# Incisor Resorption caused by Maxillary Cuspids
## A Radiographic Study

Sune Ericson
Juri Kurol

**A Detailed radiographic study of 46 cases of maxillary incisor resorption related to unerupted cuspids finds most resorption in midroot, with about half on labial or lingual surfaces where it was not detectable on periapical radiographs. Resorption appears early, making it desirable to evaluate cuspid position no later than 10 or 11 years of age.**

KEY WORDS: • CUSPID • ERUPTION • INCISOR •
• RADIOGRAPHY • RESORPTION, TOOTH •

Maxillary permanent cuspids are second only to the third molars in frequency of impaction, with prevalences of 1% and 2% of the population (RAYNE 1969, THILANDER AND JAKOBSSON 1968, HOWARD 1972, ERICSON AND KUROL, 1986A,B). Diagnosis of disturbances in eruption and the location of ectopic cuspids necessitates a thorough clinical examination with visual inspection and palpation of the buccal sulcus and palatal mucosa, usually aided by radiographic examination.

From the many reports of ectopic eruption and impaction of the cuspids, it may be concluded that the rate of complications like resorption of adjacent teeth in persons with ectopic cuspids is very low or underestimated, as very few reports have been published on this related condition. It has been stated that the risk of resorption of the neighboring teeth is small (TOWNEND 1967, BERGSTROM 1977, AZAZ AND SHTEYER 1978, OLOW-NORDENRAM AND ANNEROTH 1982).

On the other hand, it has also been suggested that resorptions occur more often than is generally assumed (HOTZ 1974, LEIVESLEY 1984). HITCHIN (1956) found resorption due to the maxillary cuspids in 6% of a group of referred children. HOWARD (1972) reported resorption of 7 incisors in 52 patients with impacted maxillary cuspids, and NITZAN ET AL. (1981) reported 2 incidents of resorption among 12

*Author Address:*
Dr. Juri Kurol
Department of Orthodontics
The Institute for Postgraduate Dental Education
Jarnvagsgatan 9
S-552 55 Jonkoping
SWEDEN

Sune Ericson is Head of the Department of Maxillo-Facial Radiology, Institute for Postgraduate Dental Education, Jonkoping, Sweden. He holds a D.D.S. from the Royal School of Dentistry, Stockholm, and an Odont. Dr. from the University of Umea, Sweden, where he is also an Associate Professor.

Juri Kurol is Head of the Orthodontic Department, Institute for Postgraduate Dental Education, Jonkoping, Sweden. He holds a D.D.S. from the Dental School at Malmo, and an Odont. Dr. from the University of Göteborg, Sweden, where he is also an Associate Professor.

impaction cases. THILANDER AND JAKOBSSON (1968) found resorption of one incisor (0.3%) among 384 children in a combined epidemiologic and longitudinal study.

The selection of radiographic techniques can be a significant factor in the diagnosis, especially when one is concerned with resorption on adjacent teeth or other complications due to an ectopic cuspid. By using a stepwise radiographic procedure, including polytomography when necessary, the rate of detection of resorptions of the root of the adjacent incisors can be doubled.

Root resorption can be expected in about 12% of the incisors that adjoin ectopically erupting maxillary cuspids, indicating a prevalence of about 0.7% in the 10-13 year age group (ERICSON AND KUROL, 1987).

Resorption of incisors due to the eruption of the maxillary cuspids is often a serious complication, in many cases requiring surgery and prolonged orthodontic treatment. Early diagnosis is of great importance for the most effective treatment of these cases.

Further study of the location and extent of such root resorptions in a larger sample may provide more definitive guidelines for the selection of radiographic procedures to improve the diagnosis and optimize the orthodontic treatment.

The aim of this study was to analyze the location of resorptions of maxillary incisors due to ectopically erupting maxillary cuspids, and the extent of the resorption in relation to the child's age at diagnosis. Local factors were also studied, including lateral incisor position, degree of deciduous cuspid resorption, and width of the cuspid dental follicle.

## *Subjects*

The study sample consisted of 41 consecutive cases (11 boys and 30 girls) who demonstrated radiographic evidence of resorptions related to aberrant eruption of maxillary cuspids. These children had been referred for radiographic investigation after a clinical investigation with defined criteria which led to suspicion of eruption disturbance of the cuspids (ERICSON AND KUROL, 1986A, 1987).

Primary selection criteria were inability to palpate the maxillary cuspids in the normal positions at 11 years of age or earlier, or a palpable difference between the two sides. The age of the children when the resorptions were radiographically verified ranged from 10.1 to 14.9 years (mean 12.2yrs $\pm$ 1.2yrsSD).

Altogether, 47 teeth showed resorptions — 6 central incisors, 40 lateral incisors, and 1 bicuspid (Table 1). In three children, both lateral incisors showed resorptions, and in another three, both

Table 1

Distribution of 47 Maxillary Teeth Resorbed due to Erupting Cuspids

| | Unilateral | Bilateral | Total |
|---|---|---|---|
| Central incisor | 3 | | 3 |
| Lateral incisor | 31 | 3 | 37 |
| Both Central & Lateral | 3 | | 6 |
| First bicuspid | 1 | | 1 |
| Totals | 38 | 3 | 47 |

the lateral and central incisors were resorbed. In the remaining 35 of the 41 children, only one resorbed maxillary tooth was found.

A thorough orthodontic examination, including a record of the position and inclination of maxillary incisors, was also performed. Space deficiency exceeding 2mm in the cuspid-incisor region was found in 3 of the children.

