Early treatment of palatally erupting maxillary canines by extraction of the primary canines

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SUMMARY  The effect of extraction of the primary canine on palatally erupting ectopic maxillary canines was analysed. There were 46 consecutive ectopic canines, in 35 individuals, aged 10.0–13.0 years (mean age 11.4 years) at the time of discovery of the ectopic eruption. All cases showed no or minor space loss. After extraction of the primary canine, the children were investigated clinically and radiographed at 6-month intervals for up to 18 months.

In 36 of the 46 canines (78%) the palatal eruption changed to normal; 23 already showed improved positions after 6 months and 13 after 12 months. No new cases normalized after 12 months.

We suggest that extraction of the primary canine is the treatment of choice in young individuals to correct palatally ectopically erupting maxillary canines provided that normal space conditions are present and no incisor root resorptions are found.

Introduction

The maxillary permanent canine is second only to the third molar in frequency of impaction, with a prevalence of approximately 2 per cent of the population (Thilander and Jakobsson, 1968; Ericson and Kurol, 1986a). The canine is found palatal to the dental arch in about 85 percent of the cases and buccal only in about 15 percent (Hitchin, 1956; Rayne, 1969; Ericson and Kurol, 1987a).

If orthodontic treatment is not started, there is always a risk of retention and also of resorption of the roots of the permanent incisors. Such resorptions have recently been reported to occur in 12 percent of cases of ectopic eruption of the maxillary canines in the age range 10-13 years (Ericson and Kurol, 1987a). Resorptions may be found as early as 10 years of age but occur most often in the age groups 11 to 12 years (Ericson and Kurol, 1987b).

The most common treatment procedure in children and adolescents is surgical exposure followed by orthodontic appliance treatment, where, as a rule, the primary canines are left in place until the orthodontist has moved the impacted tooth to this region (Moyers, 1973; Clark, 1971; Bishara et al., 1976; Hunter, 1983a, b; Fleury et al., 1985). Other proposed strategies are 1. acceptance, i.e. no treatment, 2. extraction of the malerupting canine, and 3. surgical repositioning (Richardson and McKay, 1983).

Several aetiological factors for ectopic canine eruption have been proposed, and include hereditary factors, lack of space, persistence of primary canines, a true ectopic path of eruption, reduced root length or aplasia of lateral incisors (Richardson and McKay, 1982; Jacoby, 1983; Becker et al., 1984).

Delayed exfoliation of the primary canine was believed by Lappin (1951) to be the principal aetiological factor and he presumed that it would be possible to prevent the condition from occurring in a great many cases, by extracting the primary canine. This was also suggested by Miller (1963) and Williams (1981). Berger, in 1943, stated that widening of the arch in the premolar region and early extraction of the primary canines were advisable as precautionary measures to prevent incisor root resorptions.

A thorough search of the literature has shown that sporadic case reports where extraction of the primary canine has favourably influenced the future path of eruption have been presented over the last 50 years (Buchner, 1936; Kettle, 1957; Lind, 1977; Williams, 1981; Leivesley, 1984). In some of the presented case reports,
however, only a slight displacement of the canine is present in the periapical intra-oral radiographs, for example with the crown in a good position but with an increased mesial angulation (Kettle, 1957). Other authors have made more or less casual remarks that extraction of the primary canine may offer a possibility of correcting impacted canines (Hotz, 1974; Howard, 1978; Silling et al., 1979). On the other hand, there is also a case report in which extraction of the primary canine did not affect the eruption of the permanent canine (Hotz, 1974).

No systematic longitudinal study to evaluate the corrective effect of primary canine extraction on the palatally deflected path of eruption of maxillary canines has been carried out, however. The purpose of this prospective study was to analyse the effect of extraction of the primary canine on palatally erupting maxillary canines in young individuals. It was also considered of interest to determine when such a corrective effect of the extraction could be ascertained.

Subjects and methods
Forty-six consecutive ectopic palatally placed maxillary canines were studied. The children, 14 boys and 21 girls, were between 10 and 13 years old.

Figure 1  Orthopantomogram (A), intra-oral axial-vertex radiograph (B) and intra-oral periapical films (C) showing the left maxillary permanent canine in a true palatal ectopic path of eruption and the right canine with a lingual tendency. At the start of treatment, the primary canines are present. Normal space conditions. Normalization of the left canine 6 months after extraction of the primary canine (D).
old at the time of the discovery of the ectopic position (Table 1) and were referred for treatment from the Public Dental Service after the introduction of a digital palpation screening method (Ericson and Kurol, 1986b). Inability to locate the canine in the normal position by digital palpation prompted a supplementary radiographic examination of the canine, where its position was carefully determined in three planes (Ericson and Kurol, 1986a, Fig. 1).

