
Assessment of radiographic factors affecting surgical exposure and orthodontic alignment of impacted canines of the palate: A 15-year retrospective study

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Objective. Impacted canines require a combination of both surgical and orthodontic management. In this study, patients treated for bone-impacted canines of the hard palatal were evaluated to assess which radiographic factors influenced the feasibility to move impacted maxillary permanent canines from the hard palate into the alveolar arch.

Materials and methods. Eighty patients aged 12 to 24 (average 16 years) were treated surgically and orthodontically to align 146 bone-impacted canines of the hard palate (from 1994 to 2008). Factors such as age, sex, angulation of the canine to the midline (CAM), anomaly of the canine root (RA), overlap of the adjacent lateral incisor root (OALIR), and ratio of root formation (RRF) upon treatment were documented. Radiographic records and demographic data were assessed. The following radiographic measurements of canine position were made from the orthopantomogram (OPG): (1) angulation to the midline, (2) anteroposterior position of the root, (3) overlap of the adjacent incisor. RA or dilaceration was assessed from the OPG, maxillary occlusal (MO), and periapical (PA) radiographs. Whether the impacted canine had responded to surgical exposure and was orthodontically aligned, or surgically removed and discarded was also recorded. The data were analyzed to assess and correlate significance.

Results. Eighty patients aged 12 to 24 (19 males and 61 females) with 146 bone-impacted permanent canines of the hard palatal were treated. One hundred and three teeth (70.54%) had responded to surgical exposure and orthodontic alignment within 9 to 12 months. Forty-three impacted canine teeth (29.46%) had to be surgically removed because of ankylosis and no movement after 8 to 9 months using 50 to 60 g of traction force via elastic chains. Data analysis via chi-square and Pearson correlation tests showed that as the CAM increased (> 45 degrees), the canine was more likely to be unresponsive to treatment ($P < .001$). Increased overlap (> half the root) of the adjacent lateral incisor root (OALIR) via the canine crown influenced the treatment results negatively ($P < .001$). Additionally, presence of RA was also negatively influential ($P < .001$). However, the anteroposterior position of the canine did not influence the treatment results significantly, neither did age, sex, nor amount of root formation.

Conclusion. Bone-impacted canines of the hard palatal are more likely to respond to surgical exposure and orthodontic management if AM is less than 45 degrees on the OPG; there is no RA found on OPG, periapical (PA), and maxillary occlusal (MO) radiographs; and OALIR by the canine crown is nonexistent or less than grade 2 (half the root) on the OPG. (*Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009;107:772-775)

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Impaction of the permanent canine is a condition in which the tooth is embedded in the bone such that its eruption is prevented.¹ The incidence of impaction is between 1.7% and 2.2%.² Management of this condition is varied. A comprehensive evaluation must be done to assess whether space is available in the arch or can be made available for alignment of the impacted canine, patient age, degree of oral hygiene, suitability of the first premolar to replace a permanent canine, length of orthodontic treatment, costs, and so forth. There are several treatment options open to a patient with a permanent canine impacted in the hard palate: (1) interceptive removal of the deciduous canine; (2) no treatment, but with periodic evaluation for pathologic changes; (3) surgical removal of the impacted canine and prosthetic replacement; or (4) surgical exposure of

the canine and orthodontic alignment.^{3,4} Radiographic factors such as canine angulation to the midline (CAM) on orthopantomogram (OPG), root anomaly (RA), and position (lateral incisor root overlap) should also be assessed because it may help the decision process. The bone-impacted canine of the palate usually requires a combination of both surgical and orthodontic management. We aimed to assess the factors influential in predicting the outcome of exposure and movement of impacted upper permanent canines from the hard palate into the alveolar arch in order to choose whether to expose and align, or to remove and discard.

MATERIALS AND METHODS

Records of 80 patients aged 12 to 24 years (average 16 years) treated surgically and orthodontically to align 146 bone-impacted canines of the palate from 1994 to 2008 were reviewed.

