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SPECIAL ARTICLE

Impacted maxillary canines: A review

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An overview of the incidence and sequelae, as well as the surgical, periodontal, and orthodontic considerations in the management, of impacted canines is presented. The clinician needs to be familiar with the differences in the surgical management of the labially and palatally impacted canines, the best method of attachment to the canine for orthodontic force application, the advantages of one-arch versus two-arch treatment, and the implications of canine extraction. The various factors that influence all these decisions are discussed. (AM J ORTHOD DENTOFAC ORTHOP 1992;101:159-71.)

Almost everything I know or find out through experience and study has, I find, appeared in print in one place or another, and often many years ago. The saving grace is that what I am about to present may have been forgotten or overlooked.
Wilbur D. Johnston[1]

The ectopic eruption and impaction of maxillary permanent canines is a frequently encountered clinical problem. The diagnosis and treatment of this problem usually requires the expertise and cooperation of the general practitioner, the pediatric dentist, the oral surgeon, and the periodontist, as well as the orthodontist.

INCIDENCE OF CANINE IMPACTION

Dachi and Howell[2] reported that the incidence of maxillary canine impaction is 0.92%, whereas Thilander and Myrberg[3] estimated the cumulative prevalence of canine impaction in 7- to 13-year-old children to be 2.2%. Ericson and Kurol[4] estimated the incidence at 1.7%. Impactions are twice as common in females (1.17%) as in males (0.51%). Of all patients with maxillary impacted canines, it is estimated that 8% have bilateral impactions. The incidence of mandibular canine impaction is 0.35%.[2]

Since maxillary canines are impacted more frequently, the emphasis of this presentation will be on their management. However, the general principles of diagnosis and treatment can be applied to both the maxillary and the mandibular teeth.

DEVELOPMENTAL CONSIDERATIONS

According to Dewel,[5] maxillary canines have the longest period of development, as well as the longest and most tortuous course to travel from point of formation, lateral to the piriform fossa, until they reach their final destination in full occlusion.

During their course of development, the crowns of the permanent canines are intimately related to the roots of the lateral incisors. Broadbent[6] cautioned against early correction of the flared and distally tipped lateral incisors for fear of either impacting the canines or resorbing the roots of the lateral incisors.

ETIOLOGY OF MAXILLARY CANINE IMPACTION

In general, the causes for retarded eruption of teeth may be either generalized or localized.[7,8] Generalized causes include endocrine deficiencies, febrile diseases, and irradiation. The most common causes for canine impactions are usually localized and are the result of any one, or combination of the following factors: (a) tooth size–arch length discrepancies, (b) prolonged retention or early loss of the deciduous canine, (c) abnormal position of the tooth bud, (d) the presence of an alveolar cleft, (e) ankylosis, (f) cystic or neoplastic formation, (g) dilaceration of the root, (h) iatrogenic origin (discussed earlier), and (i) idiopathic condition with no apparent cause.

More recently, the absence of the maxillary lateral incisor and variation in the root size of the tooth, as well as variation in the timing of its root formation, have been implicated as important etiologic factors associated with canine impaction.[9-11] It seems that the presence of the lateral incisor root with the right length, formed at the right time, is an important variable needed to guide the mesially erupting canine in a more favorable distal and incisal direction. Becker et al.[11] reported an increase of 2.4 times in the incidence of palatally impacted canines adjacent to the sites of missing lateral incisors as compared with the general population.

This multifactorial etiology may explain why canine impactions occur when other dental relationships are apparently normal, or in cases in which lateral incisors

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are congenitally missing when more than sufficient space is available for eruption of the impacted tooth.

SEQUELAE OF IMPACTION

Shafer et al.[12] suggested the following sequelae for canine impaction: (a) labial or lingual malpositioning of the impacted tooth, (b) migration of the neighboring teeth and loss of arch length, (c) internal resorption, (d) dentigerous cyst formation, (e) external root resorption of the impacted tooth, as well as the neighboring teeth, (f) infection particularly with partial eruption, (g) referred pain, and (h) combinations of the above sequelae. It is estimated that in 0.71% of children in the 10- to 13-year age group, permanent incisors have resorbed because of the ectopic eruption of maxillary canines.[13] On the other hand, the presence of the impacted canine may cause no untoward effects during the lifetime of the person.

These potential complications, as well as others that will be detailed later, emphasize the need for close observation of the development and eruption of these teeth during "routine" periodic dental examination of the growing child.

DIAGNOSIS OF IMPACTION

The diagnosis of canine impaction is based on both clinical and radiographic examinations.

Clinical evaluation. It has been suggested that the following clinical signs might be indicative of canine impaction: (1) delayed eruption of the permanent canine or prolonged retention of the deciduous canine beyond 14 to 15 years of age, (2) absence of a normal labial canine bulge, in other words, either inability to locate canine position through intraoral palpation of the alveolar process or the presence of an asymmetry in the canine bulge noted during alveolar palpation, (3) presence of a palatal bulge, and (4) delayed eruption, distal tipping, or migration (splaying) of the lateral incisor.

According to Ericson and Kurol,[13] the absence of the "canine bulge" at earlier ages should not be considered as indicative of canine impaction. In their evaluation of 505 schoolchildren between 10 and 12 years of age, they found that 29% of the children had nonpalpable canines at 10 years, but only 5% at 11 years, whereas at later ages only 3% had nonpalpable canines. Therefore for an accurate diagnosis the clinical examination should be supplemented with a radiographic evaluation.

Radiographic evaluation. Although various radiographic exposures, including occlusal films, panoramic views, and lateral cephalograms, can help in evaluating the position of the canines, in most cases periapical films are uniquely reliable for that purpose.