The eruption angles and positions of the permanent maxillary canines were determined as follows:

- In the frontal view (orthopantomogram) (A) the angle of the canine (B) the distance of the cusp tip to the occlusal line (Fig. 2) and the medial crown position in sectors 1-5 (Fig. 3).
Table 2  Effect of the extraction of the primary canine on the 46 maxillary canines with a palatally ectopic path of eruption in 35 individuals, 14 boys and 21 girls, aged 10–13 years.

<table>
<thead>
<tr>
<th>Canine position (orthopantomogram)</th>
<th>Total number of canines</th>
<th>Improved position</th>
<th>No change</th>
<th>Worsening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>after 6 months</td>
<td>after 12 months</td>
<td>after 18 months</td>
</tr>
<tr>
<td>Sector 1, 2</td>
<td>24</td>
<td>19</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Sector 3, 4</td>
<td>22</td>
<td>4</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
<td>23</td>
<td>13</td>
<td>8</td>
</tr>
</tbody>
</table>

— In the transverse plane (vertex projection) the position of the crown of the canine relative to the adjacent lateral incisor and dental arch was determined from the vertex projection and the conventional intra-oral projections. The position of the canine crown relative to the dental arch was classified as completely lingual, lingual tendency and correctly positioned.

— In the sagittal plane (lateral head film), the distances to the occlusal line.

Immediately after diagnosis of the ectopic palatal path of eruption, the primary canine was extracted. The permanent canines were then followed clinically and radiographically at six-month intervals up to 18 months for the radiographic procedure, if necessary, and clinically to full eruption or to the end of necessary orthodontic appliance treatment. Thus, if a clearly noticeable improvement of the position of the maxillary permanent canine was registered, the radiographic follow-up was terminated at the 6 or 12-month control.

In four of the 46 cases (one boy and three girls), the lateral incisors already showed root resorption on the palatal side at start. Two of the resorptions were superficial and two were extensive and reached the pulp. In the latter two cases, the treatment planning for orthodontic treatment of their malocclusion included extraction of maxillary teeth and these two cases were therefore included in this study.

The maximum width of the dental follicle of the canine was measured on the intra-oral periapical radiographs.

All cases had good dental arches and no space deficiency was registered after measuring with sliding calipers. There had been no early extraction of primary molars in the maxilla.

Conventional statistical methods were used for calculation of means and standard deviations. Student’s t-test was used for parametric variables and the chi-square test for non-parametric variables for the analysis of differences between the registrations (Nie et al., 1975).

Results

The main results are presented in Table 2. Altogether 36 (78%) of the 46 ectopic canines showed normalization of the path of eruption and later clinically correct position at the final control. For ten teeth no improvement was registered: seven showed no change at all, one only slight improvement and two an impaired position with the crown moving more medially during the observation period.

Time factor

Of the 36 cases with normalization and clinically correct position at the final control, 23 canines (64%) already showed improved positions radiographically at the 6-month control, Table 2. Nine of these had already normalized at this time (for example, Fig. 1). After 12 months, another 13 teeth had normalized and another 14 canines had improved positions and showed clinically good positions at the 18-month control. No new cases of improvement occurred between the 12-month and 18-month observations.

Medial position (sectors 1–5, Fig. 3)

Of the 46 canines, 22 overlapped the adjacent lateral incisor (in the orthopantomogram) by more than half of the lateral root, and 14 (64%) of these normalized (Table 3). Of the 24 canines which overlapped the lateral incisor root by less
ECTOPIC MAXILLARY CANINES

Table 3  Distribution of the medial position of the maxillary permanent canine in sectors 1-4 in the vertical plane as shown in the orthopantomogram. No teeth were in sector 5. At the start of treatment, after 12 and after 18 months. Number and percent.

<table>
<thead>
<tr>
<th>Registration</th>
<th>Medial maxillary canine crown position in sector</th>
<th>Total number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 n(%)</td>
<td>2 n(%)</td>
</tr>
<tr>
<td>At start (n = 46)</td>
<td>13(28)</td>
<td>11(24)</td>
</tr>
<tr>
<td>12 months after extraction (n = 37)</td>
<td>28*(61)</td>
<td>9(20)</td>
</tr>
<tr>
<td>18 months after extraction (n = 24)</td>
<td>36*(78)</td>
<td>2(4)</td>
</tr>
</tbody>
</table>

* 9 canines had normal positions at the 6-month radiographic control and another 13 at the 12-month control.

