Orthodontic Treatment of Maxillary Incisors with Severe Root Resorption Caused by Bilateral Canine Impaction in a Class II Division 1 Patient

Na-Young Chang */ Jae Hyun Park **/ Mi-Young Lee ***/Jin-Woo Cho ****/Jin-Hyoung Cho *****/ Ki-Yong An ******/ Jong-Moon Chae *******

This case report shows the successful alignment of bilateral impacted maxillary canines. A 12-year-old male with the chief complaint of the protrusion of his maxillary anterior teeth happened to have bilateral maxillary canine impaction on the labial side of his maxillary incisors. Four maxillary incisors showed severe root resorption because of the impacted canines. The patient was diagnosed as skeletal Class II malocclusion with proclined maxillary incisors. The impacted canine was carefully retracted using sectional buccal arch wires to avoid further root resorption of the maxillary incisors. To distalize the maxillary dentition, two palatal miniscrews were used. After 25 months of treatment, the maxillary canines were well aligned without any additional root resorption of the maxillary incisors.

Key words: *Canine impaction, Root resorption, Miniscrew, Distalization*

*Na-Young Chang, DDS, MSD, Assistant Professor, Department of Orthodontics, School of Dentistry, University of Wonkwang, Wonkwang Dental Research Institute, Iksan, Korea.

**Jae Hyun Park, DMD, MSD, MS, PhD, Professor and chair, Postgraduate Orthodontic Program, Arizona School of Dentistry & Oral Health, A.T. Still University, Mesa, Ariz; Adjunct Professor, Graduate School of Dentistry, Kyung Hee University, Seoul, Korea.

***Mi-Young Lee, DDS, MSD, Graduate student, Department of Orthodontics, School of Dentistry, University of Wonkwang, Iksan, Korea.

****Jin-Woo Cho, DDS, MSD, PhD, Clinical Associate Professor, Department of Orthodontics, School of Dentistry, University of Wonkwang, Daejeon Dental Hospital, Daejeon, Korea.

*****Jin-Hyoung Cho, DDS, MSD, PhD, Professor, Department of Orthodontics, School of Dentistry, University of Wonkwang, Wonkwang Dental Research Institute, Iksan, Korea.

******Ki-Yong An, DDS, MSD, Department of Orthodontics, College of dentistry, Gangneung-Wonju National University, Gangneung, Korea.

*******Jong-Moon Chae, DDS, MSD, PhD, Professor, Department of Orthodontics, School of Dentistry, University of Wonkwang, Wonkwang Dental Research Institute, Iksan, Korea; Visiting Scholar, Postgraduate Orthodontic Program, Arizona School of Dentistry and Oral Health, A. T. Still University, Mesa, Ariz; Instructor, The Charles H. Tweed International Foundation, Tucson, Ariz.

Send all correspondence to:

Jong-Moon Chae, Department of Orthodontics, School of Dentistry, Wonkwang University, Daejeon Dental Hospital, 1268 Doonsan–Dong, Seo-Gu, Daejeon, 302-120, Korea
Tel ; +82-42-366-1103, Fax ; +82-42-366-1115 / E-mail ; jongmoon@wonkwang.ac.kr

INTRODUCTION

Maxillary canine impaction presents a tricky situation for orthodontists because of the risks to adjacent teeth. Depending on the direction and position of impaction, and timing and modality of the treatment, there are various prognoses for not only the impacted teeth but also the adjacent teeth. To obtain a successful outcome, careful treatment planning is necessary.

The prevalence of impacted maxillary canines varies between 0.9% and 2.2%, with most of them being ectopically positioned.[1] Impaction of maxillary canines usually occurs less frequently on the labial side than on the palatal,[2] however, in the Korean population, impaction on the labial side is 3-fold greater.[3] Research of labially impacted canines indicates there is a correlation with a deficiency in maxillary arch length.[4]

Canine impaction can occur for various reasons. Bishara *et al* [5] reported that abnormal tooth bud eruption, abnormal eruption rate, and delayed resorption of primary teeth were possible factors. Baccetti[6] noted an association between canine impactions and other dental anomalies. However, lateral anterior teeth (agenesia, or peg laterals) appear to play a major role on the eruption guidance of maxillary canines.

