

# World Journal of *Clinical Cases*

*World J Clin Cases* 2021 April 26; 9(12): 2696-2950



## Contents

Thrice Monthly Volume 9 Number 12 April 26, 2021

## MINIREVIEWS

- 2696** Standardization of critical care management of non-critically ill patients with COVID-19  
*Wang CS, Gao Y, Kang K, Fei DS, Meng XL, Liu HT, Luo YP, Yang W, Dai QQ, Gao Y, Zhao MY, Yu KJ*
- 2703** Mediastinal lymphadenopathy in COVID-19: A review of literature  
*Taweasedt PT, Surani S*
- 2711** Polycystic ovary syndrome: Pathways and mechanisms for possible increased susceptibility to COVID-19  
*Ilias I, Goulas S, Zabuliene L*

## ORIGINAL ARTICLE

## Clinical and Translational Research

- 2721** Circulating tumor cells with epithelial-mesenchymal transition markers as potential biomarkers for the diagnosis of lung cancer  
*Jiang SS, Mao CG, Feng YG, Jiang B, Tao SL, Tan QY, Deng B*

## Retrospective Study

- 2731** Management and implementation strategies of pre-screening triage in children during coronavirus disease 2019 pandemic in Guangzhou, China  
*Shi X, Cai YT, Cai X, Wen XL, Wang JY, Ma WC, Shen J, Wu JX, Liu HY, Sun J, He PQ, Lin Y, Zhao DY, Li PQ*
- 2739** Clinicopathological features of superficial CD34-positive fibroblastic tumor  
*Ding L, Xu WJ, Tao XY, Zhang L, Cai ZG*
- 2751** Application of a rapid exchange extension catheter technique in type B2/C nonocclusive coronary intervention *via* a transradial approach  
*Wang HC, Lu W, Gao ZH, Xie YN, Hao J, Liu JM*

## SYSTEMATIC REVIEWS

- 2763** Paradoxical relationship between proton pump inhibitors and COVID-19: A systematic review and meta-analysis  
*Zippi M, Fiorino S, Budriesi R, Micucci M, Corazza I, Pica R, de Biase D, Gallo CG, Hong W*

## META-ANALYSIS

- 2778** Predictive risk factors for recollapse of cemented vertebrae after percutaneous vertebroplasty: A meta-analysis  
*Ma YH, Tian ZS, Liu HC, Zhang BY, Zhu YH, Meng CY, Liu XJ, Zhu QS*

## CASE REPORT

- 2791** Malignant pheochromocytoma with cerebral and skull metastasis: A case report and literature review  
*Chen JC, Zhuang DZ, Luo C, Chen WQ*
- 2801** Unresectable esophageal cancer treated with multiple chemotherapies in combination with chemoradiotherapy: A case report  
*Yura M, Koyanagi K, Hara A, Hayashi K, Tajima Y, Kaneko Y, Fujisaki H, Hirata A, Takano K, Hongo K, Yo K, Yoneyama K, Tamai Y, Dehari R, Nakagawa M*
- 2811** Role of positron emission tomography in primary carcinoma ex pleomorphic adenoma of the bronchus: A case report  
*Yang CH, Liu NT, Huang TW*
- 2816** Positive reverse transcription-polymerase chain reaction assay results in patients recovered from COVID-19: Report of two cases  
*Huang KX, He C, Yang YL, Huang D, Jiang ZX, Li BG, Liu H*
- 2823** Laryngeal myxoma: A case report  
*Yu TT, Yu H, Cui Y, Liu W, Cui XY, Wang X*
- 2830** Prostate stromal tumor with prostatic cysts after transurethral resection of the prostate: A case report  
*Zhao LW, Sun J, Wang YY, Hua RM, Tai SC, Wang K, Fan Y*
- 2838** Intramuscular hematoma in rhabdomyolysis patients treated with low-molecular-weight heparin: Report of two cases  
*Yuan SY, Xie KF, Yang J*
- 2845** Partial response to Chinese patent medicine Kangliu pill for adult glioblastoma: A case report and review of the literature  
*Sun G, Zhuang W, Lin QT, Wang LM, Zhen YH, Xi SY, Lin XL*
- 2854** Behcet's disease manifesting as esophageal variceal bleeding: A case report  
*Xie WX, Jiang HT, Shi GQ, Yang LN, Wang H*
- 2862** Successful endoscopic surgery for emphysematous pyelonephritis in a non-diabetic patient with autosomal dominant polycystic kidney disease: A case report  
*Jiang Y, Lo R, Lu ZQ, Cheng XB, Xiong L, Luo BF*
- 2868** Robotically assisted removal of pelvic splenosis fifty-six years after splenectomy: A case report  
*Tognarelli A, Faggioni L, Erba AP, Faviana P, Durante J, Manassero F, Selli C*
- 2874** Pulmonary alveolar proteinosis complicated with nocardiosis: A case report and review of the literature  
*Wu XK, Lin Q*
- 2884** Detection of EGFR-SEPT14 fusion in cell-free DNA of a patient with advanced gastric cancer: A case report  
*Kim B, Kim Y, Park I, Cho JY, Lee KA*

