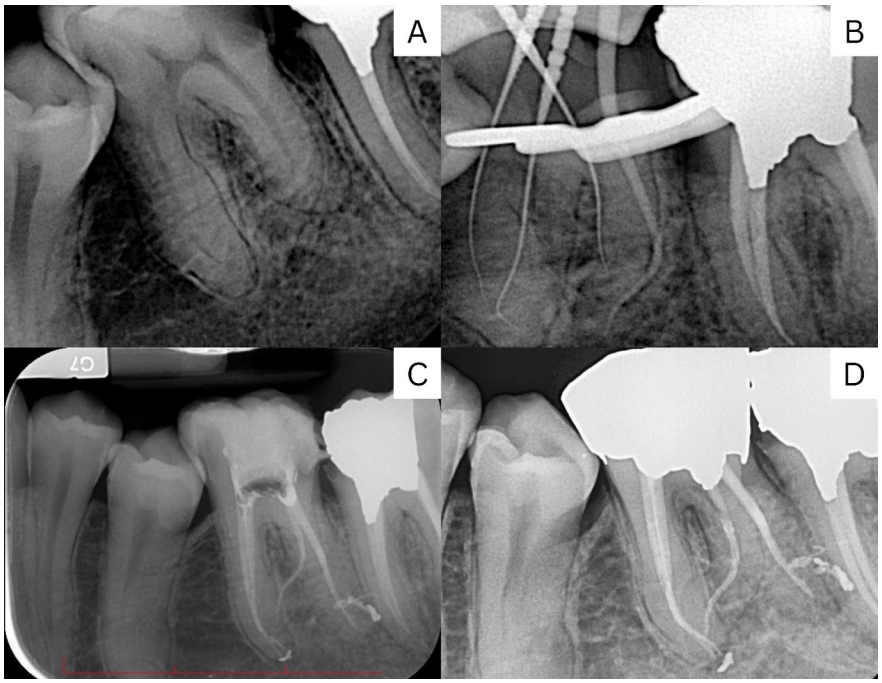


Figure First molar on the left side of the mandible: A) initial radiograph, extensive distal caries, PDL widening, S-shaped canals; B) working length determining; C) final radiograph, obturation, apical seal, temporary restoration; D) 18-month follow-up, coronal seal

## Case \RL 2

A healthy 10-year-old girl with spontaneous pain in the right mandibular first molars was referred to the endodontics department. The sensitivity test to heat and cold was negative and only unstimulated. Initial radiography revealed (Figure 2A), radix entomolaris, and double curvature with the bull's eye view. Clinical and radiography examinations showed signs of irreversible pulpitis. The access cavity was obtained according to the mesial caries and extra RE root. Each canal's shaping, instrumentation, irrigation, and obturation were done according to the treatment protocol described in the first case (Figures 2). A follow-up visit was performed 8 months later and he reported no pain in the two treated teeth. Clinical examination and radiography also showed an asymptomatic tooth with successful endodontic treatment (Figure 2E ) <Figures 2 >.

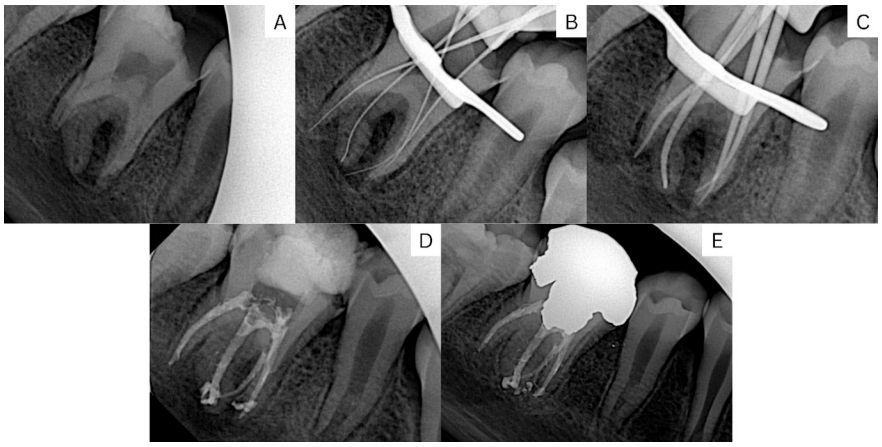


Figure Mandibular right first molar: A) initial radiograph, extensive mesial caries, widening of PDL, double curvature (Bull's eye view); B) working length determination; C) cone fit confirmation; D) final radiograph, obturation, apical seal, temporary restoration; E) 8-month follow-up, coronal seal