Untreated maxillary canine impaction can interfere with the alignment of neighboring teeth, shorten dental arches, and increase the chance of follicular cyst formation and recurrent infections.[7] It can also cause serious tooth loss by resorbing the root of the adjacent teeth.

Using periapical films and polytomography, Ericson and Kurol[8] reported that lateral incisor root resorption occurred in approximately 12% of the 125 ectopically erupting maxillary canines. Later, they did a further study using computerized tomography and reported that root resorption occurred in 38% of maxillary lateral

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/40/2/161/1743305/1053-4628-40_2_161.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

incisors and 9% of central incisors among 158 cases of ectopically erupting maxillary canines.[9]

Ericson and Kurol[8,10] also reported that maxillary incisor resorption occurred most often on the middle and apical third of the root of the injured incisor (64%), and appeared just as commonly on the buccal as on the lingual side. They pointed out that when the resorbed area was located lingually or buccally in the middle third of the lateral incisor's root, even injurious resorptions might be missed on periapical films. 60% of the resorptions on the lateral incisors and 43% of the centrals had pulpal involvement. However, most of them showed no clinical signs or symptoms when diagnosed.

In this report, we will present the case of a patient with severe resorption of the four maxillary incisors related to impacted canines.

Case report

A 12-year-old male patient presented with a chief complaint of the protrusion of his upper anterior teeth and a large overjet. He had a retruded mandible showing slight protrusion of the lower lip and deep mentolabial sulcus. No facial asymmetry was seen in the frontal view. The molar relationship was end-on Class II on both sides with a large overjet (8.3 mm), deep overbite (5.6 mm) and mild crowding on the maxillary anterior arch and moderate crowding on the mandibular anterior arch. He also he had primary maxillary canines and primary mandibular second molars. (Figure 1).

The cephalometric analysis showed a skeletal Class II relationship (ANB: 4.5°) with mandible deficiency (SNB: 76.5°, Wits: -0.5°). His maxillary incisors were proclined (U1 to FH: 127.5°) while his mandibular incisors showed normal inclination (IMPA: 92.0°). He had an acute nasolabial angle (NLA: 86.8°) (Figure 2 and Table).

Table. Cephalometric measurements

Measurements	Norm	Pre-treatment	Post-treatment
SNA (°)	81.7	81.0	82.3
SNB (°)	79.2	76.5	78.1
ANB (°)	2.5	4.5	4.2
Wits (mm)	-2.1	1.6	-0.5
SN - MP (°)	31.1	37.2	37.2
FH - MP (°)	24.9	28.0	28.7
LFH (ANS-Me/N-Me) (%)	56.0	53.0	55.0
U1 to SN (°)	107.5	118.3	110.0
U1 to NA (°)	29.2	25.7	38.8
U1 to FH (°)	116.0	127.5	118.5
IMPA (°)	96.8	92.0	103.6
L1 – NB (°)	30.7	25.7	38.8
U1/L1 (°)	122.5	112.5	109.3
Upper lip (mm)	2.0	1.5	-0.0
Lower lip (mm)	2.0	2.9	1.5
Nasolabial angle (°)	100.0	86.8	82.7

In the panoramic radiograph, severe root resorption of the four maxillary incisors was seen, caused by bilateral ectopic eruption of maxillary canines (Figure 2). Because of his retained primary canines, the patient and the parents did not realize the absence of permanent canines, mistaking the primary canines as permanent teeth. Further cone-beam computed tomography (CBCT) findings showed that both

Figure 1. Pretreatment facial and intraoral photographs.

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/40/2/161/1743305/1053-4628-40_2_161.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

maxillary canines were impacted on the labial side, pressing the four maxillary incisors and causing them to be proclined. The status of the resorption and impaction was carefully observed by 3-dimensional (3D) image analysis software (Simplant, CEP tech corporation, South Korea). There were oblique patterns of root resorption in all four incisors (Figure 3). Some roots still had long parts but on the shortest parts, the remaining length was only about two to three millimeters. The root of the right central incisor showed the most severe resorption. The root length was just about half that of the crown, but the patient had no clinical symptoms on his maxillary incisors.

