



A Review of the Diagnosis and Management of Impacted Maxillary Canines

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A review of the diagnosis and management of impacted maxillary canines

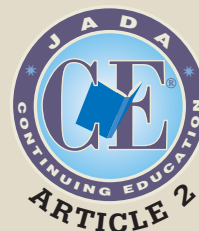
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With early detection, timely interception, and well-managed surgical and orthodontic treatment, impacted maxillary canines can be allowed to erupt and be guided to an appropriate location in the dental arch. However, it is only with interdisciplinary care of general dentists and specialists that impacted maxillary canines can be treated successfully. For many years, the treatment of impacted canines has sparked interest among general dentists and specialists, including orthodontists, periodontists, pediatric dentists and oral surgeons.

Disturbances in the eruption of permanent maxillary canines are common because they develop deep within the maxilla and have the longest path to travel compared with any other tooth in the oral cavity. Canines play a vital role in facial appearance, dental esthetics, arch development and functional occlusion. As a result, orthodontists have acknowledged the significance of retaining impacted maxillary canines and have proposed various techniques to effectively and efficiently recover these teeth. In orthodontics and dentistry in general, canine impaction is a dental anomaly that occurs frequently, and clinicians must be prepared to manage it.

We conducted a search of the lit-

ABSTRACT



Background. The authors conducted a literature review regarding the clinical and radiographic diagnoses of impacted maxillary canines, as well as the interceptive treatment (including surgical and orthodontic management) used to prevent or properly treat impacted canines.

Types of Studies Reviewed. The authors reviewed clinical and radiographic studies, literature reviews and case reports. They selected only studies that pertained to the prevalence, etiology and diagnosis of impacted maxillary canines, as well as the most recent studies regarding surgical and orthodontic techniques for the proper management of impacted maxillary canines.

Results. Impacted canines can be detected at an early age, and clinicians might be able to prevent them by means of proper clinical diagnosis, radiographic evaluation and timely interceptive treatment. Surgical techniques that can be used to manage impacted canines vary depending on whether the impactions are labial or palatal, and orthodontic techniques vary according to clinical judgment and experience.

Clinical Implications. Canine impaction is a common occurrence, and clinicians must be prepared to manage it. With early detection, timely interception, and well-managed surgical and orthodontic treatment, impacted maxillary canines can be erupted and guided to an appropriate location in the dental arch.

Key Words. Impacted canines; surgical techniques; orthodontic techniques.

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BOX

Etiologic factors associated with impacted canines.*

LOCALIZED

- Tooth size–arch length discrepancies
- Failure of the primary canine root to resorb
- Prolonged retention or early loss of the primary canine
- Ankylosis of the permanent canine
- Cyst or neoplasm
- Dilaceration of the root
- Absence of the maxillary lateral incisor
- Variation in root size of the lateral incisor (that is, peg-shaped lateral incisor)
- Variation in timing of lateral incisor root formation
- Iatrogenic factors
- Idiopathic factors

SYSTEMIC

- Endocrine deficiencies
- Febrile diseases
- Irradiation

GENETIC

- Heredity
- Malposed tooth germ
- Presence of an alveolar cleft

* Source: Ngan and colleagues,¹ Bishara,² Cooke and Wang,³ Proffit and colleagues,⁴ Yavuz and colleagues,⁵ Ericson and Kuroi,⁶ Mitchell,⁷ Jacoby,⁸ Becker,⁹ Peck and colleagues,¹⁰ and Baccetti.¹¹

erature from 1959 to 2009 using several electronic databases, including PubMed and Cochrane Library, as well as bibliographies from identified reviews relevant to our study. We selected clinical and radiographic studies involving impacted maxillary canines, literature reviews and case reports containing information about the prevalence, etiology and diagnosis of impacted canines. We also selected literature reviews and case reports from the past 10 years that addressed the surgical and orthodontic techniques used for the proper management of impacted maxillary canines.

