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# Lingual Radicular Rift Valley in a Mandibular Right First Premolar Root: Report of a Rare Case and Review of the Literature

## Surco Radicular Lingual en la Raíces del Primer Premolar Mandibular Derecho: Reporte de un Raro Caso y Revisión de la Literatura

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**SUMMARY**: Irregular root configurations which often challenge the requirements of successful root canal treatments are always misleading doctors to incorrect clinical judgments and treatment planning. In this article we describe a rare case of CBCT C-shaped mandibular premolar with a huge area of invagination measuring 6 mm ´ 3 mm, which we termed a "radicular rift valley" from a 76-year-old man. Considering the complex process of differential diagnosis, the overall status of disease condition and the will of the patient we proposed five treatment plans and finally conservatively chose plan B composed of both RCT and periapical scaling. A related literature review is also added into this article to describe the whole situation of root invagination, to stress the importance of the vigilance of diagnosis and to provide reference views for future similar diseases.

**KEY WORDS: Radicular groove; Premolars; CBCT; Root canal treatment.**

## INTRODUCTION

Successful root canal treatment (RCT) requires thorough debridement, sterilization, and three-dimensional (3D) obturation of the entire root canal system. However, such requirements are often challenged by irregular root configurations, which compromise conventional root canal instrumentation and may leave a remnant after debridement, thus increasing the difficulty of RCT (Jerome, 1994; Gutmann & Rakusin, 1987). Such irregular root configurations have also been reported to directly affect periodontal attachment loss (Bhusari & Chopra, 2011). Therefore, clinicians must possess a thorough understanding of the conventional root anatomy and its variants, and must be able to make appropriate and skillful adjustments to ensure successful endodontic treatment (Sert & Bayirli, 2004).

Mandibular first premolars are mostly single-rooted teeth but may also have two roots or more (Sandhya *et al*., 2010; Iyer *et al*., 2006; Sikri & Sikri, 1994; Robinson *et al.*, 2002). In the Chinese population, the incidence of a proximal radicular groove is relatively high (78.5%), but that of a lingual radicular groove is only 3.2% (Ong & Neo, 1990; Fan *et al*., 2008).

Usually before beginning RCT, a traditional X-ray examination is required to obtain basic information about the number, shape, and length of the roots and canal systems, and the severity of periapical destruction. Variations in root number or configuration can influence the clinician's interpretation of X-ray films, treatment planning, and prognosis expectations.

This article describes a rare case of root radicular groove with odd X-ray image and opposite cone beam computed tomography (CBCT) result. Five treatment plans are proposed and compared in well-founded way.

## CASE REPORT

The patient was a 76-year-old man. One month before his visit, he had his mandibular right second premolar treated elsewhere because of spontaneous pain in the right mandibular region. The symptoms were alleviated in that tooth, but pain in the mandibular right first premolar

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worsened. He was referred to the Department of Operative Dentistry, Sichuan University West China Hospital of Stomatology. Physical examination revealed a wedge-shaped defect, which reached only to the level of superficial dentin. The tooth displayed II° of looseness and was very sensitive to percussion. Subsequent X-ray examination revealed an odd finding: the root canal had stopped suddenly in the middle of the root and there seemed to be a root bifurcation in the middle and apical thirds of the root. The area of periodontal destruction surrounded the entire root (Fig. 1).

Fig. 1. The clear canal of the mandibular right first premolar stopped suddenly in the middle of the root and through an apparent "root bifurcation" (red arrow), suggesting the presence of a configuration variation in either the root or the canal system.

Fig. 2.CBCT 3D reconstruction of the mandibular right first premolar indicating a radicular horizontal groove (red arrow), a vertical groove (yellow arrow), and an enlarged area of radicular invagination (blue arrow).

The clinical diagnosis was chronic periapical periodontitis.

**Treatment planning**. The tooth was separated with a rubber dam, and the pulp chamber was exposed from the occlusal surface. The infected pulp tissue was removed, and the root canal was probed with a #10 K-file (Dentsply/Caulk, Dentsply International, Inc., Milford, DE). Only one canal was observed. No other findings were noted using an endodontic microscope.

We questioned the variation of the root configuration. An additional examination was considered, and CBCT was chosen because of its substantial advantages in revealing root configuration variations and in treatment planning, and its ability to provide a rapid volumetric image from a single low-radiation-dose scan (Cheng *et al*., 2011; Kottoor *et al*., 2011; Zhang *et al.*, 2011; Kottoor *et al.*, 2010; Huang *et al.*, 2010).

