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Guidelines for the Assessment of the Impacted Maxillary Canine

Abstract: Canine impactions are frequently encountered, occurring in 1.7% of the population. The aim of this paper is to provide guidance on the assessment and management of cases which present in general dental practice. Canine position is considered in four categories; canine overlap with adjacent incisor, vertical canine height, angulation to midline and position of canine root apex. Good, average and poor prognostic outcomes are considered for each category and a brief outline of their management is included.

Clinical Relevance: Canine impactions frequently present during routine examination. Appropriate recognition, investigation and referral, if necessary, are paramount to successful treatment.

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Treatment of impacted maxillary canines is a common challenge faced by dental professionals in daily practice. According to Mead, an impacted tooth is one that is prevented from erupting into position because of malposition, lack of space or other impediments.¹ After lower third molars, maxillary canines are the most frequently impacted teeth.² The incidence of ectopic canine eruption has been shown by Ericson and Kuroi to be 1.7%.³ According to the literature, 85% of canine impactions occur palatally and 15% buccally.⁴ Impacted maxillary canines have been shown to occur twice as commonly in females as males.⁵ Dachi and Howell also showed that the majority of impactions of maxillary canines are unilateral at 92%, and only

8% are bilateral.⁵ The canine has a long root and good bony support, which is advantageous in lateral excursions, and it serves as an excellent abutment for fixed and removable prostheses. For these reasons, the canine is often referred to as the 'corner stone of the maxillary arch'. An absent canine poses aesthetic and functional problems and should be avoided at all costs.

Development

Canine development commences at 4–5 months of age, high in the maxilla, lateral to the piriform fossa, and has the longest path of eruption at 22 mm.⁶ Crown calcification starts at 1 year, between the roots of the deciduous first molar, and is complete at 5–6 years of age. It then migrates forward and downwards to lie buccal and mesial to the apex of the deciduous canine, then continues to move down the distal aspect of the root of the upper lateral incisor. As the canine erupts into position, the physiological median diastema may close.⁷ Maxillary canines erupt on average at 11–12 years of age, erupting earlier in females than in males.⁸ Canine displacement is classified as buccal, palatal, or in the line of the

arch. Occasionally, canines can be found lying horizontally above the apices of the maxillary incisors, or displaced near the nose.

Aetiology

Buccally and palatally impacted canines have different aetiologies. Jacoby's study found that 85% of palatally displaced canines had sufficient space to erupt, whereas 83% of buccally impacted canines had insufficient space to erupt. Therefore crowding was determined as the main aetiological factor in buccal impactions.⁹ Two theories have been proposed to explain the aetiology of palatally impacted canines. The guidance theory described by Becker *et al*,¹⁰ in 1981, suggests that the distal aspect of the lateral incisor is the guide for canine eruption. In his study, Becker found that palatally impacted canines were very closely associated with spaced dentitions and lateral incisors that are peg-shaped, of small mesiodistal width, or congenitally absent. Approximately half of the cases of palatal impactions that were examined were associated with anomalous lateral incisors. The genetic theory described by Peck *et al*,¹¹ in 1994, considers the dental anomaly of impacted canines to be a product of

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polygenetic multifactorial inheritance. They based their theory on the fact that palatally displaced canines are concomitant with other dental anomalies, such as lateral-premolar hypodontia and peg laterals, that they occur bilaterally and that there is a gender, familial and population difference in occurrence. Other factors documented in the multifactorial aetiology for impacted canines include:

- Presence of supernumeraries;
- Odontomes;
- Pathological lesions, eg cysts;
- Delayed exfoliation of the deciduous canine (although this is thought to be an indicator rather than a cause of displacement);
- Early trauma to the maxilla;
- Cleft lip and palate;
- Ankylosis;
- Displacement of crypt;
- Long path of eruption; and
- Syndromes, eg cleidocranial dysplasia.

Investigations

Investigations for unerupted canines should be carried out clinically and radiographically. Clinical assessment will involve visual inspection and palpation. Radiographic assessment will involve the use of parallax or Cone Beam Computerized Technology (CBCT).

