

Treatment of Molar Incisor Malformation and the short term follow-up: Case reports



S. Park¹, S. Byun², J. Kim²,
B. Yang², S. Oh³

¹DDS, MSD - Department of Pediatric Dentistry
Hallym University Sacred Heart Hospital,
Anyang-si, Republic of Korea

²DDS, PhD - Department of Oral and Maxillofacial
Surgery Dentistry, Hallym University Sacred Heart
Hospital, Anyang-si, Republic of Korea

³DDS, PhD Department of Pediatric Dentistry
Hallym University Sacred Heart Hospital,
Anyang-si, Republic of Korea

e-mail: park070676@gmail.com

DOI 10.23804/ejpd.2020.21.03.15

Abstract

Background Molar Incisor Malformation (MIM) or Molar Root Incisor malformation (MRIM) is a recently discovered root malformation with constricted pulp and abnormally located furcation presented in permanent first molars and sometimes incisors.

Case reports Two cases that feature MIM are presented with the description of the characteristic tooth form, clinical/radiographic examination, medical history, the supposed aetiology, treatment procedure and results at the 2-year follow-up. Conservative endodontic treatment was performed in both cases, furcation perforation and canal perforation were filled with MTA (Mineral Trioxide Aggregate), and a good prognosis was observed after 2 years of follow-up. Furthermore, recommended treatment options are discussed to provide a more appropriate treatment for the patients.

Conclusion Patients with MIM need to be treated at the right time to avoid severe infection and other problems. Early diagnosis with appropriate treatment is more likely to lead to a more favourable prognosis.

KEYWORDS Molar incisor malformation (MIM), Molar root incisor malformation (MRIM), Conservative endodontic treatment, MTA (Mineral Trioxide Aggregate), Extraction.

Introduction

Molar Incisor Malformation (MIM) or Molar Root Incisor Malformation (MRIM) is a condition found recently in permanent first molars, deciduous second molars, and upper permanent central incisors [Lee et al., 2014]. Also, MIM shows a particular shape specifically bilaterally or in the four quadrants.

MIM-affected molars may present with normal crowns with thin, constricted pulp cavity and root pulp, and malformed roots with abnormally located furcation with perforation as shown from the radiographs. Particularly, dilacerated and elongated roots or shortened roots are common malformations. Therefore, panoramic, periapical radiographs and cone-beam computed tomography (CBCT) are recommended for diagnosis and follow-ups. Patients with MIM showed severe clinical issues such as pulp necrosis, periapical abscess and more severe abscess of MIM-affected molars. Therefore, these patients need appropriate timely treatment to prevent clinical problems.

However, Yue et al [2016] reported a case with successful root canal treatment of a MIM-affected molar.

In this paper we aim to describe treatment methods by presenting two cases, including the endodontic treatment for MIM-affected molars. The paper will show clinical, radiographic examination, medical history, treatment procedures and short-term follow-up in order to make sure that appropriate subjects are selected for good prognosis.

Case reports

Brief information including gender and age, affected teeth and radiographic and clinical features, treatment and prognosis of the cases are summarised in Table 1. The medical history is shown in Table 2. There was no specific family history and the individual systemic medical conditions were recorded.

Case 1

The patient was an 11-year-old male who came to Hallym University Sacred Heart Hospital (Anyang, South Korea) with the chief complaint of a swelling on the right buccal space and painful lower right permanent first molar. The lower permanent first molars on both sides were affected by MIM, with the right submandibular, sublingual and retropharyngeal abscess and the periapical abscess on lower left MIM-affected molar (Fig. 1A, 2A, 3A) (Table 1). Some peculiar bullet points were made through the history-taking process: The patient had been hospitalized one month after birth because of severe birth asphyxia with cephalohematoma which was treated with Cephazolin. He also had experienced acute pharyngotonsillitis with parenteral diarrhoea at the age of 18 months, therefore he underwent MRI examination (Table 2). The patient underwent incision and drainage due to abscess under general anaesthesia, and nonsurgical conservative endodontic treatment was performed. Every canal of the right lower first permanent molar was negotiated and the distobuccal canal was a C-shaped one (Fig. 2B). Mesio Buccal, mesiolingual and distobuccal canals were filled using continuous technique and Endoseal MTA (Maruchi, Wonju, Korea). There was a pinpoint perforation, which was repaired with Endocem MTA (Maruchi, Wonju, Korea) (Fig. 4B). After endodontic treatment, the affected tooth was covered with a stainless steel crown (SSC).