Upon the patient's consent, a CBCT (Morita, Kyoto, Japan) examination was performed. Both cross-sectional analysis and 3D reconstruction showed an obvious C-shaped root with only one canal, which was located in the middle and only slightly mesial portion of the root. The radicular groove started 4 mm from the cementoenamel junction (CEJ) and coursed increasingly deeper to 12 mm apical to the CEJ where there was a huge area of invagination measuring 6 mm x 3 mm, which we termed a "radicular rift valley". The lingual wall of the radicular invagination was extremely thin (<0.5 mm at the apex). A distinctive area of periodontal destruction surrounded the entire root, especially in the apical third of the root (Figs. 2 and 3).

**Treatment plans available:** Five treatment plans were prepared.

Plan A: RCT + periapical scaling and retrograde filling + lingual root surface remodeling.

Plan B: RCT + periapical scaling.

Plan C: only conservative RCT + regular follow-up, although poor prognosis was expected.

Plan D: RCT + periapical scaling +lingual root surface remodeling and MTA filling.

Plan E: extraction.

After thorough consideration of the patient's overall status and in consultation with the patient, we chose plan B. The bases for comparison and consideration of these plans are illustrated in detail in discussion part.

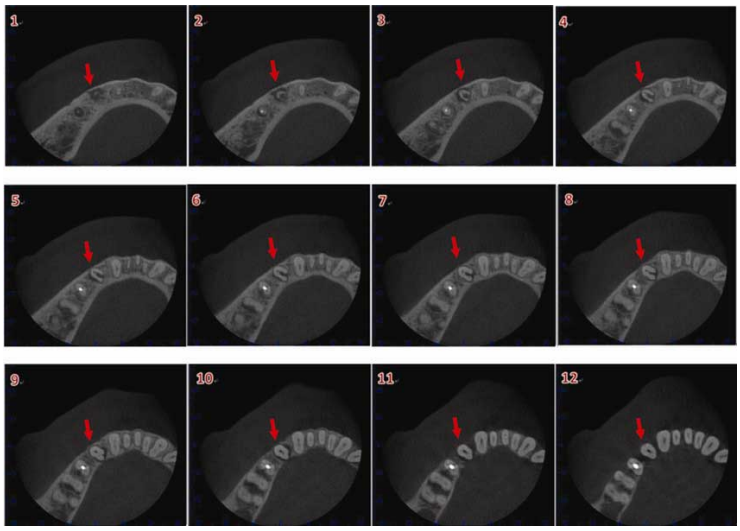

Fig. 3. CBCT multilayer cross-sections show a large area of invagination at the apical third of the root and a shallow radicular groove at the coronal third of the root. Red arrow points at the mandibular right first premolar.

Fig. 4.Use of a gutta-percha point to test the length of the canal preparation.

The root canal was prepared using the crown-down technique using the K3 system (Sybron Endo, Orange, CA) from #25 conicity to #.04 taper with the help of EDTA gel (Glyde, Maillefer, Dentsply, Ballaigues, Switzerland) and an apex locator (Raypex 5, VDW, Munich, Germany). The canal was irrigated with a large volume of 1% sodium hypochlorite solution (NaClO), and the endodontic microscopic examination was repeated, but no extra canal was found. A #25 taper 04 gutta-percha point was inserted into the canal to confirm the working length of the canal preparation (Fig. 4).

The canal was next dried with sterile paper points and then sterilized with calcium hydroxide and 2% chlorhexidine. The patient attended our department several times. Only when the symptoms had disappeared did we fill the canal with gutta-percha points and AH Plus (DeTrey, Dentsply) using the lateral-condensation technique.

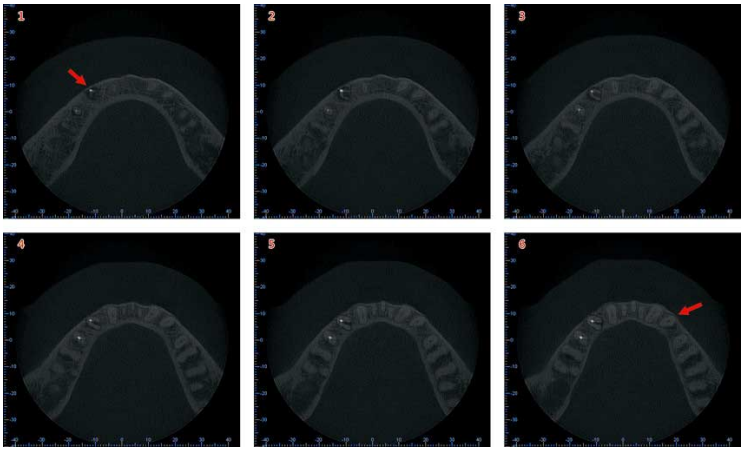

Fig. 5. CBCT examination after RCT shows satisfactory canal filling of the mandibular right first premolar (first red arrow) and a mandibular left first premolar with a normal anatomy last red arrow.