Clinical assessment

Data such as age and sex, space for alignment, presence of the primary canine, migration of the first premolar in the site of the canine, and so forth were documented. Whether the impacted canine had responded to surgical exposure and was orthodontically aligned (into occlusion) or had to be surgically removed (after no orthodontic movement) was also recorded.

Radiographic assessment

Radiographic records (OPG, periapical [PA], and maxillary occlusal [MO]) were assessed and documented. Preoperative radiographs of each patient were viewed and examined using a light box. The following canine position measurements were made from the OPG radiograph: (1) canine angulation to the midline (CAM), (2) ratio of root formation (RRF), and (3) canine crown overlap of the adjacent lateral incisor root (OALIR). RA or dilaceration was assessed from the OPG, MO, and PA radiographs.

Canine angulation to the midline. A midline was constructed as shown in Fig. 1 and a second line drawn through the canine root apex and canine tip. The angle between the 2 lines formed the impacted canine angulation to the midline, which was grouped as follows: Grade 1 (0-15°), Grade 2 (16-30°), and Grade 3 (31°+). The distribution is shown in Table I.

Root formation. The canine root formation was judged as being Grade 1 (1/3 formed), Grade 2 (2/3 formed), or Grade 3 (completely formed). The distribution is shown in Table II.

Canine crown overlap of the adjacent lateral incisor root. The canine crown overlap of the adjacent lateral incisor root is judged relative to the adjacent lateral incisor root and was graded as follows: Grade 1: no

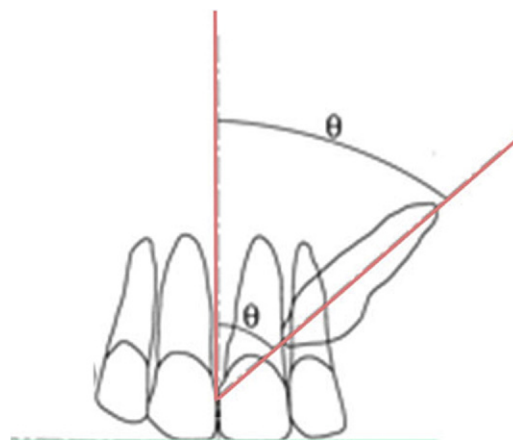


Fig. 1. The angulation of the canine to the midline.

Table I. The impacted canine angulation to the midline

Angulation to midline	% cases
0-15°	18.75
16-30°	21.25
> 30°	60

Table II. Ratio of the canine root formation

Ratio of canine root formed	% cases
1/3	2.5
2/3	11.25
3/3	86.25

horizontal overlap; Grade 2: less than half the root width; Grade 3: more than half, but less than the whole root width; Grade 4: complete overlap of root width or greater (Fig. 2). The distribution is shown in Table III.

Presence of root anomaly. The presence or absence of root anomaly was also recorded when apparent on the OPG, PA, and MO radiographs (Table III).

Surgical technique

After local anesthesia, an electrosurgical knife was used to remove the overlying tissue. Then, the palatal mucoperiosteum was dissected off the bone. The bony covering was removed with a rose bur under saline irrigation. The follicular tissue was scraped from the palatal surface of the enamel and removed. The cavity was enlarged if necessary by further soft tissue and/or bone removal as required to expose the entire palatal or buccal surface. The cemento-enamel junction was undisturbed. The wound was packed using periodontal dressing. Orthodontic brackets were bonded 3 to 7 days later and 50 to 60 g elastic traction was applied.

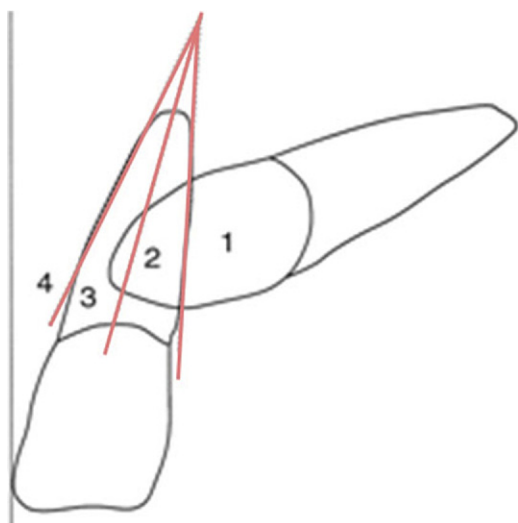


Fig. 2. Canine overlap of the adjacent lateral incisor.