Two years later, the apical lesion of the right lower first permanent molar almost disappeared with no symptom and

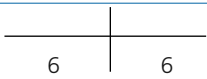
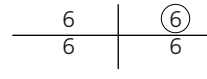
	Case 1	Case 2
Gender / Age	M 11 y	F 11 y
MIM Affected tooth		
Chief complaint	Submandibular, sublingual and retropharyngeal abscess	Periapical abscess
Radiographic features	Abnormal furcation position Shorten middle of tooth Constricted pulp cavity Dilacerated , elongated roots	Abnormal furcation position Shorten middle of tooth Constricted pulp cavity Shorten roots
Furcation involvement (bone loss)	Right 1/3 of root Left 2/3 of root	Upper left X Lower both 1/3 of root
Root malformation	Elongation	Upper: elongation Lower: short
Treatment teeth		
Treatment	Conservative endodontic treatment with MTA	Conservative endodontic treatment with MTA
Calcification	On Left: ML	Upper left : Palatal canal
Perforation	Both: Furcation transmission	Distal canal perforation

TABLE 1 Summary of clinical, radiographic features and treatment of each case.

	Case 1	Case 2
Medical history (At birth-1 year)	1 month Severe birth asphyxia With cephalohematoma Meconium aspiration	At birth Prematurity (32 weeks) Low birth weight Left inguinal hernia
Medical history (1 year - 3 year)	18months Acute pharyngo-tonsillitis with parenteral diarrhoea	-
Treatment	4 months CT, MRI *2 times	4 months MRI
Antibiotics	1 months cephazolin	-

TABLE 2 Medical history, radiographic taking and antibiotics in each case.



FIG. 1 Panoramic view; short term follow-up of Case 1. A. Panoramic x-ray obtained at the first visit. B. Panoramic x-ray obtained after 2 years.

apparently intact lamina dura (Fig. 1B, 2B). Likewise, in the lower left first molar, mesiobuccal, distolingual, and distobuccal canals were filled using continuous technique and Endoseal MTA. The mesiolingual canal orifice of the left lower first permanent molar could not be accessed to the apex due to canal calcification (Fig. 3B). There also was a perforation in the furcation, which was repaired with Endocem MTA (Fig. 4). The affected tooth was also covered with a SSC. However,

1 year after treatment, the left lower permanent molar showed apical lesion on the mesial canal, which could not be negotiated. It showed a questionable prognosis despite the fact that no abnormal symptom was present (Fig. 1B, 3B). Since the lower second permanent molar had erupted, it was decided that it should be maintained as long as possible as it did not show any complications. Afterwards, in the case of poor prognosis, the tooth could be extracted and prosthetic



FIG. 2 Treatment and short term follow-up of the lower right first permanent molar of Case 1. A. Periapical x-ray obtained at the first visit. Periapical abscess is marked with an arrow. B. Canal negotiation. All canals are negotiated. C. 1 year post-treatment. Periapical lesion subsided with no symptom. D. 2 years post-treatment. The lower right permanent molar shows good prognosis

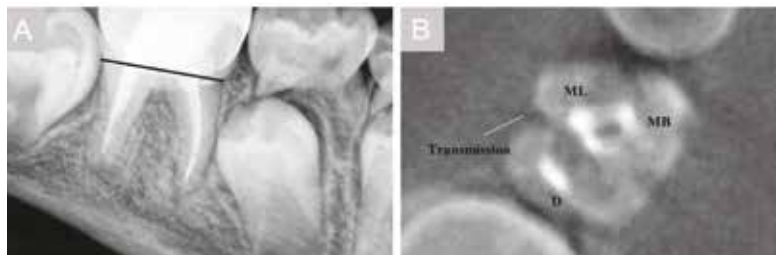


FIG. 3 Treatment and short term follow-up of the lower left first permanent molar of Case 1. A. Periapical view obtained at the first visit. Periapical abscess is marked with an arrow. B. Canal negotiation. ML canal could not be negotiated, due to calcification. C. 1 year post-treatment. Periapical lesion subsided with no symptoms. D. 2 years post-treatment. The lower left permanent molar shows the increase of periapical lesion due to the de-negotiated canal.