- 2890** Timing of convalescent plasma therapy-tips from curing a 100-year-old COVID-19 patient using convalescent plasma treatment: A case report  
*Liu B, Ren KK, Wang N, Xu XP, Wu J*
- 2899** Torsades de pointes episode in a woman with high-grade fever and inflammatory activation: A case report  
*Qiu H, Li HW, Zhang SH, Zhou XG, Li WP*
- 2908** Salivary duct carcinoma of the submandibular gland presenting a diagnostic challenge: A case report  
*Uchihashi T, Kodama S, Sugauchi A, Hiraoka S, Hirose K, Usami Y, Tanaka S, Kogo M*
- 2916** Allogeneic hematopoietic stem cell transplantation in a 3-year-old boy with congenital pyruvate kinase deficiency: A case report  
*Ma ZY, Yang X*
- 2923** Congenital bilateral cryptorchidism in an infant conceived after maternal breast cancer treatment: A case report  
*Hu WK, Liu J, Liu RX, Liu XW, Yin CH*
- 2930** Sclerosing polycystic adenosis of the submandibular gland: Two case reports  
*Wu L, Wang Y, Hu CY, Huang CM*
- 2937** Budd-Chiari syndrome associated with liver cirrhosis: A case report  
*Ye QB, Huang QF, Luo YC, Wen YL, Chen ZK, Wei AL*
- 2944** Separated root tip formation associated with a fractured tubercle of dens evaginatus: A case report  
*Wu ZF, Lu LJ, Zheng HY, Tu Y, Shi Y, Zhou ZH, Fang LX, Fu BP*

**ABOUT COVER**

Editorial Board Member of *World Journal of Clinical Cases*, Jing Liu, MD, PhD, Chief Doctor, Professor, Department of Neonatology and NICU, Beijing Chaoyang District Maternal and Child Healthcare Hospital, Beijing 100021, China. liujingbj@live.cn

**AIMS AND SCOPE**

The primary aim of *World Journal of Clinical Cases* (WJCC, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

**INDEXING/ABSTRACTING**

The WJCC is now indexed in Science Citation Index Expanded (also known as SciSearch®), Journal Citation Reports/Science Edition, Scopus, PubMed, and PubMed Central. The 2020 Edition of Journal Citation Reports® cites the 2019 impact factor (IF) for WJCC as 1.013; IF without journal self cites: 0.991; Ranking: 120 among 165 journals in medicine, general and internal; and Quartile category: Q3. The WJCC's CiteScore for 2019 is 0.3 and Scopus CiteScore rank 2019: General Medicine is 394/529.

**RESPONSIBLE EDITORS FOR THIS ISSUE**

Production Editor: Ji-Hong Lin; Production Department Director: Xiang Li; Editorial Office Director: Jin-Lai Wang.

**NAME OF JOURNAL**

*World Journal of Clinical Cases*

**ISSN**

ISSN 2307-8960 (online)

**LAUNCH DATE**

April 16, 2013

**FREQUENCY**

Thrice Monthly

**EDITORS-IN-CHIEF**

Dennis A Bloomfield, Sandro Vento, Bao-Gan Peng

**EDITORIAL BOARD MEMBERS**

<https://www.wjgnet.com/2307-8960/editorialboard.htm>

**PUBLICATION DATE**

April 26, 2021

**COPYRIGHT**

© 2021 Baishideng Publishing Group Inc

**INSTRUCTIONS TO AUTHORS**

<https://www.wjgnet.com/bpg/gerinfo/204>

**GUIDELINES FOR ETHICS DOCUMENTS**

<https://www.wjgnet.com/bpg/GerInfo/287>

**GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH**

<https://www.wjgnet.com/bpg/gerinfo/240>

**PUBLICATION ETHICS**

<https://www.wjgnet.com/bpg/GerInfo/288>

**PUBLICATION MISCONDUCT**

<https://www.wjgnet.com/bpg/gerinfo/208>

**ARTICLE PROCESSING CHARGE**

<https://www.wjgnet.com/bpg/gerinfo/242>

**STEPS FOR SUBMITTING MANUSCRIPTS**

<https://www.wjgnet.com/bpg/GerInfo/239>

**ONLINE SUBMISSION**

<https://www.f6publishing.com>

## Separated root tip formation associated with a fractured tubercle of dens evaginatus: A case report

Zhi-Fang Wu, Ling-Jiao Lu, Hai-Yan Zheng, Yan Tu, Ying Shi, Zi-Huai Zhou, Lin-Xian Fang, Bai-Ping Fu

**ORCID number:** Zhi-Fang Wu 0000-0001-7380-039X; Ling-Jiao Lu 0000-0001-9429-0325; Hai-Yan Zheng 0000-0001-7794-0242; Yan Tu 0000-0002-0443-7037; Ying Shi 0000-0003-3376-398X; Zi-Huai Zhou 0000-0002-1685-6730; Lin-Xian Fang 0000-0003-0723-4056; Bai-Ping Fu 0000-0002-9444-1856.