### *Methods*

The *radiographic examination* was performed according to a previously described stepwise method (Ericson and Kurol, 1986b). Intraoral periapical films included conventional and vertex-axial projections, in which the x-ray beam is parallel to the long axes of the incisors. Orthopantomographs and lateral head films were exposed using standard procedures, and in those cases where the cuspid images overlapped the incisors excessively, polytomography was also used. Of the 47 teeth studied, polytomography was required in 17 (36%).

The location of resorbed areas was determined in all three planes. The extent of the resorption was recorded as advanced if the resorption had reached the pulp — otherwise, it was recorded as moderate.

*Conventional statistical methods* were used for calculating means, standard deviations and correlations (Nie et al. 1975). The chi-square test was used to evaluate relationships between distributions.

## — Results —

Most of the cuspids in the sample studied (35 teeth (85%)) could not be palpated either buccally or palatally. In four cases, the cuspid could be palpated as a bulge labial to the lateral incisor root. Two others were judged radiographically to be in buccal positions, but could not be palpated. In these two cases, the lateral incisors showed pronounced buccal inclinations.

No child is this group reported pain or discomfort in the cuspid or incisor region. All incisors showed normal root development. There was no aplasia of incisors. Most were referred and the resorptions diagnosed radiographically between 11 and 12 years of age (Table 2).

The difference in overall incidence between the sexes (11 boys and 30 girls) was statistically significant ($p < .05$). However, 5 of the 6 involved central incisors were in boys.

Figure 1 shows the extent of the resorption on central and lateral incisors. Advanced resorption was found on 19 lateral incisors, and moderate resorption on 21.

Table 2

Child's Age at Radiographic Diagnosis of Resorption

| | Age (years) | | | | |
|---|---|---|---|---|---|
| | 10–10.9 | 11–11.9 | 12–12.9 | >13 | Total |
| Central | – | 2 | 2 | 2 | 6 |
| Lateral | 6 | 11 | 15 | 8 | 40 |
| bicuspid | - | - | - | 1 | 1 |
| Total | 6 | 13 | 17 | 11 | 47 |

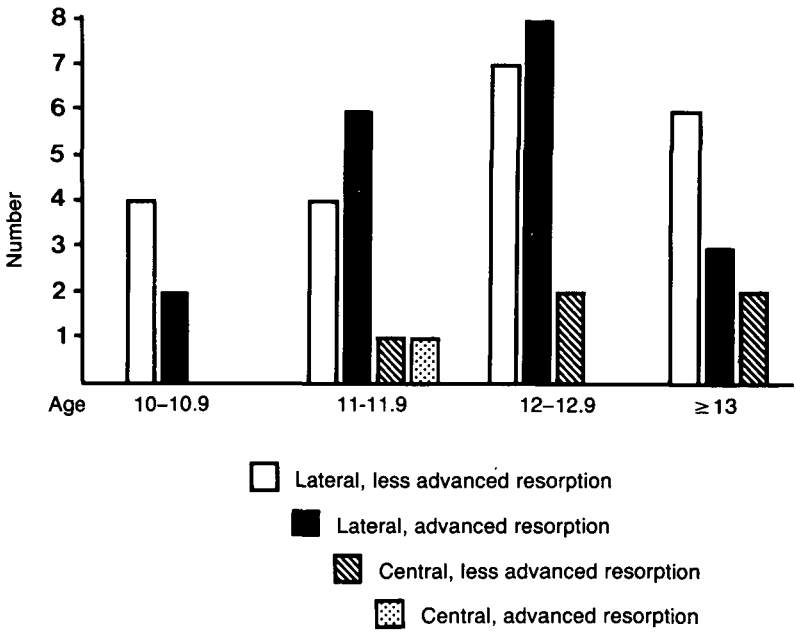



**Fig. 1** Degree of resorption and age at diagnosis for forty resorbed lateral incisors and six central incisors.

### *Central Incisors*

Advanced resorption was seen on 5 of the 6 central incisors, at ages ranging from 11.8 to 14.5 years. Local crowding was recorded in only one of these children.

In all cases of central incisor resorption, the lesions were on the distolingual or distal surfaces. In 4 of those 6 cases, the cuspid was positioned buccal to the lateral, and in 2 it was lingual (Figs. 2 and 3).

### *Lateral Incisors*

On lateral incisors, the most common location of the resorption was lingual or distolingual (68%). However, resorptions were also seen when the cuspid erupted labially (Table 3).

Table 3

Association between Cuspid Crown Position and Degree of Resorption

| | Cuspid position relative to the resorbed root | | | | |
|---|---|---|---|---|---|
| | Lingual | Distolingual | Distal | Buccal | Total |
| Moderate resorption | 7 | 7 | 2 | 5 | 21 |
| Advanced resorption | 6 | 7 | 4 | 2 | 19 |
| Total | 13 | 14 | 6 | 7 | 40 |