PREVALENCE AND ETIOLOGY

Maxillary canines are the most commonly impacted teeth, second only to third molars.^{1,2} Maxillary canine impaction occurs in approximately 2 percent of the population and is twice as common in females as it is in males.^{3,4} The incidence of canine impaction in the maxilla is more than twice that in the mandible.⁵ Of all patients who have impacted maxillary canines, 8 percent have bilateral impactions.² Approximately one-third of impacted maxillary canines are located labially, and two-thirds are located palatally.^{6,7}

Canine impaction can be caused by various factors. The exact etiology of palatally displaced

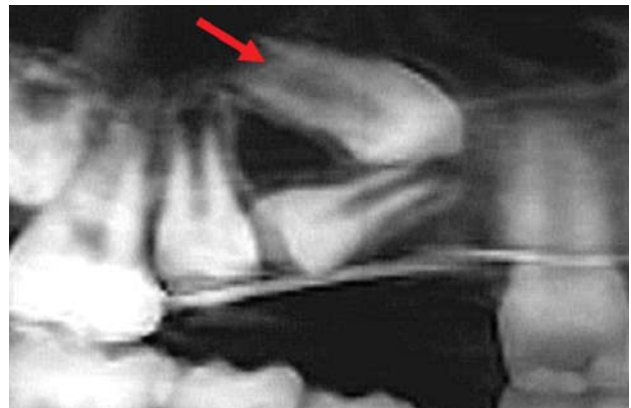


Figure 1. Panoramic radiograph showing the maxillary canine (arrow), which had lost eruption guidance owing to an absent lateral incisor.

maxillary canines is unknown. The results of Jacoby's⁸ study showed that 85 percent of palatally impacted canines had sufficient space for eruption, whereas only 17 percent of labially impacted canines had sufficient space. Therefore, arch length discrepancy is thought to be a primary etiologic factor for labially impacted canines.⁷ Several etiologic factors for canine impactions have been proposed: localized, systemic or genetic (Box¹⁻¹¹).

Two major theories associated with palatally displaced maxillary canines are the guidance theory and genetic theory. The guidance theory proposes that the canine erupts along the root of the lateral incisor, which serves as a guide, and if the root of the lateral incisor is absent or malformed, the canine will not erupt (Figure 1).⁹ The genetic theory points to genetic factors as a primary origin of palatally displaced maxillary canines and includes other possibly associated dental anomalies, such as missing or small lateral incisors.¹⁰ Baccetti¹¹ reported that palatally impacted maxillary canines are genetically reciprocally associated with anomalies such as enamel hypoplasia, infraocclusion of primary molars, aplasia of second premolars and small maxillary lateral incisors.

Peck and colleagues¹⁰ stressed that the high probability of additional dental abnormalities' occurring in combination with a palatally displaced canine—such as congenital tooth absence

ABBREVIATION KEY. **CBCT:** Cone-beam computed tomography. **EWC:** Easy-Way-Coil. **MGJ:** Mucogingival junction. **NiTi:** Nickel titanium. **SLOB:** Same lingual opposite buccal. **TADs:** Temporary anchorage devices.