A second CBCT examination was performed and revealed satisfactory root canal filling and no other canals within the root (Fig. 5). Periapical scaling was then performed.

The patient was followed for 3 months. No symptoms were present, the tooth was? loose, but the shade surrounding the root did not change.

## DISCUSSION

There are several unique aspects of this case. First, the radicular groove started almost from the CEJ but enlarged rapidly into a termed “valley” in the radicular third of the root. Valley in this article means that a huge radicular groove in a C-shaped root forms a deep area of space observed like a “valley” in morphology. Second, the mesial and distal walls of the root were relatively thick, but were extremely thin in the buccal part. Thus, the X-ray film showed that the shape of the canal stopped suddenly and seemed to continue through an apparent yet misleading “root bifurcation”. Third, further examination with an endodontic microscope and CBCT yielded no new findings and confirmed the presence of a single canal within the root.

Yoshioka *et al*. (2004) analyzed the X-ray findings of 139 mandibular premolars and noted that the sudden shrinkage of the root canal is a

reliable sign for canal system variations. Abnormal radiographic findings may also indicate variations in root configurations besides the canal system.

Reports of radicular grooves are rare, and this abnormality is observed more often in maxillary premolars and mandibular second premolars than in maxillary incisors and mandibular first premolars. Tamse *et al.*, (2000) examined maxillary premolars with two roots and found that 97% of the teeth had renal invaginations on the buccal root. These invaginations usually started 1.18 mm apical to the root bifurcation and were on average 5.38 mm long and 0.40 mm deep. The larger the root and the more coronal its location, the deeper the radicular invagination. Joseph *et al*., (1996) found that these invaginations occurred in 62% of their study sample and were on average 0.46 mm deep.

Fan *et al.*, (2004) studied 58 mandibular second molars with a fused root and found that 39.7% had only one lingual radicular groove and that the remaining 60.3% had both a buccal and a lingual groove. Kogon (1986) reported a 4.6% incidence of palatal radicular groove in maxillary incisors. Unfortunately, the data were not available for buccal grooves in maxillary incisors but three cases have been reported (Goon *et al*., 1991; Kerezoudis *et al*., 2003; Kozlovsky *et al*., 1988). Robinson *et al*., found that only 9% of the *ex vivo* mandibular first premolars had mesial radicular invaginations.

Cleghorn *et al.*, (2001) summarized the configuration of >6700 mandibular first premolars, of which approximately 98% were single rooted, 1.8% were double rooted, 0.2% had three roots, and less than 0.1% had four roots. In the other 20 teeth with variations in the root or canal system, no deep radicular groove was observed.

Fan *et al.*, (2008) analyzed the size of the radicular groove of C-shaped roots in mandibular first premolars with microcomputed tomography (mCT) and found an average length of 8.77 mm and depth of 1.44 mm; the total range of depth was 0.39–3.23 mm. The site of maximum radicular concavity was located 5.41 mm coronal to the apex. Lu *et al*., (2006) reported that the radicular groove of the mandibular first premolar with a C-shaped root is usually located mesially and slightly lingually on the root surface and originates in the apical 3 mm and/or 6 mm level cross-section in their coronal sections, but the groove did not reach the apex.

In this present case, CBCT cross-sectional analysis and 3D reconstruction showed that the lingual radicular groove started from 4 mm apical to the CEJ. It first extended horizontally for 3 mm then turned at a right angle and continued 8 mm, after which it swelled into the shape of a "rift valley" measuring 6 mm ´ 3 mm. This root surface abnormality has not been reported, and we termed it a "radicular rift valley". The rift valley produced the clear C-shaped root morphology in CBCT 3D reconstruction, the deepest part of which was located 5 mm coronal to the apex (i.e., 3 mm deep). Because the tooth had a normal counterpart in the left mandible, we considered that the contributing factor of this tooth abnormality was not developmental.

In Asia, the incidence of root configuration variations in mandibular first premolars is relatively high, and the C-shaped root is one of the most frequent variations (Cleghorn *et al*.; Cooke & Cox, 1979; Jafarzadeh & Wu, 2001). It has been reported the incidence of C-shaped roots as 14%, 10%, 18%, and 24%, respectively (Sikri & Sikri; Fan *et al*., 2008; Lu *et al.*; Baisden *et al*., 1992), and the incidence of only one canal within the C-shaped root was 1.87% (Baisden *et al.*; Weine, 1989).

