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Review Article

Orthodontic Considerations of Impacted Teeth

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***ABSTRACT*:**
Orthodontic management of impacted teeth can be very complex and requires a carefully planned inter-disciplinary approach. In present time third molars are more commonly retained, and it is likely that more patients will develop impactions than a generation ago because of non-extraction orthodontic treatment plans. There are still valid reasons for the surgical removal of selected third molars during the teenage years, during which time impaction can be anticipated to avoid the higher rate of morbidity associated with later removal.. This review article describes the changing approach to the management of various impacted teeth.

Keywords: Impaction, canine impaction, orthodontics.

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When is a tooth considered to be impacted?
Under normal circumstances, a tooth erupts with a developing root andwith approximately three-quarters of its final root length.The mandibular central incisors and first molars have marginallyless root development and the mandibular caninesand second molars marginally more when they erupt.[1]

INCIDENCE OF CANINE IMPACTION

- Dachi and Howell- maxillary canine impaction is 0.92%
- Thilander and Myrberg- cumulative prevalence of canine impaction in 7- to 13-year-old- 2.2%.
- Ericson and KuroP estimated the incidence at 1.7%.
- 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.
- Mandibular canine impaction- 0.35%.[7]

DEVELOPMENTAL CONSIDERATIONS

According to Moyers, "The maxillary cuspid follows a more difficult and tortuous path of eruption than any other tooth. At the age of 3 years it is high in the maxilla, with its crown directed mesially and somewhat lingually." The canine changes its position in the bone: at first, its crown lies in close proximity to the distal aspect of the root of the lateral incisor. As it erupts farther into the oral cavity it tends to upright itself and finally assumes its position in the arch.[3]

According to Dewel, maxillary canines have thelongest period of development, as well as the longestand most tortuous course to travel from point of for mation, lateral to the piriform fossa, until they reachtheir final destination in full occlusion.[8]

ETIOLOGY (according to Moyers)

(1) **Primary Causes,** e.g.,
- (a) rate of root resorption of deciduous teeth,
- (b) trauma to the primary tooth bud,
- (c) disturbance in tooth eruption sequence,
- (d) availability of space in the arch,
- (e) rotation of tooth buds,
- (f) premature root sure,
- (g) canine eruption into the cleft area in cleft-palate individuals ;

(2) **Secondary Causes**, e.g.,
- (a) abnormal muscle pressure,
- (b) febrile disease,
- (c) endocrine disturbances, and
- (d) vitamin D deficiency.

SEQUELAE OF IMPACTION

Shafer, Hine, and Levy listed seven possible sequelae which can be related to the unerupted canines :
(1) labial impaction, usually vertically impacted;
(2) lingual impaction, usually horizontally impacted;
(3) root resorption of impinged teeth ;
(4) referred pain ;
(5) infection from partial impaction resulting in pain and trismus ;
(6) dentigerous cyst which can possibly become an ameloblastoma; and
(7) self-resorption-which radiographically resembles caries and begins usually in the crown portion of the impacted tooth.

DIAGNOSIS AND LOCALIZATION OF IMPACTED CANINES

1. Clinical. Any one or a combination of the following signs may be present:
   a. delayed eruption of one or more of the permanent canines after 14 years of age;
   b. prolonged retention of a primary canine;
   c. elevation of the soft tissue of the palatal or labial mucosa (depending on canine location) ;
   d. distal migration of the lateral incisors with or without a midline shift.
2. Roentgenographic.

1. PERIAPICAL FILMS.

(a) Tube-shift technique or Clark's rule : Two periapicalfilms are taken of the same area, with the horizontal angulation of the conechanged when the second film is taken. If the object in question moves in thesame direction as the tube head it is lingually positioned. If it moves in the opposite direction it is situated closer to the source of radiation and therefore is buccally located.

