Journal of Dental Sciences 19 (2024) 1174–1181

Available online at www.sciencedirect.com

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journal homepage: www.e-jds.com

Original Article

Risk factors and treatments for impacted permanent second molars

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Received 27 November 2023; accepted 28 November 2023
Available online 3 December 2023

KEYWORDS
Impacted permanent second molar;
Surgical exposure;
Orthodontic traction;
Mini-screw;
Inherent tooth eruption potential

Abstract *Background/purpose:* Impaction of permanent second molar (PM2) is found occasionally. This study tried to explore the risk factors associated with the impacted PM2 teeth and show how to use different treatment modalities to correct the impaction of PM2 teeth.
Materials and methods: This study used three cases of PM2 impaction to show how to identify the risk factors of PM2 impaction and how to remove these risk factors to facilitate the eruption of impacted PM2 teeth to the correct occlusal positions.
Results: The first and second cases both showed delayed eruptions of two maxillary PM2 teeth. After resection of the dense fibrotic gingival tissues on the tooth eruption pathway, these two impacted maxillary PM2 teeth finally erupted to the normal occlusal positions by their inherent tooth eruption potential. The second case also had mesioangular impaction of two mandibular PM2 teeth. After odontectomy of teeth 38 and 48, the two impacted mandibular PM2 teeth also erupted to the normal occlusal positions by their inherent tooth eruption potential. The third case had impaction of teeth 17, 27 and 47. After extraction of four third molars and four selected premolars, orthodontic mesialization of four permanent first molars, and orthodontic traction using a mini-screw, the three impacted teeth finally erupted to the normal occlusal positions.
Conclusion: We conclude that after removing the obstacles on the tooth eruption pathway, the impacted PM2 teeth usually can erupt to their normal occlusal positions by their inherent tooth eruption potential with or without the assistance of orthodontic traction.

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https://doi.org/10.1016/j.jds.2023.11.023

Introduction

Teeth normally erupt when two-thirds to three-fourths of their estimated final root length has developed. An impacted permanent tooth is defined as a permanent tooth whose root development is more than three-fourths of the final root length but whose spontaneous eruption is not expected in a reasonable time.[1]

Clinically, the permanent second molar (PM2) impaction, either the maxillary or the mandibular PM2, is seen occasionally in the orthodontic clinic. The prevalence of PM2 impaction may be low, although it has not yet been investigated in general population. The PM2 impaction is not disfiguring as the incisor or canine impaction. Although the PM2 impaction shows tooth missing in the oral cavity, it does not attract much attention by the inexperienced dentists and parents. On top of that, the diagnosis of PM2 impaction is only made by the dentist using mainly the periapical and panoramic radiographies. It is possible not revealed by the patient long after the due time of tooth eruption.

By the time of 12 years of age, if the patient's PM2 does not erupt into the oral cavity, the panoramic radiography is necessarily used to clarify the tooth germ's location. The possible reasons of the PM2 impaction include primary displacement of tooth buds, space insufficiency, local obstruction anomaly (such as gingival fibrosis), trauma, and local pathology of periodontal origin.[1−6] Of the 5 possible reasons of the PM2 impaction, the space insufficiency and local obstruction anomaly are the two most commonly-seen reasons for the PM2 impaction. Moreover, the disturbances from the adjacent third molar may be the possible reason for the PM2 impaction in some cases.[2,3]

The key to decide whether the tooth impaction has occurred is not judged by the chronologic age of the patient but by the dental age of the impacted tooth. If the developing teeth are discovered in advanced root development stage, i.e., more than three-fourths of the final root length, from the radiographies, their spontaneous eruptions are questionable.[1]

In this study, we used a series of three cases of the PM2 impaction to show how to identify the risk factors associated with the impacted PM2 teeth and how to remove these risk factors to facilitate the eruption of the impacted PM2 teeth to the proper occlusal positions in the dental arch. These cases might also have some other dental problems that were not associated with the PM2 impaction. However, these dental problems were also solved by other appropriate treatments concomitantly.

