

Evaluation of Orthodontic Treatment Options for the Impacted Maxillary Canine

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Maxillary canine impaction has an incidence of 1 in 100 in the general population and has been reported as much higher in an individual orthodontic practice¹⁵.

Impaction of the upper permanent canine is almost as common as impaction of the third molar. The likelihood of being able to align one of these teeth with the rest of the dentition depends on a number of factors, and several treatment options are available¹⁶.

Incidence of impacted maxillary canine:

- Maxillary canine is impacted 20 times more than mandibular canine, and more frequently among female than among male.
- Maxillary canine is impacted palatally 3 times more than labially.
- Maxillary canine is the third tooth in order of frequency after mandibular and maxillary third molars. In some population it is the first one due to congenital absence of third molars.¹
- It usually occurs palatally and unilaterally; labial impaction occurs in only 7 to 16% of cases¹⁶.

Etiological Factors:

There are several reasons for failure of eruption:

A. Palatal barriers:

- Preventing the tooth from erupting palatally, this explains why impacted maxillary canine, is impacted in palatal position 3 times more than in buccal position, these barriers are:
- Maxillary cuspid is impacted palatally 3 times more than labially.

- Maxillary canine is the third tooth in order of frequency after mandibular and maxillary third molars. In some population it is the first one due to congenital absence of third molars.
- Palatal bone is most dense than any other alveolar bone.
- Palatal mucoperiosteum
- Specially in the anterior third is subjected to frequent masticatory stress making it more thicker and more resistant than any other mucoperiosteum.

B. Eruption disturbances:

- The maxillary canine has the longest distance between the point of its formation and point of eruption. The more that distance is the more liability to eruption disturbances.
- Most of the root of maxillary canine is formed before its normal date of eruption i.e. the eruption force of root formation has minimal effect.
- Usually the maxillary canine erupt in the same date range of eruption of second molar i.e. the two teeth compete for space, when there is loss of space the second molar shears the canine.

C. Deciduous predecessors:

- The mesiodistal diameter of deciduous canine is less than that of its permanent successor.
- Retained deciduous canine is most common than any other tooth.
- Permanent canine is formed in a point immediately palatal to the apex of deciduous canine. Any periapical lesion (from trauma or deep caries) in the deciduous canine will affect the position and direction of permanent canine tooth germ.

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- Permanent canine is the last tooth (of those teeth having deciduous predecessors) to be erupt i-e. subjected more to any adverse circumstances.

Development

The maxillary canine can start to develop early. Crown calcification can start somewhere between 4 and 12 months after birth, and is usually complete at 6 or 7 years of age. The tooth begins to develop high up in the frontonasal process near the infraorbital foramen. As it migrates downwards, the crown is guided by the distal aspect of the lateral incisor root, giving rise to the splayed appearance of the incisors in the 'Ugly Duckling' phase of dentition (Figure 1).^{2, 16}

An association has been found between crowding and buccally placed canines: in spaced arches the canine tends to be displaced palatally.³ Also, the upper canine has a higher chance of being displaced palatally when the lateral incisor is small or anomalous.⁴

Evaluation of the impacted canine

Early detection of impacted maxillary canines may reduce treatment time, complexity, complications and cost. Ideally, patients should be examined by the age of 8 or 9 years to determine whether the canine is displaced from a normal position in the alveolus and assess the potential for impaction¹⁷. The clinician can investigate the presence and position of the canine using 3 simple methods: visual inspection, palpation and radiography.

The purpose of evaluation, which should be carried out as part of a full orthodontic examination, is to localize the canine and decide on the prognosis for its alignment. The examination includes assessment of spacing, crowding and vertical and horizontal skeletal relations. Generally, there are few symptoms, except perhaps excessive mobility of the incisor and first premolar or deteriorating appearance of the deciduous canine.

Factors Affecting prognosis

The prognosis for alignment of the canine is affected by several factors¹⁶:

- Age of the patient if the patient is older than 16 years, the likelihood of being able to align the tooth generally decreases.
- Patient cooperation: treatment times for exposure and alignment of canines are usually quite long; patient cooperation is necessary for a favourable outcome.

