CANINE IMPACTION IDENTIFIED EARLY WITH PANORAMIC RADIOGRAPHS


ABSTRACT

This study evaluates the effectiveness of the panoramic radiograph in predicting canine palatal impaction.

Canine palatal impaction occurs once in about every 100 people.1,2 Often these impactions go undiagnosed well beyond the time of normal canine eruption for two reasons:
- Primary canines are shaped similarly to permanent canines, and it is difficult to distinguish clinically between retained primary canine crowns and permanent canine crowns;
- Maxillary canines tend to erupt later in the usual eruption sequence of maxillary teeth.

In addition, when crowding occurs eruption can be delayed even when the canine is not impacted. The result is that canine palatal impactions are not usually prevented. Often they’re treated only after protracted observation, in hopes that eruption will occur without intervention.

Treating impacted palatal canines usually involves surgery plus orthodontic therapy to place the tooth in its correct position.3,4 These procedures offer a high success rate in adolescents but involve substantial time and cost. They also increase the risk of gingival recession, bone loss and detached gingiva around the treated canine.4

A method for early detection and prevention of canine palatal impactions would reduce the need for such complicated treatments and potentially improve the canine’s long-term prognosis.

One suggested preventive procedure for canine palatal impaction is early extraction of the corresponding primary canine,3,6 on the basis that failure of primary canine root resorption offers an obstacle to normal eruption.7

Ericson and Kurol felt that palatal maxillary permanent canine impactions could be prevented by early extraction of the corresponding maxillary primary canines.4 They studied the effect of extracting 46 such primary canines in children aged 10 to 13 years.4

Ericson and Kurol didn’t define palatal placement but determined it by a series of radiographs—panoramic, occlusal, lateral and periapical films. They reported that 78 percent of the ectopic canines had a normal eruption path after this procedure. Since no untreated group was examined, we don’t know if any of these
Figure 1. Modification of Ericson and Kurol’s definition of sectors used in this study: sector I is located distal to a tangent to the distal crown and root of the lateral incisor; sector II includes the area from the tangent on the distal surface to a midline bisector of the lateral incisor tooth; sector III includes the area from the midline bisector to a tangent to the mesial surface of the lateral incisor crown and root; sector IV includes all areas mesial to sector III.

Permanent canines would have erupted normally without the primary canine extractions.

It is difficult to evaluate the efficacy of simple interceptive procedures designed to prevent canine palatal impactions without a reliable way to predict which canines will become impacted. If extracting primary canines improves the chances for eruption of permanent canines otherwise destined to become impacted, this would be a simple preventive approach and reduce the need for complicated treatment procedures.

To find a way to predict canine impaction, we studied the clearly contains considerable distortion that limits its value in determining the faciolingual position of unerupted maxillary canines. Hang, however, reports empirical evidence that the spatial relationship between the unerupted maxillary canine and the erupted permanent lateral incisor root on the panoramic radiograph can predict canine palatal impaction.

In any instance, the dentist must obtain additional diagnostic information, including periapical radiographs, to confirm the location of the unerupted tooth and to evaluate potential damage to adjacent teeth. By establishing a method for predicting canine palatal impaction, we can develop appropriate preventive measures, test and use them.

**METHODS AND MATERIALS**

We compared panoramic radiographs taken at an early stage of dental development between two groups of patients. One group consisted of 28 patients—15 girls and 13 boys—all with either unilateral

Figure 2. Radiographs show a typical canine palatal impaction subject and a control subject. Left, the left canine’s cusp tip is located in sector III, and later became palatally impacted. Right, the right canine cusp tip is located in sector I, and later erupted normally.
Number of Canine Cusp Tips Located in the Various Sections in the Canine Impacted Group and the Non-Impacted Control Group in this Study*

<table>
<thead>
<tr>
<th>Impactions</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral</td>
<td>6</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>26 canines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>15 canines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Impactions</strong></td>
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<td>15</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>41 canines</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Non-impactions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age-matched controls</td>
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<td>1</td>
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<td></td>
</tr>
<tr>
<td>56 canines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>13</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 canines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Non-Impactions</strong></td>
<td>68</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71 canines</td>
<td></td>
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</tbody>
</table>

* See Figure 1 for definition of sector boundaries.

or bilateral palatally impacted canines and currently in the permanent dentition. This impaction group had 41 canine palatal impactions: 26 were bilateral; eight, right unilateral; and seven, left unilateral.

We defined a canine as impacted if it was unerupted after complete root development, or if the contralateral tooth was erupted for at least six months with complete root formation.

All impacted canines required surgery, and we confirmed visually the radiographic diagnoses of palatal canine positions. No patients in the impaction group had any extraction or orthodontic treatment before the diagnosis of impacted teeth. The mean age of the patients at the time of the earlier panoramic radiograph was 12 years, 1 month ± 11 months, in the late mixed dentition.

The second group of 28 chronologically and dentally age-matched control patients was 11 girls and 17 boys whose 56 canines had erupted normally. None of the patients had extractions or orthodontic treatment before the eruption of the permanent canines. Average age of the control group patients at the time of their earlier mixed-dentition panoramic radiographs was 11 years, 8 months ± 19 months.

We evaluated the panoramic radiographs taken during the late mixed-dentition period to determine the spatial relationship between the unerupted permanent canine cusp tip and the lateral incisor root for both groups. Our definition of the mixed-dentition stage was a period in which lateral incisors were erupted completely and maxillary primary canines and primary second molars were retained.

We compared the radiographic relationships of the unerupted permanent canine cusp tip and the lateral incisor root between the two groups.