Materials and methods

The study group consisted of 3 cases of maxillary and/or mandibular PM2 impactions retrieved from the files of our treated patients' data from January 2000 to October 2023. All the 3 cases were diagnosed as having maxillary and/or mandibular PM2 impactions after examination of patients' periapical and panoramic radiographs. Those maxillary or mandibular PM2 teeth that had the advanced root development of more than two-thirds of the estimated root length, but the crowns of the PM2 teeth did not erupt out of the overlying gingiva, were diagnosed as having the PM2 impaction.

The patients' data on the age and gender of the patients, impacted PM2 teeth condition, the risk factors or obstacles impeding the eruption of the impacted PM2 teeth, the treatments for removing the obstacles from the eruption pathway of the PM2 teeth, the need of orthodontic traction to facilitate the eruption of the PM2 teeth, and the related risk factors from other teeth that might influence the eruption of the impacted PM2 teeth were obtained by reviewing the dental charts and the associated periapical and panoramic radiographs. The other teeth conditions or anomalies occurring concomitantly with the maxillary or mandibular PM2 impactions were also recorded and analyzed.

Results

The maxillary or mandibular PM2 teeth impactions could be managed by the following procedures, including the diagnosis of maxillary or mandibular PM2 teeth impactions by the examinations of the periapical and panoramic radiographs, the removal of the tooth eruption obstacles (such as dense fibrotic gingival tissues overlying the crowns of the impacted PM2 teeth or the third molars with mesioangular or horizontal impaction) on the eruption pathway of the impacted PM2 teeth, and traction of the impacted PM2 teeth by the orthodontic force using either a mini-screw or other teeth as the anchorage.[7−11]

This study used three therapy-finished cases of the impacted PM2 teeth to elucidate the whole treatment procedures of moving the impacted PM2 from the beginning impacted position to the final fully-erupted position with normal occlusion. The first case was a female patient (14 years and 3 months of age) with delayed eruptions of both maxillary PM2 teeth. She came and sought for orthodontic treatment for the mandible deviation, anterior crossbite, and crowding of teeth (Fig. 1A and B). The panoramic radiography showed delayed eruptions of both maxillary PM2 teeth. The roots of both maxillary PM2 teeth were in the advanced root development stage, and their crowns were situated high in the alveolar ridge. A thin layer of alveolar bone was discovered on the distal occlusal surface of both maxillary PM2 teeth (Fig. 1C). The maxillary alveolar ridge seemed to have enough space for the eruption of both maxillary PM2 teeth (Fig. 1C). Clinical examination revealed a dense fibrotic gingival tissue of approximately 4 mm in thickness overlying the crowns of impacted teeth