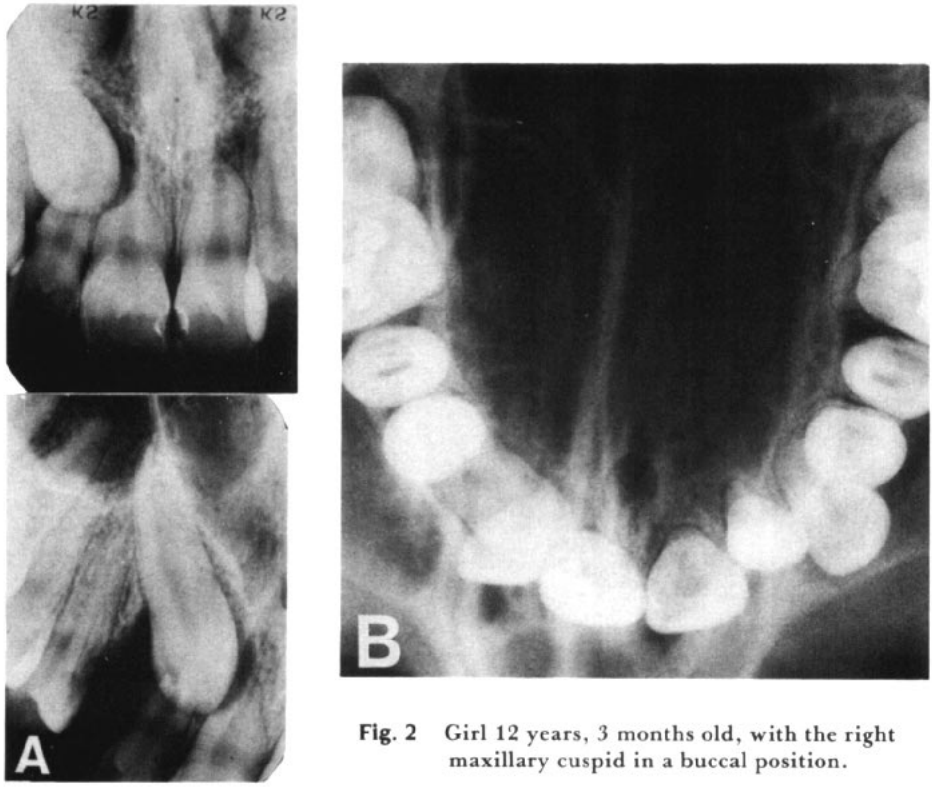



**Fig. 2** Girl 12 years, 3 months old, with the right maxillary cuspid in a buccal position.

**A — Periapical radiographs showing an uneven contour of both lateral and central incisor roots. Due to the overlapping, the full extent of root resorption is not interpretable for the lateral incisor root.**

**B — The axial-vertex intraoral radiograph shows the cuspid buccal to the lateral, which shows the buccal crown tipping and a distolingual cuspid position relative to the central incisor root.**

The position and inclination of lateral incisors was not related to the extent or location of resorptions. Proclination was found in 15% of the laterals, and distal tipping in 27%.

In the vertical dimension, the resorptions were found in the central part of the root in 82% of the cases. Apical locations accounted for only 13%, and cervical 5% (Fig. 4). There was an association between the extent of resorption and the vertical position of the cuspid crown along the resorbed root. The most severe resorptions were predominately located apically, but some were found in all root areas.

### *Cuspid Position*

It was only possible to accomplish a periapical x-ray projection that separated the image of the cuspid crown from the adjacent root in 20% of the cases. With periapical radiographs alone, four out of five of the cases could not be examined adequately. Polytomography was used in

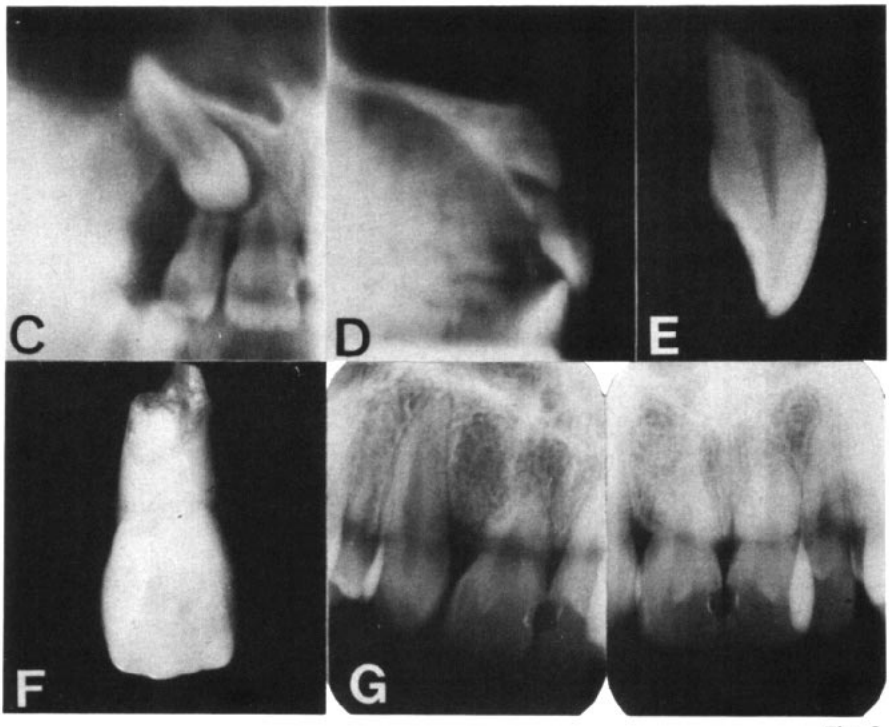



Fig. 2

**C — Frontal polytomograph showing cuspid position and relation to the resorbed lateral and central incisor roots. Half of the lateral incisor root is resorbed.**

**D — Sagittal polytomograph showing the position of the cuspid crown in the dental arch relative to the resorbed root of the lateral incisor.**

**E — Radiograph in the mesiodistal direction of the extracted lateral incisor.**

**F — Frontal view of the extracted lateral incisor shows the extent of root resorption.**

**G — Periapical radiographs showing the position of the cuspid after treatment, arrest of the resorptive process, and tissue repair of the right central incisor root.**

most of the remainder to help ascertain the presence and degree of resorption.