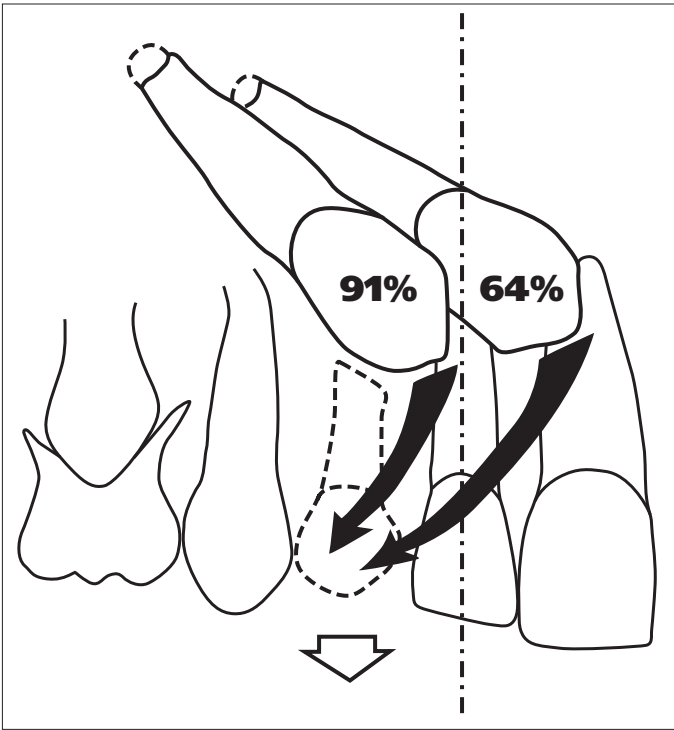


Figure 2. Schematic illustration showing the normalization rates of the maxillary canine after extraction of the primary canine when the permanent maxillary canine is located mesially and distally to the midline of the lateral incisor. Reprinted with permission of the publisher from Ericson and Kuroi.⁶

and delayed eruption—should alert clinicians to be circumspect when planning treatment. Becker⁹ reported an increase of 2.4 times in the incidence of palatally impacted canines adjacent to the sites of missing lateral incisors compared with palatally impacted canines in the general population.

It remains uncertain, however, whether an anomalous lateral incisor is a local causal factor for palatally displaced canines or the displaced canines are the result of an associated genetic developmental influence.

SEQUELAE OF MAXILLARY CANINE IMPACTION

Impacted canines usually are asymptomatic. Therefore, a patient usually is unaware of the impacted canines' existence. General practitioners and orthodontists discover most of these impacted teeth during initial radiographic examinations. Sequelae of abnormal eruption paths within the dentoalveolar process can include impactions and have serious clinical ramifications. For example, labially or palatally impacted teeth cause migration of the neighboring teeth and loss of arch length. In addition, unerupted canines may increase the patient's risk of developing a cystic lesion and infection and cause root resorption of the nearby lateral incisors and jeopardize the longevity of lateral incisors.¹² Lateral incisors adjacent to ectopically erupted canines have an incisor root resorption incidence of approximately 0.7 percent, but even with continued root development, an abnormally erupting canine can harm the adjacent lateral incisor.¹²⁻¹⁴ On the other hand, the presence of the impacted canine may cause no untoward effects during the patient's lifetime. The potential complications, however, emphasize the need for dentists to monitor the development and eruption of impacted canines closely during routine dental exami-

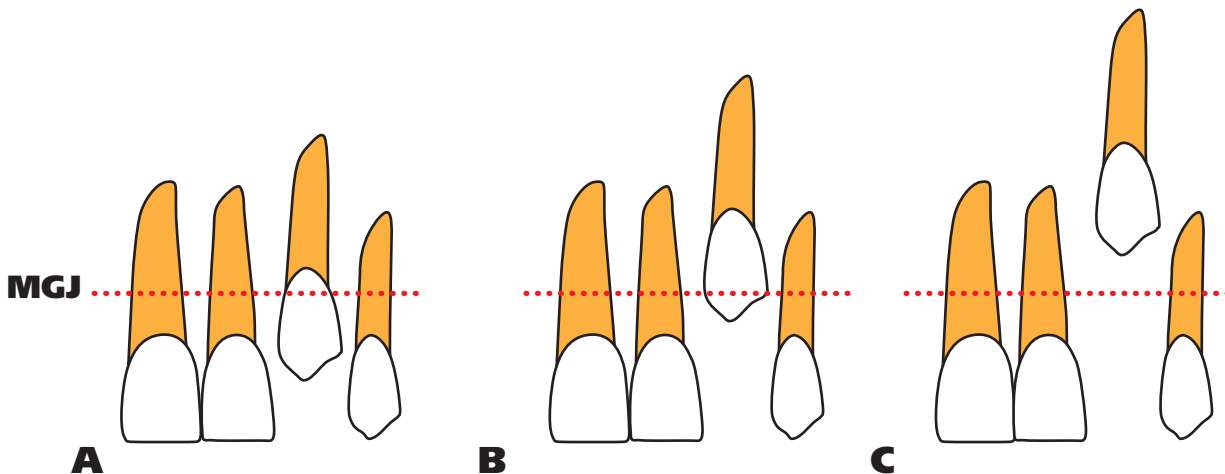


Figure 3. Recommended surgical techniques relative to the mucogingival junction (MGJ) when the canine cusp is (A) coronal to the MGJ: gingivectomy; (B) apical to the MGJ: creating an apically positioned flap; and (C) significantly apical to the MGJ: using a closed eruption technique.