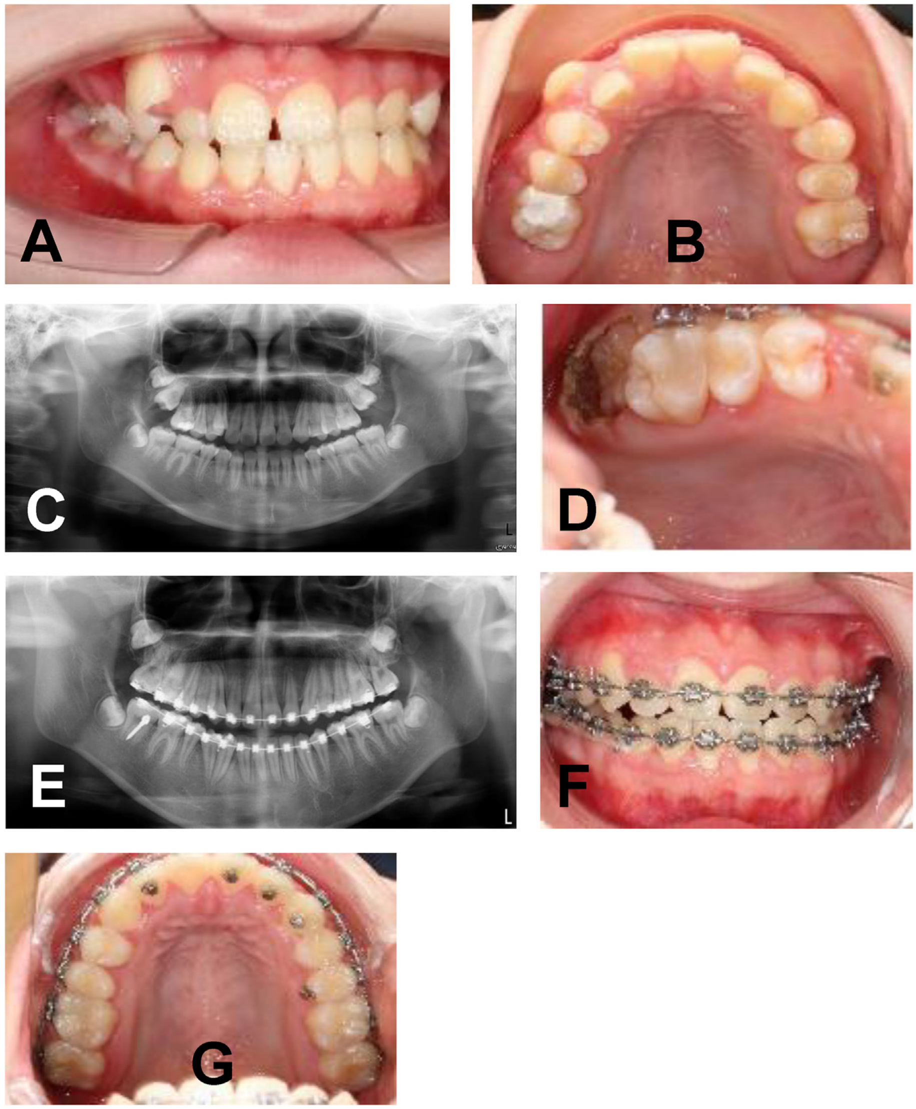

Fig. 1 Clinical and radiographic photographs of the first case. (A and B) Clinical photographs revealing the mandible deviation, anterior crossbite, crowding of teeth, the absence of teeth 17 and 27 in the oral cavity, and dense fibrotic gingival tissues overlying the crowns of impacted teeth 17 and 27. (C) The panoramic radiography showed the delayed eruptions of both maxillary permanent second molars (PM2) teeth. The root of both maxillary PM2 teeth was in the advanced root development stage, and their crowns were situated high in the alveolar ridge. A thin layer of alveolar bone was discovered on the distal occlusal surface of impacted teeth 17 and 27. (D) Surgical exposure of the crown of impacted tooth 17 was performed. (E) Panoramic radiograph exhibiting eruption of teeth 17 and 27 to the normal occlusal positions by the inherent tooth eruption potential without orthodontic traction after waiting for 7 months. (F and G) The orthodontic treatment was further performed for correcting the mal-alignment of full-mouth teeth.

17 and 27 (Fig. 1B). Therefore, the dense fibrotic gingival tissues overlying the crowns of impacted teeth 17 and 27 together with the thin layer of alveolar bone on the distal occlusal surface of impacted teeth 17 and 27 were resected (Fig. 1D). After 7 months of waiting, the impacted teeth 17 and 27 finally erupted to the normal occlusal positions by the inherent tooth eruption potential without orthodontic traction (Fig. 1E). In addition, the orthodontic treatment was performed for correction of mal-alignment of full-mouth teeth (Fig. 1F and G).

The second case was a male patient (12 years and 4 months of age) with delayed eruptions of the four PM2 teeth. He initially came for the regular dental checkup. Since he was in the late mixed dentition stage, all the remaining deciduous teeth were extracted and then he was advised to wait for further eruptions of the unerupted teeth (Fig. 2A). When he was 13 years and 10 months of age, he came for the regular follow-up. Clinical examination showed that all four PM2 teeth were absent in the oral cavity and both maxillary PM2 teeth were covered by the dense fibrotic gingival tissues (Fig. 2B and C). The second panoramic radiography revealed that both maxillary PM2 teeth with the advanced root development of more than three-fourths of the estimated root length and vertical