TREATMENT OBJECTIVES AND PLAN

The treatment objectives were to retract the maxillary canines without causing any further root resorption of the incisors, to distalize maxillary posterior teeth for the impacted canines to prevent further proclination of the maxillary incisors, to relieve anterior crowding, and to establish Class I dental relationships.

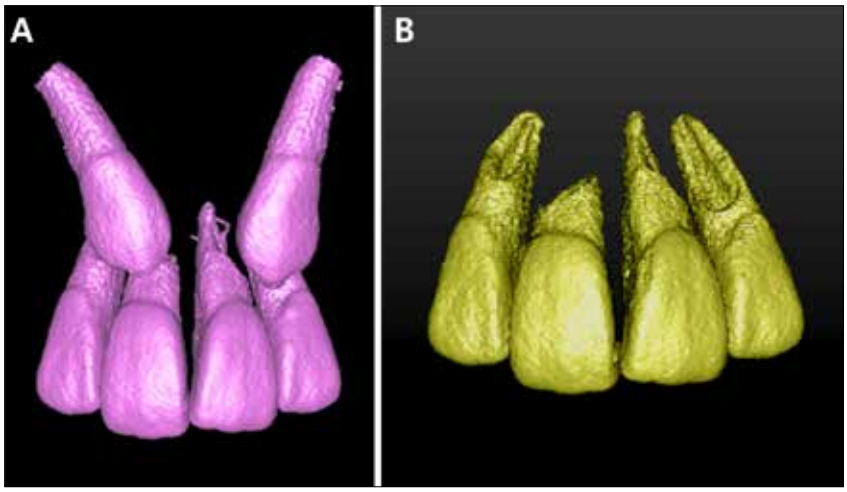
TREATMENT ALTERNATIVES

When retracting labially impacted maxillary canines, the direction of the retraction force has to be carefully analyzed in order to prevent further resorption of the maxillary incisors. At first, there should be absolutely no posterior vector but just a horizontal force to prevent further root resorption (Figure 4A, B). This means that a force from outside the arch is necessary, but it is hard to attach an appliance to the labial side of the impacted canines. Even if it were possible, the magnitude of the force would not be great enough because of the short range between the hooks of the impacted canines unless the appliance were to be extended extra-orally. To solve the problem in this patient, sectional buccal arch wires were used to apply appropriate forces in favorable directions (Figure 4C). Dual slot tubes were welded and palatal arch was soldered on the first molar bands. The sectional wires were fabricated with .017 × .025-in TMA or .016 × .022-in stainless steel. The total length of the wires was determined by the anteroposterior distance between the first molars and the impacted teeth. A hook was added at the end of the wire which could be activated with a V-bend. Unlike other routine retraction forces which are generated by elastic modules, the retraction force in this appliance was exerted by the elasticity of the sectional wire. The elastic modules were just used to connect the hooks between the impacted teeth and the sectional wires. This overcame the problem of short range that made it hard to exert sufficient force to move the impacted canines away from the adjacent teeth and retract them.

Regaining space for the impacted canines was another problem we had to consider. Since the maxillary incisors were proclined

Figure 2. Pretreatment radiographs; lateral cephalogram, periapical and panoramic radiographs.

Figure 3. The aspect of impaction and root resorption using a 3D simulation program; A, maxillary canines present; B, maxillary canines deleted.



Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/40/2/161/1743305/1053-4628-40_2_161.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

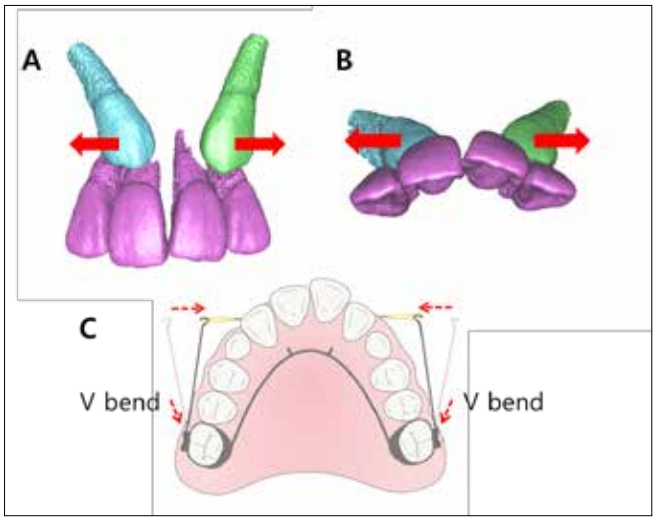
with severe overjet, either extraction of maxillary first premolars or extraction of maxillary first premolars and mandibular second premolars would have been the usual treatment plan. However, these routine treatment options would have caused further root resorption during the space closure because of the large amount of retraction needed, making the prognosis for the maxillary incisors very poor. Even if two incisors had been extracted instead of the premolars, the other incisors would have been compromised during space closure. Naturally, the parents were concerned about the premolar extraction treatment option because of the risk their son would have of losing his incisors, so even though the chief complaint was the protrusion of his anterior teeth, they declined the premolar extraction treatment plan. Distalization of the maxillary first molars using miniscrews was the preferred treatment option to gain space for the impacted canines without causing further resorption of the anterior teeth.

Treatment Progress

After attaching buttons on the impacted maxillary canines using the closed approach, sectional buccal arch wires were delivered following miniscrew installation. At first, the miniscrews were installed at the buccal side between the second premolar and the first molar on both sides, but due to the repetitive failure of the miniscrews on the right side of buccal, two more miniscrews were additionally inserted on the palate. However, two months later, the miniscrew on the right side of the palate failed (Figure 5). The left canine moved away from the roots of the incisors, but the right canine was still close to the lateral incisor root. Since there was some possibility of contact between the right canine and incisors if the distalization of the right molar was done under these conditions, distalization of only the left first molar was initiated.

After a month, the right maxillary canine had moved away from the roots of the incisors and both canines were emerged, making it possible to distalize the right first molar. Since the miniscrew had failed on the right side of the palate, another one was inserted.

Figure 4. Illustrations of the horizontal vector that reduces the risk of further resorption of the incisors and modified appliance with sectional buccal arch wires and palatal arch; A, coronal view; B, axial view; C: .017 × .025-in TMA or .016 × 022-in stainless sectional wires apply horizontal forces by activating the wires with V-bends. The retracting forces come from the elasticity and the adjustment of the length of the wires.



Elastic modules were connected from the miniscrews to the hooks of the palatal arch. Five months after starting the treatment, distalization was stopped and the teeth were held in place with a 0.012-in annealed stainless steel wire since Class I molar relationships had been obtained (Figure 6). Both primary canines were extracted and leveling was started except for the maxillary incisors. Due to the deep bite and severe curve of Spee, a removable anterior bite plate was delivered to accelerate the leveling process.

After using removable anterior bite plate for three months, the severe curve of Spee on the mandibular arch had been leveled (Figure 7). Premolars and molars were distally distalized to gain space for the canines. Twelve months after starting the treatment, both maxillary canines were aligned into the arch. To finalize the anterior teeth, four incisors were bonded and the palatal arch was sectioned. Throughout the process, orthodontic force was applied discreetly on the incisors due to the condition of their roots. Retraction of the anterior teeth was performed after the premolars were distalized.