The degree of resorption could be determined only by polytomography in 40% of the resorptions. A notable related finding is that an intact periodontal contour could still be seen in the periapical dental radiographs of one-third of the cases in which resorption was seen with polytomography (Fig. 5).

No association could be found between the position of the cuspid crown relative to the dental arch and the extent of resorption on lateral incisors (Table 3).

Due to the low number of involved central incisors, no statistical analysis was applied.

The thickness of the cuspid dental follicle was determined by measurement on the intraoral radiographs. The follicle thickness was within normal limits in 78% of the cases, and exceeded 3mm in 22% (Figs. 2, 3, and 5). No association was found between the extent of resorp-

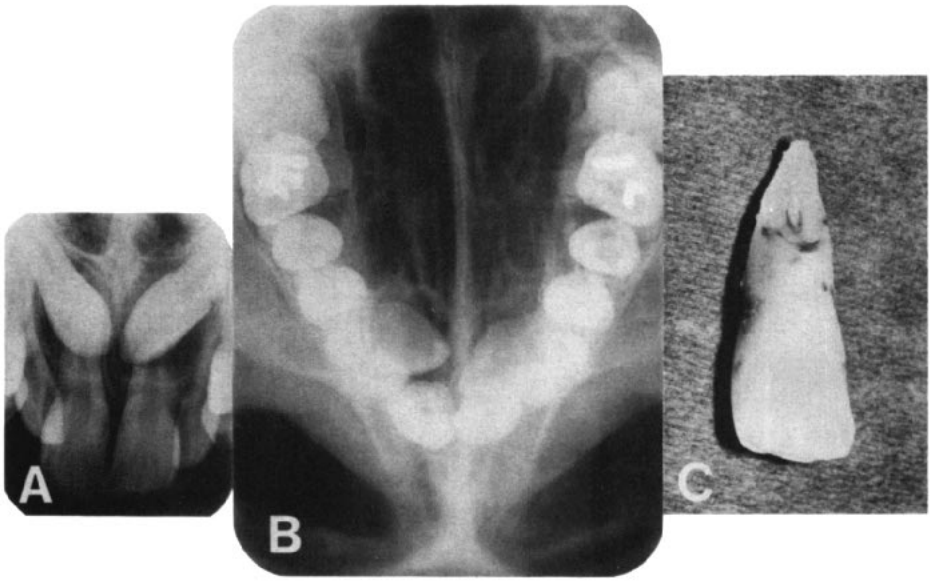



**Fig. 3**

**A — Periapical radiograph showing mesial inclination and medial crown position of both cuspids. Due to the overlapping, the full extent of any root resorptive cannot be ascertained.**

**B — Axial-vertex intraoral radiograph shows the left cuspid in close contact with the central incisor, whereas the right cuspid is clearly away from the central incisor.**

**C — Extracted left central incisor shows resorption of the root in the apical area extending into the pulp from the palatal side.**

**Fig. 4**

**The location of resorptions in the vertical plane in forty lateral incisors associated with ectopic eruption of maxillary cuspids (percent).**

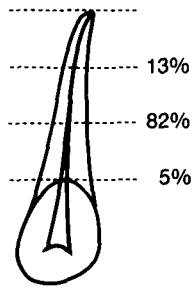



**Fig. 5** *(opposite page)*

**Girl 11 years, 3 months old, with one of her cuspids resorbing the adjacent lateral incisor into the pulp.**

**A — The orthopantomograph shows a nearly normal inclination, with a medial position of the cuspid crowns overlapping the lateral incisor roots.**

**B — Periapical radiographs of the left and right side show the buccal cuspid position, overlapping and unbroken mesiodistal root contour, but missing lamina dura.**