FIG. 4 Periapical view and CBCT view of the right first permanent molar of Case 1. Periapical and CBCT view after canal filling. All canals were filled. The furcation perforation on the lingual area was repaired by MTA. It showed a favourable prognosis until 2 years post-treatment.

treatment would be provided.

Case 2

The patient was a 10-year-old female diagnosed of periapical abscess of the upper left permanent first molar. The crown of the teeth appeared clinically normal. In the radiograph, the roots of lower teeth affected were shortened without furcation bone loss, but the roots of the upper teeth affected were elongated without furcation bone loss, only in the periapical lesion (Fig. 5A, 5C-5F, Table 1). In particular, the upper permanent second molar showed taurodontism (Fig. 5A). Case history was also collected. The patient was born prematurely, delivered at 32 weeks with low birth weight. Therefore, she was hospitalised for 4 months. Also, she underwent surgery in general anesthesia of left inguinal hernia on abdominal area 4 months after birth (Table 2).

Similarly to the previous case, conservative endodontic treatment was done on the upper left first permanent molar. The palatal canal was not negotiated due to orifice calcification and there was a pinpoint perforation on the distal canal area. Only the mesiobuccal canal was filled with continuous technique and Endoseal MTA, and perforation was repaired with Endocem MTA (Fig. 2G). The tooth was restored with SSC (Table 2).

One year after treatment, the left upper first molar showed no specific increase of symptoms or periapical lesion or bone resorption involving the furcation (Fig. 5B, 5H). However, the lower MIM-affected teeth with short roots, which did not undergo treatment as they originally had no symptoms and showed no special issues, started showing root resorption (Fig. 5I, 5J). Since the lower second permanent molar had completely

erupted, it was decided that it should be maintained as long as possible, as it did not show any complications.

Discussion

MIM-affected teeth have normal crown but malformed roots with a constricted pulp cavity and abnormal furcation. Diagram in Figure 6 demonstrates the schematic comparison between normal tooth and root elongation version of MIM-affected-tooth, especially on the terms of the morphological feature and position of the abnormal furcation. These teeth frequently present with several complications such as pulp necrosis and severe abscess and may be exposed to the possibility of early loss [Lee et al., 2015]. The distinguishing microscopic feature is a roughly lens-shaped mineralised plate at the level of the cemento-enamel junction, which is called cervical mineralised diaphragm (CMD), which seems to act as a mechanical obstacle interfering with the normal retraction of the odontoblasts [Witt et al., 2014]. So, severe abscess is thought to be caused by the exposure of the pulp with dentin deformity and by the bacterial infection through perforation.

The aetiology of MIM has been thought to involve epigenetic factors that are associated with brain-related systemic diseases such as meningitis, occurring one to two years after birth [Lee et al., 2014]. The causal factors of MIM has also been considered to be medication or hormonal changes associated with a systemic disease [Lee et al., 2014]. Likewise, in our cases, all patients developed a severe systemic disease before the age of one year. In addition, two out of five patients were prematurely