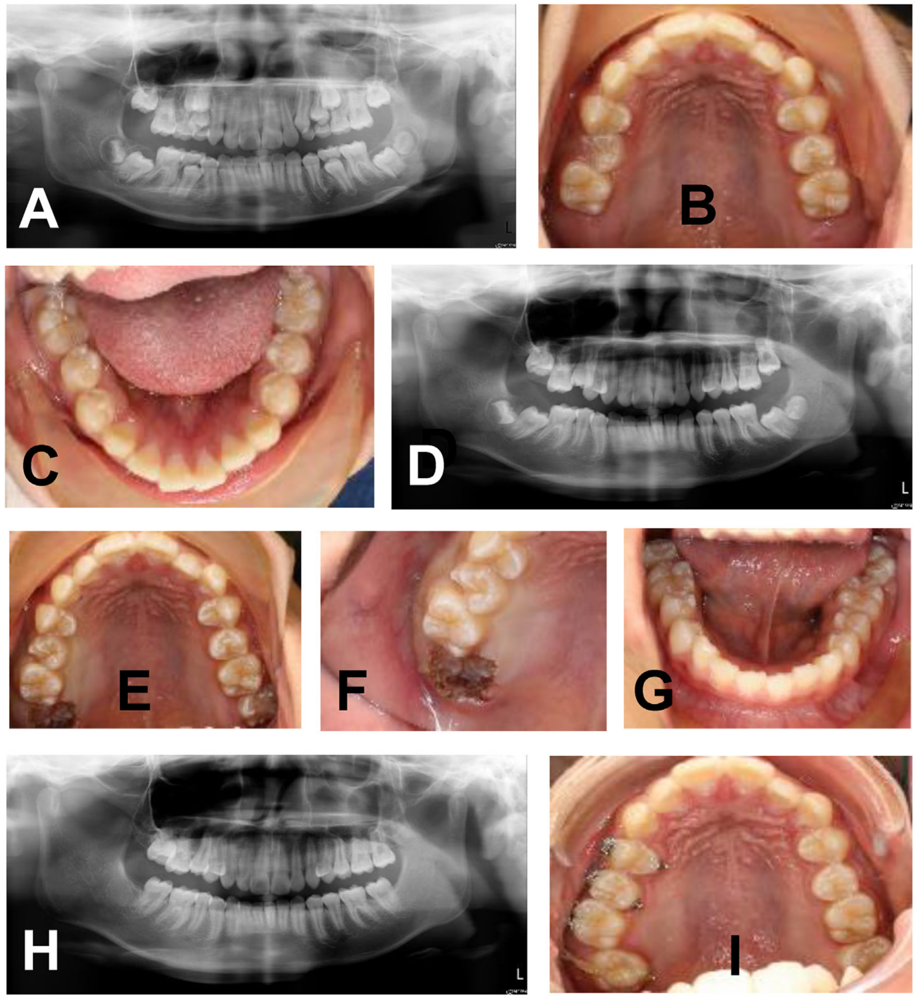

Fig. 2 Clinical and radiographic photographs of the second case. (A) Panoramic radiograph showing that the patient was in the mixed dentition stage when he was 12 years and 4 months of age. (B and C) Clinical examination showed that all four permanent second molars (PM2) teeth were absent in the oral cavity and both maxillary PM2 teeth were covered by the dense fibrotic gingival tissues. (D) The second panoramic radiograph revealing both maxillary PM2 teeth with the advanced root development of more than three-fourths of the estimated root length and vertical impaction of tooth 15. Both impacted mandibular PM2 teeth tilted mesially under the crowns of the right and left mandibular first molars. Moreover, the developing crowns of the right and left mandibular third molars seemed to compress on the root portions of the two impacted mandibular PM2 teeth when the patient was 13 years and 10 months of age. (E, F, G and H) After resection of the dense fibrotic gingival tissues overlying the crowns of the impacted teeth 17 and 27, it was found that tooth 17 erupted palatally because of insufficient buccal bone width of the alveolar ridge, but the tooth 27 erupted to the nearly normal occlusal position. Moreover, the teeth 37 and 47 erupted to the normal occlusal positions after odontectomies of adjacent teeth 38 and 48 were performed. (I) Clinical photograph exhibiting local orthodontic traction of the palatally-positioned tooth 17 to the correct occlusal position.