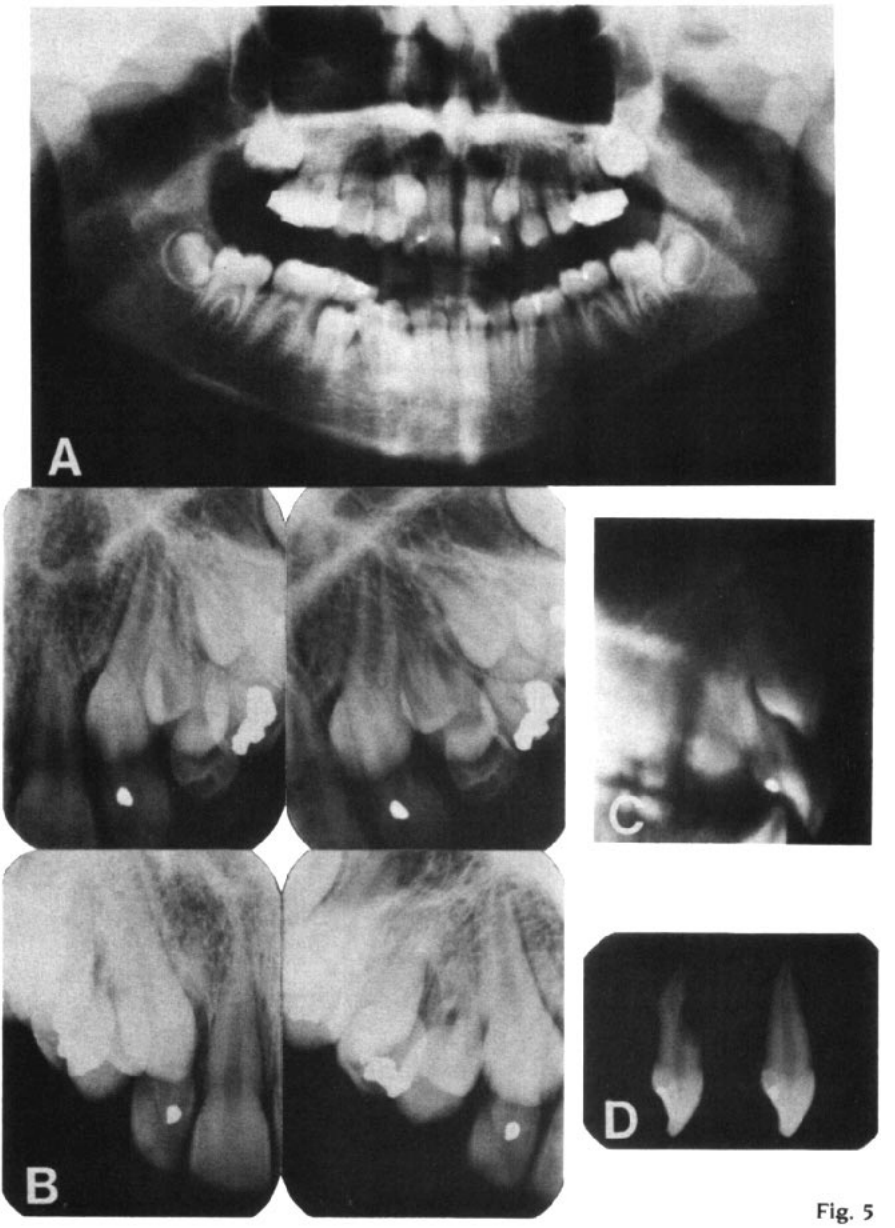



Fig. 5

**C — Sagittal polytomograph shows the extent of right lateral incisor root resorption where the cuspid cingulum is seen in close contact with the pulp.**

**D — For reasons of symmetry, both laterals were extracted, and the extent and location of the buccal resorption can be seen on the right lateral incisor (to the left). Radiographs taken in the mesio-distal direction.**

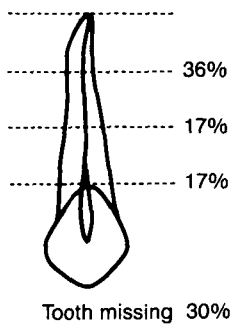



**Fig. 6**
**Schematic illustration of the degree of physiologic root resorption in forty deciduous maxillary cuspids distal to lateral incisors which were resorbed due to ectopic eruption of the cuspid (percent resorption).**

tion and the thickness of the cuspid follicle.

### *Deciduous Cuspids*

No association was found between the degree or location of permanent incisor resorption and the condition of the deciduous cuspid root. The deciduous cuspid was not present in 30% of the cases at the time of examination. Deciduous cuspids showed varying degrees of resorption. in 36% of the cases, there was no resorption of the deciduous cuspids; in 17% the resorption had reached ⅓ of the original root length, and in another 17% less than ⅓ of the root remained (Fig. 6).

## — Discussion —

Severe resorption of maxillary incisors due to ectopic eruption of the cuspids may already be under way at 10 and 11 years of age (Fig. 1). This is well before or within the average normal eruption period for the maxillary cuspids. HURME (1949) reports that their eruption should be considered to be late after 12.3yrs in girls and 13.1yrs in boys.

The prevalence in the population of resorbed permanent incisors due to ectopic eruption of the maxillary cuspid has been estimated to be about 0.7% in the 10-13yr age group (ERICSON AND KUROL 1987). This may seem low, but these resorptions are often severe. Both surgical and orthodontic treatment are often required, and early diagnosis revealing the location and full extent of resorption can be a critical factor in minimizing damage and serious long-term sequelae.

The subjects in this study were mostly referred for radiographic examination as a follow-up on findings by the Public Dental Service in a newly-introduced clinical screening with defined criteria (ERICSON AND KUROL 1986A). One of the criteria is that eruption disturbances should be suspected in children at 11 years of age or older if the cuspid cannot be palpated in the correct position. Some of the children in this study had already reached 14 years of age.

In the older patients, the cuspid eruption had been awaited for some time, or was merely considered to be somewhat delayed. Even with this accumulation of older patients, the age of the children investigated is low compared to other reported studies and groups of individuals with impacted maxillary cuspids (HOWARD 1972, NITZAN ET AL. 1981).

This sample is also relatively large, so it provides a reasonably representative basis for analysis of the location and extent of incisor resorption in cases of ectopic eruption of the cuspids. It also provides a significant sample of those with established impaction, where the degree of resorption may be even more severe.

The use of polytomography in cases where resorptions could not be ruled out has also contributed to a more complete

and precise picture of the early complications associated with ectopic eruption of maxillary cuspids.

The resorptions on permanent maxillary incisors were often severe in this sample of young individuals, extending into the pulp in half of the affected teeth.

### *Sex Differences*

Other studies have also found that girls experience ectopic eruption of the maxillary cuspid more often than boys (HOWARD 1972, AZAZ AND SHTEYER 1978, SASAKURA ET AL. 1984, AND ERICSON AND KUROL 1987). The highest ratio (10:1) was reported by Sasakura. The present study finds a 4:1 ratio of cuspid-induced resorptions between girls and boys, but it was also found that 5 of the 6 resorbed central incisors were in boys.