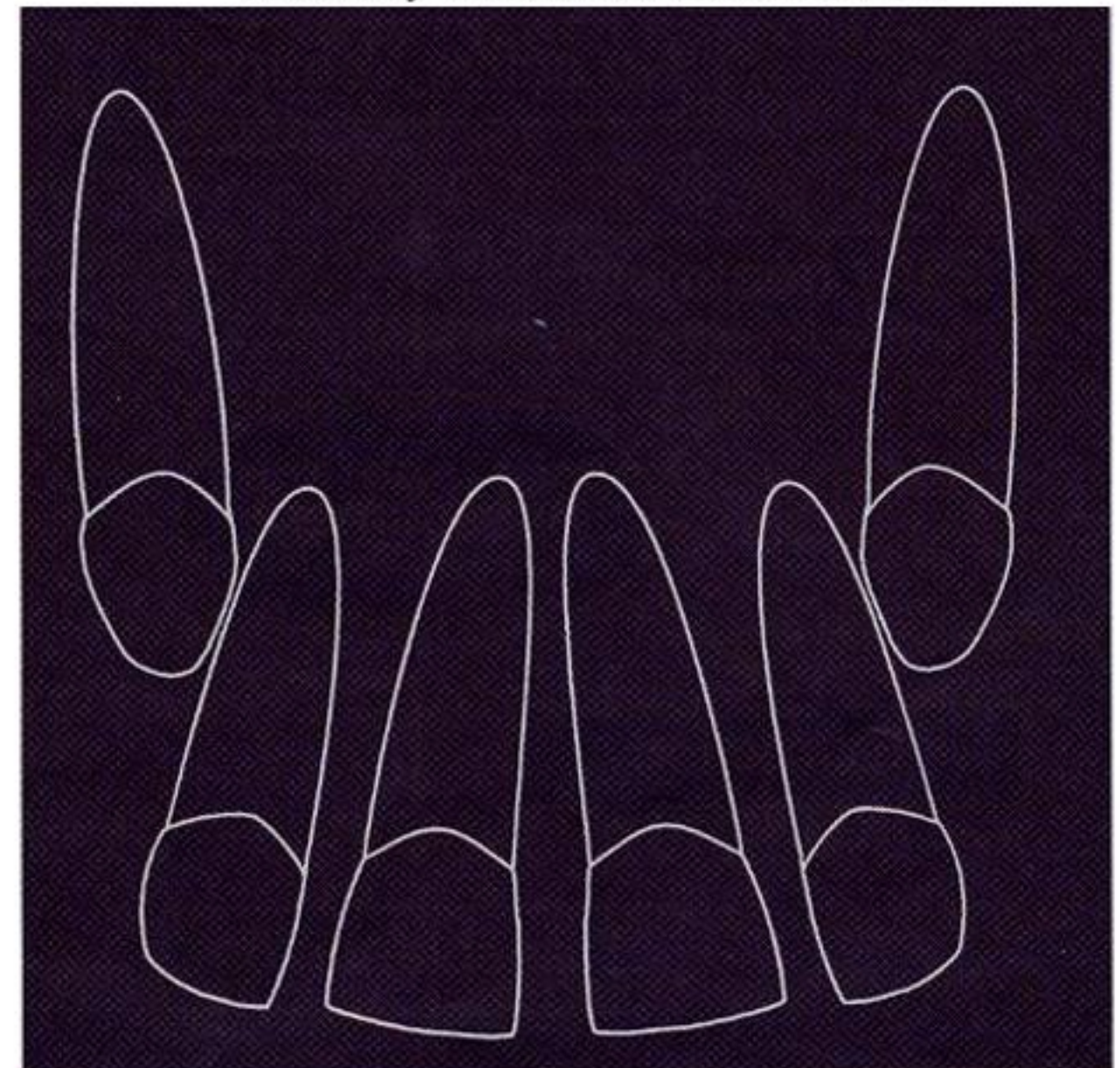


Figure 1. Between 8 and 11 years the canine lies close to the dental aspect of the lateral incisor roots. This gives the splayed appearance of the incisors in the 'Ugly duckling' stage of development¹⁶.

- General oral hygiene: good oral hygiene will give a better result;
- Skeletal variation (anteroposterior, vertical and transverse);
- Crowding/spacing: the more space available in the arch, the greater the probability of achieving a good result.

When evaluating the prognosis for alignment for a maxillary canine, it is important to carry out vitality tests on the incisors, especially the lateral incisor. Any discoloration should also be considered.

Radiographic Procedures and 3-D imaging

Radiographs are indicated when canine bulges are not present; right and left labial or palatal canine development and eruption is asymmetrical (Fig. 1 and 2); occlusal development is advanced and there are no palpable bulges indicating the presence of the cuspids in the alveolar process; and the lateral incisor is delayed

in eruption, malpositioned, or has a pronounced labial or palatal inclination in relation to the adjacent central incisor.¹⁸⁻¹⁹



Figure 2a: Before treatment. Significant asymmetry of the eruptive stages of maxillary permanent cuspids may be a sign of potential impaction. The 13 was palatally impacted and required surgical exposure and orthodontic alignment. **Figure 2b** After treatment permanent cuspids aligned in place.