**Author contributions:** Wu ZF and Tu Y were the patient's dentists, reviewed the literature and contributed to manuscript drafting; Lu LJ, Zheng HY and Zhou ZH reviewed the literature and contributed to manuscript drafting; Shi Y and Fang LX analyzed and interpreted the imaging findings; Fu BP were responsible for the revision of the manuscript for important intellectual content; All authors issued final approval for the version to be submitted.

**Supported by** National Natural Science Foundation of China, No. 81801028; and Natural Science Foundation of Zhejiang Province, No. LQ19H140001.

### Informed consent statement:

Informed written consent was obtained from the patient for publication of this report and any accompanying images.

**Conflict-of-interest statement:** The authors declare that they have no conflict of interest.

**Zhi-Fang Wu, Lin-Xian Fang,** Department of Pediatric Dentistry, The Affiliated Hospital of Stomatology, School of Stomatology, Zhejiang University School of Medicine, Key Laboratory of Oral Biomedical Research of Zhejiang Province, Hangzhou 310006, Zhejiang Province, China

**Ling-Jiao Lu, Hai-Yan Zheng, Ying Shi, Zi-Huai Zhou, Bai-Ping Fu,** Department of Prosthodontics, The Affiliated Hospital of Stomatology, School of Stomatology, Zhejiang University School of Medicine, Key Laboratory of Oral Biomedical Research of Zhejiang Province, Hangzhou 310006, Zhejiang Province, China

**Yan Tu,** Department of Endodontics, The Affiliated Hospital of Stomatology, School of Stomatology, Zhejiang University School of Medicine, Key Laboratory of Oral Biomedical Research of Zhejiang Province, Hangzhou 310006, Zhejiang Province, China

**Corresponding author:** Bai-Ping Fu, PhD, Director, Professor, Department of Prosthodontics, The Affiliated Hospital of Stomatology, School of Stomatology, Zhejiang University School of Medicine, Key Laboratory of Oral Biomedical Research of Zhejiang Province, No. 395 Yan'an Road, Hangzhou 310006, Zhejiang Province, China. [fbp@zju.edu.cn](mailto:fbp@zju.edu.cn)

## Abstract

### BACKGROUND

Several previous studies have reported an unusual root formation in which a fractured apical fragment of an immature root continued to develop independent of the main root after trauma to an immature tooth. To date, there have been only rare reports of the continuing apical formation of the fractured root associated with dens evaginatus (DE). This paper presents a case of a separated root tip formation associated with a fractured tubercle of DE.

### CASE SUMMARY

An 11-year-old boy was referred for gingival sinus on the buccal side of the right mandibular second premolar (tooth # 45). Clinically, tooth # 45 was free of caries, but there was a sign of a fractured tubercle of DE on the occlusal surface. Radiography showed that the root canal of tooth # 45 was widely radiolucent. A separated root apex was found apically under the main root and was nearly completely formed with an apical orifice at the apical tip. Tooth # 45 was diagnosed as tubular fracture of DE with chronic apical periodontitis. A revascularization technique was recommended to treat the tooth. At 3-mo and 1-yr follow-up, the patient remained asymptomatic. Periapical radiography revealed that the separated root tip distally drifted with closure of the apex.

**CARE Checklist (2016) statement:**

The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Manuscript source:** Unsolicited manuscript

**Specialty type:** Medicine, research and experimental

**Country/Territory of origin:** China

**Peer-review report's scientific quality classification**

Grade A (Excellent): 0  
Grade B (Very good): 0  
Grade C (Good): C  
Grade D (Fair): 0  
Grade E (Poor): 0

**Received:** January 7, 2021

**Peer-review started:** January 7, 2021

**First decision:** January 24, 2021

**Revised:** January 25, 2021

**Accepted:** February 24, 2021

**Article in press:** February 24, 2021

**Published online:** April 26, 2021

**P-Reviewer:** Chen S

**S-Editor:** Gao CC

**L-Editor:** Filipodia

**P-Editor:** Xing YX



However, the root length and thickness of the main root did not increased.

**CONCLUSION**

Clinicians should be aware that even if tubercle of DE is fractured in an immature tooth, the root tip may be separated from the main root and completely formed.