No sex differences were found in the location or severity of resorption of lateral incisors, although the sample of 11 boys is too small to permit any definite conclusions on these aspects.

### *Tooth Position*

The position and inclination of lateral incisors in this study were generally not found to be related to the incidence of resorption. This is contrary to opinions based on isolated case reports in the literature, where labial inclination of the lateral incisor has been associated with resorptions (REESE 1945).

It is interesting to note that in a case report by BUCHNER in 1936, he describes a normal lateral incisor root on a tooth with the crown protruded, whereas the well-aligned tooth on the opposite side was extensively resorbed.

Although the present study shows that most root resorptions occur in situations with normal incisor positions, we still feel that special attention should be paid to incisors with a buccal or distal tilt in children over 11 years of age. This may be one of the few clinical indicators for some of the resorption cases, as is indicated by the finding that buccal proclination was found in 15% and distal tilting in 27% of the resorbed incisors in this study.

### *Central Incisors*

The risk of resorptions on central incisors must not be underestimated. In this study, 13% of the resorbed teeth were central incisors. In these cases, the erupting cuspid had a slightly more horizontal path of eruption and was usually positioned buccally to the lateral. One of the central incisors in our study was already severely damaged at the age of 11. This possibility for early resorption has also been described in a case report by NOGUCHI AND OHMORI (1985).

### *Bicuspids*

Resorption of bicuspids due to aberrant cuspid eruption must be considered very unusual. Only one case was found in this sample.

### *Impaction Considerations*

It has been suggested that demonstrable impaction, or physical obstruction of further movement, must be present to give cause for resorption (REESE 1945, HOWARD 1972). This is not supported by our observations, as resorptions were also seen when the cuspids were erupting in an almost normal position relative to the adjacent lateral incisor (Fig. 7). The cuspid was often rotated in these cases.

### *Lesion Location*

This investigation found most of the resorptions in the middle third of the incisor roots, not in the apical area as commonly expected. REESE (1945) and HOWARD (1972) also suggest the apical area as the most prevalent site.

The midroot location, together with the fact that lingual and buccal resorptions

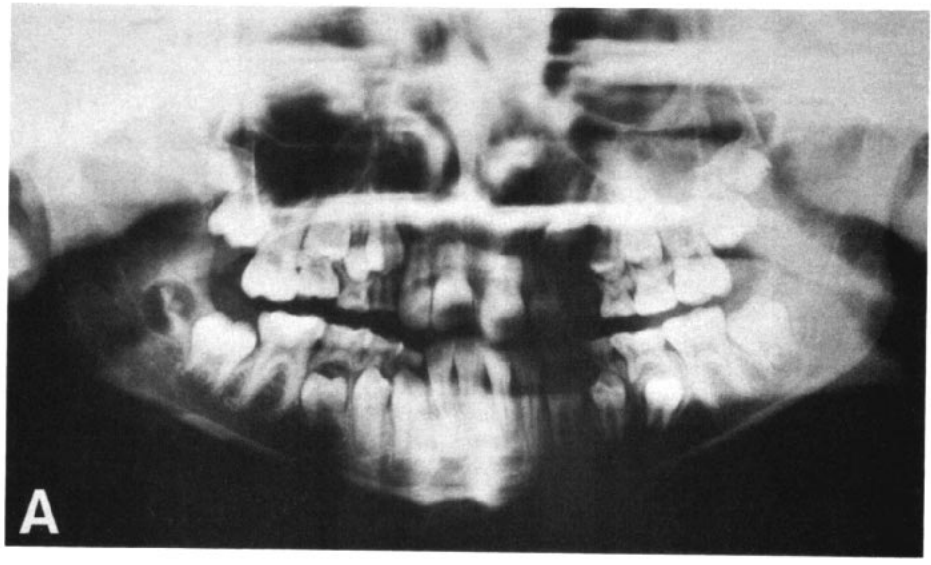



**Fig. 7**

Maxillary cuspid eruption in a girl from the age of 10 years, 2 months (A-C) to 11 years, 2 months (D-H).

A — Clinical palpation of the buccal cuspid area at 10 years, 2 months revealed an asymmetry in which the right cuspid could be palpated but the left one could not. The orthopantomograph shows a difference in vertical eruption of the cuspids.

B — The periapical radiographs at 10 years, 2 months show the cuspids in a normal position distal to the lateral incisors.

C — The axial-vertex intraoral radiograph at 10 years, 2 months shows both cuspids in normal positions in the dental arch, with the right one slightly buccal.

The routine clinical checkup one year later, at 11 years, 2 months of age, found that the left cuspid still could not be palpated in the correct position, and the subsequent radiographs, D-F, show the development.

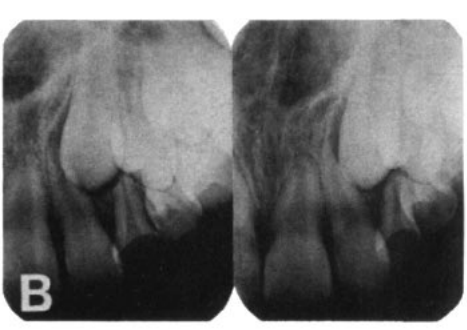
D — The axial-vertex intraoral radiograph at 11yrs, 2mo shows a slightly more palatal position of the left maxillary cuspid, with the right cuspid in normal position.