Three examiners—unaware of the subject groupings—individually evaluated random mixed-dentition radiographs from the impaction and control groups. The examiners located the unerupted canine cusp tip relative to the lateral incisor root in one of four sectors using a modified method of Ericson and Kuro’s:

- Sector I was the area distal to a line tangent to the distal heights of contour of the lateral incisor crown and root;
- Sector II was mesial to sector I, but distal to a line bisecting the mesiodistal dimension of the lateral incisor along the long axis of the tooth;
- Sector III was mesial to sector II, but distal to a line tangent to the mesial heights of contour of the lateral incisor crown and root;
- Sector IV included all areas mesial to sector III.

Right and left canines were scored separately for each patient. We tested the differences in the location of the canine cusp tips between the impaction and control groups using a χ² analysis. Differences in canine cusp tip locations
between the impacted and non-impacted canine in the unilateral impaction patients were also tested.

RESULTS

Inter-examiner reliability was 93 percent. In those seven instances where one examiner differed from the other two, the discrepancy was never by more than one sector. The examiners located in the impaction group 17 of the 41 canine cusp tips in sectors III or IV, 15 in sector II and only nine in sector I.

In the age-matched control group, the examiners saw 55 of the 56 canine cusp tips in sector I with a single exception in sector II. They found none of the control teeth mesial to the line bisecting the lateral incisor mesiodistally (sectors III and IV). The location of the mixed-dentition canine cusp tip was significantly different for the impaction group compared with the non-impaction control group ($P < 0.001$).

The 15 patients who had unilateral canine palatal impactions had normally erupted contralateral canines. It was possible, therefore, to use these patients as their own controls and to compare their canine cusp tip locations relative to the lateral incisor on the mixed-dentition panoramic radiographs between impacted and non-impacted sides.

The results again showed a significant difference between the impacted and non-impacted sides ($P < 0.005$). On the canine impaction side, the evaluators found seven of the 15 canine cusp tips located in sectors III and IV, five in sector II and three in sector I. On the non-impaction side, they found 13 of the 15 canine cusp tips in sector I, two in sector II and none in sectors III or IV.

DISCUSSION

Although the panoramic radiograph is inadequate to detect incipient carious lesions or early periodontal bone loss, it can provide worthwhile information regarding the presence and general location of unerupted teeth. Panoramic images are easy to obtain, and radiation levels are substantially reduced when intensifying screens are used in the panoramic cassettes.

In the mixed-dentition stage, there’s a significant difference in the panoramic image of the canine cusp tip relative to the lateral incisor root between canines destined to become palatally impacted and those that will not.

Of the palatally impacted canines, 32/41 (78 percent) had cusp tips located in sectors II, III or IV of the mixed-dentition panoramic radiographs; only nine appeared in sector I. Since sector I included all areas distal to the lateral incisor root, most canines destined to become palatally impacted had cusp tips overlapping or mesial to the lateral incisor root. The sensitivity of this criterion for predicting canine impaction is 0.78; 78 percent of all canines destined to become palatal impactions were identified.

In addition, the examiners located 68 of 71 (96 percent) of the non-impacted canine cusp tips (55/56 age-matched controls and 13/15 non-
impacted canines in the unilateral impaction group) in sector I. Only three non-impacted canine cusp tips appeared in sector II and none in sectors III or IV. Therefore, applying the same test, the specificity is 0.96—or 96 percent of all permanent canines will erupt when their cusp tips do not overlap or lie mesial to the lateral incisor root (sector I) on the mixed-dentition panoramic radiograph.

With a sensitivity of 0.78 and a specificity of 0.96, this test helps predict the canines likely to become impacted.

The average age of the patients in the impaction group was 12 years, 1 month at the time of their mixed-dentition panoramic radiographs. We chronologically and dentally age-matched the control subjects to the impaction patients.

To know if the permanent canine cusp tip position is equally predictive at an even earlier chronological age, we identified a third group of 18 patients identical in all respects to the age-matched control group. Each patient in this third group possessed a dental record containing a panoramic radiograph taken at an earlier chronological age. The average age of this group at the time of their panoramic radiographs was 9 years and 6 months ± 10 months.

As with the older control group, canine cusp tips appeared in sectors III or IV, and 33 (92 percent) of the 36 canine cusp tips were located in sector I—distal to the lateral incisor root—not significantly different between the younger and older non-impaction patients (P > 0.05).

The additional younger chronological age group showed only the position of non-impacted canine cusp tips at an earlier age. It did not address the position of the tips of canines destined to become impacted, as they would appear at an earlier chronological age.

To address this, it's necessary to establish the canine cusp-tip lateral incisor root spatial relationships on earlier panoramic radiographs for canines that have become impacted. This step establishes the earliest possible point in developing a positive diagnosis of canine palatal impaction—it requires identifying a series of patients with palatally impacted canines for whom panoramic radiographs were taken at an earlier age than those in this study.

CONCLUSION

When a routine panoramic survey of a mixed-dentition patient showed the canine cusp tip mesial to the long axis of the erupted lateral incisor root, canine palatal impaction occurred. When the canine cusp tip overlaid the distal half of the lateral incisor root, a canine palatal impaction was usually present.

However, 22 percent of the canines destined to be palatally impacted had their cusp tip distal to a line tangent to the distal surface of the lateral incisor. The relationship between the unerupted canine cusp tip and the lateral incisor, as it appeared on the mixed-dentition panoramic radiograph identified 78 percent of the canines destined to become impacted, but 22 percent remained undetected. We still need a method for early detection of all palatally impacted canines.

The informed consent of all human subjects who participated in the experimental investigation reported or described in this manuscript was obtained after the nature of the procedure and possible discomforts and risks had been explained fully.

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