## Case 3

A 41-year-old woman, systematically healthy, was referred to the endodontics department of the faculty due to the separation of the file in the mesiobuccal canal of the mandible right first molar. The broken file was retrieved by examining the radiograph with the help of ultrasonic tips and the loop technique (Kamand, Suzhou, Zumax). The framed material of the orifice shaper separated at the radix and the broken file was bypassed using C-files #8,10,15 (VDW, Munich, Germany). (Figure 5). After the bypass, shaping, and instrumentation of the channels were done as described previously. The ethylene diamine tetraacetic acid (EDTA) 17% (Master-dent, monroe, USA) irrigation was the only deference. normal saline was used for final irrigation (Figure 6). Follow-up was done 9 months later and the patient reported no pain or discomfort. Observing and examining the radiograph also showed the success of the treatment process (Figure 6D) <Figures 5 & 6>.

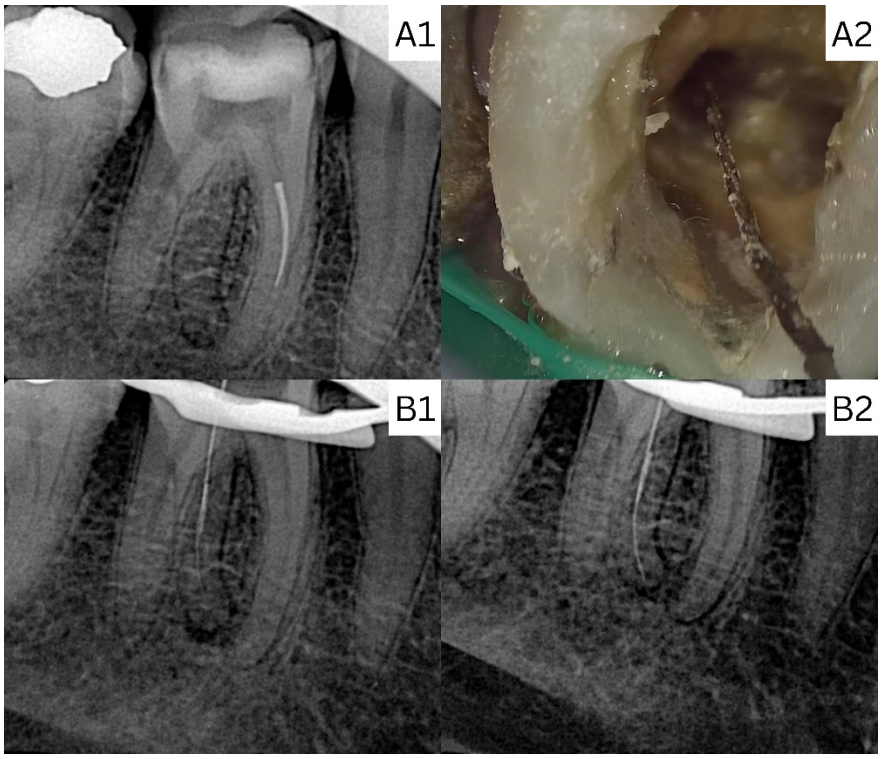


Figure Mandibular right first molar: A1) radiograph of the broken file in the mesiobuccal canal; A2) Photograph from the file retrieval from mesiobuccal canal; B1) Orifice shaper file broken in radix, C file #10; B2) Bypassing the broken file