1. Periapical films. A single periapical film provides the clinician with a two-dimensional representation of the dentition. In other words, it would relate the canine to the neighboring teeth both mesiodistally and superoinferiorly. To evaluate the position of the canine buccolingually, a second periapical film should be obtained by one of the following methods.[14]
   a. Tube-shift technique or Clark's rule. Two periapical films are taken of the same area, with the horizontal angulation of the cone changed when the second film is taken. If the object in question moves in the same direction as the cone, it is lingually positioned. If the object moves in the opposite direction, it is situated closer to the source of radiation and is therefore buccally located (Fig. 1, *a*).
   b. Buccal-object rule. If the vertical angulation of the cone is changed by approximately 20° in two successive periapical films, the buccal object will move in the direction opposite the source of radiation (Fig. 1, *b*). On the other hand, the lingual object will move in the same direction as the source of radiation. The basic principle of this technique deals with the foreshortening and elongation of the images of the films.
2. Occlusal films also help determine the buccolingual position of the impacted canine in conjunction with the periapical films, provided that the image of the impacted canine is not superimposed on the other teeth.
3. Extraoral films. (a) Frontal and lateral cephalograms can sometimes aid in the determination of the position of the impacted canine, particularly its relationship to other facial structures (e.g., the maxillary sinus and the floor of the nose). (b) Panoramic films are also used to localize impacted teeth in all three planes of space, much the same as with two periapical films in the tube-shift method, with the understanding that the source of radiation comes from behind the patient; thus the movements are reversed for position.[15]

The proper localization of the impacted tooth plays a crucial role in determining the feasibility of, as well as the proper access for, the surgical approach, and the proper direction for the application of orthodontic forces.

According to Ericson and Kurol,[16] with the use of periapical films the clinician is able to evaluate the position of the canine with sufficient accuracy in 92% of the cases. However, in only 37% of the cases were

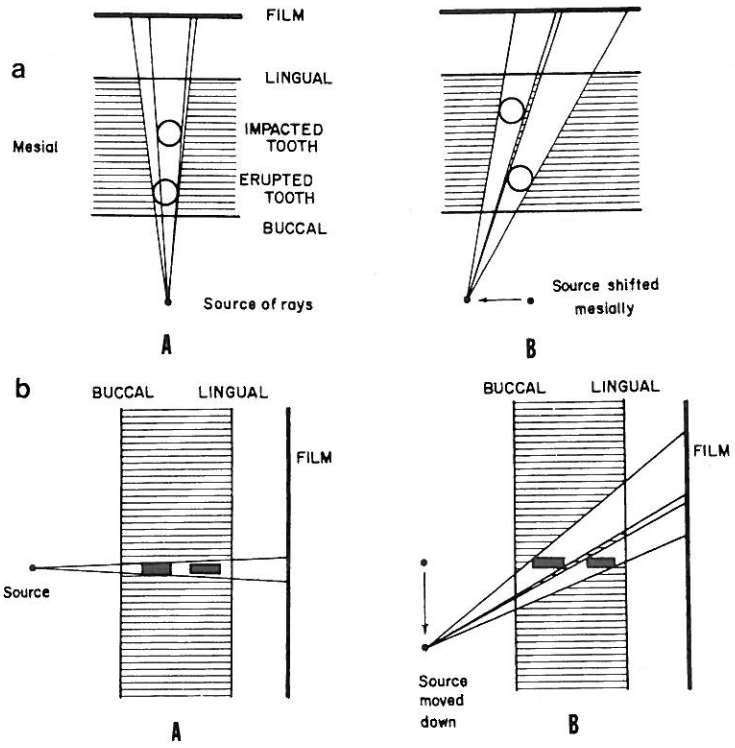


Fig. 1. Tube shift technique to locate impacted canines. **a,** Effect of mesiodistal cone movement on the relative position of the teeth. **b,** Effect of superoinferior cone movement on the relative position of the teeth.

they able to project the lateral incisor image away from that of the canine (Fig. 2).

The evaluation of the condition of the lateral incisor root is of great importance to the clinician since 80% of the teeth resorbed by the ectopically erupting canines were found to be lateral incisors (Fig. 3, *F* and *G*). Ericson and Kurol[16] estimated that 0.7% of the children in the 10- to 13-year age group have resorbed permanent incisors because of ectopic eruption of the maxillary canines. With a more elaborate radiographic technique, polytomography, Ericson and Kurol found the number of teeth that were diagnosed as resorbed almost doubled. Of concern is that in half of the teeth that showed resorption, the lesion extended into the pulp. Furthermore, 50% of the children had either labial or lingual resorption that would escape detection in routine periapical radiographic evaluations.[17]

PREVENTION OF MAXILLARY CANINE IMPACTION

When the clinician detects early signs of ectopic eruption of the canines, an attempt should be made to prevent their impaction and its potential sequelae.

Selective extraction of the deciduous canines as early as 8 or 9 years of age has been suggested by

Fig. 2. Superimposed images of lateral incisor and canine can be separated in only 37% of the cases.[14]