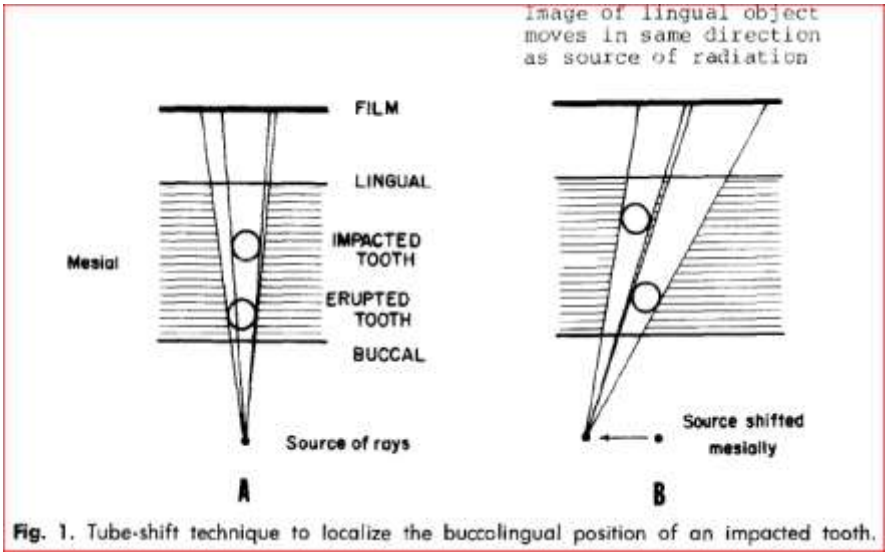


Fig. 1. Tube-shift technique to localize the buccolingual position of an impacted tooth.

(b) Buccal-object rule : If the vertical angulation of the cone is changed byapproximately 20 degrees in two successive periapical films, the buccal object willmove in the direction opposite to the source of radiation. On the otherhand, the lingual object will move in the same direction as the source of radiation.

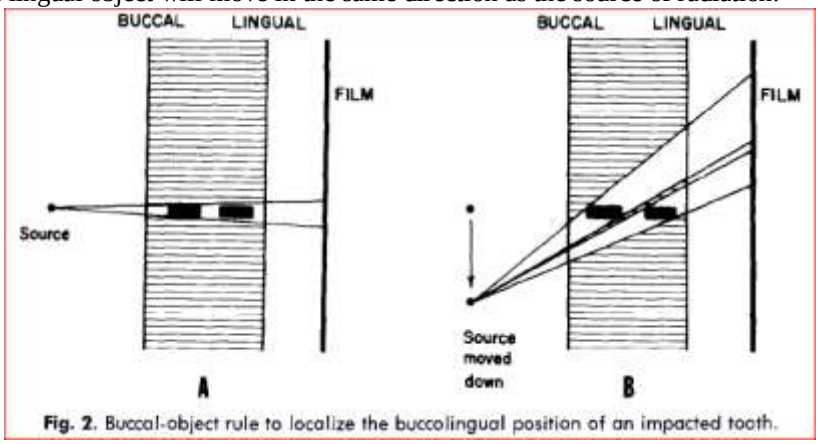


Fig. 2. Buccal-object rule to localize the buccolingual position of an impacted tooth.

The basic principle of this technique deals with the foreshortening and elongationof the images of the films.

2. OCCLUSAL FILMS. These also help to determine the buccolingual position of the impacted canine in conjunction with periapical films, provided that theimage of the impacted canine is not superimposed on the other teeth.

3. EXTRAORAL FILMS.
(a) Frontal and lateral cephalograms can sometimes be of aid in determining the position of impacted canines, especially in relation to other facial structures-particularly the maxillary sinus and the floor of the nose.
(b) Panorex films are also used to locate impacted teeth in all three planes of space (much the same as using two periapical films in the tube-shift method or Clark's rule)-with the exception that, since the source of radiation comes from behind the patient, the movements are reversed for position ; e.g., a palatal impaction will move left to right roentgenographically when the tube head moves from the patient's right to his left. A labially impacted or positioned tooth will move roentgenographically in the same direction as the tube head because it is farther from the source of radiation than the reference point.