Table 4  The distribution of the canine crown position relative to the midline of the dental arch in the horizontal plane as shown in the axial-vertex radiogram. At the start of treatment, 12 months and 18 months after extraction of the primary canine. Number and percent.

<table>
<thead>
<tr>
<th>Registration</th>
<th>Position relative to the dental arch</th>
<th>Total number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Palatal</td>
<td>Palatal tendency</td>
</tr>
<tr>
<td>At start (n = 46)</td>
<td>27(59)</td>
<td>19(41)</td>
</tr>
<tr>
<td>12 months after extraction (n = 37)</td>
<td>9(20)</td>
<td>15(33)</td>
</tr>
<tr>
<td>18 months after extraction (n = 24)</td>
<td>8(17)</td>
<td>2(4)</td>
</tr>
</tbody>
</table>

* 9 canines had normal positions at the 6-month radiographic control and another 13 at the 12-month control.

than half of the root at the start of treatment, 22 (91%) normalized (Table 2, Fig. 4). The change in medial canine crown position in relation to time after extraction can be seen from Table 3, where eight of the ten teeth with no final normalization belonged to sectors 3 and 4 and one to sector 2 at the start. The positions of the canines in the vertex projection (Fig. 3) showed concordant results and will not be reported in detail.

Position relative to the dental arch

The distribution of the canine crown position relative to the midline of the dental arch is shown in Table 4. Of the 27 canines (59%) in a lingual position at the start of treatment (22 in
could be seen for eight of the canines at the last control at 18 months. All the rest normalized except one, which remained in a slight lingual position (lingual tendency). This means complete normalization in 78% of all cases.

**Mesial inclination**

The distribution of the mesial inclination of the maxillary canines at the start of treatment is shown in Figure 5. The inclination is approximately normally distributed. The change after extraction of the primary canines at the 6-month and 12-month controls is shown in Table 5. The dynamic change in position and the mean difference at the different registrations are presented. Note the large standard deviations (Table 5).

**Canine vertical distance to the occlusal plane**

The distance from the canine cusp to the occlusal plane (Fig. 2) at the different registrations is shown in Table 6. The distance at the start of treatment ranged from 9.5 to 20.3 mm. At that time, the canines were on average positioned about 15 mm from the occlusal line in the orthopantomogram and Table 6 shows the change during the observation period up to 12 months. The distance as measured on the lateral head film showed concordant results compared to Table 6.
Table 5  Mesial inclination (degrees) of the canine to the midline in the orthopantomogram. Mean value and standard deviation at the different registrations and mean difference and level of significance.

<table>
<thead>
<tr>
<th>Registration</th>
<th>mean s.d.</th>
<th>$\bar{d} \pm$ s.d.</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>At start (n = 46)</td>
<td>22.0</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>6-month control (n = 46)</td>
<td>17.9</td>
<td>12.5</td>
<td>4.1 ± 8.3 p &lt; 0.01</td>
</tr>
<tr>
<td>12-month control (n = 37)</td>
<td>14.0</td>
<td>13.3</td>
<td>9.8 ± 9.1 p &lt; 0.001</td>
</tr>
</tbody>
</table>

Table 6  The distance (mm) from the canine cusp to the occlusal plane in the orthopantomogram. Mean value and standard deviation at the different registrations and mean difference and level of significance.

<table>
<thead>
<tr>
<th>Registration</th>
<th>mean s.d.</th>
<th>$\bar{d} \pm$ s.d.</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>At start (n = 46)</td>
<td>14.7</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>6-month control (n = 46)</td>
<td>11.7</td>
<td>4.3</td>
<td>3.0 ± 1.8 p &lt; 0.01</td>
</tr>
<tr>
<td>12-month control (n = 37)</td>
<td>9.2</td>
<td>5.0</td>
<td>5.5 ± 2.7 p &lt; 0.001</td>
</tr>
</tbody>
</table>

Table 7  Treatment procedures for 10 out of the 46 ectopic maxillary canines where no improvement of position was registered 12 months after extraction of the primary canine.

<table>
<thead>
<tr>
<th>Change of eruption path</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Orthodontic fixed appliance</td>
</tr>
<tr>
<td>Position in the orthopantomogram</td>
<td>No change</td>
</tr>
<tr>
<td>Overlapping less than half of the lateral (sectors 1, 2)</td>
<td>2</td>
</tr>
<tr>
<td>Overlapping more than half of the lateral (sectors 3, 4)</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
</tr>
</tbody>
</table>
No normalisation

Ten of the 46 canines showed no change or an impaired position. The clinical treatment is shown in Table 7. Nine of these teeth had a true lingual position at the start of treatment (Table 4) and in eight cases the cusp was positioned more medially to the midline of the lateral incisor in the orthopantomogram. Surgical exposure and orthodontic fixed appliance treatment was carried out in eight cases (Table 7). After orthodontic treatment, all canines were in clinically favourable positions.