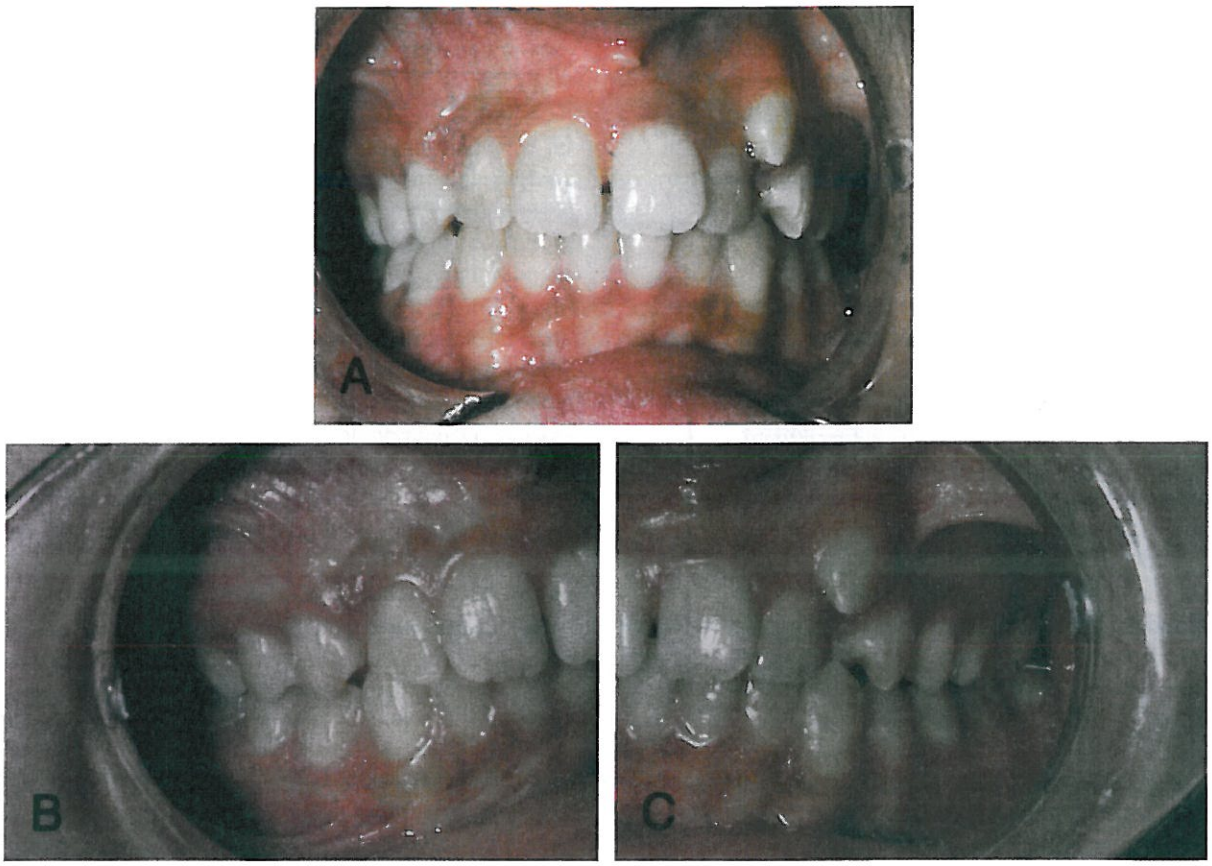


Fig. 3. A-C, Intraoral photographs of dentition of a patient with a Class II malocclusion with an impacted maxillary right canine and ectopic labially erupting left canine.

Williams[18] as an interceptive approach to canine impaction in Class I uncrowded cases. Ericson and Kurol[19] suggested that removal of the deciduous canine before the age of 11 years will normalize the position of the ectopically erupting permanent canines in 91% of the cases if the canine crown is distal to the midline of the lateral incisor. On the other hand, the success rate is only 64% if the canine crown is mesial to the midline of the lateral incisor, as seen in Fig. 2.[19]

TREATMENT ALTERNATIVES

Each patient with an impacted canine must undergo a comprehensive evaluation of the malocclusion. The clinician should then consider the various treatment options available for the patient, including the following: (a) No treatment if the patient does not desire it. In such a case, the clinician should periodically evaluate the impacted tooth for any pathologic changes. It should be remembered that the long-term prognosis for retaining the deciduous canine is poor, regardless of its present root length and the esthetic acceptability of its crown. This is because, in most cases, the root will eventually resorb and the deciduous canine will have to be extracted (Fig. 2). (b) Auto transplantation of the canine.[20,21] (c) Extraction of the impacted canine and movement of a first premolar in its position (Fig. 3). (d) Extraction of the canine and posterior segmental osteotomy to move the buccal segment mesially to close the residual space.[22] (e) Prosthetic replacement of the canine. (f) Surgical exposure of the canine and orthodontic treatment to bring the tooth into the line of occlusion. This is obviously the most desirable approach.

WHEN TO EXTRACT AN IMPACTED CANINE

It should be emphasized that extraction of the labially erupting and crowded canine, unsightly as this tooth may look, is contraindicated (Fig. 3, *A*). Such an extraction might temporarily improve the esthetics but may complicate and compromise the orthodontic treatment results, including the ability to provide the patient with a functional occlusion. The extraction of

the canine, although seldom considered, might be a workable option in the following situations: (1) If it is ankylosed and cannot be transplanted, (2) if it is undergoing external or internal root resorption, (3) if its root is severely dilacerated, (4) if the impaction is severe (e.g., the canine is lodged between the roots of the central and lateral incisors and orthodontic movement will jeopardize these teeth) (Fig. 3, *F* and *G*), (5) if the occlusion is acceptable, with the first premolar in the position of the canine and with an otherwise functional occlusion with well-aligned teeth (Fig. 3, *B*), (6) if there are pathologic changes (e.g., cystic formation, infection), and the patient does not desire orthodontic treatment.

PALATAL VERSUS LABIAL IMPACTIONS

It is estimated that the incidence of palatal impaction exceeds that of labial impaction by a ratio of at least 2:1 or 3:1.[23] Jacoby[24] believed that it is difficult to establish an accurate rate for palatal versus labial impaction. He attributed this to the difficulty in determining whether a labially impacted tooth might eventually erupt on its own, often further superiorly and labially than its normal position. Jacoby further observed that roughly 85% of palatally impacted canines had sufficient space for eruption into the dental arch. Conversely, only 17% of the labially unerupted maxillary canines appeared to have sufficient space for eruption (i.e., 83% showed an arch length deficiency). This suggests that for labially impacted canines, arch length deficiency is often a primary etiologic factor.[24]

As stated earlier, ectopic labially positioned canines may erupt on their own without surgical exposure and orthodontic treatment, frequently high in the sulcus or alveolar ridge (Fig. 3, *C*). On the other hand, palatally impacted canines seldom erupt without intervention.[24] It is believed that this impeded eruption is due to the thickness of the palatal cortical bone, as well as the dense, thick, and resistant palatal mucosa.