After the entire space closure was accomplished, Class I molar and canine relationships were obtained, but labial inclination was still evident in four maxillary incisors. After 23 months of treatment, a torquing spring fabricated with .017 × .025-in TMA was applied to torque the maxillary incisor crowns more lingually (Figure 8). Based on information presented by Burstone,[11] a modified torquing spring was applied in this case. Instead of preactivating the spring toward the ginigival side, it was done toward the incisal side making a lingual crown torque. The anterior part of the spring was engaged in the brackets of the incisors while the posterior arm was hooked on the buccal main arch wire which was cinched back to stabilize the maxillary dentition. The anterior part of the main arch wire was placed above the brackets on the maxillary incisors to avoid interruption of the torquing moment, which was accomplished with light force from the torque spring. Torquing was done for a short period of just two months. The total active treatment period was 25 months. After debonding, fixed retainers were bonded on the anterior teeth and removable retainers were also delivered.

Treatment Results

Class I canine and molar relationships were established with successful alignment of the maxillary canines. The second molars were not fully aligned because they showed late eruption during treatment. No further root resorption was seen in the maxillary incisors. His maxillary incisors were retroclined compared with pretreatment (U1 to FH: 118.5°) but his mandibular incisors were proclined (IMPA: 103.6°) to correct his severe overjet.

His profile has improved since treatment. There was mandibular growth (SNB: 78.1°, Wits: -0.5 mm) but the mandibular plane (FMA: 28.7°) did not worsen even after maxillary molar distalization (Figures 9, 10 and Table).

Despite the effort to avoid further root resorption of the maxillary incisors, the patient had a unfortunate accident two years later where a baseball struck his maxillary incisors. There were fractures in the crowns of both maxillary central incisors plus a fracture in the root of the right lateral incisor while the left lateral incisor was subluxated. After root canal therapy on three incisors, porcelain fused to metal (PFM) crowns were restored on both maxillary central incisors and resin was restored on the left lateral incisor. Still, there might be a stroke of good luck since no further root resorption was

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/40/2/161/1743305/1053-4628-40_2_161.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

seen after 16 months (Figure 11). Although it seems that the anterior overjet and protrusion of the maxillary incisors increased, this might be due to the shape of the prosthodontic crowns (Figure 12).

DISCUSSION

In order to prevent incisor root resorption, early detection is crucial. Annual palpation of the canine regions, periodic radiographs before 10 years of age, and early extraction of deciduous canines is recommended.[12] However, root resorption of the incisors associated with impacted canines has a tendency to be diagnosed late because of a general lack of symptoms and clinicians' reliance on 2-dimensional (2D) radiographic imaging for diagnosis.[13,14] It has been reported that superimposition of an impacted canine crown on adjacent incisor roots obscured the root morphology in 45% of the teeth, and 37% of the lateral incisors affected by root resorption that appeared normal in 2D radiographs.[10]

Recent advancements in computed tomography (CT) techniques, especially CBCT, have significantly improved the sensitivity and accuracy of the diagnosis of root resorption.[15-17] Using CT techniques, it was found that about 40% of the incisors adjacent to impacted canines in white people had resorption,[9] whereas root resorption was found in 50% of Asians.[3] Especially in our case, 3D CBCT image analysis was very useful in analyzing the impaction status of the canine and root morphology of the upper incisors. Through this analysis, more careful consideration about the direction of the retraction force was possible.