Accurate radiographs are critical for determining the position of impacted canines and their relation to adjacent teeth, assessing the health state of the neighbouring roots and determining the prognosis and best mode of treatment.²⁰ A panoramic radiograph taken in conjunction with 2 periapical views obtained using Clarke's Rule (Buccal Object Rule) or a 60% maxillary occlusal film (Fig. 3) allows the impacted teeth to be located either palatally or buccally relative to adjacent teeth.²⁰ Ericson and Kurol¹⁹ found that periapical radiographs allowed accurate location of the teeth in 92% of the cases they evaluated. Although periapical films are diagnostic for transverse position, occlusal radiographs are more accurate for determining the positions of the canines relative to the midline.^{21,22} Lateral cephalometric radiographs are also helpful in assessing the anterior-

posterior position of the displaced tooth, as well as its inclination and vertical location in the alveolus.²⁰

Although conventional dental radiographs provide satisfactory diagnostic images, they lack the accuracy necessary for assessing palatal or buccal root resorption of the lateral incisor especially with mild or early resorption.^{22,23} Computed tomography (CT) is more accurate in terms of locating the impacted canine in 3 dimensions and for diagnosing associated lesions such as root resorption of adjacent teeth.²² However, although CT is an assess in cases where root resorption is suspected, cost, time and increased radiation exposure restrict its routine use.¹⁸

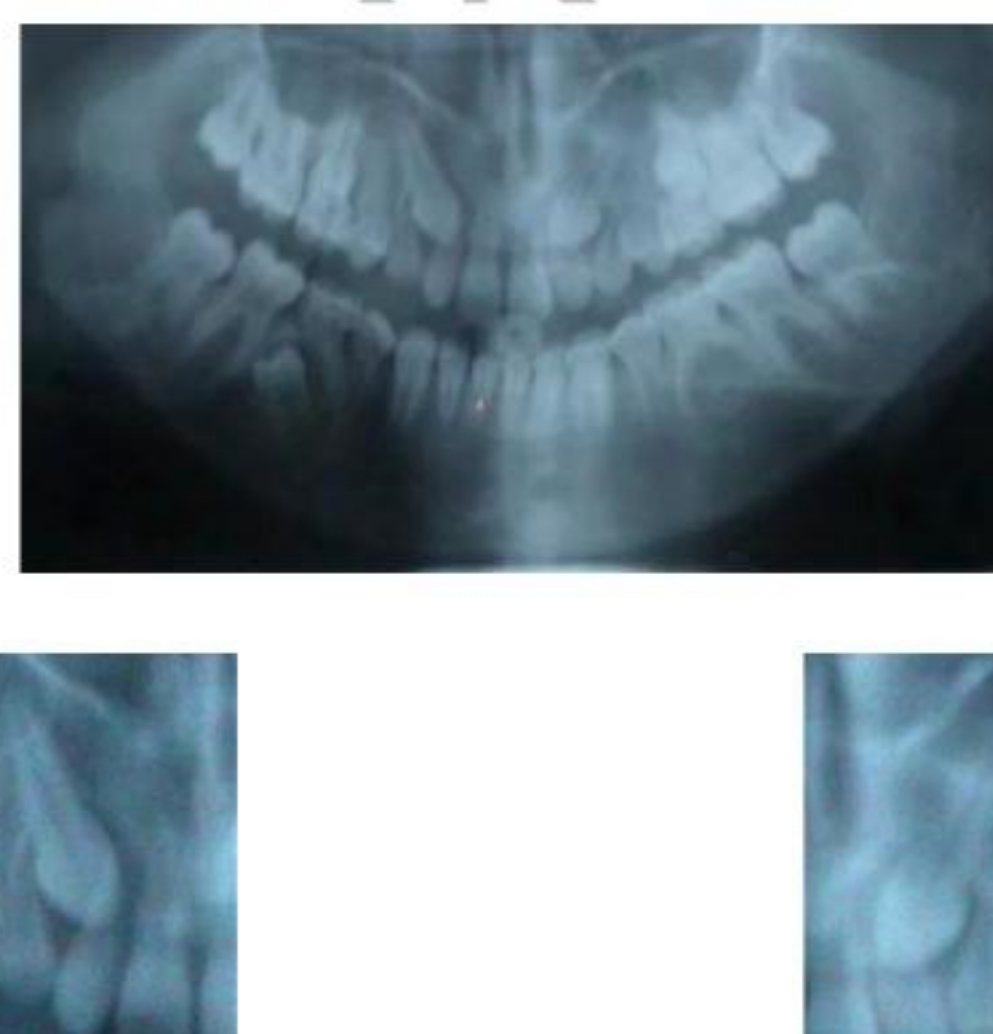


Figure 3: The degree of asymmetry of the eruption of the maxillary right and left canines, and the overlap of the maxillary right canine with the maxillary right lateral incisor were signs of impaction. Panoramic and periapical radiographs were used to locate the maxillary right and left canines on the palate

The radiographs most commonly used in assessment of the upper canine are listed in Table 1.