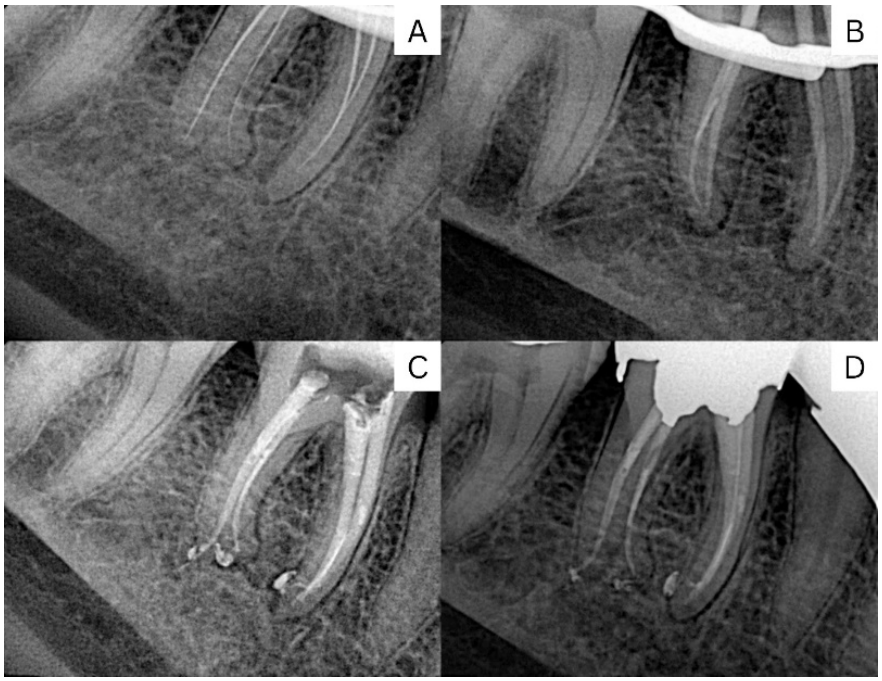

Figure Mandibular right first molar: A) working length determination; B) Master cone; C) final radiograph, obturation, apical seal, temporary restoration D) 9-month follow-up, coronal seal



# Discussion

One of the crucial factors that may affect the treatment outcome is knowing the anatomy of the root canal system and the anatomical variations in different types of teeth. The clinical importance of the present study is the coincidence of complex root canal curvatures (S-shaped canals) with RE, which confirms the rarity of the reported cases. The etiology of RE is not precisely known, but it is stated that external factors during odontogenesis can be one of its causalities. Ethnicity and genetic modifications can lead to more phenotypic manifestations of RE (8). The RE prevalence varies according to the ethnic group and up to 30% has been mentioned in studies \RL (3, 9). According to the location of the RE orifice, Carlsen and Alexandersen presented a classification (10): Type A: cervical part of RE located distally - two cone-shaped macrostructures Type B: RE cervical located distally - one cone-shaped macrostructure Type C: cervical part of RE located mesially Type AC: cervical part of RE located Centrally In addition to the classification mentioned above, De Moor et al (8) also provided another classification for RE, which was based on the curvature of the root or root canal: Type 1: without curvature (straight) Type 2: curvature located coronally - without curvature in the middle or apical Type 3: coronal curvature with the middle or apical second curvature RE creates an important challenge in the treatment process due to the root complex morphology and creating miss canal potentially. Due to the placement of the roots behind each other, there is a possibility of misdiagnosis. Therefore, the diagnosis of RE is necessary with a clinical examination along with a careful examination of radiographs, especially periapical radiographs (11). To diagnose RE, complementary angular radiography (mesial or distal) or using CBCT can be helpful. In addition to careful radiographic investigation, clinical examinations are important for the RE diagnosis. The use of periodontal probes, endodontic explorer, micro-opener, and path finder are among the instruments that can help in diagnosis. Also, examining the more prominent distal or distolingual occlusal lobe or the presence of an extra cusp can doubt the RE presence. In addition, it is worth investigating the champagne effect in the pulp chamber (12). One of the most important basic principles for RCT is the principle of Straight-Line Access (SLA). The RE presence may affect the way SLA is established and cause the access cavity to change from the classic triangular shape to larger dimensions such as a trapezoid or rectangle, of course, all these factors are also affected by the caries location. In these cases, Successful management of RE was achieved through thorough irrigation and shaping of the canal system using appropriate disinfectants. Also, using Nickel-Titanium rotary instruments enabled effective penetration in the root curves. Ni-Ti instruments can preserve the original shape of the canal and minimize procedural errors. A summary of some similar studies can be seen in the table below. As expected in the literature review, the principles of a successful RCT were observed in the studies (12-20). In all studies, the canals were irrigated with sodium hypochlorate with concentrations of 1 to 5.25% (12-20). EDTA has also been used as supplemental irrigation in most studies (12-16, 18-20). Like the present study, the use of the crown-down instrumentation technique was mentioned in two studies (12, 19). C-files (13, 14, 20) and K-files (12, 16, 17) for negotiation were mentioned in 3 studies respectively\RL. The use of Ni-Ti rotary systems was suggested in all studies (12-20). In the present study, obturation was performed using the warm vertical technique with gutta-percha and AH plus sealer. In line with the present study, AH plus sealer has been used repeatedly in studies (14, 15, 17-19). Among obturation methods, the continuous wave compaction technique has been the favorite of therapists (13, 15, 20). The comparison of these studies depends on the results of the treatment, and the treatment success will be evident with patients' follow-up. Unfortunately, in the cited studies, unlike the present study, the follow-up result of the treatment was not mentioned. Of course, it should be mentioned that these studies are only a part of the existing literature review. The noteworthy point in the mentioned studies was the attention to the expansion of the access hole in the direction of better access to RE (14-16). Table A summary of the treatment of radix entomolaris case report studies