TABLE 1

Surgical techniques for exposing impacted maxillary canines.*					
IMPACTION SITE	EXPOSURE TECHNIQUE	INDICATION THAT SURGICAL TECHNIQUE NEEDED TO BE PERFORMED	INITIATION OF ORTHODONTIC THERAPY	ADVANTAGES OF USING THE TECHNIQUE	DISADVANTAGES OF USING THE TECHNIQUE
Labial	Gingivectomy	Canine cusp is coronal to mucogingival junction (MGJ); adequate amount of keratinized gingiva is present; canine is not covered by bone	Orthodontic traction usually is not necessary because the tooth tends to erupt normally (usually only leveling and alignment is adequate)	Easy to perform; less traumatic	Used only occasionally; loss of attached gingiva, possible damage to periodontium; potential gingival overgrowth at surgical site
	Apically positioned flap	Canine crown is apical to MGJ; the amount of attached gingiva is minimal (used when less than 3 millimeters of attached gingiva is present)	Two to three weeks after surgery	Commonly used; conservation of keratinized gingiva	Increased risk of experiencing gingival recession; height differences and orthodontic relapse; more traumatic
	Closed eruption	Tooth is in the center of alveolus; crown is significantly apical to MGJ	One to two weeks after surgery	Greater esthetics; ease of tooth movement	Patient discomfort; second surgery may be necessary; possible mucogingival problems
Palatal	Closed flap	Canine is located near the lateral and central incisors, horizontally positioned, and higher in the roof of the mouth	One to two weeks after surgery	Immediate orthodontic traction	Bone necrosis; root resorption; longer operation time; repeat surgeries as a result of failure to erupt, bond failure due to blood or saliva contamination and fractured wire ligature; slightly longer overall treatment time
	Open eruption	Late mixed dentition; permanent dentition	When cusp tip is at the level of the occlusal plane	Improved bone levels; little or no root resorption; fewer re-exposures; shorter overall treatment time; less operating time; improved oral hygiene during treatment	Failure to erupt may extend total treatment time; unable to influence the path of eruption
	Open window eruption	Canine is located near the lateral and central incisors, horizontally positioned, and higher in the roof of the mouth	One to two weeks after removal of the pack	Visualization of the crown and better control of the direction of tooth movement; avoidance of moving the impacted tooth into the roots of the adjacent teeth	Gingival overgrowth at incision site; gingiva is subject to infection; patient discomfort
	Tunnel traction	The presence of primary canine in the arch	The suture is removed 10 days after surgery and the traction phase begins	Reduced amount of bone around the impacted tooth; the permanent canine is guided into the primary canine socket site	Requires the presence of a primary canine

* Source: Ngan and colleagues,¹ Bishara,² Cooke and Wang,³ Proffit and colleagues,⁴ Kokich and Mathews,²¹ Schmidt and Kokich,²² Kokich,²³ Vermette and colleagues,²⁴ Jarjoura and colleagues,²⁵ Crescini and colleagues,²⁶ Crescini and colleagues,²⁷ Ling and colleagues,²⁸ Quiryen and colleagues,²⁹ and Zasciurinskiene and colleagues.³⁰

nations of growing children.