<i>Radiograph</i>	<i>Use</i>	<i>Typical effective dose equivalent (milliseverts-mSV)</i>
Periapical	Root morphology Resorption	0.008mSv
Anterior Occlusal	Parallax technique	0.008mSv
Orthopantomogram	Mesiodistal position Height	0.007-0.014mSv
Lateral cephalogram	Anteroposterior Height	0.019mSv

Table 1. Radiographs commonly used to localize canines.¹⁶

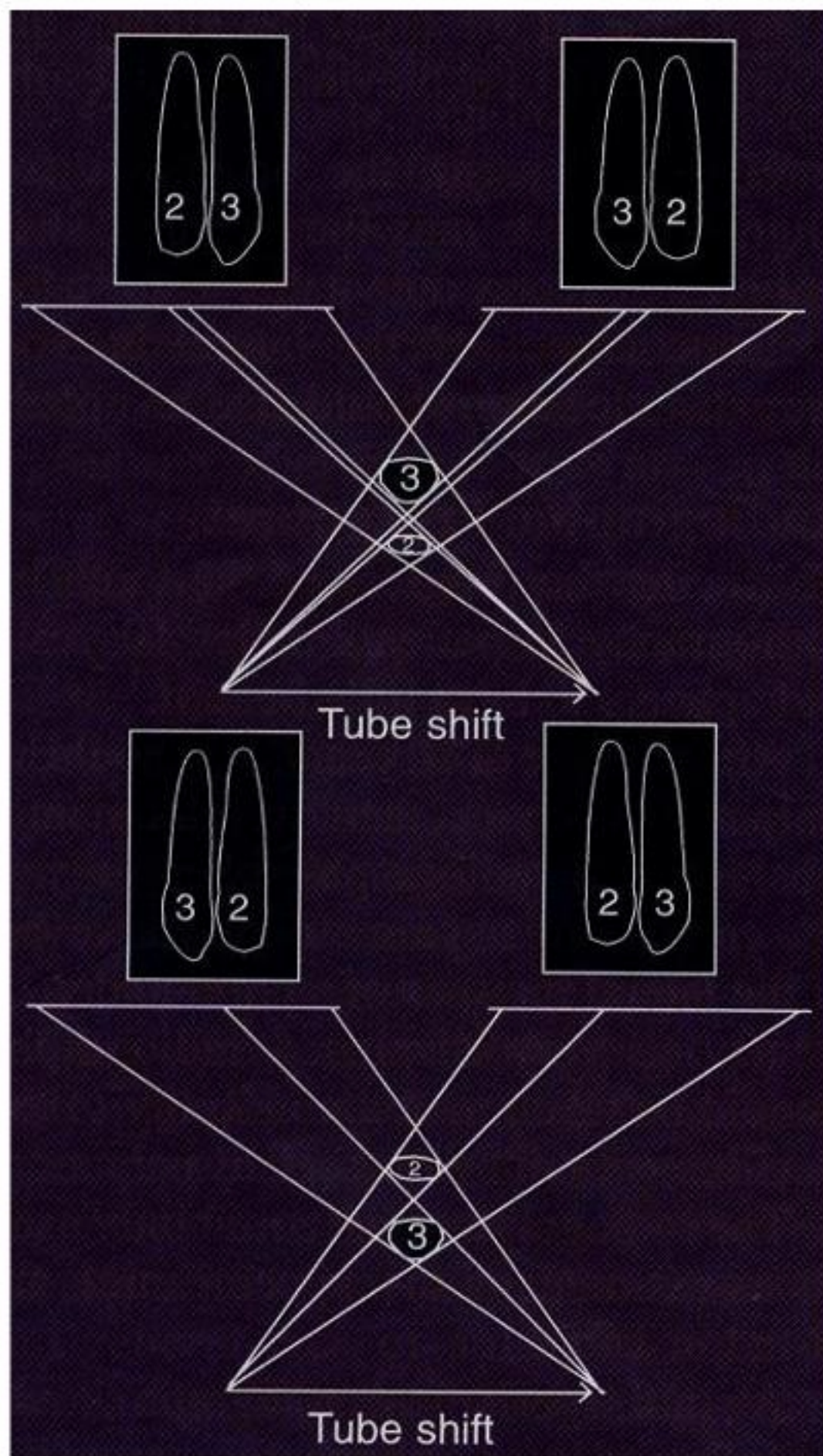


Figure 4. The principles of parallax (the tube shift technique) to localize impacted canine. A radiograph (periapical or anterior occlusal) is taken from two angles differing by 20°. (a) If the canine moves in the same direction as the tube shift it lies in a palatal position but if it moves in the opposite (b) then it lies buccally.

An initial periapical radiograph should be followed by an orthopantomogram if it looks suspicious. Use of the parallax technique can give clues as to the buccopalatal position of the tooth.

Special radiographic localization:

Shift sketch technique:

- Utilizing 2 or more periapical films.
- The film is kept in fixed position in every exposure.
- The x-ray cone of the machine (x-ray beam), is shifted from each exposure to another in special direction (Figure 4).

Interpretation: By comparison of the 2 or more films:

- If the impacted tooth moves from film to another in the same direction of beam shift i.e.

the impacted tooth exposed more. This means that the tooth impacted in palatal position.

- If the impacted tooth moves against the beam shift i.e. disappear more. This means that the tooth impacted in labial position.