impaction of tooth 15 (Fig. 2D). Both impacted mandibular PM2 teeth tilted mesially under the crowns of the right and left mandibular first molars. Moreover, the developing crowns of the right and left mandibular third molars seemed to compress on the root portions of the two impacted mandibular PM2 teeth (Fig. 2D). Therefore, the clinical diagnoses were described as follows: 1) vertical impaction of tooth 15 due to its rotation and space insufficiency; 2) non-eruption or impaction of both maxillary PM2 teeth due to the local obstruction by the overlying dense fibrotic gingival tissues; and 3) mesioangular impaction of both mandibular PM2 teeth due to wrong eruption direction and compression on the root portion of both mandibular PM2 teeth by the right and left mandibular third molars. After discussing with the patient and his parents, the patient was advised to receive resection of the dense fibrotic gingival tissues overlying the crowns of impacted teeth 17 and 27 (Fig. 2E and F). He was also referred to an oral and maxillofacial surgeon for odontectomy of fully embedded teeth 38 and 48 (Fig. 2G). After the necessary oral surgeries were performed, it was found that the eruption path of tooth 17 tilted mesially and palatally (Fig. 2E and F) because of inadequate ridge bone width on its buccal side. A follow-up visit was further arranged to see the subsequent eruptions of the four PM2 teeth. One year and 2 months later, a new panoramic radiograph was taken when the patient was 15 years of age (Fig. 2H). All four PM2 teeth had erupted to the normal occlusal positions by their inherent potential of tooth eruption after the associated obstacles were removed from the eruption pathway (Fig. 2H). Because the tooth 17 demonstrated palatal crossbite, a local orthodontic treatment was initiated to tract the tooth to the correct occlusal position (Fig. 2I).

The third case was a male patient (8 years of age) who came and asked for treatment of an ugly left maxillary central incisor. The periapical and panoramic radiographies revealed a mesiodens which occupied the space of tooth 21 and thus was mistaken as an ugly maxillary central incisor (Fig. 3A and B). Moreover, the first panoramic radiography showed that the development of teeth 37 and 47 had reached the crown 3/4 stage (Fig. 3B). The mesiodens was extracted and the surgical exposure of tooth 21 was performed several months later to facilitate the eruption of tooth 21. When the patient was 13 years and 5 months of age, the follow-up second panoramic radiograph was taken and exhibited non-eruption of teeth 17 and 27, while the root formation of teeth 17 and 27 was in the advanced stage of more than three-fourths of the estimated root length (Fig. 3C). The eruption direction of teeth 17 and 27 tilted distally. In addition, horizontal impaction of tooth 47 was discovered and the tooth germ of tooth 48 was located at the top of the root of tooth 47. However, the tooth 37 had already erupted (Fig. 3C). The patient also asked for orthodontic treatment to correct the protrusion of maxillary central incisors and crowding of the mandibular anterior teeth (Fig. 3D and E). We suggest that the non-eruption of teeth 17 and 27 could be due to the insufficient length of the posterior region of the maxillary alveolar bone. Moreover, the tooth germs of adjacent maxillary third molars might also hinder the uprighting of teeth 17 and 27 (Fig. 3C). In addition, the horizontal impaction of the tooth 47 could be caused by space insufficiency, tooth crowding, and the compression of tooth 47 by the adjacent tooth germ of tooth 48 (Fig. 3C). For creating an adequate environment for eruptions of impacted teeth 17, 27, and 47, the odontectomies of all four third molars were performed under general anesthesia. Furthermore, extractions of four selected premolars, one in each quadrant, were done to treat Class II malocclusion and provide enough alveolar bone spaces for the eruptions of teeth 17, 27, and 47. Moreover, orthodontic treatment to mesialize teeth 16, 26 and 46 was planned to gain enough alveolar bone spaces for the eruption of impacted teeth 17, 27, and 47, respectively. A mini-screw was inserted into the ascending ramus of the right mandible to aid the uprighting of tooth 47 eleven months after the odontectomy of tooth 48 was performed (Fig. 3F). A hook was bonded on the distal crown surface of tooth 47 to connect the power chain to the mini-screw, and then levelling with wires. The tooth 47 was completely uprighted after 8 months of orthodontic traction (Fig. 3G). However, the teeth 17 and 27 still had infraocclusion, and thus the orthodontic traction was conducted to pull the teeth 17 and 27 to the occlusal contact positions (Fig. 3F, G and H). Furthermore, mesialization of all the four first molars was done intentionally to create enough alveolar bone space for the eruption of the teeth 17, 27 and 47 (Fig. 3H, I, J and K).