CLINICAL DIAGNOSIS

Various clinical signs of canine impaction are documented in the dental literature. These signs include delayed eruption of the permanent canine, overretention of the primary canine, absence of a labial bulge, presence of a palatal bulge and distal crown tipping of the lateral incisor.² Ericson and Kuroi^{6,12} suggested that absence of the “canine bulge” when the child is around 11 years of age is not an indication of canine impaction. However, they suggested palpation of the buccal surface of the alveolar

process distal to the lateral incisor to help determine the position of the maxillary canine before its emergence.⁹ If a labial bulge is absent in a 9- or 10-year-old patient, eruption disturbance of the permanent canine should be suspected and a radiograph obtained to confirm the diagnosis.^{2,9}

RADIOGRAPHIC DIAGNOSIS

Several methods have been used to radiographically evaluate impacted maxillary canines. These methods include intraoral techniques (occlusal and periapical projections) and extraoral techniques (panoramic, posteroanterior or lateral cephalometric radiographs). The most practical method of obtaining an occlusal radiograph is by positioning the x-ray tube directly over the bridge of the nose, at a 60-degree angle to the occlusal plane.⁹ This method has been used to determine the buccolingual position of impacted teeth. However, the traditional method of locating impacted teeth—specifically, maxillary canines—has been the use of a two-dimensional technique with periapical radiographs, known as the buccal object rule.² This technique consists of taking two peri-

TABLE 2

Orthodontic techniques used to treat and manage impacted maxillary canines.			
STUDY	TECHNIQUE USED	ADVANTAGES	DISADVANTAGES
Fischer and Colleagues³¹	Cantilever system	Predictable tooth movement; low load or deflection; less frequent reactivations	Potential side effects should be identified on the anchor tooth
Park and Colleagues³²	Temporary anchorage devices (TADs)	Could provide absolute anchorage for tooth movement; bonding of orthodontic brackets can be delayed until the canine is aligned	Does not produce root movement; insertion and removal of TADs
Kim and Colleagues³³	Double-archwire mechanics	Minimizes root resorption of the lateral incisors; allows horizontal tooth movement	Insertion and removal of TADs; requires laboratory procedure; patient discomfort
Schubert³⁴	Easy-Way-Coil (EWC) system	Constant application of force; a long activation distance; simple reactivation	Loosening of EWC attachment; infectious reactions in oral mucosa
Tausche and Harzer³⁵	Auxiliary arm from transpalatal arch	Simple design; simple reactivation	Requires laboratory procedure; tends to break easily
Kornhauser and Colleagues³⁶	Auxiliary spring	No laboratory procedure; measured forces; complete eruption control; lack of damage to adjacent teeth	Requires extra chair time to bend the spring
Kalra³⁷	K-9 spring	Simple design; easy to fabricate and activate; continuous force	Side effects on the posterior teeth

apical radiographs at different mesiodistal angulations and using the same-lingual-opposite-buccal (SLOB) rule to determine the tooth’s buccolingual position. The radiographic interpretation of the SLOB rule is if, when obtaining the second radiograph, the clinician moves the x-ray tube in a distal direction, and on the radiograph the tooth in question also moves distally, then the tooth is located on the lingual or palatal side. Accordingly, if the impacted canine is located buccally, the crown of the tooth moves mesially.

When children are 8 or 9 years of age, dentists can locate the children’s maxillary canines easily on lateral cephalometric radiographs. The inclination of the maxillary canines should be parallel to that of the maxillary incisors. In posteroanterior radiographs, the canines should be angled medially, and the crowns should be located below the apexes of the lateral incisors and well below the lateral border of the nasal cavity. The canine roots should be located laterally to the lateral border of the nasal cavity. If a canine is angled medially, with the crown located medially to the lateral border of the nasal cavity, the possibility

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of impaction should be considered.⁹

Assessing the position of the impacted canine is key to determining the feasibility of and proper access for a surgical procedure, as well as the best direction for application of orthodontic forces. Visualizing and assessing the root of the lateral incisor is suggested, as 80 percent of these teeth can resorb owing to ectopically erupting canines.² The crown of the ectopically erupting canine may put pressure on the lateral incisor root, causing it to resorb. Clinicians can localize canines by using advanced three-dimensional imaging techniques. Cone-beam computed tomography (CBCT) can identify and locate the position of impacted canines accurately. By using this imaging technique, dentists also can assess any damage to the roots of adjacent teeth and the amount of bone surrounding each tooth. In a study, Liu and colleagues¹⁵ used CBCT to evaluate variations in location of impacted maxillary canines. They found that the position of impacted maxillary canines varies greatly. Reports of maxillary canine impactions vary considerably in orientation, and CBCT provides information to dentists so that they can properly manage impacted canines surgically and orthodontically.^{16,17} However, increased cost, time, radiation exposure and medicolegal issues associated with using CBCT limit its routine use.¹⁸