An orthopantomogram can assess the height, inclination and mesiodistal position of the buried canine. A posteroanterior radiograph is rarely indicated as it gives a higher radiation dose than other radiographs (0.034 mSv compared with 0.014 mSv for an orthopantomogram).^{5,6,7}

Treatment options

The options for treatment of the impacted upper canine are¹⁶:

- **No active treatment.**
- **Early extraction of the primary canines;**
- **Extraction of the impacted tooth or teeth;**
- **Transplantation.**

Figure 5 shows a flow chart for the treatment options.

No Active Treatment

Occasionally the impacted canine can be left alone, especially if the tooth is placed very high and above the roots of the incisor teeth. The situation should be reviewed regularly to rule out potential cystic degeneration of the follicle, and migration or resorption may occur (Figure 2 and 3). Resorption of the root of the lateral incisor can be assessed radiographically by the degree of overlap and the loss of lamina dura outline (Figure 2 and 3).

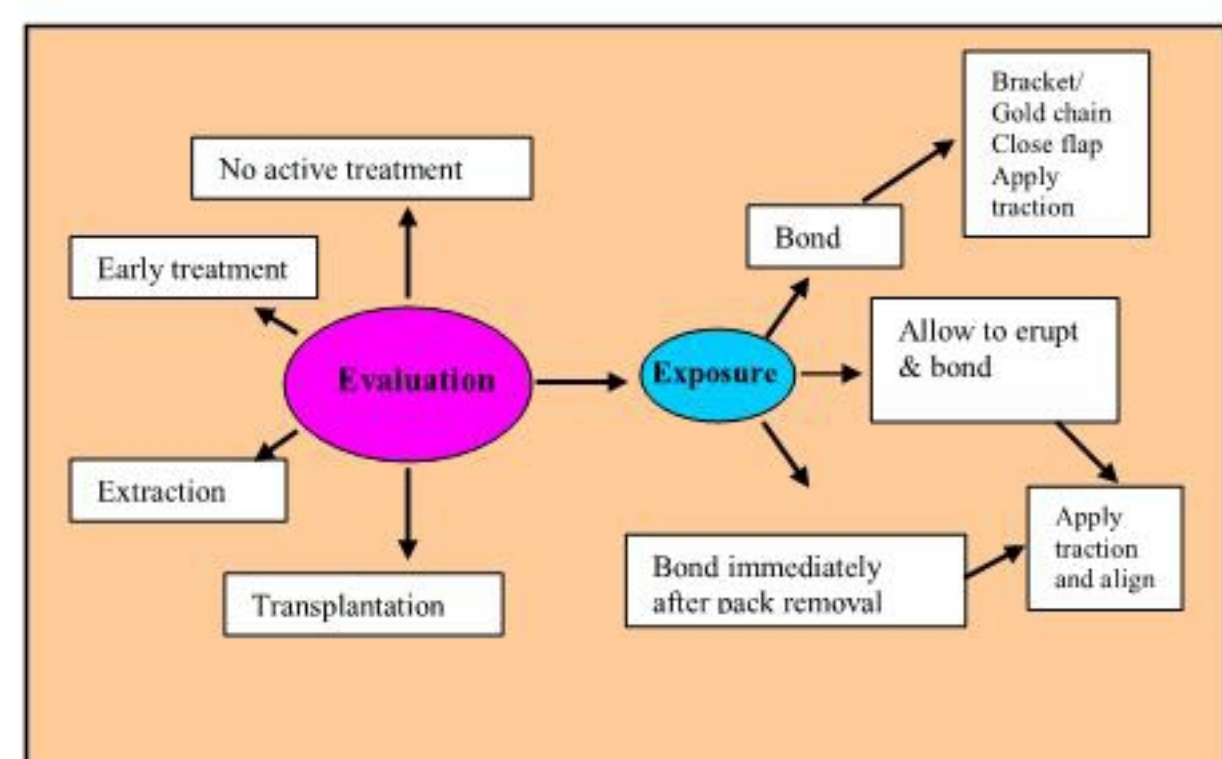


Figure 5. Options for treating the impacted canine.

Early Treatment

If the canine is palatally displaced extraction of the primary canines can encourage eruption,⁸ particularly if there is enough space in the arches. The conditions necessary for this treatment to be successful are:

- The patient must be aged between 10 and 13 years;
- The case should be left for 12 months to evaluate the improvement, and then reassessment;
- Space in the arch must be adequate;
- 3/3 should overlap 2/2 little or not at all.

The average success of this study was 78% (varying from 64% to 91% depending on the degree of overlap of the canine over the lateral incisor). If crowding is present, spontaneous correction of the palatal canine is less likely.^{9, 16}

Extraction

Extraction may be necessary when the prognosis for alignment is hopeless when the canine is too high, displaced too far mesially or at an extreme angle. Other reasons for extraction are:

- Contact between the premolar and lateral incisor is good;
- The patient is older than 16 years;
- The patient is unwilling to wear an orthodontic appliance.