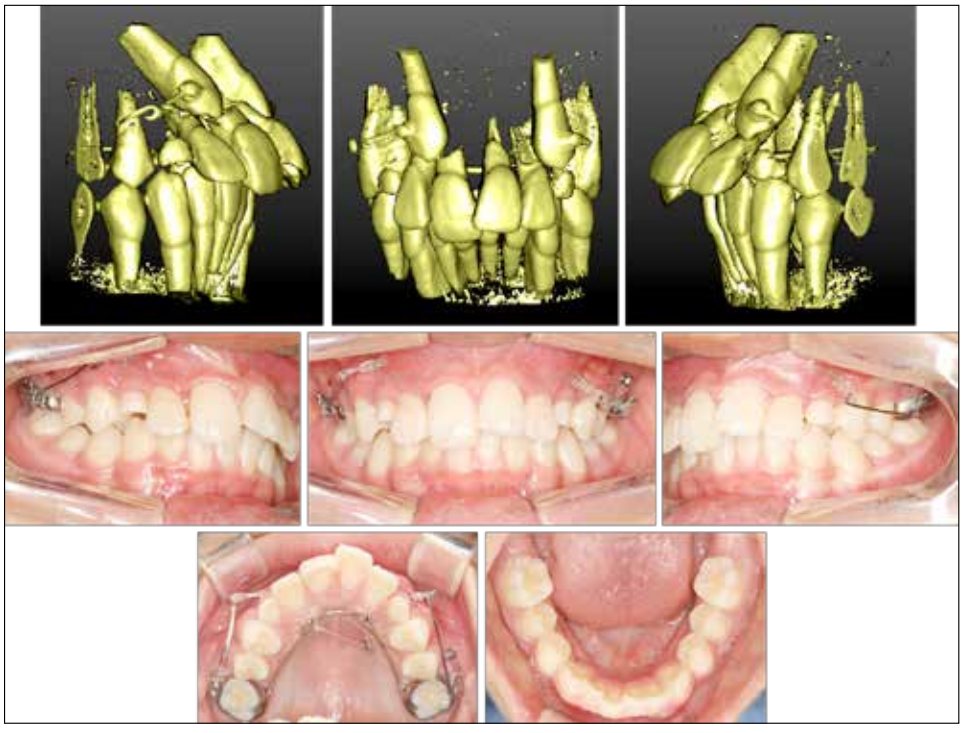
So far, the pathogenesis of root resorption is unclear, a complex biological process that is not well understood.[18] However, Ericson *et al* [19] reported that the dental follicle cannot directly resorb the hard tissue of the root even though it is able to resorb the periodontal contour. They also suggested that physical contact, active pressure, and cellular activities of a contact point between the canine crown and adjacent roots were the major action causing root resorption.

Unlike Caucasians, Kim *et al* [3] reported that Koreans showed a 3-fold greater prevalence of impaction on the labial side, suggesting that there is a larger area of cancellous bone towards the palatal side of the lateral incisor root than between the buccal cortical bone. This increases the possibility of physical contact between the canine crown and lateral incisor root when the impacted canine is positioned labially, and the impacted tooth seems to apply a greater force, making the prognosis poor.

In our case, the roots of the maxillary incisors were severely resorbed in an oblique pattern. This condition can compromise the success of orthodontic treatment, reduce tooth longevity and its capacity to endure mastication forces, and limit its use as an anchor in prosthetic rehabilitation.[20] On the other hand, some researchers reported that the relationship between root length and longevity of a tooth is not known, and some clinical observations have shown that teeth with extremely short roots can function well for many years.[21] So it can be presumed that if there is no further ongoing resorption of the root, there is a possibility that the damaged incisors can function well for a considerable amount of time.

Becker and Chaushu[22] studied eleven patients with severe maxillary incisor root resorption due to canine impaction. Although there was an increase in the crown/root ratio during active orthodontic treatment, they reported that the root resorption ceased during the follow-up period with no presence of diffuse radiolucency and an absence of a discernible lamina dura or periodontal ligament which had been seen during the active resorption. Based on the evidence, they suggested that subsequent orthodontic movement does not appear to generate appreciable additional resorption, even when the resorbed tooth needs considerable orthodontic treatment. The cementum and the dentin resist force induced osteoclastic resorption, while the adjacent bone is subject to extensive resorption and remodeling.[23]

Figure 5. 2-months after starting retraction of both maxillary canines; 3D images generated by Simplant software and intraoral photos.



Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/40/2/161/1743305/1053-4628-40_2_161.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

CONCLUSIONS

Although orthodontic treatment on maxillary incisors with severe root resorption due to impacted maxillary canines is challenging, further root resorption can be avoided by careful biomechanics. Once the maxillary canines are moved away from the short incisor roots, further root resorption may cease and the incisors could function well in spite of the short roots.

ACKNOWLEDGMENT

This paper was supported by Wonkwang University in 2014.

Figure 6. After 5-months of treatment showing distalization of the first molars.

Figure 7. 8-months after starting treatment; anterior deep overbite and severe curve of Spee on the mandibular arch were leveled.

Figure 8. 23-months after starting treatment.