Fan *et al*. (2008) developed a modified six-category classification system to describe the root canal system of C-shaped roots. In our case, the radicular groove started from the coronal third of the root and formed a C-shape in CBCT cross-section. There was a single canal in the root, and the long and short diameters were almost equal (Fig. 3, parts 8–11). This root falls within category C4a of the classification system of Fan *et al*. However, in the middle third of the root, the radicular groove began to deepen and eventually formed a deep and wide area, which appeared as an extremely clear C-shape with a single canal in the middle (Fig. 3, parts 3–8). This root morphology cannot be ascribed to any classification category.

This abnormal root and canal anatomy presents extra difficulties in controlling inflammation, debridement, and shaping of the root canal. In the study of Chai & Thong (2004) at the site of the radicular groove, the C-shaped root had a canal with reduced mean wall thickness of 0.96 ± 0.26 mm on the buccal side and 0.58 ± 0.21 mm on the lingual side, indicating an area of isthmus that could be endangered during RCT (Jerome; Chai & Thong; Gao *et al.*, 2006). Sandhya *et al.*, measured the canal wall thickness of mandibular first premolars with mesial invagination and found average thicknesses of the walls of 0.8 mm in the coronal third, 0.78 mm in the middle third and only 0.3 mm in the apical third. In the present case, the cross-sections of the root showed a very clear C-shape, and the root canal was located in the middle. Therefore, the canal wall at the site of maximum root concavity was so thin that special care was needed during the root canal instrumentation because over-preparation could have caused root perforation, especially at the fragile site of the C-shaped

invagination. We advise that in such cases of a radicular groove or rift valley, the extent and location of the canal must be profiled clearly to measure the canal diameter, and instrumentation and cutting at the side of the invagination should be minimal to avoid perforation.

In our patient, CBCT multilayer cross-sections showed that the C-shaped root rift valley was accompanied by an area of alveolar bone defect. Thus, periapical inflammation could be controlled only with RCT to the single canal. We suggested four treatment plans to the patient. Plan A was thought to be the most thorough, but retrograde filling might have caused the following problems. First, because the area of both the gingival fistula and alveolar bone destruction were located in the buccal part of the mandible, an operation from the lingual side was very difficult and would cause more alveolar bone destruction. Second, the huge radicular rift valley was located at the apex, and retrograde filling would have had to be performed coronal to it, which would have inevitably increased the crown–root ratio and severely reduced masticatory support. Third, the alveolar bone repair would have been poor because of the patient's age. Plan B was thought to be more feasible because it combined root canal treatment and periapical scaling. This was advantageous because it would have produced a smaller wound and better treatment of the periapical inflammation, and would have been tolerated better by the patient. However, the area of inflammation at the radicular rift valley could not be reached by scaling, and the long-term prognosis of this tooth was deemed poor. Plan C was not considered a good plan because RCT alone was insufficient to resolve this complicated condition, Plan D focus on MTA closed root surface defects place and induction of surrounding bone tissue regeneration and plan E was considered to be the last resort.

Most patients want to participate in making the decision about the treatment strategy, and the two main tasks for the clinician lie in offering different available treatment plans and instruction about the selection process instead of choosing the best plan irrespective of the patient's wishes (Hayes-Bautista, 1976; Nease *et al*., 1995; Deber *et al*., 1996). In other words, clinicians must adjust their treatment plans accordingly.

After thorough consideration of the patient's overall health status, the clinical situation of the target tooth, the cost, and the patient's preference, we agreed on the second treatment plan B. However maybe plan D is easy repair methods relating tooth surface defect and the surrounding bone tissue engineering in the future.

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**HONG, X.; ZHANG, R.; PAN, H. Y.; ZHANG, W. M. &HU, T.** Surco radicular lingual en la raíces del primer premolar mandibular derecho: Reporte de un raro caso y revisión de la literatura. ***Int. J. Morphol., 31(1)***:338-344, 2013.

**RESUMEN:** Las configuraciones radiculares irregulares que a menudo desafían las exigencias de un tratamiento de canal radicular exitoso, son siempre engañosas llevando al especialista a juicios clínicos y planificación de tratamientos erróneos. En este artículo se describe, en un hombre de 76 años de edad, un raro caso de un premolar mandibular que mediante CBCT se observa la forma de C con un área enorme de invaginación midiendo 6 mm x 3 mm, lo que hemos denominado un "Rift valley radicular ". Teniendo en cuenta el complejo proceso de diagnóstico diferencial, el estado general de enfermedad y la voluntad del paciente, se propusieron cinco planes de tratamiento y, finalmente, se eligió el plan B conservador compuesto por el tratamiento del canal radicular y tratamiento periapical. Una revisión de la literatura relacionada se añade en este artículo para describir las situación de invaginación radicular, haciendo hincapié en la importancia del diagnóstico y para proporcionar referencias para enfermedades similares futuras.

**PALABRAS CLAVE: Fisura radicular; Premolares; CBCT, Tratamiento de canal radicular.**

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