**Key Words:** Separated root tip; Dens evaginatus; Tubercle fracture; Young permanent tooth; Revascularization; Case report

©The Author(s) 2021. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core Tip:** Studies have reported an unusual root formation where a fractured apical fragment of an immature root continued to develop independent of the main root after trauma to an immature tooth. There are only rare reports of continuing apical formation of the fractured root associated with dens evaginatus. We present a case of a separated root tip formation associated with a fractured tubercle of dens evaginatus. The case highlights that clinicians should be aware that even if the tubercle of dens evaginatus is fractured in an immature tooth, the root tip may be separated from the main root and completely formed.

**Citation:** Wu ZF, Lu LJ, Zheng HY, Tu Y, Shi Y, Zhou ZH, Fang LX, Fu BP. Separated root tip formation associated with a fractured tubercle of dens evaginatus: A case report. *World J Clin Cases* 2021; 9(12): 2944-2950

**URL:** <https://www.wjgnet.com/2307-8960/full/v9/i12/2944.htm>

**DOI:** <https://dx.doi.org/10.12998/wjcc.v9.i12.2944>

**INTRODUCTION**

Dens evaginatus (DE) is an odontogenic developmental anomaly and occurs in both primary and permanent dentition<sup>[1]</sup>. It is defined as a supernumerary tubercle of tooth structure located in the palatal or lingual surfaces of anterior teeth and the central groove or on the buccal or lingual cusps of premolars or molars<sup>[1]</sup>. However, its exact etiology remains undetermined<sup>[1,2]</sup>. The prevalence of DE varies with different race and different diagnostic criteria<sup>[1,2]</sup>. DE occurs more frequently in premolars, particularly in the mandibular second premolar<sup>[1,2]</sup>. A previous study reported that DE occurs in bilateral dentitions of approximately half of all cases<sup>[1,2]</sup>. Tubercles of DE are usually fractured or worn by the opposing tooth, and inflammation or infection of the pulp and even periapical abscess most likely ensue<sup>[1]</sup>.

It is well known that completion of root development and apex closure occurs up to 3 years after tooth eruption. Thus, once the pulp is inflamed or necrosed during this period, the root formation is interrupted, which results in an open apex and thin root canal wall. The continuing formation of the affected root is a great challenge for dentists<sup>[3]</sup>. Several previous studies reported an unusual root formation in which a fractured apical fragment of an immature root continued to develop independent of the main root after a trauma to an immature tooth<sup>[4-8]</sup>. Hertwig's epithelial root sheath and mesenchymal stem cells are believed to be responsible for the root development<sup>[9]</sup>. Although the stemness of the apical papilla cells remains to be further investigated<sup>[10]</sup>, it is believed that stem cells from the apical papilla (SCAPs) play a pivotal role in continuing root development in the erupting teeth with immature roots<sup>[11]</sup>. The authors hypothesize that this continuing development of the apex is accompanied by SCAPs that are separated by trauma to cause detachment of SCAPs and Hertwig's epithelial root sheath<sup>[4-8]</sup>. Jung *et al*<sup>[12]</sup> reported that a separated apex continued to develop without any direct traumatic episode. However, the exact underlying mechanism is still unclear. To date, there are only rare reports of continuing apical formation of a fractured root associated with DE.



---

## CASE PRESENTATION

---

### **Chief complaints**

An 11-year-old boy was referred to his dentist for gingival sinus on the buccal side of the right mandibular second premolar.

### **History of present illness**

The boy experienced intermittent spontaneous pain in the affected part for about 2 mo. His initial dentist referred the boy to our clinic for an incompletely formed root associated with a large radiolucency.

### **History of past illness**

Any trauma of the tooth was denied by his parents.

### **Personal and family history**

His parents denied any personal and family history.

### **Physical examination**

The clinical signs were described as follows. Tooth # 45 was free of caries, but there was a sign of a fractured tubercle of DE on the occlusal surface. The tooth mobility was grade I, and there was a gingival fistula on the buccal side. The pyogenic fluids flowed out of the fistula under palpation (Figure 1A). Tooth percussion was sensitive. The probing depths of the affected tooth were within a normal range.

### **Imaging examinations**

Initial panoramic radiography at his first visit showed that the root of tooth # 45 was fractured. A separated root apex was found apically under the main root and was almost completely formed. The main root remained immature with a thin root wall and was associated with a large radiolucency. However, the root of tooth # 35 was not erupted, and the second primary molar remained. The root development was graded as Nolla 8 (Figure 1B).

---

## FINAL DIAGNOSIS

---

Tooth # 45 was diagnosed as tubular fracture of DE with chronic apical periodontitis.