The importance of localization of impacted teeth is that it is necessary in order to determine both the surgical approach and the feasibility of managing the condition orthodontically. Accurate determination of the relation of the impacted tooth to the adjacent teeth and/or structures is essential if injury to other dental units or facial spaces is to be avoided.[3]

CLASSIFICATION OF CANINE IMPACTION

1. ANGULAR CLASSIFICATION

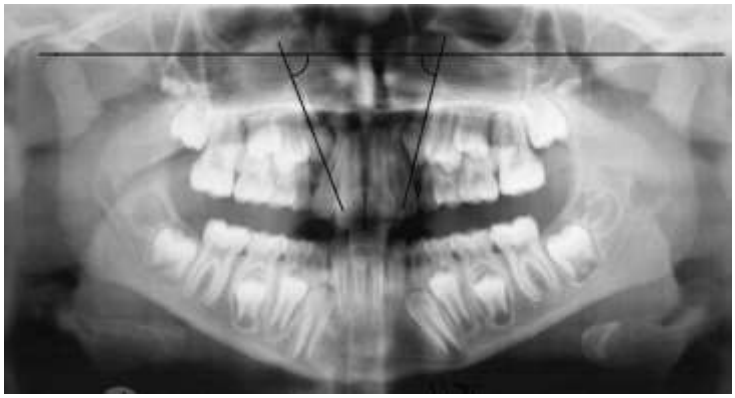
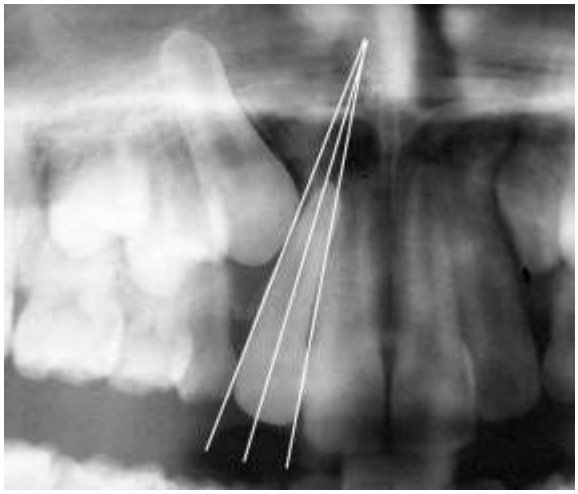


Table III. Probability of canine impaction based on sector and angle measurements

	Sector			
	I	*II*	*III*	*IV*
Angle (degrees)				
40–54	0.11	0.53	0.91	0.99
55–69	0.08	0.43	0.87	0.98
70–84	0.05	0.33	0.81	0.98
85–99	0.04	0.25	0.75	0.96
Angle not considered	0.06	0.38	0.87	0.99

2. SECTOR CLASSIFICATION

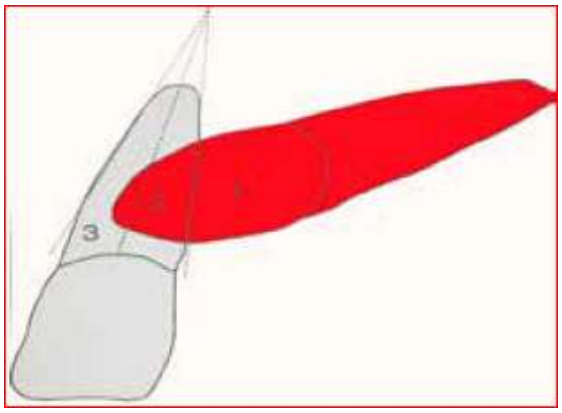


Modification of Ericson and Kurol's definition of sectors, from Lindauer et al.
Sector I represents area distal to line tangent to distal heights of contour of lateral incisor crown and root. Sector II is mesial to sector I, but distal to bisector of lateral incisor's long axis.
Sector III is mesial to sector II, but distal to mesial heights of contour of lateral incisor crown and root. Sector IV includes all areas mesial to sector III.[9]