| Author/year | Cases | Instrumentation |
|---|---|---|
| Gupta et al (12); 2011 | 2 cases | Initial negotiation: K-file #10 - Crown down technic \RL/ protaper rotary s |
| Davini et al (15); 2012 | One case | protaper rotary system |
| Parashar et al (17); 2015 | 2 cases | Initial negotiation: K-file #10 \RL/ protaper rotary system |
| Alkhawas et al (13); 2017 | one case | Initial negotiation: C-file #6,8 & 10 \RL/ Revo-S (Micro-Mega, France) rot |
| van der Vyver et al (20); 2017 | One case | Initial negotiation: C-file # 8 \RL/ ProTaper Next X1 and X2 |
| Alok Raina (18); 2017 | 2 cases | protaper rotary system (up to F2) |
| Munaga et al (16); 2020 | 2 cases | Initial negotiation: K-file #10 \RL/ How to shape the canals was not descri |
| Costa Michelotto et al (14); 2021 | 3 cases | Initial negotiation: C-file # 10 & 15 / NiTi CM Rotary system |
| Singh et al (19); 2023 | One case | protaper rotary system (up to F2) / crown-down technique |

The complex morphology of the root canal system causes the canal instrumentation to face challenges. Perforation, apical transportation, and ledge formation are some of the errors that may be encountered during the instrumentation of canals with a double curvature or S-shape. Therefore, it is necessary to determine the curvature of the canal before starting the RCT (21). To avoid these errors, the basic principles of RCT should be followed. Proper radiography, obtaining SLA, precurving the files, adequate irrigation, and most importantly using Ni-Ti instrumentation systems (22).

The broken file in the third case of the present study led to more challenging RE root canal therapy. One of the most important factors in managing the retrieval of a broken file depends on the location of the instrument separation (23). The current study used the loop technique and bypass to manage two broken files. The success of the bypass method, especially in the more apical spots, has been emphasized in previous studies (24), and the use of removal kits with a loop system shows promising results (25, 26).

In the present study, three cases of RE were discussed. Management of RE treatment requires special care that should be considered within the framework of the RCT basic principles. In addition to the management of RE treatment, canals with double curvature or S-shapes add to the treatment challenges, which may lead to errors such as broken files, which were also noted in the present study. Therefore, prior knowledge of the morphological characteristics of the possible anatomical variations, the appropriate use of clinical or paraclinical tools, and increasing technical sensitivity are essential for preoperative planning and effective therapeutic intervention.

## Conclusion

RE root canal therapy along with complex root canal curvatures or S-shaped canals can be managed despite the possible challenges by following the principles of root canal treatment. Appropriate radiography, attention to the access cavity size, establishing SLA, using Ni-Ti rotary systems, sufficient irrigation, and using the proper technique of instrumentation and obturation will lead to standard treatment results.

## Conflict of interest

No conflict of interest was declared

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## Author Contributions

Ali Chamani: Conceptualization, Project Administration, Methodology Maryam Gharechahi: Investigation, Review & Editing, Supervision Reza Shakiba: Original Draft Preparation, Review & Editing Farshad Alipour: Original Draft Preparation, Data collection

## Consent

Following the journal's patient consent policy, the patient provided written informed consent for the publication of this report.

## Funding information

Self-fund

## Data availability statement

The data supporting this study's findings are available upon reasonable request from the corresponding author. The data are not publicly available due to privacy and ethical restrictions.

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