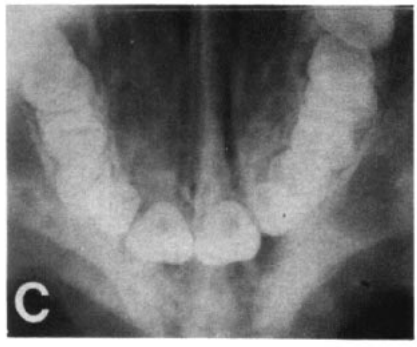
E — The periapical intraoral radiograph shows a break in the contour on the distal aspect of the lateral incisor root.

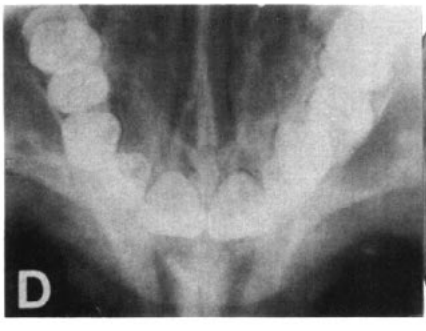
F — The frontal polytomograph shows the extent of resorption of the lateral incisor, extending into the pulp, with normal resorption of the deciduous cuspid.

G — The left lateral incisor was extracted, and the root resorption can be seen extending into the pulp.

H — Radiograph of the extracted left lateral incisor shows the extent and location of the resorption in E and F.

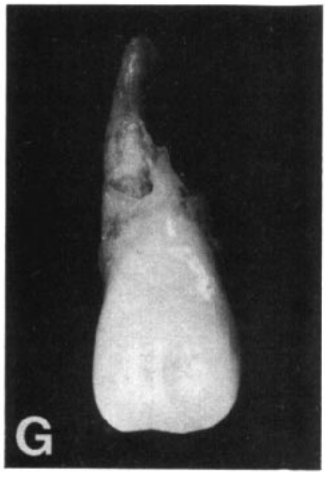

B

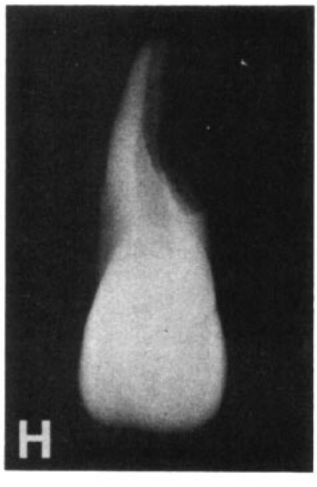

C


D


E


F


G


H

are common (50%), may explain why so many of these resorptions escape detection with routine periapical dental radiography.

The distal periodontal contour of a lateral which is overlapped by the cuspid may be normal, while the resorption occurs on the midroot labial or lingual surface. It is important to note that ⅓ of the resorbed laterals in this sample had a normal appearance on the periapical dental films.

In 40% of the sample, the extent of the resorptions could be assessed adequately only with polytomography. Early discovery, and awareness of the full extent and location of the resorbed area, may give the clinician cause to consider alternative therapeutic measures instead of risking an encounter with unpleasant surprises later.

Problems escalate when the lateral may be further resorbed, and the first bicuspids may have already been removed. A stepwise radiographic procedure based on the degree of overlapping and condition of the lamina dura may help to reveal resorptions in time to avoid such crises (Ericson and Kurol 1987).

The contact point between the cuspid and adjacent tooth proved to be the site of resorption in all instances. This indicates that pressure may be a provoking factor, even though there may be other interacting factors involved in the etiology of resorption.

The comparatively large number of lingual or distolingual lesions found in this study should not be taken as evidence that cuspids in the lingual position are more prone to cause resorption than those erupting buccally or distally. This difference is more likely due to the fact that ectopic lingual eruption is much more common than buccal eruption.

### *Age*

Resorptions were seen in relatively young children — about 10% of the involved cuspids had roots no longer than the crown. This indicates that resorption can be an effect of dynamic eruption, as well as of impaction or retention.

### *Other Predisposing Factors*

Short root anomaly, especially evident in maxillary central incisors, is often suggested as an indication of a genuine predisposition for resorption that could increase the risk of resorption during cuspid eruption (Lind 1972, Kisling and Ravn 1977, Becker et al. 1984). This anomaly was not found in the present sample.

Sasakura et al. (1984) also reported normal morphology in all but one of 23 resorbed maxillary incisors.

Excessive thickness of the cuspid follicle has also been proposed to be associated with resorption, but this is not supported by this study, nor by Howard (1972). Excessive thickness was found in the follicles of only 22% of the involved cuspids in this study.

We should also note that resorption in this sample was usually unilateral, a further indication that local factors are responsible.

Nor was crowding a significant factor — only three patients showed space deficiency in the cuspid region. It has been pointed out by several other authors that impacted cuspids usually have enough space (Dewel 1949, Behar 1980, Jacoby 1983).

Sasakura et al. (1984) suggest a genetic component in the resorption of maxillary incisors. This is not inconsistent with the possibility that some specific positions and inclinations of erupting cuspids may be more responsible than others for disturbances during eruption.

*Clinical Recommendation*

A notable finding in the development of the preliminary selection process was that resorptions were not found before the age of 10 years. Severe resorptions were registered earliest in girls (10.8yrs), and later in boys.

An important recommendation from these findings is that clinical supervision of cuspid eruption should begin with palpation no later than age 10 (ERICSON AND KUROL 1986A). If the cuspids cannot be palpated in the correct positions, we feel that radiographic examination should be carried out no later than 11 years of age. Individual variation may give cause for even earlier clinical evaluation and supervision.