Discussion

It is very interesting to know what forces or factors may cause tooth eruption. The tooth eruption is a complex biological process influenced by various genetic, hormonal, and mechanical factors.[12–15] The tooth root growth is probably the major factor leading to the tooth eruption.[12] It is well known that the tooth begins to erupt when the root development is more than two-thirds of the final root length. As the tooth root continues to grow, they exert pressure on the surrounding bone, causing the tooth to erupt through the overlying alveolar bone and gingival tissue. Actually, the tooth eruption involves a complicated process of connective tissue and alveolar bone remodeling.[12] The reduced enamel epithelium can secrete proteases to help in the breakdown of connective tissue to produce a path of least resistance, the cells in the coronal portion of the dental follicle produce colony-stimulating factor 1 that promotes the differentiation of monocytes into osteoclasts, and the osteoclasts break down the alveolar bone tissue in the path of the erupting tooth.[12–14] Moreover, the cells in the basal portion of the dental follicle produce the transcription factor Runx-2 that promotes the osteoblast differentiation and function, and subsequently the osteoblasts deposit new bone to accommodate the tooth's movement.[12–14] It has also been reported that the fibroblasts in the newly-formed periodontal ligament have traction power to facilitate the tooth eruption.[12]

Genetic factors play a significant role in determining the timing and sequence of tooth eruption. These genetic factors can also affect the size and shape of the teeth and the jawbone, which in turn can influence the tooth eruption.[12,15] The hormonal factors can also influence tooth eruption. For example, the growth and thyroid hormones play a role in regulating the overall bone growth and development of the jaw and dental arch. The excessive growth and thyroid hormones accelerate the tooth eruption and the insufficient growth and thyroid hormones delay the tooth eruption.[15] The adjacent teeth can affect the tooth eruption process.[2,3] If there is insufficient alveolar bone space due to overcrowding, it can impede the normal eruption of teeth. The adjacent teeth can also act as guides, helping the erupting tooth move to its correct position in the dental arch. This is especially important in the case of permanent teeth replacing primary teeth.[12] The surrounding soft tissue pressure, such as the tongue and lip pressure, can act on the erupting teeth, assisting in guiding them to the proper alignment during tooth eruption. Finally, the proper nutrition and overall health can also influence the tooth development and eruption. Malnutrition and certain medical conditions may disrupt the tooth eruption process.[15]

Although the teeth have the inherent potential to facilitate their eruption, sometimes the dense and fibrotic gingival tissue, mal-aligned adjacent teeth, and insufficient dental arch length may impede the normal tooth eruption.[2–6] After removing these obstacles on the tooth eruption pathway, the teeth may move to their correct positions in the dental arch.[7–10] In this study, we proposed three cases of impactions of the PM2 teeth, illustrated how