Resorptions

In the four cases with resorptions on the root of the lateral incisor, diagnosed at the start of treatment, the positions were normal in two cases, unchanged in one and one canine showed an impaired position. Three canines were positioned in sector 3 and one in sector 2 in the orthopantomogram at the start of treatment. Two of the resorptions were severe and reached the pulp at the start of treatment. One remained unchanged and one deteriorated during the observation period and these two cases are the extraction cases, where the orthodontic treatment plan included extraction of lateral incisors as one possibility from the start. No new cases of resorption were registered during the observation period.

Dental follicle

The maximal width of the dental follicle of the maxillary canine, measured on the intra-oral periapical radiographs, exceeded 3 mm in 13 cases and varied between 1 and 5 mm for the 46 canines. There was no association in those cases which did not improve related to the size of the follicle.

Discussion

The effect of extraction of the primary canine on the palatally deflected path of eruption of the maxillary canine, is analysed in this report. To our knowledge, this is the first prospective longitudinal study where such an effect on palatally erupting maxillary canines has been shown. Orthodontic textbooks and papers on treatment of ectopic maxillary canines do not mention this treatment approach, but there are sparse case reports in the literature (Buchner, 1936; Kettle, 1957; Lind, 1977; Williams, 1981; Leivesley, 1984). Perhaps extraction of the primary canine has been considered an 'oddity' and the success limited to cases with only a minor deflection, as shown by Kettle (1957).

This study clearly shows that extraction of the primary canine has a favourable effect on palatally malerupting maxillary canines. Almost 80 per cent of the cases were corrected due to the early extraction of the primary canines. Spontaneous corrections may occur but from...
clinical experience, it is not likely that ectopically erupting canines will be spontaneously corrected to such an extent, especially not those with the crown in advanced medial positions, as shown in Figures 2 and 4, Table 2. However, a few of the canines in the youngest age groups with a moderate dislocation of the canine might have corrected spontaneously, as shown by us earlier (Ericson and Kurol, 1986a). For ethical reasons, we have not been able to design a study with a traditional, untreated control group but it is hardly likely that 22 of 24 canines (92%) in sectors 1 and 2 and 14 of 22 (64%) in sectors 3 and 4 (in the orthopantomogram) would do so. The results will be discussed with this assumption and reservation.

A positive change in the path of eruption could be observed radiographically in 50 per cent of the cases, and in some cases (20%) also clinically, at the 6-month registration after extraction of the primary canine (Figs. 1 and 6). At the 12-month control, all but nine had normal or improved positions. If such a change in eruption is not detectable at that time, a new decision must be made and some canines posing a risk of further root resorption of the incisors, may have to be surgically exposed and treated with orthodontic appliances, while in most other cases a further 6 months of observation may be allowed. If no improvement is detectable at the 12-month control, we suggest alternative treatment. If the diagnosis is made early according to defined criteria i.e. clinical palpation and if necessary radiographic examination (Ericson and Kurol, 1986a), there should be enough time to carry out alternative surgical and/or orthodontic treatment.

This study has clearly demonstrated the favourable effect on the maxillary canine even in very medial positions of the canine crown (Table 3, Figs. 1 and 6) and up to a mesial inclination of the canine of 55 degrees to the midline in the orthopantomogram (Table 6). Note that canine teeth with similar positions

Figure 7  Palatal ectopic eruption of both maxillary canines in a boy aged 12 years 11 months at the start of treatment. Mixed dentition period. The width of the dental follicle exceeded 3 mm for both canines. In the orthopantomogram (A) the mesial inclination to the midline is 31 degrees for the left canine and 27 degrees for the right canine. In the axial-vertex projection (B) the cusp tips are positioned approximately in the same position lingually to the lateral incisor root. Twelve months after extraction of the maxillary primary canines the orthopantomogram (C) and axial-vertex projection (D) show an improved position of the left canine and a slightly impaired position of the right maxillary canine.
and angulations may react differently even in the same individual, as shown in Figure 7. In spite of a difference of only four degrees in mesial angulation and concordant medial and lingual positions, the left maxillary canine normalized but not the right. Due to the difficulty in predicting a favourable change of the path of eruption in the individual case, we recommend radiological and/or clinical supervision at six-month intervals after extraction of the primary canine until the permanent canine erupts.