Palatally impacted canines are more often inclined in a horizontal/oblique direction, whereas labial impactions offer a more favorable vertical angulation. Yet they are still considered difficult because of the needed delicacy in managing the associated hard and soft tissues.

MANAGEMENT OF THE PALATALLY IMPACTED CANINE

There are numerous surgical methods for exposing the impacted canine and bringing it to the line of occlusion. Two of the most commonly used methods are (1) surgical exposure, allowing natural eruption, and (2) surgical exposure with placement of an auxiliary attachment. Orthodontic forces are subsequently applied to the attachment to move the impacted tooth.

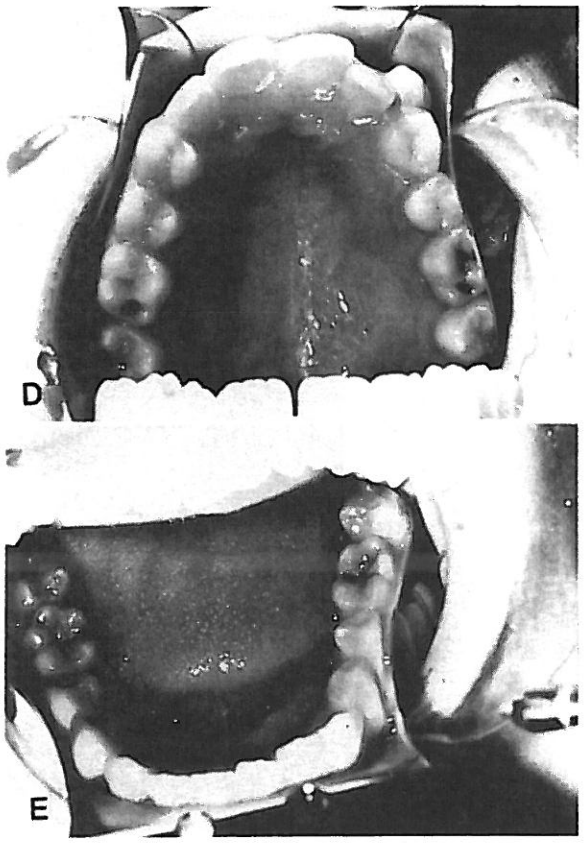


Fig. 3. (cont'd) **D** and **E,** Intraoral photographs.

Surgical exposure to allow natural eruption to occur (Fig. 4). This method is most useful when the canine has a correct axial inclination and does not need to be uprighted during its eruption. The progress of canine eruption should be monitored with roentgenograms with the use of reference points such as an adjacent tooth or the arch wire.

Clark[25] recommended that a polycarbonate crown be placed over the impacted tooth after its surgical exposure. The crown should be made long enough to extend through a window cut in the palatal tissue. The crown is then cemented with a surgical paste or regular cement. Often, 6 months to 1 year may elapse before the impacted tooth has erupted sufficiently to permit removal of the polycarbonate crown and its replacement with an orthodontic attachment. If the tooth fails to erupt, Clark recommends the removal of any cicatricial tissue surrounding the crown.