---

## TREATMENT

---

A revascularization technique was recommended to treat the tooth as follows. The tooth was isolated with a rubber dam, and the access cavity was made. The pulp was found to be completely necrotic. The root canal was cleaned, gently prepared with K-files under root canal microscopy and irrigated with copious (20 mL) 1% NaClO and 0.9% saline solution in turn for 5 min. The canals were dried with sterilized paper tips (GAPADENT, Tianjin, China) and inserted with freshly mixed metronidazole paste (Klus Pharma, Sichuan Province, China). The open access was then filled with glass ionomer cement (GC, Japan). The patient was followed up 2 wk later without any symptoms or pain. The fistula was undetectable, and the mobility of the affected tooth was within a normal range (Figure 2A). The access was reopened, and the root canal was slowly irrigated with 20 mL 1% NaClO and 0.9% saline solution in turn. A size # 20 K10/6-file was used to gently irritate the tissue to induce fresh bleeding into the canal. The bleeding was left undisturbed to allow blood clotting. A blood clot was produced to the level of the cemento-enamel junction. Then iRoot BP Plus (Innovative BioCeramix Inc., Vancouver, BC, Canada) was placed carefully over the blood clot, and subsequently glass ionomer cement was placed. Dental radiography was undertaken to secure the treatment (Figure 2B).

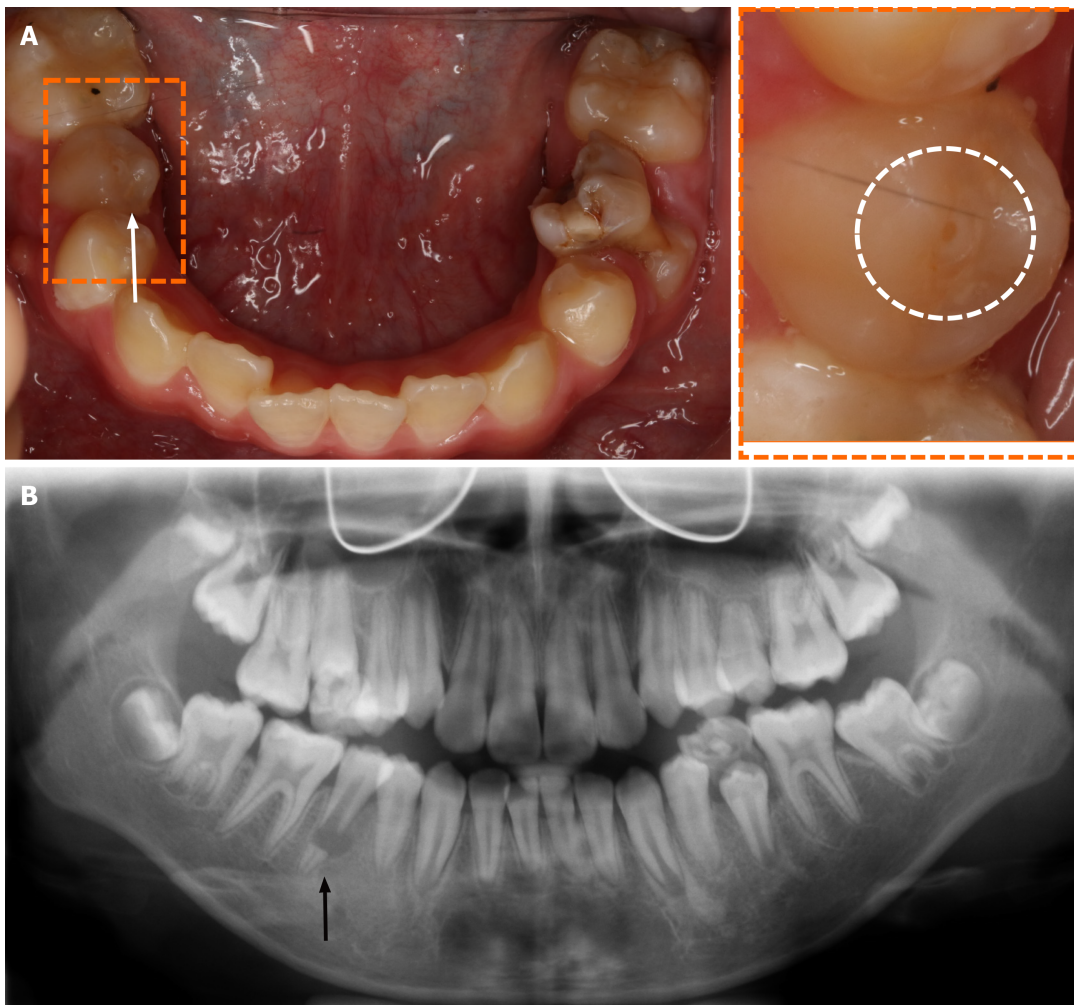
---

## OUTCOME AND FOLLOW-UP

---

At the 3 mo follow-up, the patient was asymptomatic. Periapical radiography revealed that the large radiolucency was completely resolved, and the separated root tip was