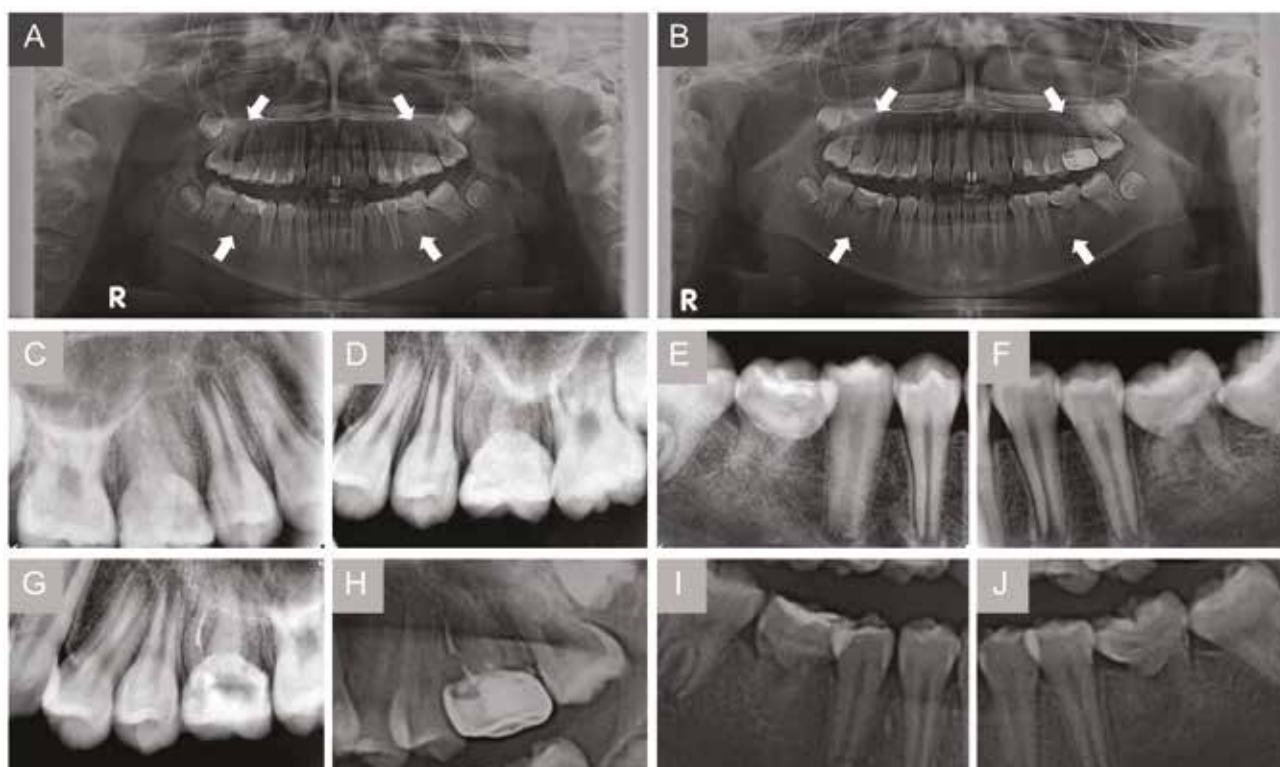


FIG. 5 Treatment and short term follow-up of Case 2.

A. Panoramic obtained at the first visit.

C, D, E and F. Periapical x-rays obtained at the first visit. All the first permanent molars were affected by MIM. The upper second permanent molars on both sides showed taurodontism.

G. Periapical x-ray of upper first permanent molars after the canal filling.

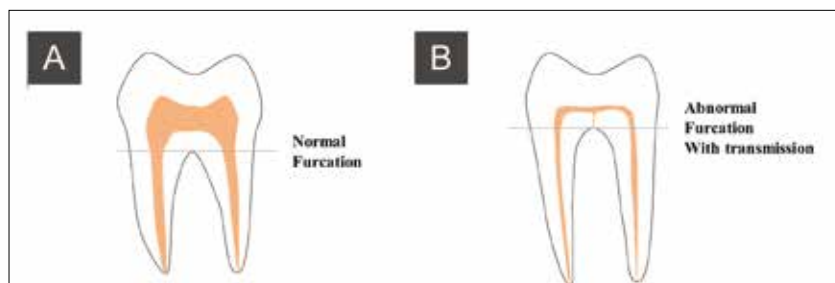
H. 1 year post-treatment. The upper left permanent molar showed no symptom.

B, I and J. 1 year after the observation. Both lower first permanent molars showed root resorption, the upper right first permanent molar was asymptomatic.

FIG. 6 Demonstration the schematic comparison between a normal tooth and a MIM-affected tooth.

A. Normal first permanent molar.

B. Root elongation version of the MIM-affected molar has a constricted pulp, shortened body of tooth with elongated roots and abnormal furcation with transmission.



born. Prematurely born patients have been reported to show delayed tooth formation [Harris et al., 1993]. However, since the roots of the first permanent molar are known to develop at the age of 3, this root malformation rather seems to be associated with some environmental factors the patient had experienced early in childhood [Witt et al., 2014; Luder, 2015; Brusevold et al., 2017]. The mechanism of tooth formation may be affected from various treatments (e.g. antibiotics, radiographic exposure) on craniofacial area, and occurrence of systemic disease, severe operation, or premature delivery is expected to affect tooth formation. In one of our cases, the systemic disease was specifically related to the head and neck area.