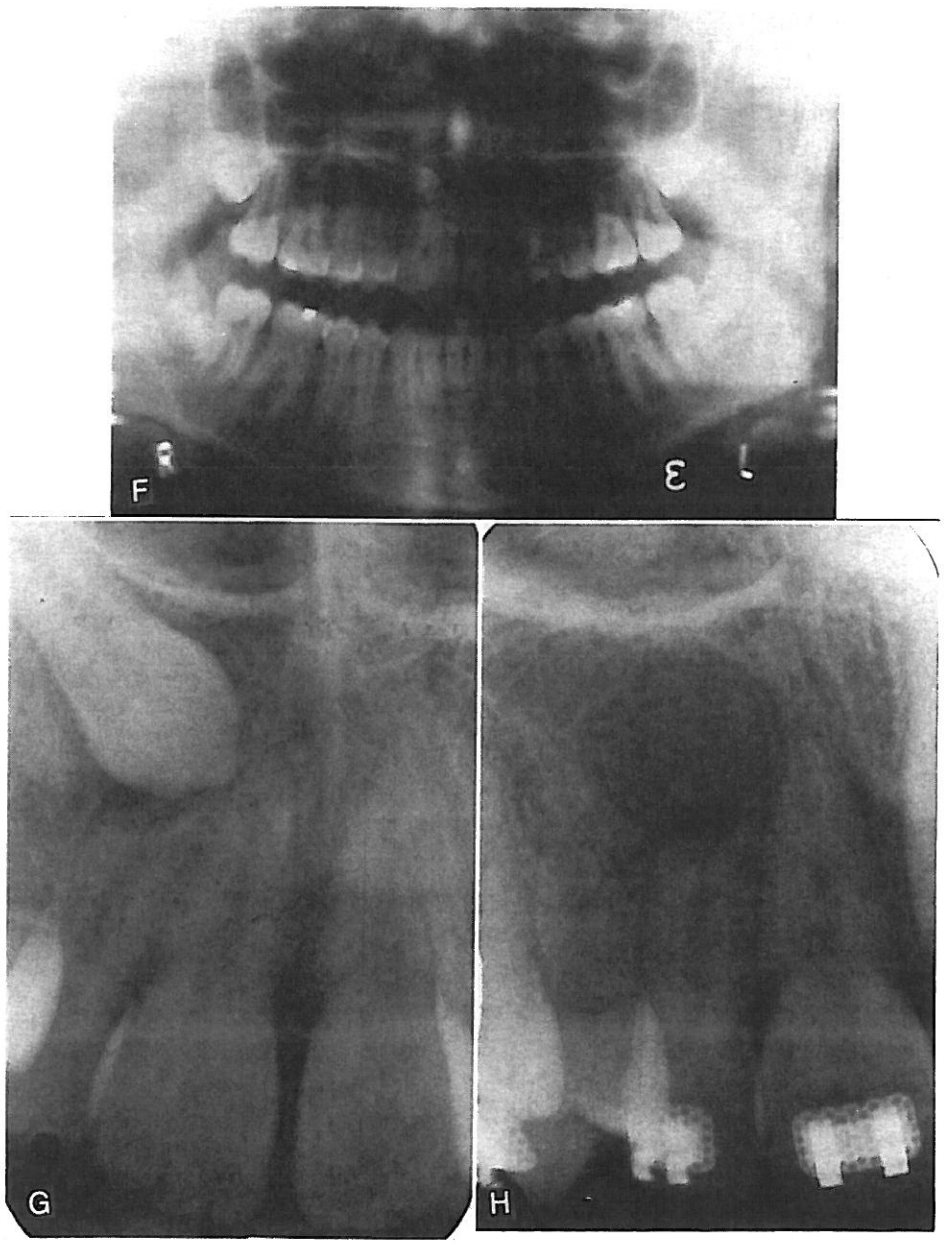


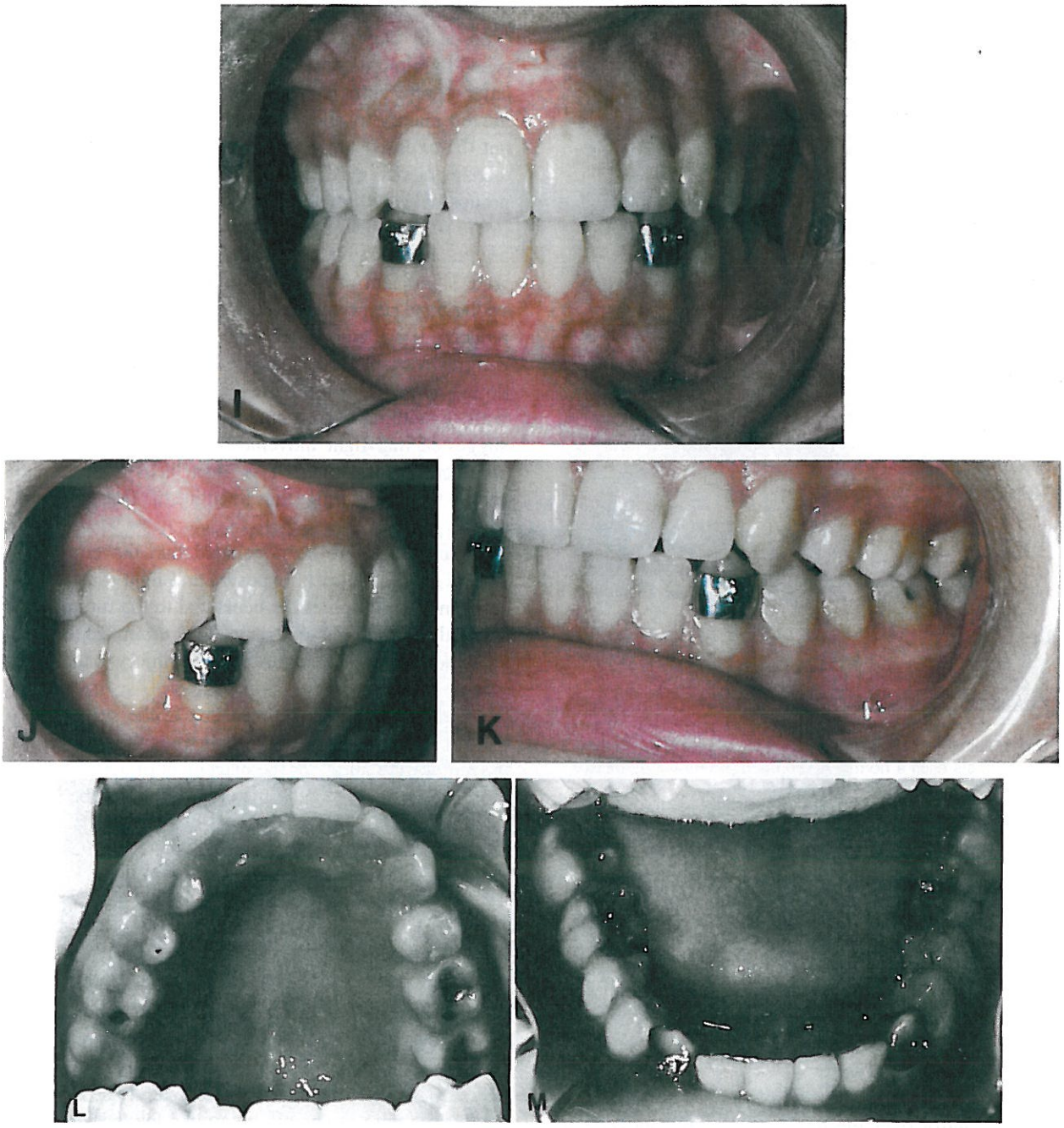
Fig. 3 (cont'd). **F-G,** Panoramic and periapical views showing the position of impacted canine and partial resorption of root of lateral incisor. **H,** Periapical film showing new bone filling the bony defect created by the surgical removal of the impacted canine.

The main disadvantages of this approach are the spontaneous but slow canine eruption, the increased treatment time, and the inability to influence the path of eruption of the impacted canine (Fig. 4).

Surgical exposure with the placement of an auxiliary. After the surgical exposure of the impacted tooth, an auxiliary is attached to the crown. Such an auxiliary can be either directly bonded to enamel or indirectly attached to a cemented band or crown.