Clinical assessment

Clinical investigation involves the following:

- Visual inspection of the canine bulge, whether it is buccal (Figure 1) or palatal (Figure 2), which should be seen between the lateral incisor and first premolar roots, and inspection of the angulation of the lateral incisor, eg a distally inclined lateral incisor may infer palatal impaction (Figure 3) and a mesially inclined lateral incisor may indicate buccal impaction (Figure 4). In addition, the colour and mobility of the deciduous canine should be inspected as this might indicate resorption of the root.
- Palpation of the buccal surface of the alveolar process distal to the lateral incisor from 8 years of age may reveal the position of the maxillary canine and has been recommended as a diagnostic tool by Kettle.¹² A longitudinal study of 505 school children evaluated clinical methods

for supervising the eruption of maxillary canines.¹³ It was found that positive palpation indicated a good prognosis for eruption and in 92% of cases palpation was positive.

Radiographic assessment

Radiographic examination is warranted where there is asymmetry on palpation or a pronounced difference in the eruption of canines between left and right side is noted. A radiograph may also be wise when the canines cannot be palpated in the normal position and the occlusal development is advanced, or when the lateral incisor is late erupting or shows a pronounced buccal displacement or proclination. Radiographic examination of canine position was only indicated in 7% of the children in Ericson and Kuroi's group over 10 years of age, according to the clinical diagnostic criteria used.¹³ The canine region should be palpated from the age of 8 years, however, lack of positive palpation is only considered abnormal at the age of 10 years plus.

Radiographs are required to view impacted canines in three dimensions (vertical, mesio-distal and buccopalatal), to view the relationship to the midline and adjacent teeth and to evaluate any resorption.¹⁴ The views commonly used for assessing ectopic canines include panoramic, periapical, cephalometric, lateral skull and maxillary occlusal. When localizing impacted canines, two radiographic views are needed to locate the tooth in the buccolingual plane.¹⁵ The right angle technique uses two radiographs taken at right angles to each other. This has been done with a lateral cephalometric radiograph and a posterior anterior radiograph but is not commonly used. The most common means of radiographic localization currently in use are parallax and CBCT.

The preferred means of localization is parallax, which is the apparent displacement of an image relative to the image of a reference object and is caused by an actual change in the angulation of the X-ray beam.¹⁶ The reference object is normally the root of an adjacent tooth. The image of the tooth that is farther away from the X-ray tube moves in the same direction as the tube, whereas



Figure 1. Buccally impacted canine.



Figure 2. Palatally impacted canine.



Figure 3. Distally inclined lateral in palatal impaction. Key: yellow and black stripes – palatal position.



Figure 4. Mesially inclined lateral in buccal impaction. Key: yellow and black boxes – buccal position.



Figure 5. Resorption area on radiograph and clinically on extracted tooth.

that of the tooth closer to the X-ray tube moves in the opposite direction to the tube (SLOB Rule – Same Lingual Opposite Buccal). An orthopantomogram (OPG) and anterior occlusal radiograph are commonly used, giving a 60° tube shift approximately. This is vertical parallax, as the angulation of the X-ray beam changes in the vertical plane from 8°, for an OPG, to 60° for an anterior occlusal.¹⁷ Horizontal parallax is caused by change in the angulation of the X-ray beam, or tube shift in the horizontal plane, and two periapicals or a periapical and an anterior occlusal radiograph are the radiographs of choice for this technique. Armstrong *et al*¹⁸ showed that the diagnostic sensitivity for palatally placed canines was significantly greater for horizontal parallax (88%) than for vertical parallax (69%) and concluded that horizontal parallax is superior to vertical parallax in diagnostic accuracy. In cases of two unerupted canines, a single OPG can be used to assess position, with the palatal canine appearing bigger on radiograph, however, this method is difficult for even experienced clinicians to use.¹⁹