INTERCEPTIVE TREATMENT

Preventing maxillary canine impaction is the ideal form of treatment and provides the best long-term results. The success of early interceptive treatment for impacted maxillary canines is influenced by the degree of impaction and the patient's age at diagnosis.¹⁹ Using panoramic techniques, Ericson and Kuroi⁶ found that early extraction of primary maxillary canines may result in normal eruption of ectopically displaced permanent maxillary canines. They proposed that extracting the primary canine before the patient is 11 years of age would normalize the erupting position of the permanent canine in 91 percent of the cases if the crown were distal to the midline of the lateral incisor root (Figure 2, page 1487).^{6,18} However, the success rate decreases to 64 percent if the permanent canine crown is mesial to the midline of the lateral incisor root.^{6,18}

The failure of the primary canine roots to resorb creates a potential mechanical obstacle for the normal eruption of the permanent canine. Generally, after the impacted maxillary canine is

exposed surgically, the likelihood of complete recovery is poor when the degree of overlap between the maxillary canine and lateral incisor surpasses one-half the width of the lateral root.¹³ Other factors that can influence prognosis include canine angulation and crowding. The probability of successful eruption of an impacted canine after extraction of the primary canine decreases as the horizontal angulation increases.^{6,13} Power and Short¹³ discovered that when the vertical angulation exceeds 31 percent, the chance of normal eruption after extraction significantly decreases. Prognosis, however, is influenced more by the degree of canine overlap with the lateral incisor than by its angulation.¹³ Ericson and Kuroi⁶ found that lateral incisor root resorption increases when the canine cusp tip is positioned more mesially on the lateral root.

Dental arch crowding also can influence maxillary canine impaction. Complex orthodontic treatment is required to resolve moderate-to-severe crowding, impaction and malocclusion.^{13,20} Clinicians should make every attempt to position the canine in its proper location within the arch. Therefore, orthodontists recommend that clinicians intercede and extract the primary canine in a timely manner to prevent impaction of the permanent canines.

THE MANAGEMENT OF IMPACTED MAXILLARY CANINES

The most desirable approach for managing impacted maxillary canines is early diagnosis and interception of potential impaction. However, in the absence of prevention, clinicians should consider orthodontic treatment followed by surgical exposure of the canine to bring it into occlusion. In such a case, open communication between the orthodontist and oral surgeon is essential, as it will allow for the appropriate surgical and orthodontic techniques to be used.

The most common methods used to bring palatally impacted canines into occlusion are surgically exposing the teeth and allowing them to erupt naturally during early or late mixed dentition,^{21,22} and surgically exposing the teeth and placing a bonded attachment to and using orthodontic forces to move the tooth.² Kokich²³ reported three methods for uncovering a labially impacted maxillary canine: gingivectomy, creating an apically positioned flap and using closed eruption techniques (Figure 3, page 1487). Kokich²³ also suggested four criteria for determining the correct