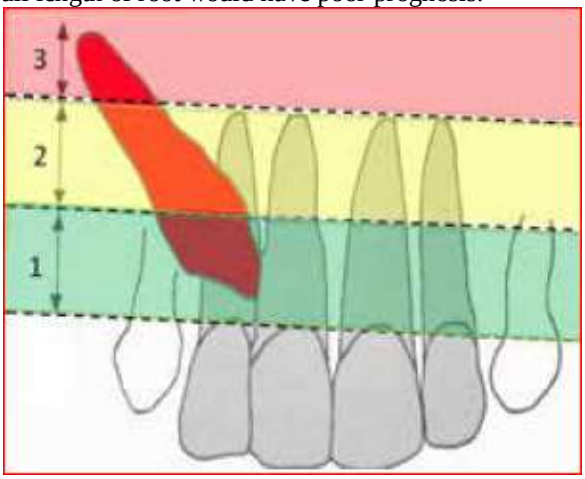
PALATAL vs BUCCAL IMPACTION

- Johnston" and Gaulis and Joho- palatal: buccal= 2:1
- In all the cases of palatally impacted teeth we used a "closed-eruption" philosophy and chose an "open approach" in the labially positioned teeth, using a repositioned mucoperiosteal flap to avoid the future mucogingival problems reported by Vanarsdall and Corn.[5]
- An arch-length deficiency will only cause the canine to erupt labially. Excluding the possibility that the tooth bud may have formed palatally, the explanation for the palatal impaction could be an excessive space in the canine area. This space can be created by (1) excessive bone growth in the canine area, (2) the agenesis or hypodevelopmenot f the lateral incisor, and (3) stimulated eruption of the lateral incisor or the first premolar. This excessive space will allow the canine to move palatally in the bone and to find a place behind the buds of the other teeth.[6]

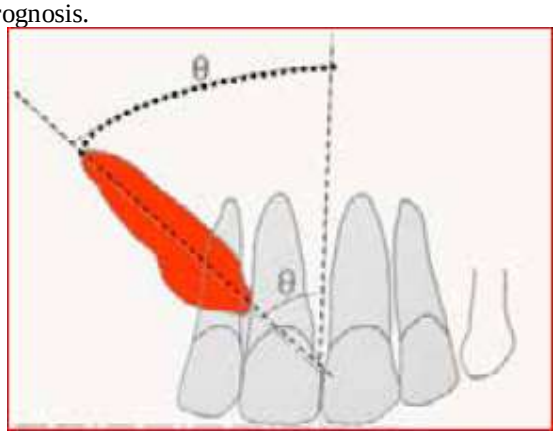
The prognostic factors have been investigated by McSherry and Pitt *et al*, who suggested the use of these factors in an index to estimate treatment difficulty. These factors are discussed below:
 The amount the canine crown horizontally overlaps the adjacent incisor. The closer the canine lies to the midline, the poorer the prognosis for alignment. No horizontal overlap of the adjacent incisor would indicate good prognosis, overlap up to half the root width suggests average prognosis and complete overlap of root would indicate poor prognosis.



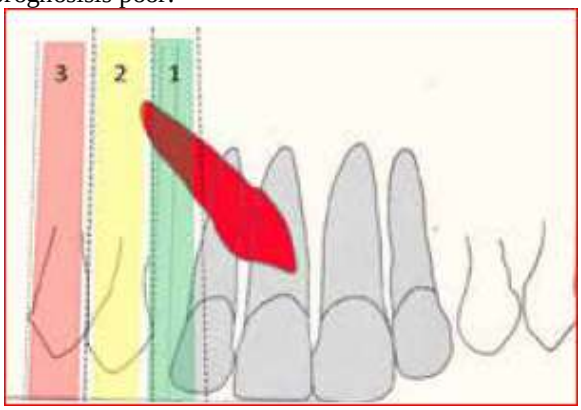
Vertical height of the canine crown.The more apical the position of the crown, the poorer the prognosis for alignment. From the level of the cementoenamel junction to less than halfway up the root of the lateral incisor would indicate a good prognosis; more than halfway up the root but less than the full length root length would indicate average prognosis; and above the full length of root would have poor prognosis.



Canine angulation to the midline. As canine angulation to the midline increases, the prognosis decreases. Angulation of 0−15° would point towards a good prognosis, angulation of 16−30° an average prognosis, and angulation of 31° or more,a poor prognosis.