The primary canine could reasonably be expected to remain until the patient is in their late twenties, when it could be replaced either prosthetically or with a bridge.



Figure 6. Occlusal radiograph of a 20-year-old girl. The 3/3 are palatally impacted and the prognosis for alignment is questionable.

Alternatively, as part of comprehensive orthodontic treatment, the primary and secondary canines could be extracted and space created for a bridge or the canine space closed by replacing the canine with the first premolar. The latter treatment involves mesio palatal rotation of the premolar and the introduction of buccal root torque to simulate the extracted canine.

Reimplantation

If the prognosis for alignment is hopeless but adequate space is available in the arch reimplantation may be indicated. This is particularly so if the patient is older than 16 years or unwilling to undergo orthodontic treatment. It must be possible to extract the tooth intact, the morphology of the tooth should be good and adequate buccal/palatal bone must be present to cover the canine once it has been reimplanted.

The technique has been described elsewhere,¹⁰ but essentially, if the root is completely formed

- 1- The palatal flap is lifted, bone removed and the canine removed intact and the root canal should be carried out.
- 2- The deciduous canine is extracted and the socket prepared.
- 3- The tooth is inserted and immobilized.

Failure of reimplantation

Failure may be caused by root resorption or pulpal calcification. Progressive root resorption occurs in up to 16% of cases. The pulp calcifies in 42% of cases and causes a characteristic yellow coloration to appear in the tooth. Failure may also occur later due to cervical resorption, resulting in fracture at the gingival level.¹⁶

Overall about 68% of cases have good prognosis 3 to 10 years out of retention.

EXPOSURE AND ALIGNMENT

In general, labial canines tend to be more difficult to align than palatal canines because of the labial plate of bone. The prognosis can be judged from a panoramic radiograph, and is affected in the following ways.

- The prognosis is likely to be better in a patient under 16 years of age.
- Good space in the arch means that alignment will probably be successful.
- Healthy root morphology suggests that alignment will be good.
- The closer a canine is to the midline the lower the likelihood of good alignment (Figure 7).
- The more apically positioned the canine is, the poorer the prognosis (Figure 8).
- The inclination of the canine can also influence the prognosis for alignment. If the canine is lying horizontally, for example, the prognosis is very poor. The closer to 45° to the occlusal plane the canine approaches, the better the prognosis.

Technique

Surgical exposure may be achieved in three ways.

The first involves exposure; packing and then allowing the tooth to erupt freely (Figure 9a and 9b). After a time a bracket is bonded and the tooth is aligned. A disadvantage of this technique is that re-exposure may be necessary.

The second, more commonly used, technique involves immediate bonding of the bracket to the tooth after removing the pack. A disadvantage of this is that a clear field may be difficult to isolate and therefore bonding is not facilitated (Figure 9b).