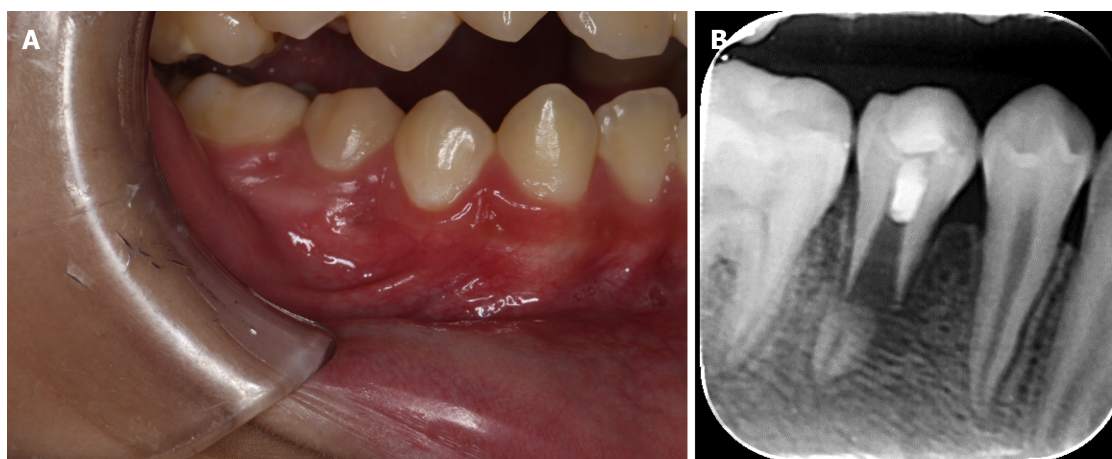
**Figure 1 Preoperative clinical and radiographic evaluation.** A: Overview of mandibular dentition shows a gingival sinus (white arrow) on the buccal side of tooth # 45. The right column is a local enlarged image of the orange dotted area with the white circle showing the fractured tubercle of dens evaginatus on the occlusal surface of tooth # 45; B: Panoramic radiograph at the initial visit showing that the root of tooth # 45 was fractured and separated. The separated root apex was almost completely formed, and the main root remained immature with thin root walls associated with a large radiolucency (black arrow).

slightly distally drifted with closure of the apex (Figure 3A). At the 1 yr follow-up, the patient was still asymptomatic, and the tooth had good clinical function. Dental radiography revealed that the separated root tip was more distally drifted than after the 3 mo follow-up. However, the main root of tooth # 45 did not increase in root length and dentin thickness (Figure 3B).

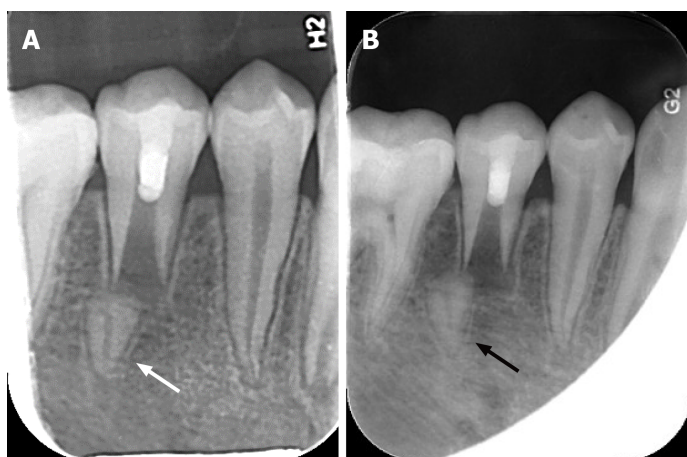
## DISCUSSION

SCAPs and Hertwig's epithelial root sheath are believed to be responsible for root development<sup>[9]</sup>. The tissues are attached to the apex of the developing root loosely, but they can be easily detached by an external force<sup>[13]</sup>. Several studies have reported separate root formation. However, most cases were associated with a traumatic history, particularly avulsion<sup>[4-8]</sup>. Other studies have reported that after apexification treatment a separately growing root was formed<sup>[12,14]</sup>. The authors inferred that the separation may have been caused by the mechanical and chemical procedures performed during apexification. Jung *et al*<sup>[12]</sup> reported a case without a clear traumatic history and showed at initial examination that the root was separated into two segments and the root tip was already present. However, the time and the cause of the fractured root are unknown. Jung *et al*<sup>[12]</sup> speculated that the separation might have been caused by tooth mobility resulting from tissue swelling. However, the separate root tip formation associated with a fractured tubercle of DE has rarely been reported.

A previous study described an anomalous and unusual root formation in a premolar DE<sup>[15]</sup>. In that study, the tooth was extracted due to the gingival



**Figure 2 Clinical evaluation at the 2 wk follow-up and periapical radiograph after revascularization.** A: Clinical evaluation at the 2 wk follow-up showing that the fistula was completely resolved (subsided); B: Periapical radiograph after revascularization showing iRoot Bp Plus was placed below the cemento-enamel junction.