Table III. Anomaly of the canine root

Anomaly	% cases
Without anomaly	78.75
With anomaly	21.25

Whether the impacted canine had responded to surgical exposure and was orthodontically aligned, or surgically removed and discarded was also recorded. The data were analyzed to assess and correlate significance using the chi-square and Pearson correlation test.

RESULTS

Eighty patients aged 12 to 24 years (19 males and 61 females) with 146 bone-impacted permanent canines of the hard palatal were treated. One hundred and three teeth (70.54%) had responded to surgical exposure and orthodontic alignment within 9 to 12 months. Forty-three canine teeth (29.46%) had to be surgically removed because of ankylosis and no movement after 8 to 9 months of 50 to 60 g traction via elastic chains.

The observed frequencies for clinical and radiographic variables are summarized in Tables I-IV. Generally, the canine angulation tended to be greater than 16 degrees with the root apex either above the region of the canine or first premolar. Most impacted canines did not have root anomalies, and more than half had no overlap of the adjacent incisor root. Data analysis via chi-square and correlation tests showed that as the CAM increased (> 45 degrees), the canine was more likely to be unresponsive to treatment ($P < .001$). Presence of RA or OALIR greater than grade 2 (> half

Table IV. Horizontal overlap of the impacted canine over the adjacent upper incisor root

Amount of overlap of the adjacent incisor root	% cases
No overlap	51.25
≤ Half the root	23.75
> Half root, but ≤ complete root width	12.5
> Complete root overlap	12.5

the root) were also negatively influential on the outcome ($P < .001$). However, the anteroposterior position of the canine did not influence the treatment results significantly; neither did age nor sex.

DISCUSSION

The position of the canine(s) on the OPG may help predict the feasibility and prognosis for alignment of the canine by reference to the amount by which the crown overlaps the incisor roots in both the horizontal and vertical planes. The closer the canine is to the midline in the horizontal plane and to the apical third of the lateral incisor root in the vertical plane, the poorer the prognosis.^{5,6}

When there is a primary canine remaining in place of the permanent canine that is impacted in the palate, the patient does not have much to lose if the impaction is exposed surgically and attempted to be aligned orthodontically. However, if the space is occupied by the permanent first premolar then extracting it to make space for the palatally bone-impacted permanent canine is risky. Thus, it should be attempted to move the impaction before the premolar is extracted but often this is not possible and is controversial. Although a large amount of information may be obtained regarding impacted canine position from radiographs, this does not seem to be a major influence on the decision to surgically expose or remove an impacted canine. Our study showed impacted canine angulation correlated with more difficulty in alignment and eruption. Age may be an influencing factor; however, this was not so in our study because all our cases were adolescents. The female-to-male ratio was great because of greater concern of females toward facial esthetics.

The influence of an increased canine angulation to the midline was not surprising as a more horizontally positioned canine is obviously more difficult to align orthodontically. Therefore, an increased probability of such canines being removed supports long-held clinical belief.⁷⁻¹⁰ In this study, 70.54% of palatally positioned canines were orthodontically aligned after exposure. Buccally oriented impacted canines are generally easier to treat and were therefore not addressed here. Follicular enlargement or cystic change around an impacted

canine was not addressed either, although it is also a radiographic factor that is taken into consideration when treatment planning for impacted maxillary canines. However, this per se does not mean that the canine must be extracted.^{5,6}

CONCLUSION

The decision to expose or remove a bone-impacted permanent canine in the palate, based on clinical and radiographic information, seems to be primarily guided by its angulation to the midline, amount of lateral incisor root overlap, and root curvature or anomaly. Presence of nondilacerated canine root, or lateral incisor root overlap via the canine crown grade 0-2, and less than 45-degree angulation of the impaction to the midline correlated with a successful outcome ($P < .001$). Demographic data in this age group did not significantly affect the outcome.

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