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/40/2/161/1743305/1053-4628-40_2_161.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

Figure 9. Posttreatment facial and intraoral photographs.

Figure 10. Posttreatment radiographs; lateral cephalogram, periapical and panoramic radiographs.

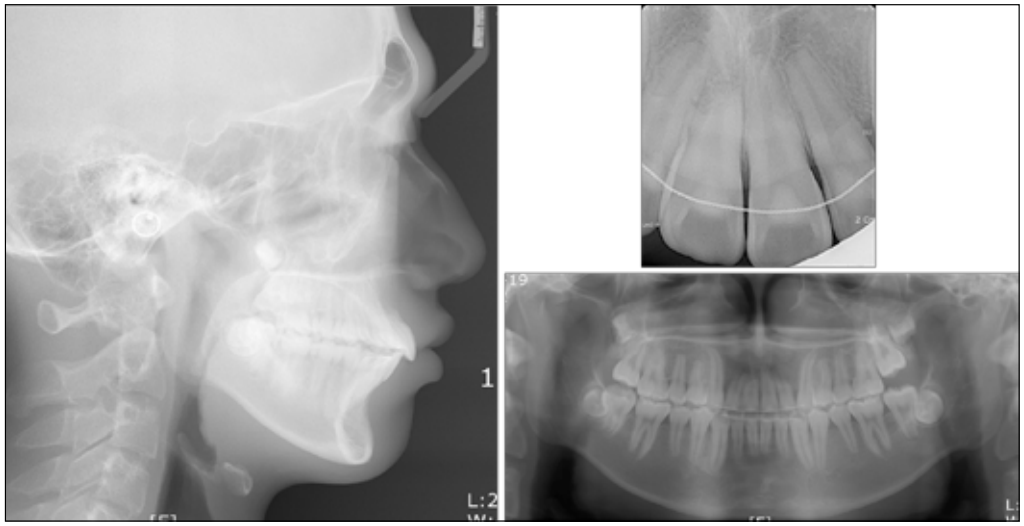
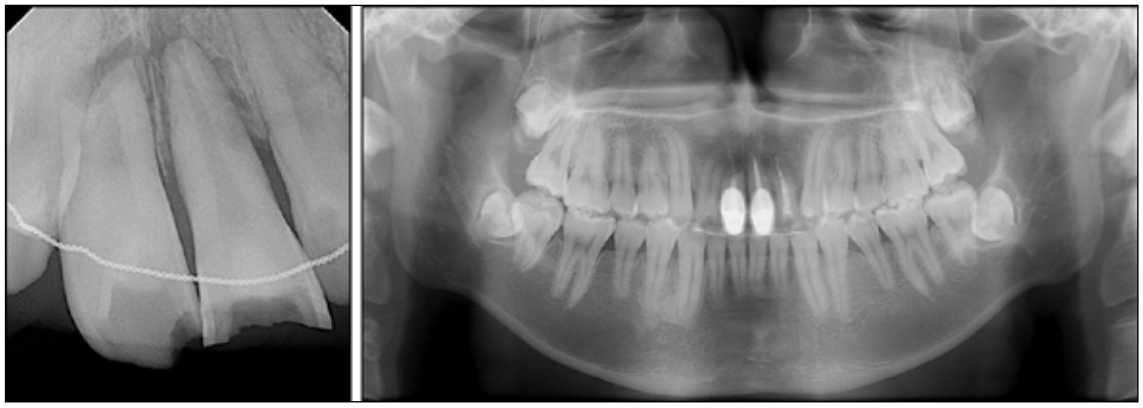


Figure 11. Trauma on the maxillary incisors two years after treatment; periapical radiograph (right after trauma) and panoramic radiograph (16-months after trauma).



Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/40/2/161/1743305/1053-4628-40_2_161.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

Figure 12. Postretention facial and intraoral photographs.