Two approaches are generally recommended in regard to the timing of placing the attachment:

1. Lewis[26] preferred a two-step approach. First, the canine is surgically uncovered and the area is packed with a surgical dressing to avoid the fill-



I-M, Intraoral photographs of the dentition 1 year after completion of treatment. Note that the left canine was replaced by the first premolar. The right canine was aligned and retracted after the extraction of the first premolar. The molar relationship is Class II.

ing in of tissues around the tooth. After wound healing, within 3 to 8 weeks, the pack is removed, and an attachment is placed on the impacted tooth.

2. The second method is a one-step approach; i.e., the attachment is placed on the tooth at the time of surgical exposure (Fig. 5). The tissues over the attachment should be excised, and a peri-

N, Periapical film showing bone healing 1 year after treatment. Vitality tests elicit a normal response from the lateral incisor.

odontal pack should be placed. The pack will minimize patient discomfort and prevent the granulation tissues from covering the attachment before the clinician is ready to apply traction forces on the impacted tooth. This approach is particularly recommended for palatally impacted teeth. One of the important advantages of such an approach is that when the force is applied to the impacted tooth, the clinician is able to visualize the crown of the tooth and to have better control over the direction of tooth movement. This will avoid moving the impacted tooth into the roots of the neighboring teeth.

Earlier methods of uncovering impacted canines advocated radical bone removal to expose the crown of the impacted tooth so as to remove all bony obstacles and to provide an easier path for tooth movement. McDonald and Yap[27] evaluated the relationship between the amount of bone removed during surgical exposure and the subsequent bone loss around the impacted tooth. They found that the more bone removed initially, the greater the bone loss after orthodontic treatment. Kohavi et al.[28] compared the periodontal health of canines exposed by such a "radical" exposure with those exposed by a more conservative "light" exposure. In the latter group, sufficient soft and hard tissues were removed mainly to allow for the placement of a bond, but the exposed area was kept coronal to the cementoenamel junction (CEJ). Comparisons between the two groups indicated the absence of significant differences in the plaque index, the gingival index, pocket depth, or attached gingiva after treatment. However, there were significant differences in bone support, i.e., alveolar bone support in the "heavy exposure" group was reduced. It was concluded that exposure of the CEJ was a critical variable and should be avoided as an objective during surgery or during the placement of a wire lasso with or without a gold chain. Kohavi et al.[28] further suggested that light movements (e.g., tipping) cause significantly less bone loss than heavy movement (e.g., torque) during the traction of the impacted tooth.

It can therefore be concluded that the combined effects of light surgical exposure and light orthodontic movements and forces are beneficial to the future periodontal health of the tooth since they minimize the loss of alveolar bone support and potential injury to the tooth during traction.

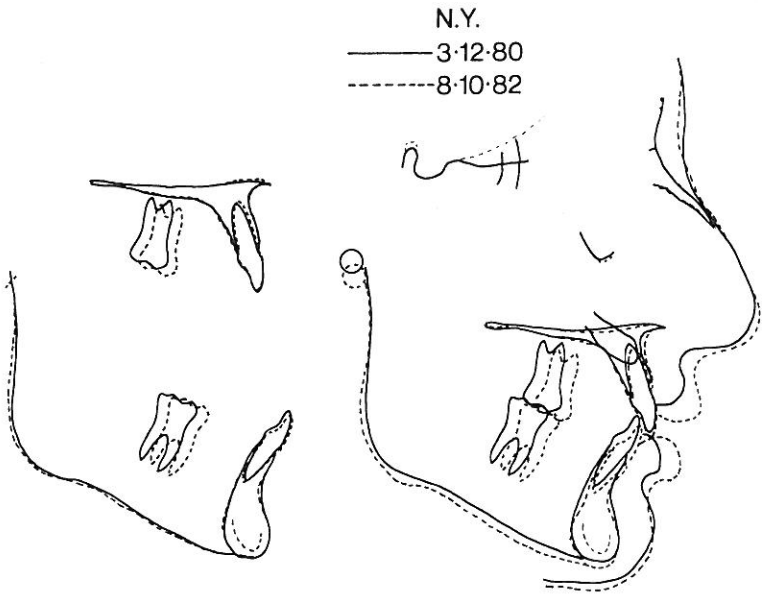
It should be reemphasized that in the surgical exposure of an impacted tooth, only enough bone should be removed to allow for the placement of a bracket and that during the procedure the CEJ should not be intentionally exposed.

METHODS OF ATTACHMENT

Different methods of attachment to the impacted tooth have been suggested, including crowns, wire ligatures, chain links, bands, and directly bonded brackets.[7]

The use of a circumferential, dead soft, ligature wire (lasso) as an attachment around the cervical area of the tooth has been fairly common. Such an approach should be discouraged, since too much bone has to be removed so that the wire can be placed around the tooth circumference. This heavy exposure, as indicated earlier, increases the risk of injuring the neighboring teeth. Furthermore, the incidence of external root resorption has been found to increase by 8% to 14% when this technique is used.[29,30] An increased incidence of ankylosis was also reported during orthodontic treatment of these teeth. The ankylosis was associated with the external root resorption, and the teeth were found to be nonrestorable and had to be extracted.[29]

Therefore it is strongly recommended that the surgical exposure of the impacted tooth be conservative



O, Superimpositions showing details of dental and skeletal changes attributed to growth and orthodontic treatment.