Computerized tomography (CT) was developed by Sir Godfrey Hounsfield in 1967 and, since the first prototype, there has been a gradual evolution to five generations of such systems.²⁰ Cone beam computerized tomography (CBCT) was designed to overcome some of the limitations of conventional CT devices (eg high radiation dose to produce the multiple images which are stacked to produce a complete image). CBCT was developed in the 1990s and is the most precise method of radiographic localization, maximizing diagnostic yield and reducing exposure,²¹ the total radiation being approximately 20% of conventional CTs and equivalent to full mouth periapicals.²² It uses a cone shaped X-ray beam to acquire a volumetric dataset of the region of interest with a single rotation of the patient.²³ Computed image reconstruction produces 3D images at high resolution. Mah *et al*²⁴ used CBCT to locate impacted canines precisely and to design treatment strategies that allowed for minimally invasive surgery to be performed. A common problem in orthodontics is underestimating the degree of resorption associated with unerupted teeth, especially maxillary canines. Resorption is not always detected on plain radiographs owing to

superimposition of the incisor roots and the crown of the impacted canine obscuring morphology. CBCT overcomes this problem, increasing detection of resorption by 50%.²⁵ CBCT eliminates potential problems with magnification and superimposition which make interpretation and localization with conventional radiography challenging. An important consideration for clinicians prescribing CBCT outlined by IR(ME)R 2000 and British Orthodontic Society Guidelines for use of radiographs in clinical orthodontics²⁶ is the need to interpret and report all the image data, including those areas outside the jaws, since any occult pathology or abnormalities found in the scans must be reported on and, if necessary, referred for further management.

Sequelae

Possible sequelae of impacted canines include cyst formation, internal resorption of the impacted tooth, external resorption of impacted or neighbouring teeth, ankylosis, infection and migration of neighbouring teeth with loss of arch length.²⁷ Resorption and pathology are more likely in females, in age groups greater than 14 years, and in cases where the angulation of the canine to the midline is more than 25°. Ericson and Kuroi showed, in a study of 107 children, that resorption on the roots of incisors adjacent to ectopically positioned canines occurred in 38% of lateral and 9% of central incisors.²⁵ Walker *et al* showed that 66.7% of lateral and 11.1% of central incisors were resorbed following ectopic eruption of adjacent canine.²⁹ The reported incidence of resorption depends upon the imaging technique used. Superimposition of the incisor roots and the crown of the impacted canine on intra-oral radiographs obscures root morphology in 45% of cases.²⁹ Computed tomography overcomes this problem. Ericson and Kuroi²⁵ concluded that resorption on maxillary incisors after ectopic eruption of canines was more common than previously thought. CT scanning increased detection of root resorption by 50%. The sensitivity of intra-oral films was low when diagnosing resorption, and was reported in 0.71% of children in earlier studies.¹³ The most likely cause of root resorption is inherent pressure due to migration of the displaced erupting canine, combined

with physical contact between the root of the incisor and prominences on the canine crown (Figure 5).³⁰ However, the response of incisors with resorbed roots following treatment of impacted canines was assessed by Becker and Chaushu³¹ and they suggested that, once the impacted canine had been moved away, there is no risk for further resorption. Falahat *et al*,³² in their follow-up of root resorption, also showed that root resorption associated with ectopic canines, in most cases, did not threaten the long-term viability of the affected incisor, even when resorption was severe. Results from their study showed good clinical and radiographic evidence of healing in all cases, except for one ankylosed tooth and one with pulpal obliteration.

Management

The management of impacted canines usually involves five treatment options:

- No active treatment, ie leave *in situ* and monitor radiographically for cyst formation;
- Interceptive treatment;
- Surgical exposure and orthodontic alignment;
- Surgical repositioning;
- Extraction.

The general dental practitioner is well placed for early detection of ectopic canines. When canine impaction is identified, extraction of the maxillary deciduous canine may, in some cases, allow the impacted canine to erupt in the correct position. In Class I non-crowded cases, where the permanent maxillary canine is impacted or erupting buccally or palatally, the preventive treatment of choice has been shown to be extraction of the deciduous canine from the ages of 10–13 years.³³ It is important that no crowding is present. Power and Short³⁴ showed that interceptive extraction of the deciduous canine completely resolved permanent canine impaction in 62% of cases, and a further 17% showed some improvement in terms of more favourable canine positioning. Ericson and Kuroi³⁵ analysed the effect of extraction of the deciduous canine on 46 palatally erupting ectopic maxillary canines in 35 individuals aged 10–13. They found that, in 78% of palatally erupting ectopic canines, the eruption paths normalized within 12 months after extraction of the