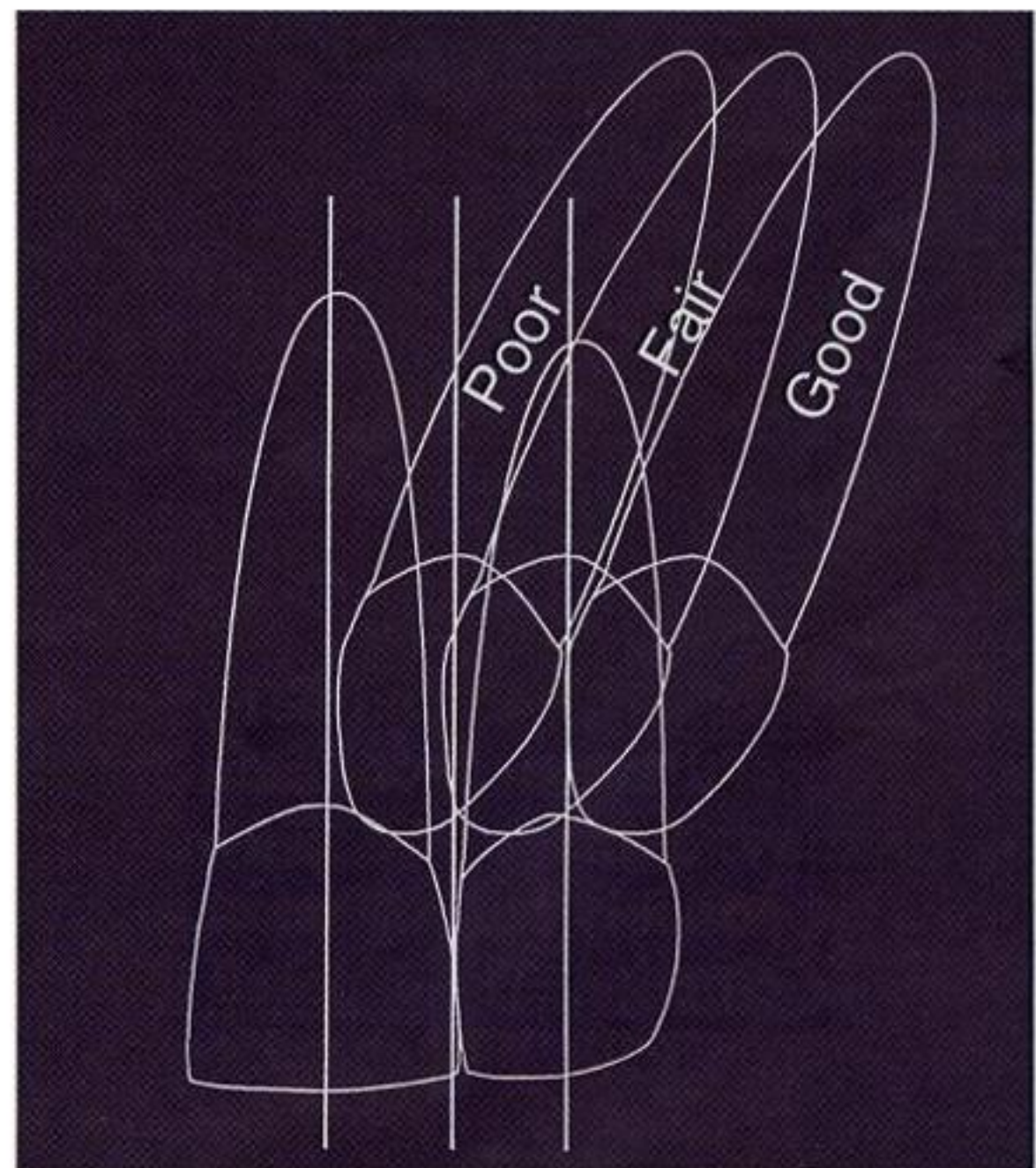


Figure 7. Horizontal rule of thirds: on a panoramic radiograph, the closer the canine lies to the midline the poorer the prognosis fo