When it comes to failure in the tooth formation, MIM is thought to be quite similar to taurodontism, and it shows unique features of malformed roots which are short, tapering roots associated with a slit-shaped pulp cavity and, if visible, an abnormal coronal position of the furcation, namely an inverse taurodontism [Witt et al., 2014]. When it comes to

taurodontism, a genetic defect of WNT10A in humans also causes tooth agenesis and alterations in the shape of the dental crowns [Yang et al., 2015]. However, other than those, no other obvious tooth abnormalities are shown. Thus, the transition from crown to root development, the initial apical growth of Hertwig's epithelial root sheath (HERS), and the induction of dentinogenesis and cementogenesis along the root periphery seem to have progressed almost unaffected. MIM-affected teeth may carry genetic defects in the early initiation stage of odontogenesis as well as in the later stages of crown and root morphogenesis, but not during the hard tissue formation as in taurodontism [Zschocke et al., 2017; Bei, 2009].

Regardless of the aetiology, the clinician should carefully select among the recommended treatment options the one that yields a more favourable prognosis (Fig. 7). When symptoms such as pain, abscess, periapical lesion, and root resorption are present, it is recommended to perform conservative endodontic treatment first. For patients without symptoms, it is

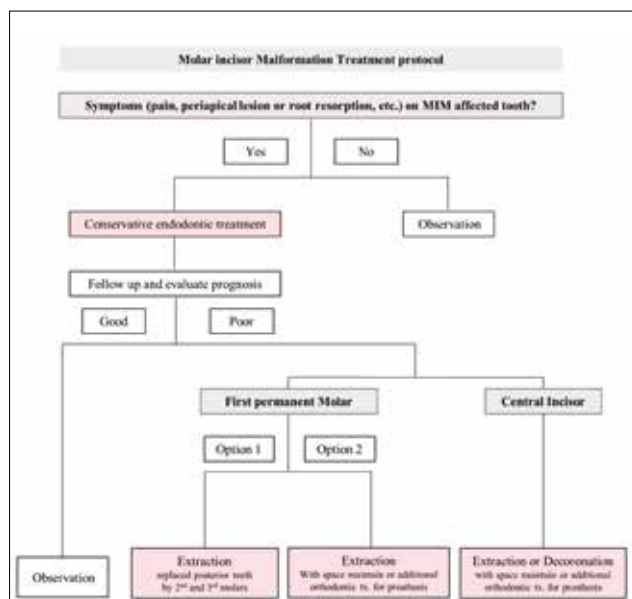


FIG. 7 Recommendation MIM-affected tooth treatment protocol.

recommended to evaluate the symptoms while following-up, but in the cases reported in this paper, the patients showed symptoms around 10 to 11 years of age, which suggests an additional care at this age period. Also, when observing the prognosis of MIM-affected incisors, since the incisor notch area is vulnerable to fracture from any kind of trauma, careful attention should be paid. To evaluate the endodontic treatment prognosis, the presence of periapical lesion, as well as the degree of furcation involvement, bone loss, number and length of the roots, and resorption should all be considered. Consideration for endodontic treatment and prognosis in MIM-affected molars depends vastly on the viability of negotiation in every root canal. However, the root canals of the affected teeth are often almost completely filled up with pulp stones [Witt et al., 2014; Wright et al., 2016; Pavlic et al., 2019]. This makes it hard to negotiate every root canal. If it is difficult to find out all of the canals, as in the case reported in this article, CBCT is recommended (Fig. 4). MTA can be considered for the perforated portion of the root canal and furcation for the sake of good prognosis. MTA has plentiful advantages, including not damaging the tissues and ideally stimulating the deposition of hard tissue, therefore promoting biological sealing. In fact, sealers containing MTA are highly biocompatible and they stimulate mineralisation [Kim et al., 2014].

Extraction is recommended when the prognosis of the affected teeth is poor, such as when the root is short or partially absent, the bone loss progresses to 1/3 of the root apex or the root canal associated with abscess can not be found. The recommended timing for extraction of MIM-affected molars is between 8 to 10 years of age, according to the general guideline for the extraction of the first permanent molar [Cobourne et al., 2014].