The position of the canine root apexin the horizontal plane. If thecanine apex is located above the normal canine position, prognosis for alignment is good, if the apex is above the first premolar region, prognosis is average, and if it is above the second premolar, prognosisis poor.[11], [12]



SURGICAL EXPOSURE

There are two methods of bringing impacted canines into the line of occlusion :

(1) surgical exposure, allowing natural eruption to occur, and

(2) surgical exposure with the immediate placement of an auxiliary attachment through which orthodontic forces can be applied to move the impacted tooth to its proper position in the line of arch.

Surgical exposure to allow natural eruption to occur. This method has many advantages and 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 frequent roentgenograms, using reference points either on an adjacent erupted tooth or on the arch wire. [3]

Clark method: (1) A palatal flap is laid back and overlying bone is removed to expose the crown. It is essential that all bone and soft tissue be removed from around the canine crown.

(2) The impacted canine is luxated.

(3) A polycarbonate crown is fitted to cover the entire crown of the canine and should be made long enough to extend through the window cut in the palatal tissue. The crown is then cemented with surgical paste or regular cement.

(4) Prior to suturing the palatal tissue, a trough is cut through the cortical plate from the impacted canine to the alveolar ridge to ease tooth movement.long enough to extend through the window cut in the palatal tissue. The crown is then cemented with surgical paste or regular cement.

(5) Prior to suturing the palatal tissue, a trough is cut through the cortical plate from the impacted canine to the alveolar ridge to ease tooth movement.

Usually 6 months to a year must elapse before the impacted tooth has erupted sufficiently to permit removal of the polycarbonate crown and replacement of it with a band. If the tooth fails to erupt it is necessary to remove any cicatricial tissue surrounding its crown. Clark indicated that, after a palatally impacted canine has been brought into the line of arch, lingual drift can be prevented by removing a halfmoon-shaped wedge of tissue from the lingual aspect of the canine down to the bone.[2]

Surgical exposure with the placement of an auxiliary. After surgical exposureof the impacted tooth, an auxiliary is attached to its crown, either directly to the enamel or indirectly to a band or crown. Orthodontic forces can be transmittedto this attachment for the purpose of moving the tooth into the line of the arch.

Two methods are generally accepted.

1. Lewis[4] preferred a two-step approach. First the canine is surgically uncovered and the area packed with surgical dressing to avoid filling in of tissues around the tooth. When, after 3 to 8 weeks, the wound has healed, the pack is removed and a band or other attachment is placed on the impacted tooth.
2. The second method is actually a one-step approach: the attachment is placed onto the tooth at the time of surgical uncovering.[3]

As Gaulis and Joho mentioned, two basic types of surgical debridement can be used for impacted teeth.

One involves a "closed eruption" in which the crown of the tooth is exposed, an attachment is fixed to it, and the flap is sutured back over the crown, leaving only a twisted wire passing through the mucosa to apply the orthodontic traction. In the second type, "open eruption", the crown is left uncovered by means of packed cement or repositioning of a mucoperiosteal flap.[5]

The most common surgical methods are:

a. Apically positioned flap
b. Excisional gingivectomy
c. Closed eruption technique [10]

ble 1: Recommended surgical technique for canine exposure, as it relates to the position of impaction.

Canine Position	Open Technique		Closed Technique
	Gingivectomy	Apically Positioned Flap	
Labial – Palatal of Alveolus	Labial	Middle or Labial	Palatal
Apical – Coronal to MGJ	Coronal to MGJ	At MGJ	Apical to MGJ
Keratinized Gingiva	Adequate	Inadequate	Mucosa
Mesial – Distal	Between lateral and premolar	Distal to lateral incisor	Mesial to lateral incisor

METHODS OF ATTACHMENT

Different methods of attachment to the impacted canine are used,

1. Wire: A dead-soft 0.020 inch brass or stainless steel round wire is passed below the cingulum of the impacted canine, with the ends of the wire twisted in a pigtail form and allowed to extend through the palatal tissue. This method sometimes demands considerable surgical skill and is at times impossible because the impacted tooth is too close to adjacent teeth.[3] It offers poor control with respect to the type of movement and direction of extrusion. lateral incisor displacement (labial and extrusive movement) may occur. There is also a risk of root resorption near the cementoenamel junction.[5]