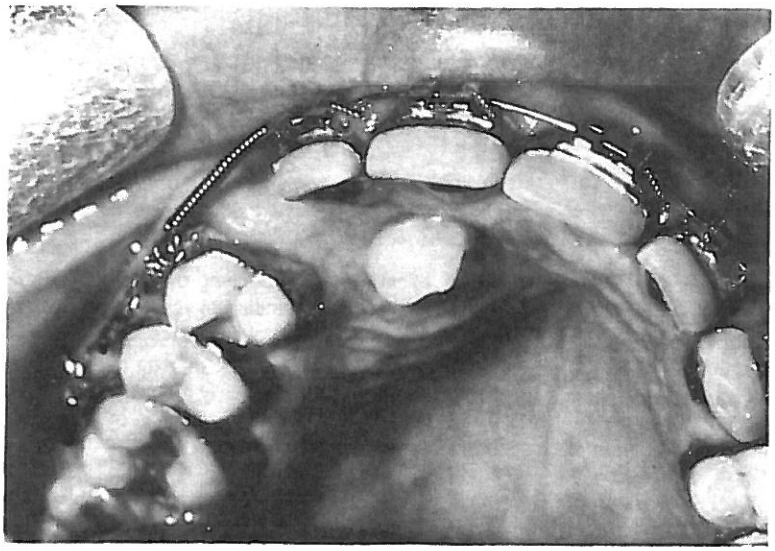


Fig. 4. Palatally impacted canine, surgically exposed, and left to erupt on its own.

to allow for the placement of a bonded bracket or button (Fig. 5). In general, the use of a wire lasso around the impacted tooth should be avoided.

MANAGEMENT OF LABIALLY IMPACTED CANINES

As stated earlier, labial impaction of the maxillary canine is less frequent than palatal impaction and is often caused by insufficient arch length. As a result, the canine is often positioned high in the alveolar bone and erupts through the alveolar mucosa (Fig. 3, *C*). Fournier et al.[23] suggest that labially impacted teeth with a favorable vertical position may be treated initially by surgical exposure but without the application of a traction force. He believes that in younger patients the tooth will erupt on its own after surgical exposure, whereas in older patients traction is almost always indicated.

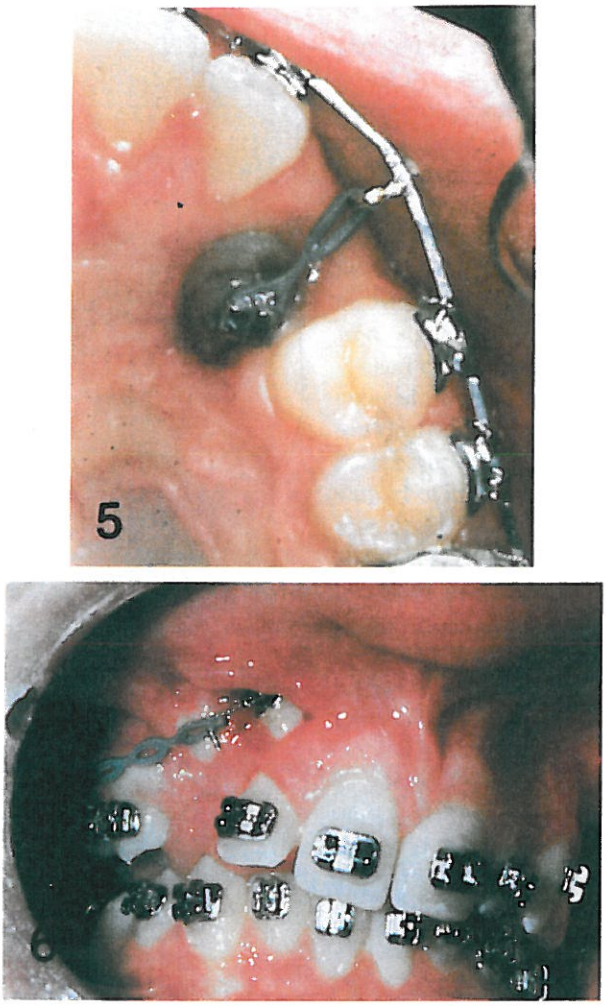


Fig. 5. Palatally impacted canine, after its surgical exposure, bonding of an attachment, and force application. A light force from an elastometric chain is transmitted to the tooth and attached to a relatively stiff arch wire (0.018 × 0.022 inch). The combination of light force and stiff wire minimizes undesirable reactive movements of the anchor teeth.

Fig. 6. Labially impacted canine, after its surgical exposure. An apically repositioned flap was used to provide a band of attached gingiva to the impacted tooth. The initial direction of the force should be to move the tooth away from the neighboring teeth to avoid their injury.

The absence of an adequate band of attached gingiva around the erupting canine may cause inflammation of the periodontium. Vanarsdall and Corn[31] emphasized that it is hazardous to move teeth in the presence of inflammation. Tissue resistance to the stresses of mastication and function is less than optimal, and loss of periodontal support is possible if precautions are not taken to alleviate such potential problems.

Therefore it is recommended that surgical procedures designed to expose impacted canines erupting through alveolar mucosa should simultaneously provide a band of attached gingiva to the exposed tooth. Otherwise, improper soft-tissue management may lead to mucogingival recession and loss of alveolar bone.

Before a labially impacted canine is exposed, careful consideration should be given to creation of sufficient space to allow for the canine to be positioned in the arch. The created space will also provide an adequate zone of attached gingiva that can act as a donor site for a partial-thickness apically or laterally repositioned flap.

Vanarsdall and Corn[31] suggested that the flap containing the keratinized tissue should be placed to cover the CEJ and 2 to 3 mm of the crown. They explained

that the advantages of such an approach are that (a) the new gingival attachment prevents the marginal bone loss and gingival recession that is frequently encountered with surgical exposure of impacted teeth; (b) the need for a series of dressings or the placement of a polycarbonate crown to prevent the tooth from being covered by granulation tissue is avoided; (c) the procedure is indicated even in teeth located beyond the vestibular depth or mucobuccal fold (Fig. 6); and (d) the apical repositioning of the flap allows for greater movement of the marginal tissue. This will minimize tension on the gingival tissues, particularly in those cases in which the canine, with its newly attached gingival tissue, needs to be moved occlusally a long distance to reach its proper position (Fig. 6).