deciduous canine. In 64% of these cases, improved positions were noted after only 6 months, and in 36% the position improved after 12 months. Inclusion criteria specified that normal space conditions were present and no incisor root resorptions were found. Baccetti *et al* looked at interceptive treatment of palatally impacted canines by extracting the deciduous canine alone or in association with the use of cervical pull headgear.³⁶ They showed that removal of the deciduous canine alone showed correction of palatal displacement in 65.2% of cases, compared with 87.5% where cervical pull headgear was used and 36% in the untreated control group. In a later study, Baccetti *et al*³⁷ showed that the use of a rapid maxillary expander as an early interceptive approach is effective for increasing the rate of eruption of impacted canines. In the treatment group, 65.7% erupted successfully compared to only 13.6% in the control group. The success of interceptive treatment depends on the degree of impaction, age at diagnosis and canine position. Generally speaking, when the degree of overlap between the impacted canine and adjacent lateral incisor exceeds half the width of the incisor root, the possibility of total recovery using interceptive treatment alone decreases.³⁴ Ericson and Kuroki³⁵ showed that, if the canine overlapped the lateral incisor by more than half of the lateral root, only 64% normalized, compared to 91% when the overlap was less than half the lateral root. The chance of successful eruption following extraction of the deciduous canine also decreases as the angle from the vertical increases.³⁵ The degree of horizontal overlap with the lateral incisor has been found to have more impact on prognosis than angulation.³⁴ A Cochrane review published in 2009 concluded that 'there is currently no evidence to support the extraction of the deciduous maxillary canine to facilitate the eruption of the palatally ectopic maxillary permanent canine'.³⁸ This review stated that randomized controlled trials were identified but, owing to deficiencies in reporting, they could not be included in the review. The authors recommended that further clinical trials should be conducted, and greater attention to the design and reporting of studies should be given to improve the quality of clinical trials. For these reasons, an orthodontic opinion should always

be sought before embarking upon any interceptive treatment. Not all canines normalize, and an orthodontist would be equipped to manage those that fail to show improvement. Furthermore, greater success for re-alignment was shown by Baccetti *et al*³⁷ with the use of space creation by cervical pull headgear and rapid maxillary expansion, where a specialist opinion again would be ideal.

Assessment for interceptive management

Four aspects of canine position should be assessed, as well as the age of the patient carefully being taken into account. The prognostic factors have been investigated by McSherry³⁹ and Pitt *et al*,⁴⁰ 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 (Figure 6). 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 (Figure 7). The more apical the position of the crown, the poorer the prognosis for alignment. From the level of the cemento-enamel 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 of root length would indicate average prognosis; and above the full length of root would have poor prognosis.

- Canine angulation to the midline (Figure 8). 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 apex in the horizontal plane (Figure 9). If the canine 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

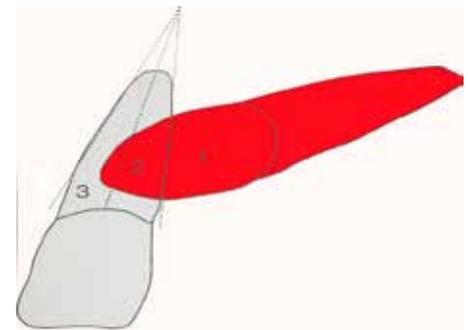


Figure 6. Canine crown horizontal overlap. Key: 1. No horizontal overlap; 2. Up to half root width; 3. Complete overlap.

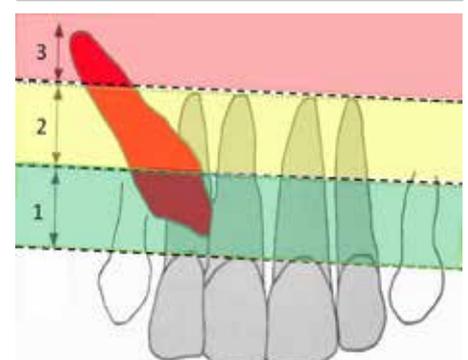


Figure 7. Vertical height of canine crown and key opposite. Key: 1. CEJ to halfway up the root; 2. > halfway < full root length; 3. > full root length.