2. A variation of the above method is to attach a gold chain (with soldered links) to the wire wrapped around the tooth. A light round wire (0.014 inch) is then soldered to the main arch wire (0.020 inch or preferably edgewise). The end of the auxiliary wire is bent in the form of a hook. To activate the system the hook at the end of the auxiliary wire is attached to one of the links of the chain, thus applying tension on the tooth. Another use of the chain is to monitor the movement of the impacted tooth by counting the number of links coming out of the tissues in consecutive visits.
3. Band : Many times a band can be fitted and cemented at the time of surgery(with a bracket, hook, or button welded to it) if all the surfaces of the crown of the impacted canine are uncovered. The corresponding tooth in the same arch can be used as a guide in choosing a suitable band for the unerupted tooth.
4. Cast gold crown or onlay : After the canine has been uncovered and packed, and the tissues have been allowed to heal, an impression is made of the exposed portion of the canine and a gold onlay with a hook or eyelet is constructed and cemented to it. The impression for the crown could also be taken on the opposite tooth in the same arch if the crown is to be fabricated before surgically exposing the impacted canine.
5. Direct bonded attachment: Adhesives can be used to band an attachment directly to the tooth at the time of surgery or after its partial eruption. One problem with this method [as well as with any method using a cement or adhesive) is the difficulty in obtaining a dry field for bonding at the time of surgery.
6. Threaded pin: A hole of appropriate size is drilled in the tooth and a pin is threaded or cemented into it. Care must be taken to avoid placing the pin in the pulp chamber. The primary disadvantage of this method is that the tooth will need a restoration after the pin is removed.
7. Wire loop, made of 0.016 inch round wire, may be embedded into a prepared cavity in the crown of the impacted tooth; the cavity is then filled with amalgam or Adaptic.[3]
8. Perforate the tip of the crown in a labiolingual direction. The hole is made near the tip of the cusp, far enough incisally to prevent pulpal damage and far enough cervically to avoid fracture of enamel. We start the hole with a No. 1 round burr on high speed and then finish with a 0.017 inch drill on a low-speed handpiece. When thetooth has made enough extrusion, the ligature is cut, the hole is filled with acrylic, and a bracket is properly positioned on the tooth to finish alignment. a carious lesion and pulpal damage may occur.[5]

METHOD OF TRACTION

- Jacoby" described a fixed appliance, termed 'ballista spring'
- a removable Hawley type of appliance with springs soldered to Adams clasps or labial bows or emerging directly from the acrylic to exert the extrusive force. It transfers great part of the anchorage demands to the palatal vault and alveolar ridge when many teeth are absent.

Principal disadvantages include the following:

1. It is limited in the possibility of treating related or unrelated problems. For example, the impacted canine may be associated with a malocclusion necessitating full-banded orthodontic treatment.
2. The final alignment of the tooth, especially when some root movement or important rotations are required, is sometimes very difficult.
3. It necessitates cooperation from the patient.

Principal advantages are as follows:

1. It may be the only possible appliance when there is a dramatic loss of anchorage, such as the absence of all upper posterior teeth.
2. It offers some possibilities for treatment of minor tooth malpositions, especially those for which we generally use this type of appliance (for example, an anterior bite plate to level a curve of Spee or correct a cross-bite).
3. It can also be used to maintain or reopen to a certain amount the edentulous space with appropriate springs.
4. It is placed in the mouth immediately after the surgical intervention and, similar to a surgical splint, it helps to contain swelling and hematoma.
5. If we suspect ankylosis of the tooth, immediate traction as suggested by Vanarsdall can be instituted. This immediate traction also helps to hold the stainless steel wire shaped as a hook into firm position, thus preventing injury to soft tissues and avoiding the need to cover it with wax or acrylic.
6. It reduces chair time and eliminates the need for using bands and/or brackets. This advantage is maximum when no other orthodontic correction is needed.
7. It can often be used as a first phase in complete orthodontic treatment, thus reducing the length of time that fixed appliances must be worn, with all associated benefits and the possibility of avoiding some gingival and/or carious problems.
8. By leaving adjacent teeth "free to move," it reduces the possibilities of damage to adjacent roots if they are contacting the emerging canine.

9. It is more esthetic, which could be appreciated by the adult patient.[5]

ORTHODONTIC MANAGEMENT OF IMPACTED CANINES

A. One-arch vs. two-arch treatment.

Most orthodontic cases do require banding of both maxillary and mandibular arches in order to achieve the desired biomechanical control necessary for optimal results. The lower arch can often be used to great advantage in helping to position the impacted canine in proper occlusion. This is especially true in horizontal impactions. By utilizing the more vertical type of force vectors the canine may be "guided" down from its impacted position. This is best achieved by building the lower arch wire to a heavy rectangular arch wire (0.018 by 0.025 inch or larger). These wires resist gross distortion when forces are applied to them. Heavier arch wires will also distribute the reactive forces over the whole lower arch and therefore minimize adverse tooth movement. On the other hand, treating one arch only, particularly if light arch wires are used, can lead to both undesirable tooth movements and difficulties in properly coordinating and interdigitating the upper and lower arches together. To prevent some of the undesirable sequelae of one-arch treatment, four considerations should be kept in mind:

(1) light forces (<60g) should be used for canine extrusion;

(2) continuous tie or stop of the teeth mesial and distal to the canine area may be indicated ;

(3) a rectangular arch wire should be present before the extrusion mechanics are started (such an arch wire resists to a greater extent the deformation caused by the extruding force) ; and

(4) the lower arch should be reasonably well aligned and leveled.

B. Cuspid vs. premolar extractions. The prognosis of successfully exposing and guiding the canine to its proper position is often guarded; therefore, in those cases requiring upper premolar extraction, it is desirable to delay this until the prognosis of the impacted tooth is more certain. The prognosis will depend onthe position of the impacted canine in the bone, the relationship of the impacted tooth to the roots of the adjacent teeth, andthe skill of the oral surgeon. Most clinicians agree that permanent canines are important from both esthetic and functional points of view and therefore should be preserved whenever possible.[5]

When to extract an impacted canine?

1. If it is ankylosed and cannot be transplanted.
2. If it is undergoing external or internal root resorption.
3. If the root is severely dilacerated.
4. If the impaction is severe on central and lateral incisors and orthodontic movement will jeopardize these teeth.
5. If the occlusion is acceptable with the first premolar in position of canine with an excellent occlusion and well aligned teeth.
6. If there are pathological lesions (e.g. cyst, infection).
7. If the patient does not desire orthodontic treatment.[7]

In difficult impactions, however, it.might be necessary to surgically remove the canine.

- If the decision is made to close the canine space orthodontically, the first and second premolars can be protracted and the case finished in a Class II molar relation on the affected side(s)-unless lower first premolars are also extracted and the molars can then be finished in a Class I relation. Such a choice of treatment alternatives is possible only if the first premolars are not extracted until the prognosis of the impacted canine (s) is determined.[3]
- Extract the impacted tooth and replace it with a fixed bridge.
- Moss- The impacted tooth can be removed and reimplanted in its proper position.[5]

OTHER METHODS

- Auto transplantation of the canine.
- Extraction of the impacted canine and movement of a first premolar in its position.
- Extraction of the canine and posterior segmental osteotomy to move the buccal segment mesially to close the residual space.
- Trans-alveolar transplantation of maxillary canines[10]

A summary of orthodontic techniques used to manage impacted canines

STUDY	ORTHODONTIC TECHNIQUE
Harry Jacob (1979)	Ballista Spring
Criscini et al (1994)	Tunnel traction
Ali Darendeliler (1994)	Magnets
Becker et al (1995)	Stainless steel archwire auxiliary
Lindauer and Issacson (1995)	Cantilever spring
Lindauer and Issacson (1995)	TMA box loop
Samuels (1997)	Two arch technique
Loring L. Ross (1999)	Nickel titanium closed coil spring
Pramod K. Sinha (1999)	Mandibular anchorage
VarunKalra (2000)	K-9 spring
Christine Hauser (2000)	Australian helical archwire
Jay Bowman (2002)	Monkey Hook
Dillingham Park and colleagues (2004)	TADs

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