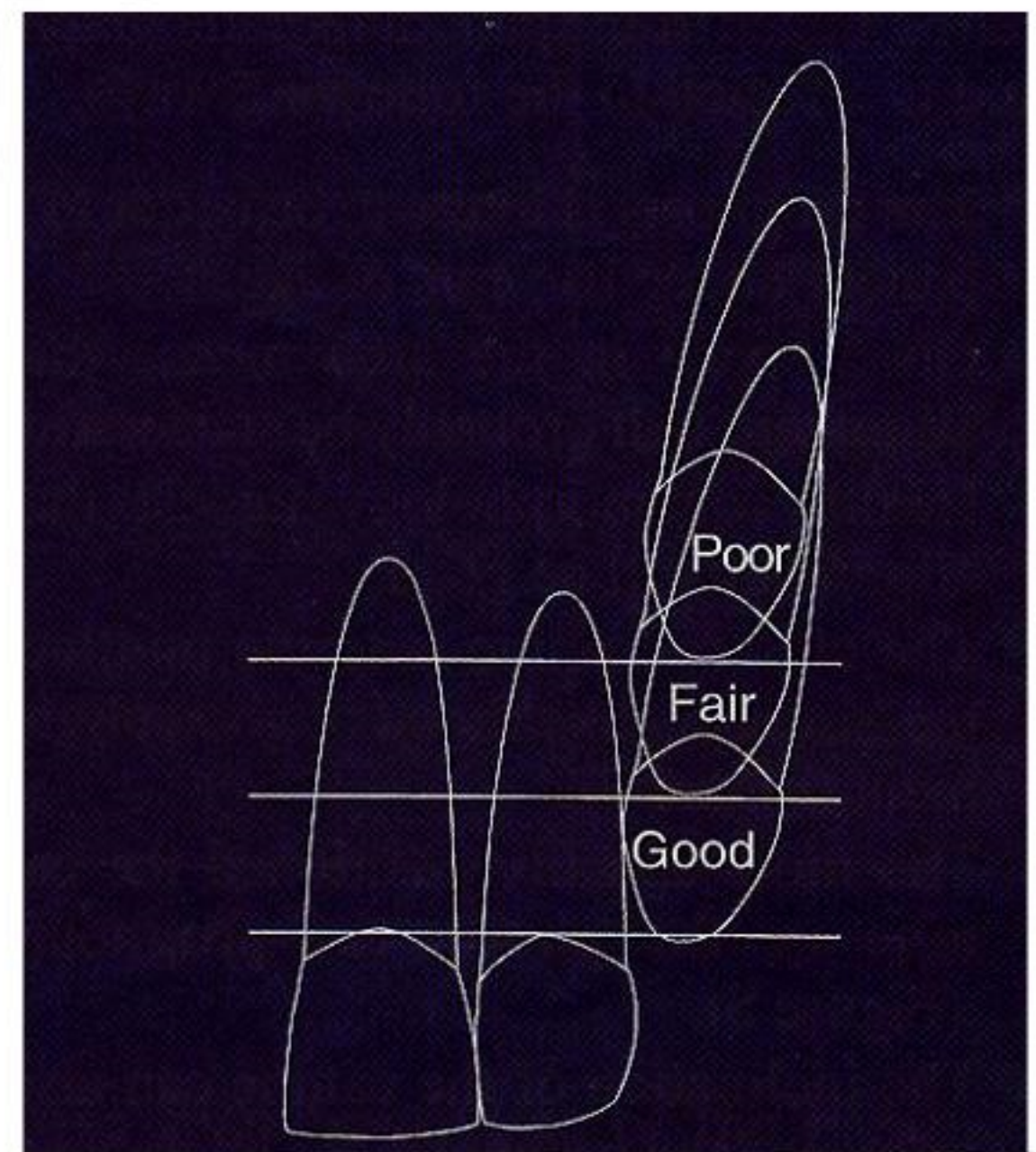


Figure 8. Vertical rule of thirds: on a panoramic radiograph, the further apically the canine lies, the poorer the prognosis for alignment.



Figure 9. (a)The upper left canine has been exposed and allowed to erupt. (b) Fixed appliances are being used to created space for the tooth, correct the midline and close the space. (c). Canine bulges were present palatally (see arrows) with retained deciduous canines. The upper left and right permanent canines have been exposed and allowed to erupt. Fixed appliances are being used to created space for the tooth, correct the midline and close the space. (d). The case after treatment.

The third option is the gold chain/bracket combination, which involves bonding of a bracket to the tooth at the time of the operation and closure of the flap over the tooth. The gold chain is unraveled and traction is applied to the tooth.¹¹ This allows the tooth to erupt through mucosa which has not been scarred.

The choice of technique varies from specialist to another one and only the principles are outlined here. Buccal canines are best exposed using an apically repositioned flap, this preserves the attached gingivae (Figure 10).¹² Palatal canines are exposed using a palatal flap and bone is removed around the maximum convexity of the tooth. Mobilization of the tooth may damage the periodontal ligament, possibly causing ankylosis and failure of eruption. The exposed tooth is packed open with

Whitehead's varnish gauze or a zinc oxide/eugenol pack. Once the pack is removed, a traction hook or bracket is bonded to the canine.



(a). Right view before treatment, (b). Left view before treatment.

(c). Right view after treatment, (d). Left view after treatment.

Figure 10. (a and b) A buried buccal canine before treatment. (c and d) The canine was exposed by an apically repositioned buccal flap and thus a wide band of attached gingival.

Magnets

The use of samarium cobalt magnets has been described in alignment of the unerupted palatal canine.^{13,14} A small magnet is bonded to the tooth and the exposure flap is closed over it. An attracting magnet is attached to a removable appliance so as to allow the force component from the magnet to align the canine. Advantages of this included preservation of attached gingivae, because the canine erupts naturally. Disadvantages include cost and ease of placement.

Fixed Appliances

Two phases of alignment using fixed appliance have been described.

The first involves the use of fixed appliance therapy using intra-oral anchorage in the form of a palatal arch or extra-oral anchorage to prevent unwanted movement of the buccal teeth. Elastic traction

or wire ligature traction is applied to the canine to align it (Figure 11).

In the second phase, when the tooth is in the correct position, buccal root torque is introduced to ensure correct root placement. Often the first premolar is extracted to allow adequate space for the canine. In other cases the buccal segment on the side of the missing canine may have drifted forwards and may need therefore to be moved distally to create space.

Conclusion:

Management of impacted canines is often extremely challenging for both the orthodontist and the surgeon. It is not only necessary to formulate a treatment strategy that will allow movement of the teeth into ideal positions, but also essential to expose the teeth with minimal adverse effects on contiguous structures.

The orthodontist decision to expose or remove an impacted upper permanent canine, based on radiographic information, seems to be primarily guided by its labio-palatal position and its angulation to the midline.

All patients with impacted permanent canines must undergo a comprehensive evaluation to determine whether exposure and orthodontic treatment or extraction is the most reliable approach. Although extraction of a labially impacted canine might temporarily improve esthetics, it is contraindicated due to the possibility of compromising orthodontic outcome as well as functional occlusion. Extraction is indicated when the tooth is ankylosed, severely impacted, undergoing root resorption, has a dilacerated root, or there are other pathologic considerations. Two basic types of surgical procedures are routinely performed.

One involves a "closed eruption" in which the crown of the canine is exposed, an attachment is fixed to the crown, and the flap is sutured back over the crown,

leaving only a wire passing through the mucosa for application of orthodontic force.

The second type of procedure is "open eruption", where the crown is left exposed either with a window cut into the tissue or repositioning of the mucoperiosteal flap.



Figure 11. Both upper palatal canines are being aligned by elastic traction. A full-thickness archwire is engaged in the brackets and extra-oral anchorage is being used to control the molar/premolar reaction.

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