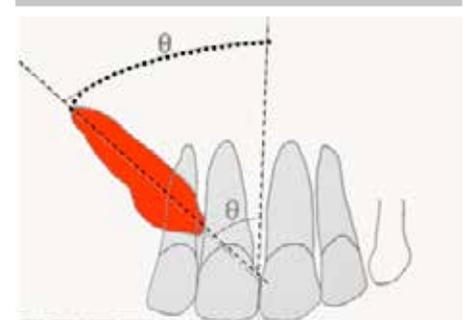


Figure 8. Canine angulation to midline.

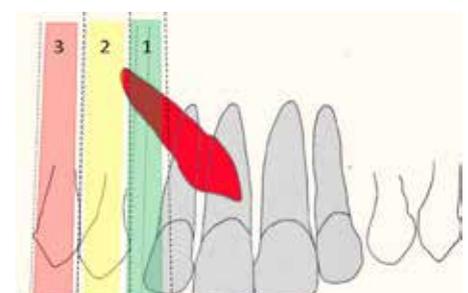


Figure 9. Position of canine root apex horizontally and key opposite. Key: 1. Above canine position; 2. Above 1st premolar; 3. Above 2nd premolar.

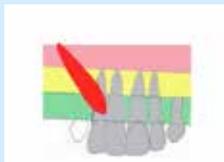
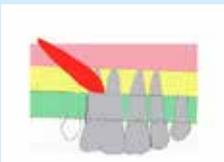
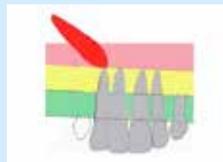
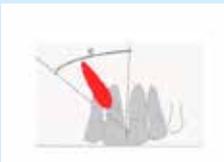
Category	Good Prognosis	Average	Poor
Overlap of incisor	No horizontal overlap 	Up to half root width 	Complete overlap 
Vertical height	CEJ – halfway up root 	>half <full root length 	>full root length 
Angulation	0–15° 	16–30° 	>30° 
Position of apex	Above canine position 	Above 1st premolar 	Above 2nd premolar 

Table 1. Prognosis for re-alignment depending on assessment in various categories. Key – Green: good prognosis; Yellow: average prognosis; Pink: poor prognosis

if it is above the second premolar, prognosis is poor.

The evidence basis for these prognostic indicators has been documented by McSherry,³⁹ Stivaros and Mandall¹⁴ and Pitt *et al.*⁴⁰ It is recommended in the RCS Eng Guidelines on *The Management of the Palatally Ectopic Maxillary Canine* that less experienced practitioners seek the opinion of an orthodontic specialist prior to initiating treatment.⁴¹ The above criteria may aid decision-making regarding management of cases. According to the criteria, if canine prognosis is good in all four categories, then a decision may be made by the orthodontist to extract the deciduous canine (Table 1). This may allow spontaneous eruption of the impacted

canine. Many clinicians choose to remove the deciduous canine interceptively and monitor the situation. If the canine fails to erupt or improve within 12 months, the orthodontic treatment will most likely be exposure and alignment.³⁵

In cases where prognosis is average, ie two categories suggest a good prognosis and two suggest an average prognosis (Table 1), definitive treatment could be the extraction of the canine, depending on the overall malocclusion and the associated factors, such as patient age, crowding and condition of the dentition. Therefore maintaining the canine could be important for the bone level or to avoid the need for restoration in an adolescent. The patient should of course be made aware of

the eventual loss of the deciduous canine and the need for permanent restoration.

If one or more of the criteria suggest a poor prognosis, or there is evidence of pathology, then orthodontic treatment is essential and the deciduous canine should not be removed (Table 1). In these cases, all factors must be carefully considered before a decision on definitive treatment can be made.

Conclusion

Incidence of maxillary canine impaction is 1.7%, therefore a common encounter for general dental professionals. Practitioners should be aware of normal canine development, relevant

investigations, and of dental anomalies such as peg-shaped lateral incisors that occur concurrently, so that early recognition and interceptive treatment can be carried out. Interceptive treatment alone is sometimes sufficient, depending on the degree of impaction. Surgical exposure and orthodontic alignment of the impacted tooth is often required. In such cases, early recognition and appropriate referral for orthodontic treatment are essential.

Acknowledgement

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