Performing the extraction in a timely manner is important. The specific circumstances to consider include eruption of the second premolar, eruption of the second permanent molar and the formation of third permanent molar follicle. If the clinician chooses to extract the MIM affected molar before eruption of the second permanent molar, it is possible to replace the affected tooth with the second permanent molar. If the first permanent molar is extracted early, then the second permanent molar can

erupt mesially. However, if the first permanent molar is extracted too early, formation of the follicle of the third permanent molar can not occur, thus requiring additional prosthetic and orthodontic treatment later. Furthermore, if the extraction is performed too early, the second premolar may be distally tilted or rotated due to the early missing of the first molar, in which case the clinicians should keep an eye on. If the clinician chooses to restore the missing space with prosthesis rather than replacement by the second permanent molar, the space should be maintained as long as possible, while relieving the symptoms by endodontic treatment until second permanent molar eruption. After eruption of the second permanent molar, a space maintainer to maintain the space of the extracted first permanent molar should be placed and patients should go through an appropriate prosthetic treatment after a careful observation of the growth (Fig. 7). In addition, if extraction should be performed, a device for preventing the extrusion of the first molar of the opposite arch will be needed. Long-term follow-ups to the extraction will also be necessary. Moreover, the prognosis of preventive endodontic treatment of MIM-affected teeth should be further investigated.

Conclusion

In conclusion, prior to any complications of the affected tooth, clinicians should evaluate the state of the tooth and predict the prognosis of a conservative endodontic treatment. Early diagnosis and rightly timed treatment with the appropriate method will lead to a favourable prognosis and reduce the need to perform additional orthodontic and prosthetic treatment of MIM-affected teeth.

References

- Bei M. Molecular genetics of tooth development. *Curr Opin Genet Dev* 2009;19:504-510.
- Brusevold IJ, Bie TMG, Baumgartner CS, Das R, Espelid I. Molar incisor malformation in six cases: description and diagnostic protocol. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2017;124:52-61.
- Cobourne MT, Williams A, Harrisonmolar M. National clinical guidelines for the extraction of first permanent molars in children. *Brit Dent J* 2014;217:643-648.
- Harris EF, Barcroft BD, Haydar S, Haydar B. Delayed tooth formation in low birthweight African-American children. *Pediatr Dent* 1993;15:30-35.
- Kim M, Yang W, Kim H, Ko H. Comparison of the Biological Properties of ProRoot MTA, OrthoMTA, and Endocem MTA Cements. *J Endodont* 2014;40:1649-1653.
- Lee HS, Kim SH, Kim SO, Choi BJ, Cho SW, Park W, Song JS. Microscopic analysis of molar-incisor malformation. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2015;119:544-552.
- Lee HS, Kim SH, Kim SO, Lee JH, Choi HJ, Jung HS, Song JS. A new type of dental anomaly: molar-incisor malformation (MIM). *Oral Surg Oral Med Oral Pathol Oral Radiol* 2014;118:101-109 e103.
- Luder HU. Malformations of the tooth root in humans. *Front Physiol* 2015;6:307.
- Pavlic A, Vredl M, Jan J, Bizjak M, Nemec A. Case report of a molar-root incisor malformation in a patient with an autoimmune lymphoproliferative syndrome. *Bmc Oral Health* 2019;19.
- Witt CV, Hirt T, Rutz G, Luder HU. Root malformation associated with a cervical mineralized diaphragm--a distinct form of tooth abnormality? *Oral Surg Oral Med Oral Pathol Oral Radiol* 2014;117:e311-319.
- Wright JT, Curran A, Kim KJ, Yang YM, Nam SH, Shin TJ, Hyun HK, Kim YJ, Lee SH, Kim JW. Molar root-incisor malformation: considerations of diverse developmental and etiologic factors. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2016;121:164-172.
- Yang J, Wang SK, Choi M, Reid BM, Hu YY, Lee YL, Herzog CR, Kim-Berman H, Lee M, Benke PJ, Lloyd KCK, Simmer JP, Hu JCC. Taurodontism, variations in tooth number, and misshapen crowns in Wnt10a null mice and human kindreds. *Mol Genet Genom Med* 2015;3:40-58.
- Yue W, Kim E. Nonsurgical Endodontic Management of a Molar-Incisor Malformation-affected Mandibular First Molar: A Case Report. *J Endod* 2016;42:664-668.
- Zschocke J, Schossig A, Bosshardt DD, Karall D, Glueckert R, Kapferer-Seebacher I. Variable expressivity of TCTEX1D2 mutations and a possible pathogenic link of molar-incisor malformation to ciliary dysfunction. *Arch Oral Biol* 2017;80:222-228.