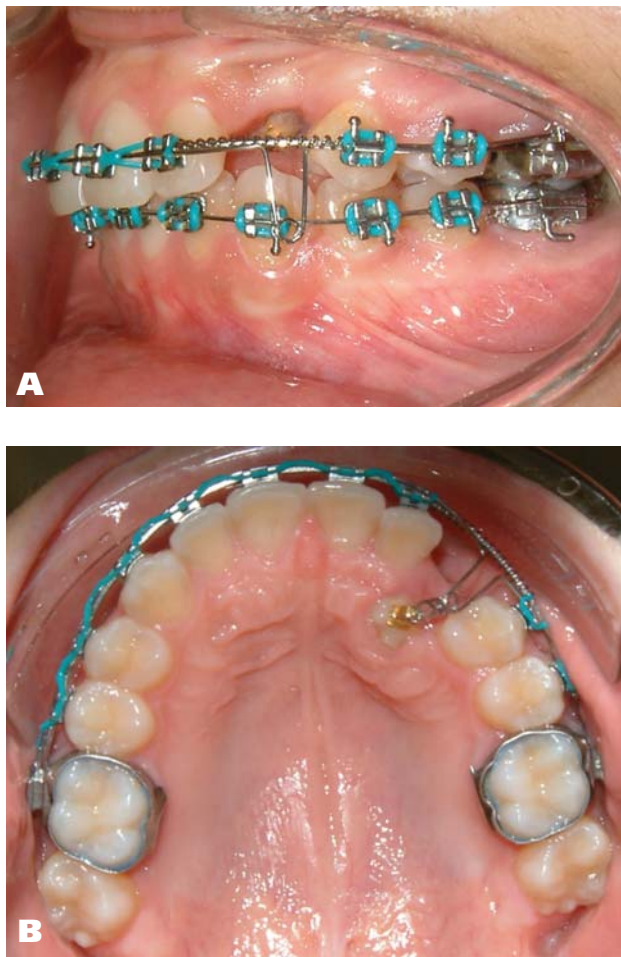


Figure 4. A. Lateral view of spring auxiliary labial arch wire (0.016-inch) ligated over main arch wire (0.018- × 0.025-inch) in its passive vertical position after surgery. A nickel titanium (NiTi) open-coil spring creates space for the impacted canine. **B.** Maxillary occlusal view of a NiTi closed-coil spring with an eyelet engaged to the tooth, and the other side of the spring (without end loops) engaged to the auxiliary arch wire to activate for extrusion.

techniques for surgically exposing a labial or intra-alveolar impaction of a maxillary canine: the labiolingual position of the impacted canine crown, the vertical position of the tooth relative to the mucogingival junction, the amount of gingiva in the area of the impacted canine and the mesiodistal position of the canine crown. A summary of surgical techniques used to manage impacted maxillary canines is presented in Table 1 (page 1488).^{1-4,21-30}

There have been conflicting studies regarding the periodontium, including gingival attachment and bone level, of recovered impacted maxillary canines. To prevent undesirable periodontal responses, factors that clinicians should consider