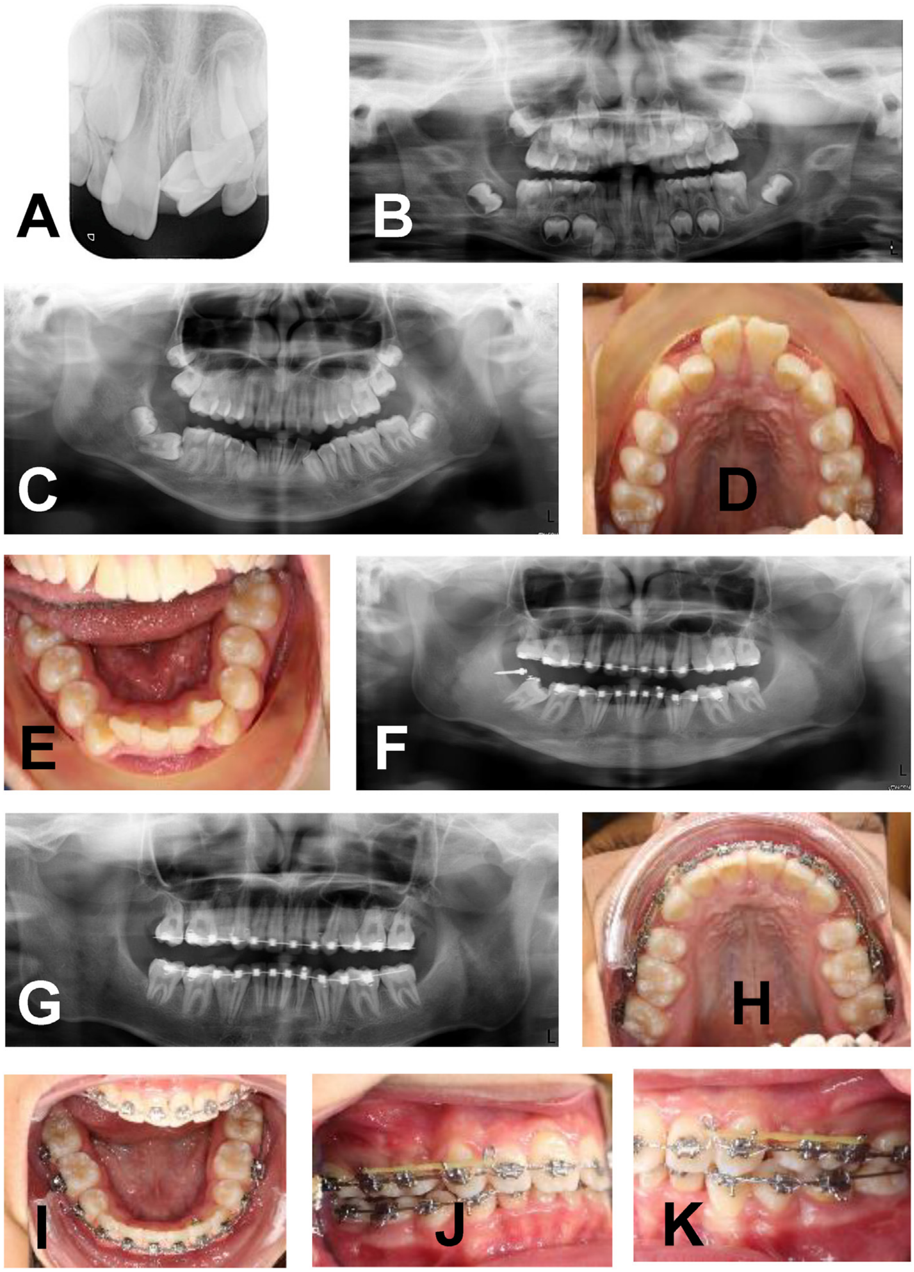

Fig. 3 Clinical and radiographic photographs of the third case. (A and B) Radiographic photographs showing a mesiodens at the alveolar bone of tooth 21 position when he was 8 years of age. Surgical exposure of the impacted tooth 21 was performed to facilitate its eruption. (C) The follow-up second panoramic radiograph exhibiting non-eruption of teeth 17 and 27, while the root formation of teeth 17 and 27 was in the advanced stage of more than three-fourths of the estimated root length. The eruption direction of teeth 17 and 27 tilted distally. In addition, the horizontal impaction of tooth 47 was discovered and the tooth germ of tooth 48 was located at the top of the root of tooth 47. However, the tooth 37 had already erupted when the patient was 13 years and 5 months of age. (D and E) Clinical photographs showing the protrusion of maxillary central incisors and crowding of the mandibular anterior teeth. (F) Odontectomy of the four third molars were performed. A mini-screw was inserted into the ascending ramus of the right mandible to facilitate the uprighting of tooth 47 with mesioangular impaction. (G and H) The teeth 17 and 27 still had infraocclusion when the patient was 14 years and 7 months of age, and thus the orthodontic traction was conducted to pull the teeth 17 and 27 to the occlusal contact positions. (G, H, I, J and K) Radiographic and clinical photographs exhibiting that the four permanent second molars were moved to normal occlusal positions in the dental arches by the help of orthodontic treatment when the patient was 15 years and 2 months of age.

to diagnose and treat these different kinds of the PM2 impactions, and finally guided the impacted PM2 teeth to their proper positions in the dental arch.