It is noteworthy that in none of these cases had the resorptions caused any perceptible symptoms. This is in accordance with earlier reports (TOWNEND 1967, SEVERSON 1971, BROWN AND MATTHEWS 1981, SASAKURA ET AL. 1984).

## — Summary and Conclusions —

Location and extent of resorptions due to ectopic eruption of maxillary cuspids are examined in 46 cases involving permanent incisors. Clinical implications of the findings point to the advantages of early examination, followed as required by a stepwise extended radiographic procedure in those patients with ectopic cuspid eruption where resorption of incisors cannot be excluded.

The degree of overlapping and condition of the lamina dura are important factors in deciding on the need for further radiographic investigations, bearing in mind that one in every three of the children with resorptions showed a normal periodontal image in periapical films.

Polytomography may be useful not only for revealing small resorptions or the location of resorptions in buccal and lingual sites, but also for showing the extent of any resorption. This gives the clinician a more complete picture of the situation and an opportunity to evaluate the prognosis and initiate required treatment at the most effective time. Special orthodontic treatment regimens to mitigate further damage may be indicated in such cases.

Depending on the dental and somatic maturity of the child, it is recommended that clinical supervision of cuspid eruption be initiated no later than age 10. Resorptions extending to the pulp of the lateral incisor may already be present before 11 years of age.

### REFERENCES

Azaz, B., and Shteyer, A. 1978. Resorption of the crown in impacted maxillary canine. A clinical, radiographic and histologic study. *Int. J. Oral Surg.* 7:167-171.

Becker, A., Zilberman, Y., Tsur, B. 1984. Root length of lateral incisors adjacent to palatally-displaced maxillary cuspids. *Angle Orthod.* 54:218-225.

Behar, R. 1980. *The association between palatal maxillary canines and the size and shape of the adjacent lateral incisor.* Graduate thesis. Hebrew University-Hadassah School of Dental Medicine, Jerusalem, Israel.

Bergstrom, K. 1977. An orthopantomographic study of hypodontia, supernumeraries and other anomalies in school children between the ages of 8-9 years. An epidemiological study. *Swed. Dent. J.* 1:145-57.

Brown, I. D., and Matthews, R. W. 1981. Apical resorption of a maxillary lateral incisor from a misplaced canine in 17 year old. A case report. *Br. J. Orthod.* 8:3-5.

Buchner, H. J. 1936. Root resorption caused by ectopic eruption of maxillary cuspid. *Int. J. Orthod.* 22:1236-1237.

Dewel, B. F. 1949. The upper cuspid: Its development and impaction. *Angle Orthod.* 19:79-90.

Ericson, S., and Kurol, J. 1986a. Longitudinal study and analysis of clinical supervision of maxillary canine eruption. *Community Dent. Oral Epidemiol.* 14:172-176.

Ericson, S., and Kurol, J. 1986b. Radiographic assessment of maxillary canine eruption in children with clinical signs of eruption disturbance. *Eur. J. Orthod.* 8:133-140.

Ericson, S., and Kurol, J. 1987. Radiographic examination of ectopically eruption maxillary canines. *Am. J. Orthod.* 91:483-492.

Hitchin, A.D., 1956. The impacted maxillary canine. *Brit. Dent. J.* 100: 1-8.

Hotz, R. 1974. *Orthodontics in daily practice.* Bern: Hans Huber Publ, p340-353.

Howard, R. D. 1972. The displaced maxillary canine: Positional variations associated with incisor resorption. *Dent. Pract.* 22:279-287.

Hurme, V. O. 1949. Ranges of normalcy in the eruption of permanent teeth. *J. Dent. Child.* 16:11.

Jacoby, H. 1983. The etiology of maxillary canine impactions. *Am. J. Orthod.* 84:125-132.

Kisling, E., and Ravn, E. 1977. Two cases of marked pressure resorption in maxillary incisors. *Tandlaegebladet.* 81:153-155.

Leivesley, M. 1984. Minimizing the problem of impacted and ectopic canines. *J. Dent. Child.* 51:367-370.

Lind, V. 1972. Short root anomaly. *Scand. J. Dent. Res.* 80:85-93.

Nie, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., Bent, K. 1975. *SPSS — Statistical package for the social sciences.* Second edition. New York, McGraw-Hill Company.

Nitzan, D., Keren, T., and Marmare, Y. 1981. Does an impacted tooth cause root resorption of the adjacent one? *Oral Surg.* 51:221-224.

Noguchi, H., Ohmori, I., 1985. Root resorption of the lateral maxillary incisors due to the ectopic eruption of maxillary canines. *Shoni Shikagaku Zasshi* 23:494-510.

Olow-Nordenram, M., and Anneroth, G. 1982. Eruption of maxillary canines. *Scand. J. Dent. Res. 90:1-8.*

*Rayne, J. 1969. The unerupted maxillary canine. Dent. Pract.* 19: 194-203.

Reese, B. L. 1945. The unerupted cuspid. *Am. J. Orthod.* 31:214-220.

Sasakura, H., Yoshida, T., Murayama, S., Hanada, K., and Nakajima, T. 1984. Root resorption of upper permanent incisor caused by impacted canine. *Int. J. Oral Surg.* 13:299-306.

Severson, A. 1971. Two cases of resorbed lateral incisors. *Swed. Dent. J.* 64:901-904.

Thilander, B., and Jakobsson, SO. 1968. Local factors in impaction of maxillary canines. *Acta Odontol. Scand.* 26:145-168.

Townend, P. I., 1967. Resorption of the roots of upper incisor teeth due to misplaced canine teeth. *Trans. Brit. