Case Report

Combined orthodontic-surgical management of a transmigrated mandibular canine

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ABSTRACT

The presence of an impacted mandibular canine is one of the most difficult challenges that an orthodontist will meet. Orthodontic treatment is planned on an individual basis after thoroughly considering the patient's overall facial and dentoskeletal characteristics; the duration, risks, and costs of treatment; patient preferences; and the orthodontist's experience. This article reports an orthodontic treatment of a boy, age 12.9 years, with an impacted mandibular canine in the permanent dentition that was successfully managed. Radiographic analysis indicated a transmigration of the mandibular right canine. The orthodontic treatment plan included extraction of the deciduous right canine followed by surgical exposure and ligation of the permanent canine. Eruption was properly guided, and the correct position of the tooth was achieved. This challenging treatment approach is described in detail, including the mechanics used to align the impacted canine. (*Angle Orthod.* 2016;86:681–691.)

KEY WORDS: Transmigration; Canine; Mandible; Impaction

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Accepted: September 2015. Submitted: May 2015.
Published Online: October 26, 2015

INTRODUCTION

The prevalence of impacted mandibular canines varies from 0.05% to 0.4%, which is less frequent than impaction of maxillary canines, ranging from 0.9% to 2.2%.[1,2] An impacted tooth occasionally migrates away from the site in which it develops but usually remains within the same side of the arch.[3] When migration of an impacted tooth crosses the midline, the phenomenon is called transmigration.[4] Transmigration is rare, and the canine is the only tooth that can migrate from either maxillary semiarch across the midline to the opposite side.[5] The literature provides little data about transmigrations of lateral incisors or premolars.[6]

Several factors are thought to be involved in transmigration, such as premature loss of deciduous teeth, retention of the deciduous canine, odontomas, crowding, supernumerary teeth, and excessive crown length of the mandibular canine. However, the etiology and exact mechanism are still unclear.[7,8]

Patients with canine transmigration are also often characterized by mandibular lateral incisor hypodontia or second premolar hypodontia, enamel developmental defects, reduced number of teeth, or impacted maxillary canines.[9]

The mandibular left canine is affected more often than the right and migrates more in females than in

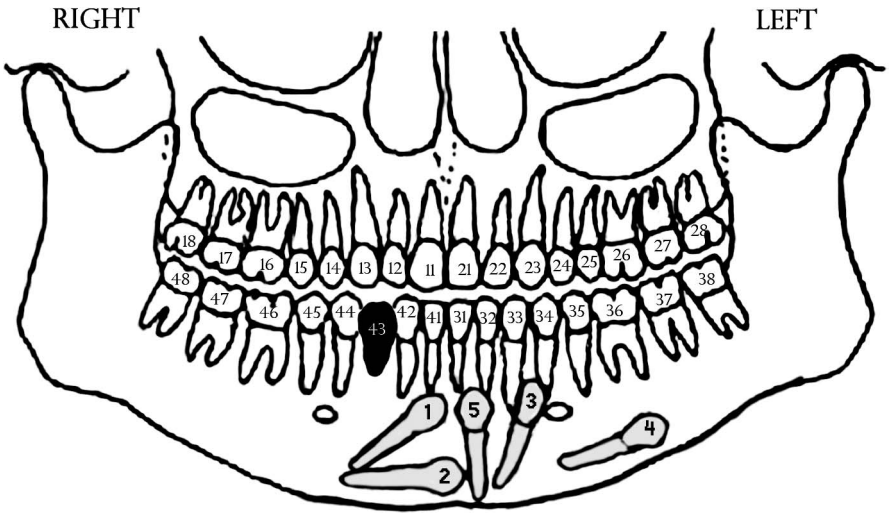

Figure 1. Diagrammatic representation of the five distinct patterns of transmigration (types 1–5). Retained deciduous tooth (tooth #83) is also represented. Type 1: Canine positioned mesioangularly across the midline within the jaw bone, labial or lingual to anterior teeth, and the crown portion of the tooth crossing the midline. Type 2: Canine horizontally impacted near the inferior border of the mandible below the incisor apices. Type 3: Canine erupting either mesial or distal to the opposite canine. Type 4: Canine horizontally impacted near the inferior border of the mandible below the apices of either premolars or molars on the opposite side. Type 5: Canine positioned vertically in the midline (the long axis of the tooth crossing the midline) irrespective of eruption status.

males (1.6:1 ratio). Unilateral migration is more common than bilateral migration. Bilateral migration of mandibular canines may occur in spite of having adequate space for eruption.[10]

Transmigrating teeth can cause root resorption, tipping, and sensitivity of adjacent teeth[11] and pain or discomfort for the patient. The side effects are related to the severity of the transmigration.

According to Mupparapu's classification,[12] there are five types of transmigrated mandibular canine (Figure 1), with type 1 being most frequent. Thus, early diagnosis and assessment of the extent of canine transmigration are crucial for the prevention of impaction, and they could reduce related complications in both esthetics and function.[13] Conversely, failure to diagnose, manage, or properly treat impacted canines can lead to external resorption of adjacent teeth (especially the lateral incisors), esthetic problems, misalignment of neighboring teeth, shortened dental arches, and increased follicular cyst formation and recurrent infections,[14,15] resulting in irreversible damage that may eventually cause tooth loss.[16,17]

In this article, we describe an unusual clinical case wherein a transmigrated mandibular canine (TMC) was diagnosed in a 12.9-year-old patient and treated with a combined orthodontic-surgical approach. This likely prevented the side effects of transmigration and allowed correct canine repositioning in the dental arch.

DIAGNOSIS AND ETIOLOGY

The patient was a 12.9-year-old boy having a Class II division 1 dental relationship of the permanent dentition with a 6-mm overjet, slight mandibular midline deviation, and mild crowding in both arches. The maxillary arch was slightly constricted with no crossbite. All mandibular teeth were erupted except the right canine and third molars, whereas the right deciduous mandibular canine was still present (Figures 2 and 3).

Lateral cephalometric evaluation[18] showed a Class II skeletal malocclusion (ANB, 5°), mesiofacial pattern (SN/GoMe, 31°), and proclined maxillary (1/SN, 110°) and mandibular incisors (IMPA, 110°). The facial profile was slightly convex.

The panoramic radiograph showed an impacted right TMC, positioned mesioangularly across the midline, labial to the anterior teeth, with the crown portion between the roots of the left incisors (Figure 4), consistent with type 1 of Mupparapu's classification (Figure 1).

The patient's medical and dental histories were unremarkable, with no trauma to the deciduous teeth, no previous orthodontic treatment, and no familial occurrences reported.

Treatment Objectives

The treatment objectives for this patient were to (1) guide the impacted right TMC into the arch, (2) achieve a bilateral Class I canine and molar relationship, (3) reduce the increased overjet, (4) solve the mild crowding, and (5) correct the midline deviation.

Treatment Alternatives

Before starting treatment, we considered the following treatment options:

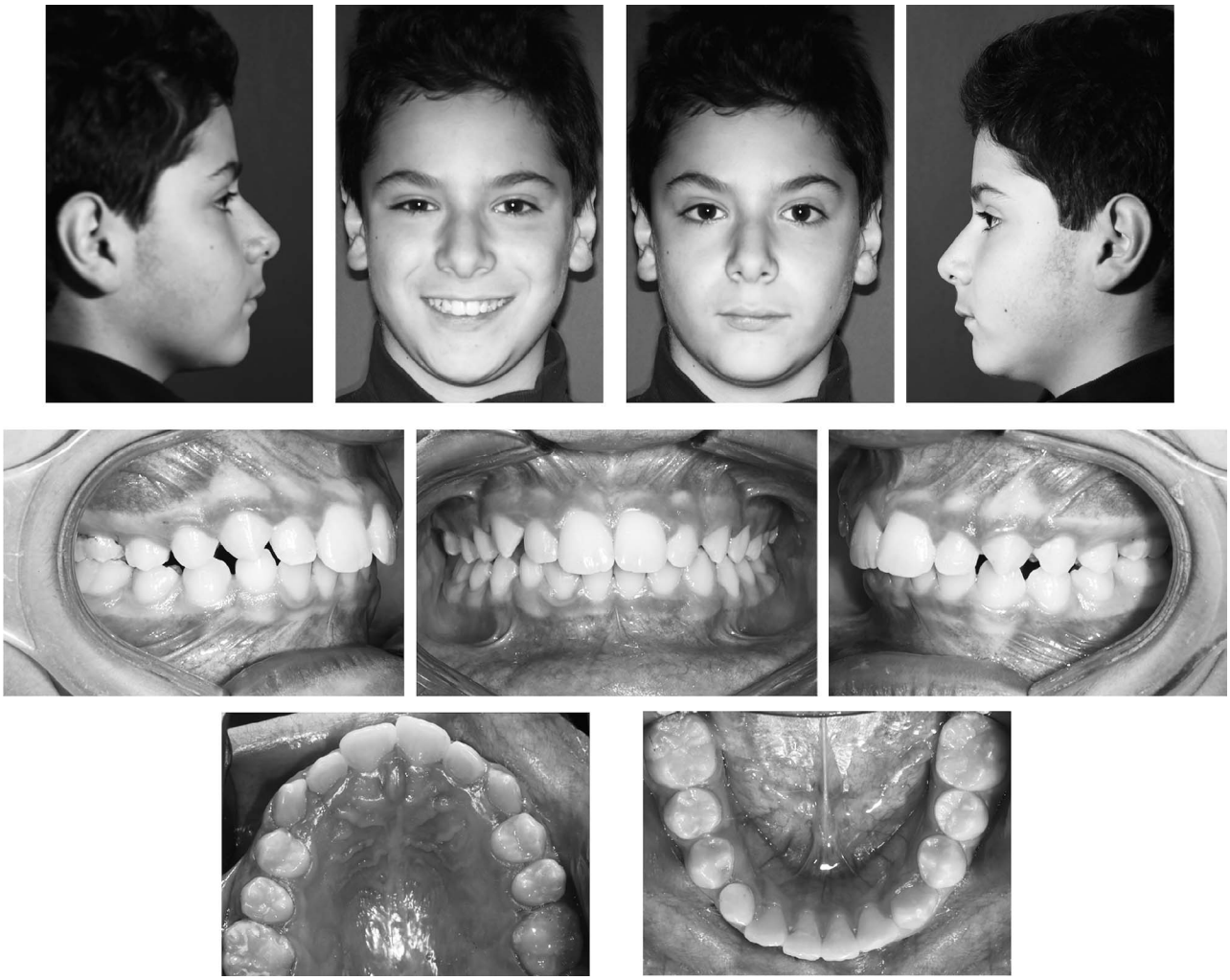

Figure 2. Pretreatment facial and intraoral photographs.

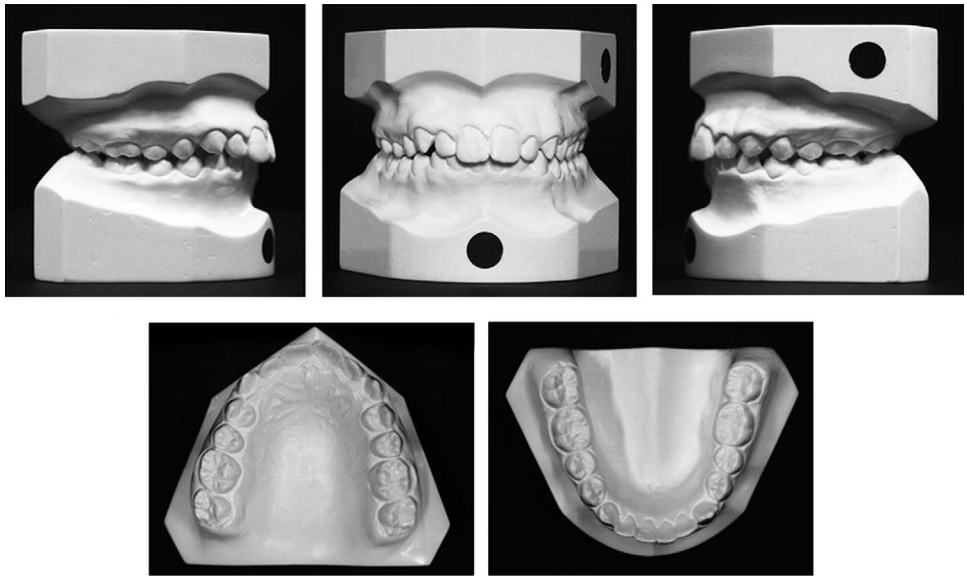

Figure 3. Pretreatment dental cast photographs.

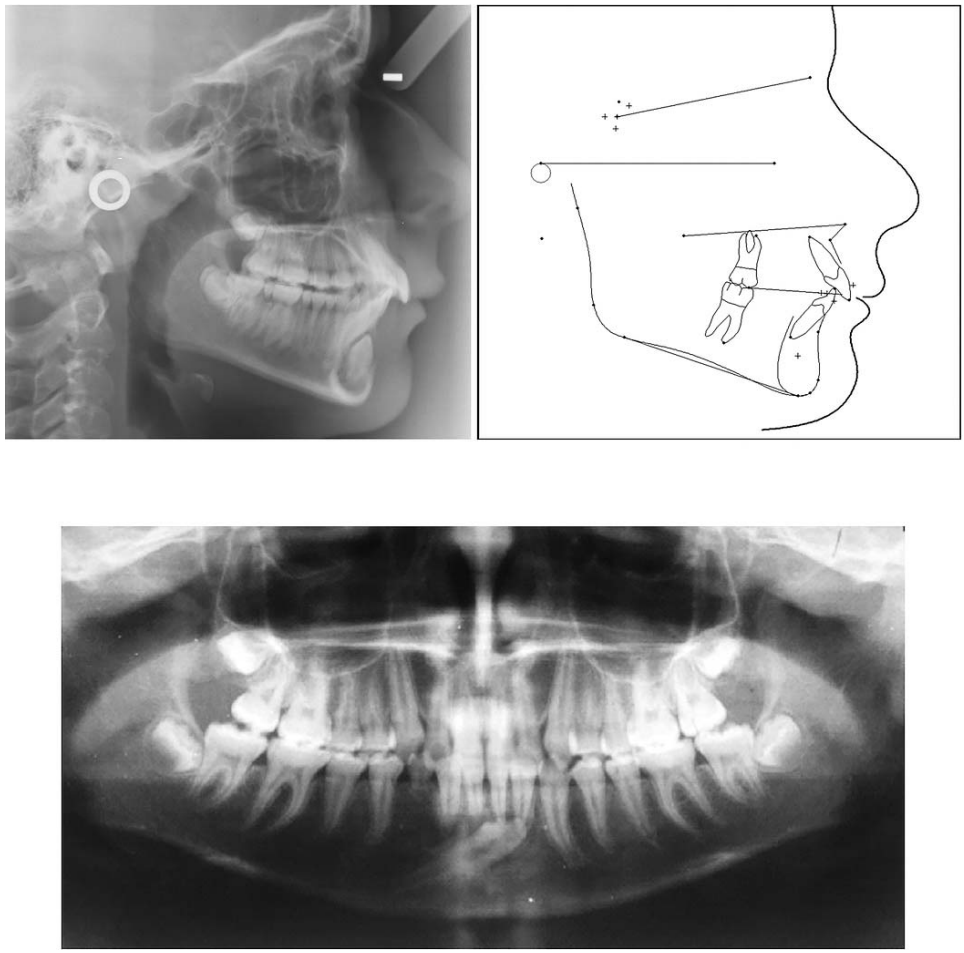

Figure 4. Pretreatment lateral cephalometric radiograph with tracing; the panoramic radiograph showed an impacted transmigrated mandibular right canine, positioned mesioangularly across the midline, labial to the anterior teeth, with the crown portion between the roots of the left incisors.

1. No treatment. The deciduous canine was esthetically acceptable and could be left. Nevertheless, the tooth did not have good root length so its longevity was limited. It would thus be monitored and restored, when necessary, with a fixed prosthesis or an implant or transplantation after extraction of the impacted right TMC. However, early removal of the impacted canine is probably better with a view to preventing resorption and other side effects.
2. Minimal treatment. Extract the impacted TMC and achieve space closure through mesial movement of the first premolar, creating a Class III relationship on the right side.
3. Treatment with premolar extractions. Extract the maxillary first and mandibular second premolars as the Class II division I dental relationship, 6-mm overjet, mild crowding in both arches, and proclined maxillary (1/SN, 110°) and mandibular incisors (IMPA, 110°) suggest. Surgical exposure of the impacted TMC would also be required to move it into proper position. However, the convex facial profile and the uncertainty of repositioning the impacted TMC might not support this option.
4. Treatment with TMC extraction. Extract three premolars along with the impacted TMC to avoid surgical exposure and orthodontic repositioning of the impacted TMC, but keep the facial profile convex. However, Abbott et al.[19] described the transposition of an unerupted permanent mandibular right canine to a position between the permanent left canine and left lateral incisor and indicated that the tooth was suitable for orthodontic treatment. It was also suggested that extraction of first premolars should be avoided when radiographs reveal the presence of an overly mesially angulated unerupted canine that has begun to migrate labially across the incisors.[19]
5. Treatment without extractions. Through a conservative, orthodontic-surgical approach with the aim of improving the Class II, division 1 dental relationship and profile with Class II mechanics, but leaving

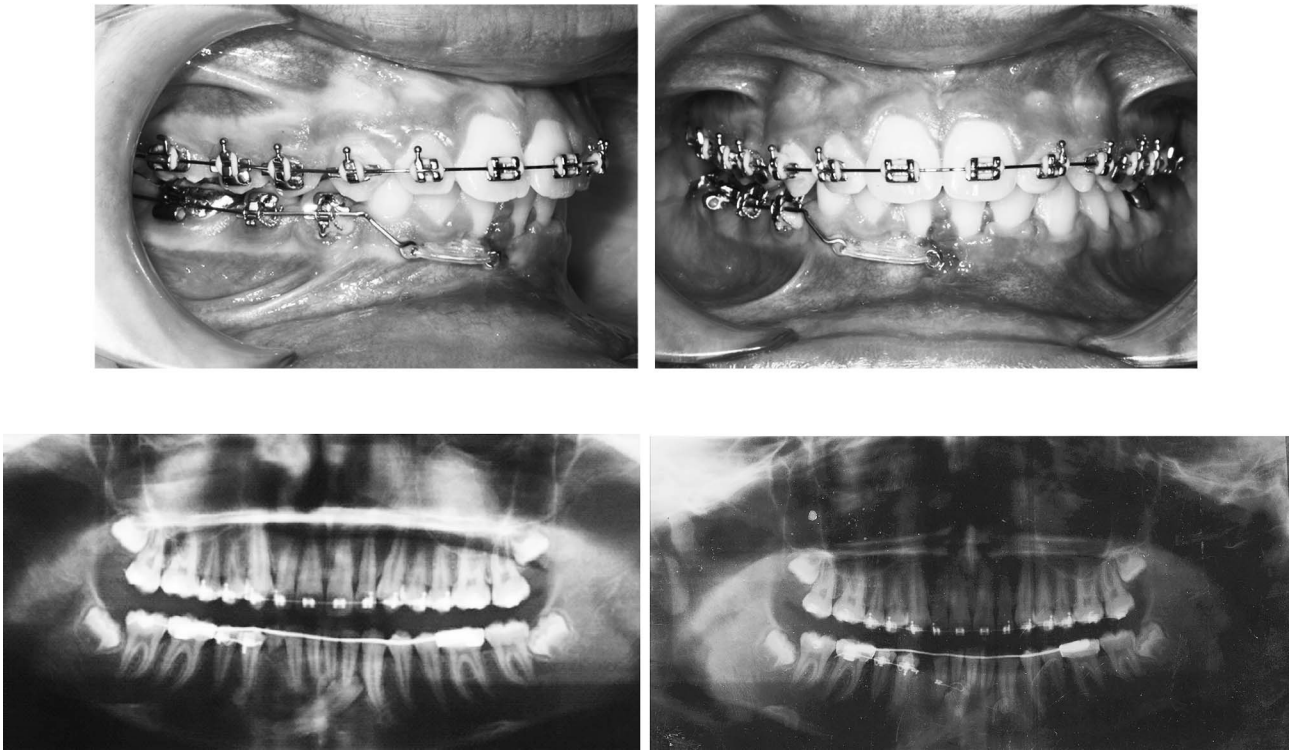

Figure 5. Intraoral photographs and panoramic radiographs showing initial alignment and leveling with a maxillary 0.016-inch NiTi wire and a 0.017 × 0.025-inchTMA mandibular right sectional wire ending with an eyelet lightly tied with an elastic module to the 0.011-inch stainless steel ligature applied on the surgically exposed canine.

incisor proclination uncorrected. In addition, third molar extractions and surgical exposure of the impacted TMC would be necessary.

Treatment Progress

Esthetic concerns and both the patient's and parents' desires called for a challenging solution and an unusual nonextraction treatment to align the TMC into its normal position.

Option 5 was favored as it avoided implants and permanent tooth extractions and would result in all teeth being in their correct positions. However, such repositioning has been described in few case reports,[1,9,20] and the required tooth movement would be complex, extensive, and protracted, with the risk of jeopardizing the roots and damaging the supporting structures of the canine and adjacent teeth.

All risks, including the usual surgical risks and failure to achieve the desired objective, were understood and accepted by the patient and the parents, who gave written informed consent.

Treatment started with the placement of a mandibular lingual arch and 0.018 × 0.025-inch Alexander brackets in the maxillary arch and partially in the mandibular arch. Initial alignment and leveling was achieved in the maxillary arch with a 0.016-inch NiTi wire, whereas the right mandibular arch was fitted with a passive, 0.017 × 0.025-inch TMA sectional wire extending from the second molar to the first premolar, bent down to the canine level and ending with an eyelet applied for distal movement of the canine crown away from the incisor roots (Figure 5).

The impacted TMC was surgically exposed with a labial approach due to the thin labial plate of the mandibular incisors and the risk of damaging their roots. Surgery was carried out under local anesthesia (mepivacaine 2% with epinephrine 1:100,000). A conservative, full-thickness flap[21] was carefully elevated by securing the mental nerve. Then a transcoronal, 0.011-inch stainless steel braided ligature was applied to tie the impacted TMC and, after flap repositioning and suturing, a very light elastic module to avoid damage to the incisor roots was used to connect the braided ligature to the eyelet of the sectional wire (Figure 5).

While the permanent canine was being uprighted labially to the incisors with its crown crossing the midline, the deciduous canine was extracted with great care being taken to prevent contact between the crown of the permanent canine and roots of the mandibular incisors.

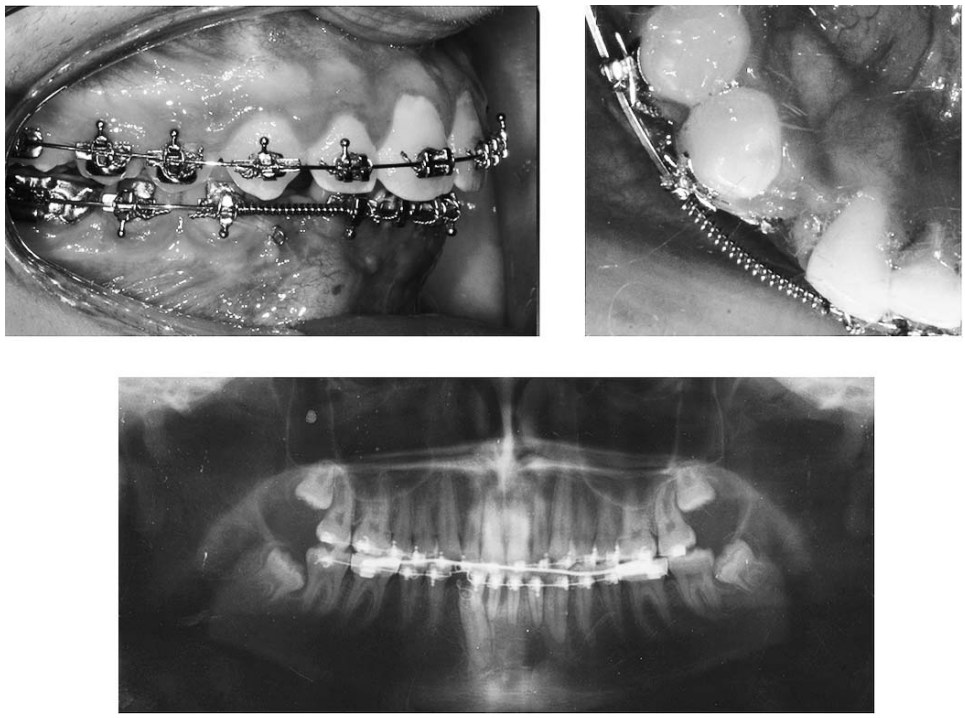

Figure 6. Intraoral photographs and panoramic radiograph showing uprighting of the transmigrated mandibular canine guided into its proper position by elastic traction. In the mandibular arch, the lingual arch was removed, bonding was completed, and a 0.016 × 0.022-inch stainless steel wire was applied along with an open NiTi coil spring to gain space for canine repositioning.

Subsequently, the lingual arch was removed, mandibular bonding was completed, and a 0.016 × 0.022-inch stainless steel wire was applied along with an open NiTi coil spring to gain the space needed for canine repositioning (Figure 6). Elastic traction was again used to fully upright the canine. As soon as possible, a button and then a bracket were bonded to the crown of the canine to bring it into its final position.

Finally, 0.017 × 0.025-inch stainless steel wires were applied to coordinate both arches, whereas 0.018-inch round Australian archwires were used for the finishing procedures. The third molars were extracted (Figure 7).

After active orthodontic treatment, the brackets were removed. A maxillary Hawley and a mandibular canine-to-canine bonded retainer were used for retention.

Treatment Results

An excellent esthetic and functional outcome was achieved through the collaborative efforts of an orthodontist and an oral surgeon. The impacted TMC was repositioned into its correct position and responded normally to a vitality test with minimal gingival recession.

The occlusion showed a well-aligned dentition with Class I molar and canine relationships. The patient had a consonant smile arch, interdigitation of the teeth was good, the initial mild crowding was corrected, and normal overjet and overbite were achieved. The maxillary midline was coincident with the facial midline (Figures 8 and 9).

The posttreatment panoramic radiograph showed normal bone levels and minimal root resorption of the TMC. Cephalometric analysis showed improved maxillomandibular relationship (ANB, 3.5°) and unchanged incisor proclination (Figure 10).

The treatment lasted 3 years, 6 months, and the patient was motivated and cooperative throughout. Oral hygiene was good to moderate. Both the patient and his parents were pleased with the outcome.

After 15 months' retention, the occlusion was well maintained and the repositioned TMC presented minimal gingival recession. Overall superimpositions showed favorable mandibular growth and improvement of overjet (Figures 10 and 11).

DISCUSSION

The patient had an impacted right TMC, with an open apex that could have developed into a more severe transmigration, that is, type 2 or 4 according to Mupparapu's classification. In fact, it is reported that movement of the canine takes place until complete development of its root[22] and transmigration of a mandibular canine across the mandibular symphysis to the opposite side of the dental arch takes several years.[23] Moreover, delayed tooth eruption can cause

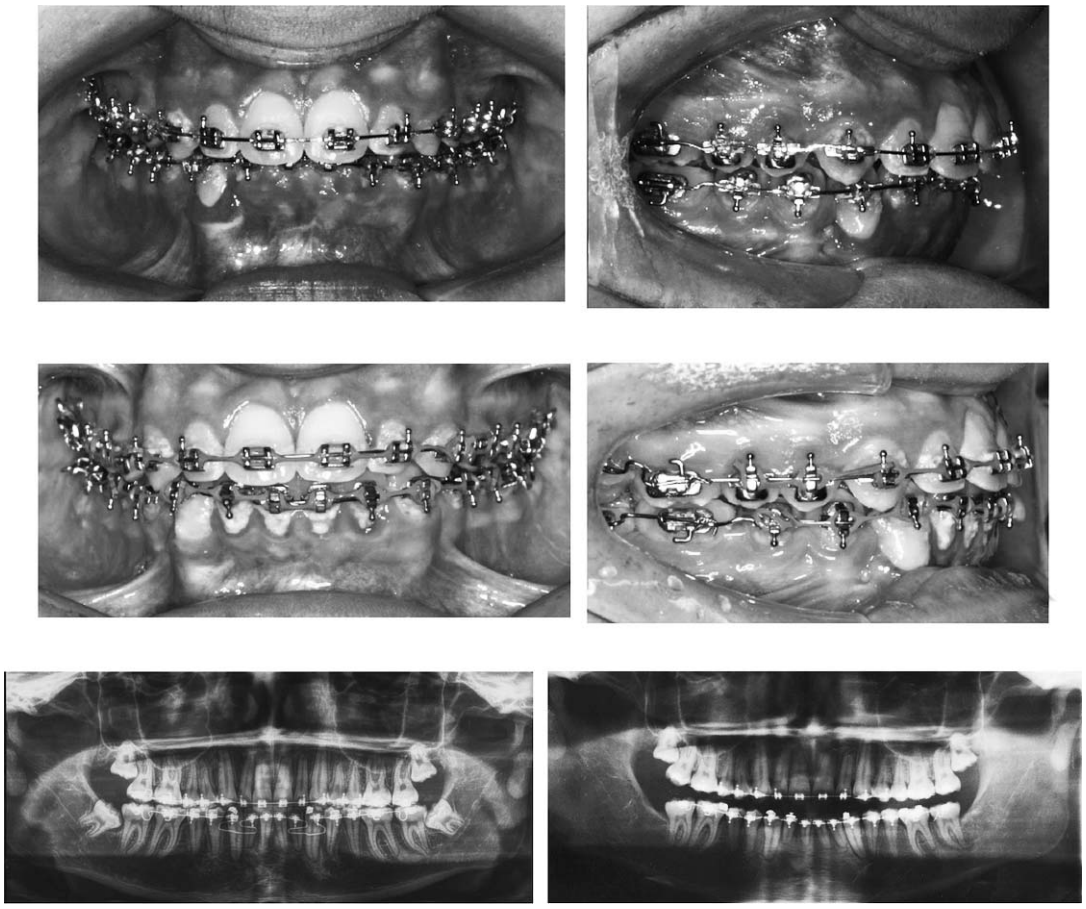

Figure 7. Intraoral photographs and panoramic radiographs showing 0.017 × 0.025-inch stainless steel wires applied to coordinate the arches, followed by 0.018-inch round Australian finishing archwires.

necrosis of the pulp, ankylosis, and external apical root resorption.[24,25]

It is not possible to predict when resorption will start. Thus, all impacted teeth should be regarded as having a high risk of external apical root resorption or damage to the adjacent tooth. So, radiographic examinations should be used to monitor these risks. Commonly, orthopantomography is used.[12,17] In some cases, supplementary diagnostic tools such as computed tomography (CT) are recommended. In fact, it was shown that CT scanning substantially increases (by 50%) the detection of possible root resorption on the adjacent tooth.[26,27] However, because it is not reasonable to perform more than one CT in the same patient, it was decided to use CT not at the beginning of the treatment but during the treatment to monitor enamel integrity and possible damage due to ankylosis and TMC or mandibular incisor root resorption.

Taking the above factors into account, we commenced orthodontic correction of the impacted TMC as soon as possible. We speculated that delayed treatment might have allowed the TMC to transmigrate farther, making later treatment mechanics more complex, whereas appropriate orthodontic intervention could prevent the possible complications caused by the TMC. Thus, an early diagnosis is recommended. Rebellato and Schabel[28] found that the greatest amount of tooth migration occurred before the root is completely formed, which emphasizes the importance of early diagnosis. However, an early diagnosis can be only the result of an early orthodontic examination.

Interestingly, this case describes a TMC on the right side and in a male patient, whereas TMC is reported to be more frequent in females and to occur on the left side.[10]

A recent comprehensive review of the literature reported 185 cases of TMC in the past 50 years,[27] with few treatment options described. The most common approach was to extract the transmigrating tooth,[5,8] and then either to treat the malocclusion orthodontically or not to treat the patient,[19,29] considering the doubtful prognosis of TMC repositioning.[20,30] Indeed, orthodontic-surgical TMC repositioning is discussed in very few reports.[1,9,20]

According to Wertz,[31] when nonextraction orthodontic treatment is indicated, TMC surgical repositioning

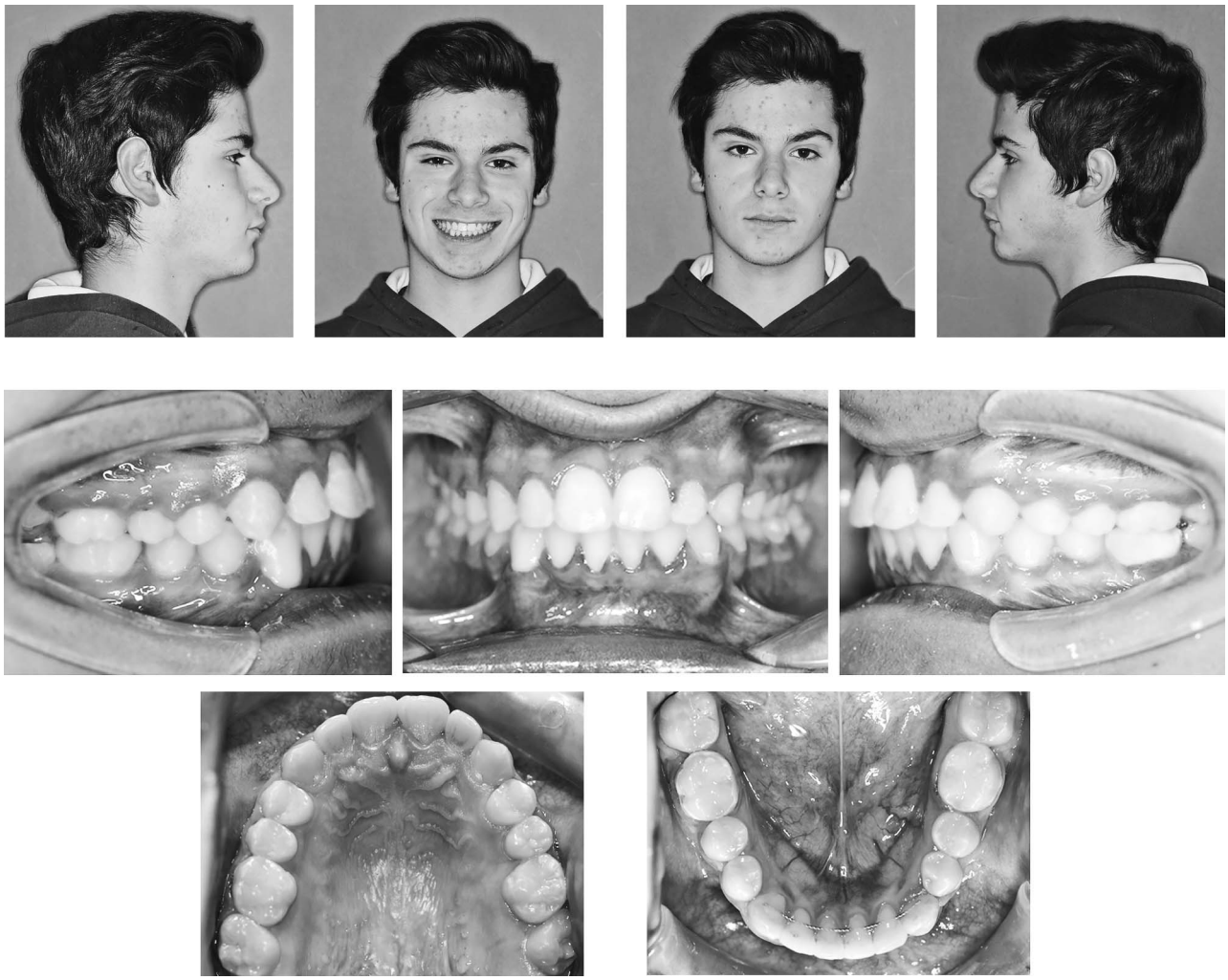

Figure 8. Posttreatment facial and intraoral photographs.

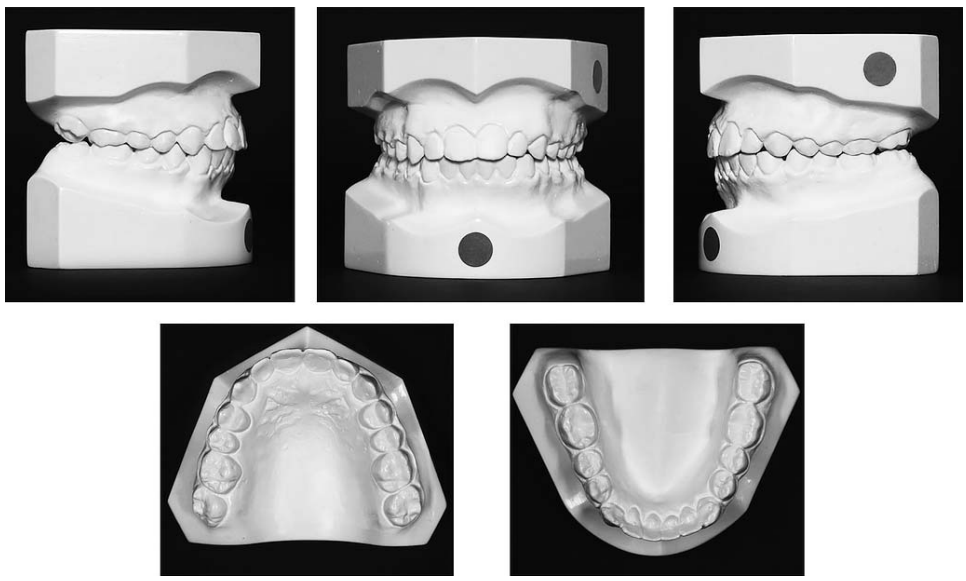

Figure 9. Posttreatment dental casts.

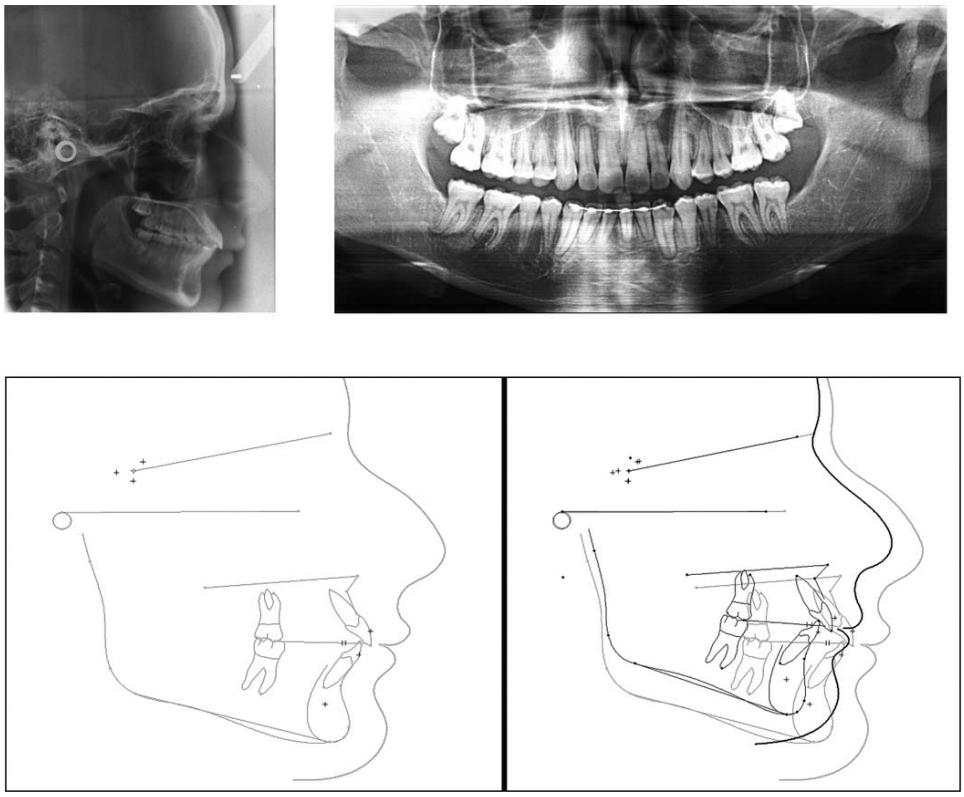

Figure 10. Posttreatment lateral cephalometric radiograph with tracing and superimpositions showing improved maxillomandibular relationship. The posttreatment panoramic radiograph highlights the complete repositioning of the TMC with proper axial inclination and light apical root resorption.

should be attempted. In fact, TMC surgical repositioning followed by extrusion with light orthodontic forces to avoid ankylosis or external root resorption has the best long-term prognosis, as reported by Becker and Chaushu[32] in a long-term follow-up study.

However, based on the patient's and parents' wishes, it was decided to reposition the TMC into its normal site in the arch. The extensive repositioning posed a significant challenge because the right canine had to be moved in a wide arc from its original position between the roots of the mandibular incisors to its physiological site. This required a longer treatment time, presented biomechanical difficulties, and risked jeopardizing the roots and damaging the supporting structures and enamel integrity. However, the patient and parents wished to avoid implants and permanent

Figure 11. Intraoral photographs after 15 months' retention show a stable occlusion.

tooth extractions, and to have all teeth in their correct positions. In addition, canines are considered important keystones in the dental arch.[33,34] Also, considering that the persistence of TCM must be regarded as a high risk for root resorption or damage to the adjacent teeth, we decided to perform this treatment using light forces and a suitable biomechanical approach to minimize iatrogenic damage.

All the advantages and disadvantages of TMC repositioning as well as the risks (including that of being unable to achieve the desired goals) and the need for good cooperation were discussed, and these were understood and accepted by the patient and parents.

The treatment goals were achieved. The esthetic result of canine repositioning was satisfactory, although minimal gingival recession was observed. The outcome was rewarding for the clinicians and appreciated by the patient and his parents. This justified the time and effort spent during this unusual treatment regimen. The key factors determining the success of this treatment option were the light forces applied and the patient's motivation. In addition, early diagnosis was crucial to prevent possible complications, especially root resorption of the adjacent teeth.[31]

CONCLUSIONS

- Combined orthodontic-surgical management of a transmigrated mandibular canine is a viable option, even though it requires a complex and lengthy treatment protocol and a cost-benefit evaluation.
- Light forces and extra care are required to prevent possible damage to the teeth and supporting structures.
- Pediatric dentists should identify transmigrations as early as possible and direct patients to the orthodontist.

ACKNOWLEDGMENTS

The authors are grateful to the patient and his parents for participating in the study. Thanks to C. Fisher for linguistic editing. The authors declare no potential conflicts of interest with respect to the authorship and/or publication of this article.

REFERENCES

1. Agarwal S, Yadav S, Shah NV, Valiathan A, Uribe F, Nanda R. Correction of bilateral impacted mandibular canines with a lip bumper for anchorage reinforcement. *Am J Orthod Dentofacial Orthop*. 2013;143:393–403.
2. D'Amico RM, Bjerklin K, Kurol J, Falahat B. Long-term results of orthodontic treatment of impacted maxillary canines. *Angle Orthod*. 2003;73:231–238.
3. Bahl R, Singla J, Gupta M, Malhotra A. Aberrantly placed impacted mandibular canine. *Contemp Clin Dent*. 2013;4: 217–219.
4. Aydin U, Yilmaz HH. Transmigration of impacted canines. *Dentomaxillofac Radiol*. 2003;32:198–200.
5. Camilleri S, Scerri E. Transmigration of mandibular canines—a review of the literature and a report of five cases. *Angle Orthod*. 2003;73:753–762.
6. Kara MI, Ay S, Aktan AM, et al. Analysis of different type of transmigrant mandibular teeth. *Med Oral Patol Oral Cir Bucal*. 2011;16:e335–340.
7. Shapira Y, Mischler WA, Kuftinec MM. The displaced mandibular canine. *ASDC J Dent Child*. 1982;49:362–364.
8. Joshi MR. Transmigrant mandibular canines: a record of 28 cases and a retrospective review of the literature. *Angle Orthod*. 2001;71:12–22.
9. Gruszka K, Różyło TK, Różyło-Kalinowska I, Denkiewicz K, Maslowska K. Transmigration of mandibular canine—case report. *Pol J Radiol*. 2014;79:20–23.
10. Shapira Y, Kuftinec MM. Intrabony migration of impacted teeth. *Angle Orthod*. 2003;73:738–743.
11. Kanavakis G, Curran KM, et al. Evaluation of crown-root angulation of lateral incisors adjacent to palatally impacted canines. *Prog Orthod*. 2015;16:4.
12. Mupparapu M. Patterns of intra-osseous transmigration and ectopic eruption of mandibular canines: review of literature and report of nine additional cases. *Dentomaxillofac Radiol*. 2002;31:355–360.
13. Cannavale R, Matarese G, Isola G, Grassia V, Perillo L. Early treatment of an ectopic premolar to avoid molar-premolar transposition. *Am J Orthod*. 2013;143:559–569.
14. Di Domenico M, Pierantoni GM, Feola A, et al. Prognostic significance of N-Cadherin expression in oral squamous cell carcinoma. *Anticancer Res*. 2011;31:4211–4218.
15. Paolantonio M, D'Ercole S, Pilloni A, et al. Clinical, microbiologic, and biochemical effects of subgingival administration of a Xanthan-based chlorhexidine gel in the treatment of periodontitis: a randomized multicenter trial. *J Periodontol*. 2009;80:1479–1492.
16. Almuthaseb E, Mao J, Mahony D, Bader R, Zhang ZX. Three-dimensional localization of impacted canines and root resorption assessment using cone beam computed tomography. *J Huazhong Univ Sci Technolog Med Sci*. 2014;34: 425–430.
17. Alaejos-Algarra C, Berini-Aytes L, Gay-Escoda C. Transmigration of mandibular canines: report of six cases and review of the literature. *Quintessence Int*. 1998;29:395–398.
18. Perillo L, Isola G, Esercizio D, Iovane M, Triolo G, Matarese G. Differences in craniofacial characteristics in Southern Italian children from Naples: a retrospective study by cephalometric analysis. *Eur J Paediatr Dent*. 2013;14: 195–198.
19. Abbott DM, Svirsky JA, Yarborough BH. Transposition of the permanent mandibular canine. *Oral Surg Oral Med Oral Pathol*. 1980;49:97.
20. Umashree N, Kumar A, Nagaraj T. Transmigration of mandibular canines. *Case Rep Dent*. 2013;2013:697671.
21. Briguglio F, Briguglio E, Briguglio R, Cafiero C, Isola G. Treatment of infrabony periodontal defects using a resorbable biopolymer of hyaluronic acid: a randomized clinical trial. *Quintessence Int*. 2013;44:231–240.
22. Stafne EC. Malposed mandibular canine. *Oral Surg Oral Med Oral Pathol*. 1963;16:1330.
23. Ando S, Aizawa K, Nakashima T, Sanka Y, Shimbo K, Kiyokawa K. Transmigration process of the impacted mandibular canine. *J Nihon Univ Sch Dent*. 1964;6:66–71.
24. Kavadia-Tsatala S, Tsalikis L, Kaklamanos EG, Sidiropoulou S, Antoniades K. Orthodontic and periodontal considera-

tions in managing teeth exhibiting significant delay in eruption. *World J Orthod*. 2004;5:224–229.
25. Peck S. On the phenomenon of intraosseous migration of nonerupting teeth. *Am J Orthod Dentofacial Orthop*. 1998; 113:515–517.
26. Ericson S, Kurol J. Resorption of incisors after ectopic eruption of maxillary canines: a CT study. *Angle Orthod*. 2016;70:415–423.
27. Vuchkova J, Farah CS. Canine transmigration: comprehensive literature review and report of 4 new Australian cases. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2010; 109:e46–e53.
28. Rebellato J, Schabel B. Treatment of a patient with an impacted transmigrant mandibular canine and a palatally impacted maxillary canine. *Angle Orthod*. 2003;73:328–336.
29. Perillo L, Padricelli G, Isola G, Femiano F, Chiodini P, Matarese G. Class II malocclusion division 1: a new classification method by cephalometric analysis. *Eur J Paediatr Dent*. 2012;13:192–196.
30. Novak HM, Baccetti T, Sigler LM, McNamara JA Jr. A controlled study on diagnostic and prognostic measurements of palatally displaced canines on lateral cephalograms. *Prog Orthod*. 2012;13:42–48.
31. Wertz RA. Transmigrated mandibular canines. *Am J Orthod Dentofacial Orthop*. 1994;106:419–427.
32. Becker A, Chaushu S. Long-term follow-up of severely resorbed maxillary incisors after resolution of an etiologically associated impacted canine. *Am J Orthod Dentofacial Orthop*. 2005;127:650–654.
33. Piancino MG, Isola G, Merlo A, Dalessandri D, Debernardi C, Bracco P. Chewing pattern and muscular activation in open bite patients. *J Electromyogr Kinesiol*. 2012;22:273–279.
34. Rinchuse DJ, Kandasamy S, Sciote J. A contemporary and evidence-based view of canine protected occlusion. *Am J Orthod Dentofacial Orthop*. 2007;132:90–102.