**Figure 3 Periapical radiograph during the follow-up period.** A: Periapical radiograph at the 3 mo follow-up demonstrated complete resolution of the radiolucency and a drifting root tip (white arrow); B: Periapical radiograph at the 1 yr follow-up showed that the separated root tip (black arrow) was more distally drifted than before. The root length and dentin thickness of the main root did not increase.

communication with the pulp space<sup>[15]</sup>. Reichart *et al*<sup>[16]</sup> reported a tooth with a similar radiographic appearance, but they interpreted it as a root fracture. Radiographic examination showed that development in the coronal part of the root had ceased, and the apical root segment was completely formed. They speculated that this may have been due to a low-grade infection that was sufficiently virulent to interrupt root development of the coronal part but could allow the continued apical root formation<sup>[15]</sup>. In our study, a separated root tip associated with a fractured tubercle of DE was formed. The precise time and exact cause of the fractured root could not be determined. As the mobility of the tooth was less and the root length of the coronal part was about half that of tooth # 44, the revascularization treatment procedure was performed for tooth # 45.

Few studies have reported the exact histology of the newly formed separate tissues. Yang *et al*<sup>[14]</sup> reported that the separate newly formed part of the root was composed of pulp tissue, odontoblasts, predentin and cementum. Another study reported that the separated root segment revealed a narrow necrotic pulp with some evidence of calcification<sup>[15]</sup>.

DE results from abnormal tooth development<sup>[1]</sup>. Several prophylactic treatment methods are recommended for DE, such as selective grinding of the tubercles and application of resin to reinforce the tubercles<sup>[1]</sup>. However, in the clinic, the fractured tubercle is frequently observed prior to complete root formation and leads to dental complications such as pulpal necrosis and apical periodontitis. This could interfere with root development and even influence survival of the affected tooth<sup>[1]</sup>. If the

tubercle is fractured and the pulp is affected in the immature tooth, then apexification is strongly recommended to treat the tooth<sup>[17]</sup>. Although apexification treatment is reported to have high endodontic clinical success, these teeth are prone to post-treatment fracture due to the thin fragile root canal walls<sup>[18]</sup>. In addition, the treatment protocol needs time for treatment execution, which requires a compliant patient<sup>[19]</sup>.

Revascularization is another viable option<sup>[19]</sup>. Revascularization is a regenerative treatment that allows root maturation by continued deposition of dentin and a cementum-like structure along the root walls<sup>[19]</sup>. In the present case, we used revascularization to promote root development. At the 3 mo follow-up, radiographic examination showed complete resolution of the radiolucency. The success of regenerative endodontic procedures, as defined by the American Association of Endodontics, is categorized as follows: (1) Primary goal (elimination of symptoms and evidence of bony healing); (2) Secondary goal [increased root wall thickness and/or root length (desired but perhaps not essential)]; and (3) Tertiary goal (a positive response to vitality testing)<sup>[20]</sup>. Although the root length and dentin thickness of the main root did not increase after 1 yr, the primary goal was achieved<sup>[20]</sup>. In this case, the root development may take longer, and additional follow-up is recommended. Compared to the initial visit radiography, the completely formed root tip was slightly drifted (Figure 3A). After 1 yr, the root tip was more distally drifted than before (Figure 3B). This phenomenon is in accordance with a previous report<sup>[14]</sup>. There is a common finding that there is a strong tendency of the teeth to drift mesially even before they appear in the oral cavity<sup>[14]</sup>. That is why the separated root tip was located distoapically to the original main root.

## CONCLUSION

There are only rare reports about the continuing apical formation of a fractured root associated with DE. The present case highlights that clinicians should be aware that even if a tubercle of DE is fractured in an immature tooth, the root tip may be separated from the main root and completely formed. Increased awareness of this will allow clinicians to make correct preventive and therapeutic decisions.

## REFERENCES

1. Chen JW, Huang GT, Bakland LK. Dens evaginatus: Current treatment options. *J Am Dent Assoc* 2020; **151**: 358-367 [PMID: 32209245 DOI: 10.1016/j.adaj.2020.01.015]
2. Pritchard B, Tefaghi FA, Makdissi J. Dens evaginatus. *Br Dent J* 2020; **228**: 397 [PMID: 3221422 DOI: 10.1038/s41415-020-1441-x]
3. Wen PH, Liou JU, Duh BR. Apexification of nonvital immature mandibular premolars using two different techniques. *J Dent Sci* 2009; **4**: 96-101 [DOI: 10.1016/S1991-7902(09)60014-3]
4. Gibson AC. Continued root development after traumatic avulsion of partly-formed permanent incisor. *Br Dent J* 1969; **126**: 356-357 [PMID: 5255742 DOI: 10.1016/j.ultras.2008.04.011]
5. Barker BC, Mayne JR. Some unusual cases of apexification subsequent to trauma. *Oral Surg Oral Med Oral Pathol* 1975; **39**: 144-150 [PMID: 234007 DOI: 10.1016/0030-4220(75)90405-3]
6. Burley MA, Reece RD. Root formation following traumatic loss of an immature incisor. A case report. *Br Dent J* 1976; **141**: 315-316 [PMID: 1069586 DOI: 10.1038/sj.bdj.4803843]
7. Smith BE, Thaler MN. Detached root apexogenesis. *Oral Surg Oral Med Oral Pathol* 1992; **73**: 129 [PMID: 1603555 DOI: 10.1016/0030-4220(92)90173-n]
8. Welbury R, Walton AG. Continued apexogenesis of immature permanent incisors following trauma. *Br Dent J* 1999; **187**: 643-644 [PMID: 10654438 DOI: 10.1038/sj.bdj.4800356]
9. Pashley DH, Liewehr FR. Structure and functions of the dentin-pulp complex. In: Cohen S, Hargreaves KM. Pathways of the pulp. St Louis: Mosby Elsevier; 2006: 460-511
10. Tziafas D, Kodonas K. Differentiation potential of dental papilla, dental pulp, and apical papilla progenitor cells. *J Endod* 2010; **36**: 781-789 [PMID: 20416419 DOI: 10.1016/j.joen.2010.02.006]
11. Huang GT, Sonoyama W, Liu Y, Liu H, Wang S, Shi S. The hidden treasure in apical papilla: the potential role in pulp/dentin regeneration and bioroot engineering. *J Endod* 2008; **34**: 645-651 [PMID: 18498881 DOI: 10.1016/j.joen.2008.03.001]
12. Jung IY, Kim ES, Lee CY, Lee SJ. Continued development of the root separated from the main root. *J Endod* 2011; **37**: 711-714 [PMID: 21496677 DOI: 10.1016/j.joen.2011.01.015]
13. Sonoyama W, Liu Y, Yamaza T, Tuan RS, Wang S, Shi S, Huang GT. Characterization of the apical papilla and its residing stem cells from human immature permanent teeth: a pilot study. *J Endod* 2008; **34**: 166-171 [PMID: 18215674 DOI: 10.1016/j.joen.2007.11.021]
14. Yang SF, Yang ZP, Chang KW. Continuing root formation following apexification treatment. *Endod Dent Traumatol* 1990; **6**: 232-235 [PMID: 2133316 DOI: 10.1111/j.1600-9657.1990.tb00425.x]

- 15 **Moule AJ**, Natkin E. Unusual root formation in a premolar with dens evaginatus. *Aust Dent J* 1987; **32**: 354-356 [PMID: [3481256](#) DOI: [10.1111/j.1834-7819.1987.tb00601.x](#)]
- 16 **Reichart P**, Tantiniran D. Dens evaginatus in the Thai. An evaluation of fifty-one cases. *Oral Surg Oral Med Oral Pathol* 1975; **39**: 615-621 [PMID: [1054469](#) DOI: [10.1016/0030-4220\(75\)90203-0](#)]
- 17 **Chu FC**, Sham AS, Yip KH. Fractured dens evaginatus and unusual periapical radiolucency. *Dent Traumatol* 2002; **18**: 339-341 [PMID: [12656869](#) DOI: [10.1034/j.1600-9657.2002.00090.x](#)]
- 18 **Cvek M**. Prognosis of luxated non-vital maxillary incisors treated with calcium hydroxide and filled with gutta-percha. A retrospective clinical study. *Endod Dent Traumatol* 1992; **8**: 45-55 [PMID: [1521505](#) DOI: [10.1111/j.1600-9657.1992.tb00228.x](#)]
- 19 **Bukhari S**, Kohli MR, Setzer F, Karabucak B. Outcome of Revascularization Procedure: A Retrospective Case Series. *J Endod* 2016; **42**: 1752-1759 [PMID: [27726882](#) DOI: [10.1016/j.joen.2016.06.021](#)]
- 20 **Kim SG**, Malek M, Sigurdsson A, Lin LM, Kahler B. Regenerative endodontics: a comprehensive review. *Int Endod J* 2018; **51**: 1367-1388 [PMID: [29777616](#) DOI: [10.1111/iej.12954](#)]



Published by **Baishideng Publishing Group Inc**  
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA

**Telephone:** +1-925-3991568

**E-mail:** [bpgoffice@wjgnet.com](mailto:bpgoffice@wjgnet.com)

**Help Desk:** <https://www.f6publishing.com/helpdesk>

<https://www.wjgnet.com>