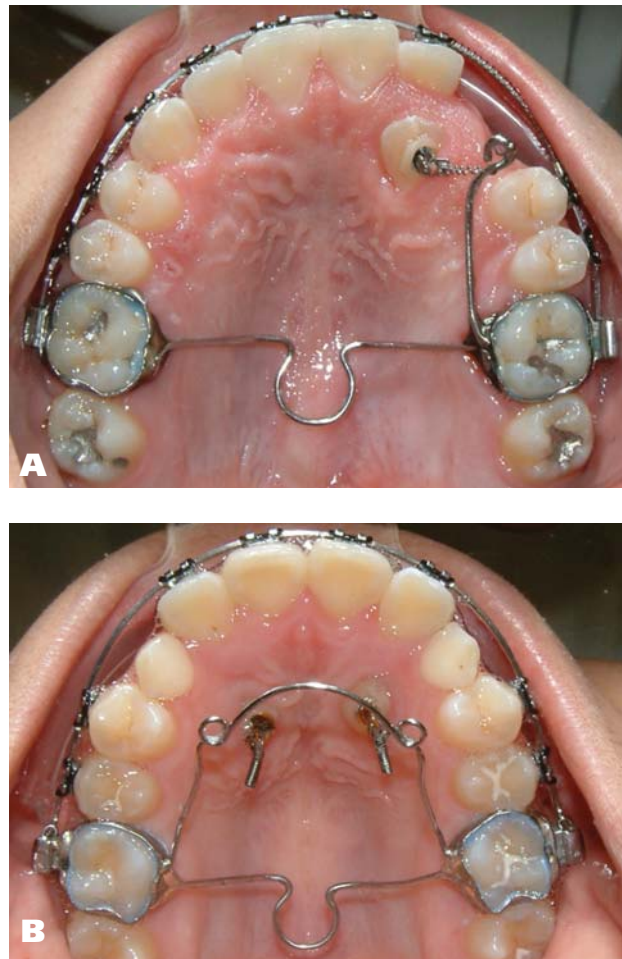


Figure 5. A. Maxillary occlusal view of sectional lingual arch wire welded to the molar band. The cantilever was activated for occlusal and buccal movement of the palatally impacted canine. **B.** Maxillary occlusal view of a palatal arch wire welded to the molar bands. To extrude the impacted canines, before ligation with NiTi closed-coil springs, the clinician activated a palatal arch wire occlusally. Note: the primary canines were not extracted (from a 13-year-old male patient) before the feasibility of moving the impacted canines was ensured.

include impaction depth, anatomy of the edentulous site, and speed and direction of the orthodontic force.²⁴ The results of several studies have shown that surgical exposure and orthodontic eruption of palatally impacted maxillary canines have minor effects on the periodontium.^{22,28,29} Schmidt and Kokich²² discovered that open surgical exposure of impacted maxillary canines had minimal effects on the periodontium, and that the overall effects on the impacted canine appeared better than those from the closed exposure and early traction techniques. Zasciurinskiene and colleagues³⁰ found that surgical exposure and orthodontic extrusion of palatally impacted maxillary canines resulted in clinically acceptable

periodontal conditions; however, this result depended on the initial vertical and horizontal position of the impacted canine.

Many techniques have been used to move impacted teeth into occlusion (Table 2, page 1489).³¹⁻³⁷ Orthodontists have recommended that other clinicians first create adequate space in the dental arch to accommodate the impacted canine and then surgically expose the tooth to give orthodontists access so that they can apply mechanical force to erupt the tooth. Although various methods work, an efficient way to make impacted canines erupt is to use closed-coil springs with eyelets, as long as no obstacles impede the path of the canine (Figures 4 and 5, page 1491).

If the canine is in close proximity to the incisor roots and a buccally directed force is applied, the canine will contact the roots and may cause damage.³⁸ In addition, the canine position may not improve due to the root obstacle. Consequently, various techniques have been proposed that involve moving the impacted tooth in an occlusal and posterior direction first and then moving it buccally into the desired position. When using a bonded attachment and orthodontic forces to bring the impacted canines into occlusion, it is important to remember that first premolars should not be extracted until a successful attempt is made to move the canines. If the attempt is unsuccessful, the permanent canines should be extracted.

The need to make a decision to extract an impacted maxillary canine is rare, as the risk exists that it may affect esthetics and occlusion. However, if the canine has limitations owing to its location or is severely affected anatomically, extraction may be the only option. In this case, the orthodontist has to decide if the premolar should be moved into the canine position. Orthodontists should consider treatment alternatives, such as autotransplantation³⁹ or restoration,^{40,41} in collaboration with other specialists, including oral surgeons, periodontists and prosthodontists. The patient should be informed about all of the potential complications before surgical and orthodontic interventions take place.⁴²

CONCLUSIONS

The management of impacted canines is important in terms of esthetics and function. Clinicians must formulate treatment plans that are in the best interest of the patient, and they must be knowledgeable about the variety of treatment

options. When patients are evaluated and treated properly, clinicians can reduce the frequency of ectopic eruption and subsequent impaction of the maxillary canine. The simplest interceptive procedure that can be used to prevent impaction of permanent canines is the timely extraction of the primary canines. This procedure usually allows the permanent canines to become upright and erupt properly into the dental arch, provided sufficient space is available to accommodate them.

Various surgical and orthodontic techniques may be used to recover impacted maxillary canines. The proper management of these teeth, however, requires that the appropriate surgical technique be used and that the clinician be able to apply measured forces in a favorable direction. This allows for complete control in efficient correction the impaction and for avoidance of damage to adjacent teeth. Careful selection of surgical and orthodontic techniques is essential for the successful alignment of impacted maxillary canines. ■

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