During the surgical procedure if bleeding makes bonding of an attachment difficult, Vanarsdall and Corn recommended placement of a surgical dressing to protect the tissues for 7 to 10 days. After removal of the dressing, a direct bonded attachment can be placed in a dry field and tooth movement can then be initiated.[31]

Kohavi et al.[32] studied the periodontal health of labially impacted maxillary canines after their orthodontic alignment. They observed significant differences in the amount of the attached gingiva available on the labial aspect of the previously impacted canines as compared with the contralateral teeth. On the average, the contralateral teeth had approximately 1 mm more attached gingiva than the treated teeth. The treated teeth still had more than 3 mm of attached gingiva, which is considered physiologically adequate.

Therefore the creation and preservation of a functional band of attached gingiva should be an important objective in the management of labially impacted teeth. The attached gingiva could be made available through an apically repositioned flap, a laterally repositioned pedicle graft, or, when necessary, a free gingival graft.

ORTHODONTIC CONSIDERATIONS

The prognosis for orthodontic movement of a palatally impacted tooth depends on a variety of factors, such as the position of the impacted tooth relative to neighboring teeth, its angulation, the distance the tooth has to be moved, and the possible presence of ankylosis. In general, horizontally impacted or ankylosed canines are the most difficult to manage and have the poorest prognosis.[33] Some of these teeth may have to be extracted as was performed in the case presented in Fig. 3.

Removable versus fixed appliances. The use of fixed appliances to move the exposed tooth is advocated in most cases. This is because there are certain disadvantages to the use of removable appliances, including the need for patient cooperation, limited control of tooth movement, and the inability to treat complex malocclusions.

McDonald et al.[27] and Fournier et al.[23] suggested the use of Hawley-type appliances designed to transfer anchorage demands to the palatal vault and the alveolar ridge. Such appliances might be useful in patients with multiple teeth missing when the use of fixed appliances is not recommended.

One-arch versus two-arch treatment. Most malocclusions, including those that involve impacted canines, require placement of the orthodontic appliance on both maxillary and mandibular arches. Such an appliance will enable the orthodontist to achieve the desired biomechanical control needed to obtain optimal results.

The mandibular arch is not frequently used as a source of anchorage to move the impacted maxillary canine. This is due to the difficulty encountered in controlling the magnitude and direction of the applied force from the mobile mandibular arch. Therefore such interarch mechanics should be considered only when the desired forces cannot be applied from within the maxillary arch.

Methods of applying traction. Various methods have been used for moving the canine into proper alignment; these include the use of light wire springs soldered to a heavy labial or palatal base wire, mousetrap loops bent in the arch wire, and rubber bands. But with the introduction of new orthodontic materials such as elastic threads and elastomeric chains, the orthodontist has greater control of force magnitude and direction.

Regardless of the material used, the direction of the applied force should initially move the impacted tooth away from the roots of the neighboring teeth (Fig. 6). In addition, the following considerations are recommended: (a) the use of light forces to move the impacted tooth, no more than 2 ounces (60 grams) of force, (b) either availability or creation of sufficient space in the arch for the impacted tooth, (c) maintenance of the space by either continuous tying of the teeth mesial and distal to the canine or placement of a close-coiled spring on the arch wire, and (d) provision by the arch wire of sufficient stiffness (e.g., 0.018 × 0.022 inch) to resist deformation by the forces applied to it as the canine is extruded (Fig. 5). The added stiffness will minimize the undesirable roller-coaster effect caused by intrusion of the anchor teeth as a reaction to the deflection of a lighter and hence more flexible arch wire.

Canine versus premolar extraction. The prognosis for the successful exposure and guidance of the canine to its proper position in the dental arch is often guarded. This is because the canine may be ankylosed, undergo resorption, or become nonvital. This should be made

clear to the patient or the parents. The prognosis for a successful outcome will depend on the position of the impacted canine (i.e., whether horizontal or vertical), the relationship of the impacted tooth to the roots of the adjacent teeth, and the skill of the clinician exposing the tooth, as well as the one moving it.

If the overall orthodontic treatment plan involves the removal of premolars, it is advisable to postpone their extractions until the canine is surgically exposed and orthodontic forces are applied. This is done to ensure the feasibility of moving the impacted tooth before extracting a workable replacement.[5] Unfortunately, in some cases the premolar has to be extracted before any attempt is made to move the canine (Fig. 6). Again the patient or the parents should be made aware of that.

Most clinicians agree that permanent canines are important for an attractive smile and are also essential for a functional occlusion. Therefore extraction of the canines should be avoided, if at all possible.

When it is necessary to remove the impacted canine surgically, the orthodontist has to decide whether to move the premolar into the canine position or to restore the space of the missing canine with a prosthesis.

When it is decided to close the canine space orthodontically, the posterior segment must be protracted and the case finished in a Class II molar relationship on the affected side, assuming that the mandibular arch is treated without extraction (Fig. 3, *J*). Such a treatment alternative is possible only if the first premolar is not extracted until the prognosis of moving the impacted canine is definitively determined. In these cases, the clinician needs to consider such factors as the tooth size discrepancy, the lingual cusp interferences, and the difficulties encountered in the handling of unilateral mechanics. These factors must be carefully assessed for each case before the extraction decision is made.

RETENTION CONSIDERATIONS

Becker et al.[34] evaluated the posttreatment alignment of the impacted canines in patients whose orthodontic treatment had been completed. They observed an increased incidence of rotations and spacings on the impacted side in 17.4% of the cases, whereas on the control side the incidence was only 8.7%. The control side had ideal alignment twice as often as the impacted side.

To minimize or prevent rotational relapse, a fiberotomy or a bonded fixed retainer may need to be considered by the clinician after completion of the desired movements and sometimes before the appliances are removed. Clark[22] suggested that, after the alignment of palatally impacted canines, lingual drift can be prevented by removal of a "halfmoon-shaped wedge" of tissue from the lingual aspect of the canine.

In conclusion, the management of the severely impacted canine is often a complex undertaking and requires the joint expertise of a number of clinicians. It is important that these clinicians communicate with each other to provide the patient with an optimal treatment plan based on scientific rational.

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