The degree of palatal position at the start of treatment relative to the dental arch has been shown to influence the result (Table 4). Maxillary canines with a moderate lingual path of eruption normalized more often (90%) than canines in true lingual positions (65%). Again, no reliable forecast of success or failure can be made in the individual case, although the prognosis for the treatment on the whole is very good. With earlier diagnosis according to our earlier recommendations (Ericson and Kurol, 1986b), it may be possible to achieve even better results as the canine is then higher up and probably has a less deflected path of eruption. Note that one-third of the patients in this study were between 12 and 13-years-old at the time of referral.

It has often been mentioned that a palatal path of eruption may be seen in cases where the primary canine is unresorbed (Dewel, 1949; Hotz, 1974; Salzmann, 1974). However, it is not established whether this is a consequence or the primary cause of the ectopic palatal eruption. In this study, in individuals aged 10–13 years, i.e. during a normal eruption period, 21 (46%) of the 46 primary canines were unresorbed and 25 (54%) showed various degrees of resorption.

In order to be successful with this procedure of extracting the primary canine, we must follow the eruption process radiologically by means of correct and standardized radiographs. If this is done, it will be possible to record even slight or moderate changes, as studies of distortion in rotational panoramic radiography and cephalography have demonstrated great tolerance with respect to angular and vertical distortions.
ECTOPIC MAXILLARY CANINES

Figure 9  Girl aged 11 years at the start of treatment (A, C, E) and 12 months later (B, D, F); an impaired position of the left maxillary canine is evident in the orthopantomogram, axial-vertex projection and intra-oral radiograph.

(Tronje, 1982; McDavid et al., 1985; Ahlqvist et al., 1986). Based on these reports, and applying a relative scale for the mesio-distal and buccolingual determinations, it can be claimed that the registrations in this study have been performed with moderate errors, acceptable for practical clinical purposes in the everyday clinical situation. Used together, we consider the methods describe the displaced canine and the changes in position with sufficient accuracy in three dimensions and are suitable for this clinical purpose. Guilford’s coefficient of reliability (Guilford, 1965) was high for all our measurements (Ericson and Kurol, 1988).

In view of the positive results of this study we suggest that primary canine extraction is the treatment of choice in the age-group 10–13 years when the permanent maxillary canine has a palatal ectopic path of eruption. Before the age of 10, spontaneous correction of potentially malplaced canines may occur (Ericson and Kurol, 1986b) and extraction is normally not indicated unless a very early somatic and dental development is found. With late diagnosis or crowding and in cases of resorption or very horizontal paths of eruption, alternative modes of treatment should be considered, as our experience of the method in such cases is too small. Surgical exposure with subsequent orthodontic appliance treatment will be the main choice in those cases.

Early extraction of the primary canine in order to correct the malerupting maxillary permanent canine has considerable advantages for the child, both economically and in terms of the discomfort that result from more traditional treatment approaches. In fact, periodontal damage to the ectopic canine after surgical exposure and orthodontic alignment has been reported compared to control canines (Wisth et al., 1976 a,b; Hansson and Linder-Aronson, 1972; Boyd, 1982; Kohavi et al., 1984; Oliver and Hardy, 1986). Incisor devitalization and some loss of alveolar bone support may also occur (Proffit and Ackerman, 1985).

The characteristics of those cases with no change or an impaired position have to be further analysed.
Conclusions and recommendations

It has been clearly shown that extraction of primary canines in the upper jaw has a favourable effect on palatally erupting maxillary canines in most cases, if this extraction treatment is performed in time. Early diagnosis of maleruption is important for success. The ectopic position and the path of eruption of the maxillary canine should preferably be identified before the age of 11.

When a favourable effect of treatment occurs, the change in position and in the path of eruption will be observed at the latest 12 months after the extraction of the primary canine. If no improvement can be found at that time, normalization is not to be expected and alternative treatment should be considered. Due to the great individual variation in the position of the maxillary canines at the start of treatment and to some extent also in the response to treatment, it is not possible to predict success or failure in the individual case, although the prognosis for the treatment on the whole is very good. Clinical and/or radiological controls at six-month intervals are recommended.

In view of the positive results, we suggest that primary canine extraction is the treatment of choice in the age-group 10–13 years when the erupting permanent maxillary canine has a palatal ectopic path of eruption. With later diagnosis or crowding, and in cases of resorption of the incisor roots or a very horizontal path of eruption, alternative modes of treatment should be considered.

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