REFERENCES

1. D'Amico RM, Bjerklin K, Kurol J, Falahat B. Long-term results of orthodontic treatment of impacted maxillary canines. Angle Orthod, 73: 231–238, 2003.
2. Bedoya MM, Park JH. A Review of the diagnosis and management of impacted maxillary canines. J Am Dent Assoc, 140: 1485-1493, 2009.
3. Kim Y, Hyun HK, Jang KT. The position of maxillary canine impactions and the influenced factors to adjacent root resorption in the Korean population. Eur J Orthod, 34: 302-306, 2012.
4. Jacobs SG. The impacted maxillary canine. Further observations on etiology, radiographic localization, prevention/interception of impaction and when to suspect impaction. Aust Dent J, 41: 310–316, 1996.
5. Bishara SE, Kommer DD, McNeil MH, Montagano LN, Oesterle LJ, Youngquist HW. Management of impacted canines. Am J Orthod, 8: 173-190, 1976.
6. Baccetti T. A controlled study of associated dental anomalies. Angle Orthod, 68: 267-272, 1988.
7. Bishara SE. Impacted maxillary canines: a review. Am J Orthod Dentofacial Orthop, 101: 159-171, 1992.
8. Ericson S, Kurol J. Longitudinal study and analysis of clinical supervision of maxillary canine eruption. Community Dent Oral Epidemiol, 14: 172–176, 1986.
9. Ericson S, Kurol J. Resorption of incisors after ectopic eruption of maxillary canines: a CT study. Angle Orthod, 70: 415–423, 2000.
10. Ericson S, Kurol J. Radiographic examination of ectopically erupting maxillary canines. Am J Orthod Dentofacial Orthop, 91: 483–492, 1987.
11. Burstone CJ. The mechanics of the segmented arch techniques. Angle Orthod 1966;36:99-120.
12. Milberg DJ. Labially impacted maxillary canines causing severe root resorption of maxillary central incisors. Angle Orthod, 76: 173-176, 2006.
13. Brin I, Becker A, Zilberman Y. Resorbed lateral incisors adjacent to impacted canines have normal crown size. Am J Orthod Dentofacial Orthop, 104: 60-66, 1993.
14. Rimes RJ, Mitchell CN, Willmot DR. Maxillary incisor root resorption in relation to the ectopic canine: a review of 26 patients. Eur J Orthod, 19: 79-84, 1997.
15. Alqerban A, Jacobs R, Souza PC, Willems G. In-vitro comparison of 2 cone-beam computed tomography systems and panoramic imaging for detecting simulated canine impaction-induced external root resorption in maxillary lateral incisors. Am J Orthod Dentofacial Orthop, 136: 764.e1-11; discussion 764-765, 2009.
16. Alqerban A, Jacobs R, Fieuws S, Nackaerts O, Willems G. Comparison of 6 cone-beam computed tomography systems for image quality and detection of simulated canine impaction-induced external root resorption in maxillary lateral incisors. Am J Orthod Dentofacial Orthop, 140: e129-39, 2011.
17. Kamburoglu K, Kursun S, Yuksel S, Oztas B. Observer ability to detect ex vivo simulated internal or external cervical root resorption. J Endod, 37:168-175, 2011.
18. Alqerban A, Jacobs R, Lambrechts P, Loozen G, Willems G. Root resorption of the maxillary lateral incisor caused by impacted canine: a literature review. Clin Oral Investig, 13: 247–255, 2009.
19. Ericson S, Bjerklin K, Falahat B. Does the canine dental follicle cause resorption of permanent incisor roots? A computed tomographic study of erupting maxillary canines. Angle Orthod, 72: 95–104, 2002.
20. Artun J, Smale I, Behbehani F, Doppel D, Van't Hof M, Kuijpers-Jagtman AM. Apical root resorption six and 12 months after initiation of fixed orthodontic appliance therapy. Angle Orthod, 75: 919-926, 2005.
21. Berg R. Evaluation of orthodontic results-a discussion of some methodological aspects. Angle Orthod, 61: 261-266, 1991.
22. 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, 127: 650-654, 2005.
23. Povolny B. Thyroid function and root resorption. Angle Orthod, 64: 389-394, 1994.

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/40/2/161/1743305/1053-4628-40_2_161.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022