The first case in this study showed impactions of both the right and left maxillary PM2 teeth. The reason of impaction of the two maxillary PM2 teeth seemed to be due to the local obstruction by the dense and fibrotic gingival tissues overlying the crowns of the two impacted maxillary PM2 teeth. In this situation, surgical exposure was advised when the root formation was found to be over 2/3 of final tooth length but no sign of tooth emergence was discovered. The patient ignored of the presence of impactions of both the right and left maxillary PM2 teeth because she only cared about the teeth crowding, anterior crossbite, and the mandibular deviation. Removal of the obstruction factors in time subsequently allowed the two impacted maxillary PM2 teeth to exhibit their inherent potential of tooth eruption. Finally, both the two impacted maxillary PM2 teeth erupted to correct occlusal positions without the help of any orthodontic traction (Fig. 1).

In the second case, the four PM2 teeth were not discovered in the oral cavity, when the patient was 13 years and 10 months of age. The clinical examination and the second panoramic radiography revealed that the two maxillary PM2 teeth were covered by the dense fibrotic gingival tissues and the two mandibular PM2 teeth showed mesioangular impaction with their root portions being compressed by the crowns of the right and left mandibular third molars. Therefore, the dense fibrotic gingival tissues were excised and the two impacted mandibular third molars were extracted. When the patient was 15 years of age, all the four impacted PM2 teeth had erupted to the correct occlusal positions by their inherent potential of tooth eruption. However, the tooth 17 demonstrated palatal crossbite, and this condition needed the subsequent local orthodontic treatment to tract the tooth 17 to the normal occlusal position.

In the third case, the patient had impaction of tooth 21 when he was a child. The impactions of teeth 17, 27, and 47 were discovered in the adolescence. Since he had tooth crowding and insufficient alveolar bone spaces at the molar region, odontectomies of all four third molars followed by extractions of four selected bicuspids (one in each quadrant) were performed. The horizontal impaction of tooth 47 was diagnosed, when the adjacent tooth 48 only reached its crown formation stage. The odontectomy of tooth 48 situated in the ascending ramus was a complicated operation to perform for an adolescent, mainly because the patient might have psychological stress during the whole procedure of odontectomy of tooth 48. Because all four third molars should be extracted in a short period of time, performing odontectomy under general anesthesia was advantageous for the patient in many respects such as less bleeding and less stress for the patient.

Several hypotheses have been proposed regarding the etiologies of impaction of PM2 teeth. It has been suggested that midline deviation towards the affected side is a contributing factor to the impaction of PM2 teeth,[6] but this was not the case in our case 3. In case 3, the patient experienced horizontal impaction of tooth 47, but the mandibular dental midline shifted to the left, which was the opposite side of the impacted right mandibular PM2 tooth. Furthermore, the results of the study of Shapira et al.[4] indicated that a deficient mesial root length of the mandibular PM2 teeth is the primary factor leading to the mandibular PM2 impaction. However, this also did not apply to our case 3. In fact, the patient in case 3 had an impacted right mandibular PM2 tooth with its mesial root being slightly longer than its distal root (Fig. 3G).

It's important to note that the timing and sequence of tooth eruption can vary among individuals. Some people may experience delayed or accelerated tooth eruption, while others may have teeth that erupt in a different order.[12] In cases of impaction of the PM2 teeth, various treatment approaches are necessary to overcome the PM2 impaction. These treatment modalities include surgical-orthodontic uprighting, surgical uprighting, and surgical repositioning.[7–11] In this study, three cases of impaction of the PM2 teeth were presented to illustrate the appropriate timing for diagnosis, the treatment modalities for clearing obstacles from the tooth eruption pathway, and the utilization of the inherent tooth eruption potential to facilitate the eruption of impacted PM2 teeth. In situations that the impacted PM2 teeth do not exhibit self-eruption, orthodontic traction using either other teeth or a mini-screw as the anchorage is initiated at the appropriate time to move the impacted PM2 teeth to the correct occlusal positions in the dental arch.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

Acknowledgments

None.

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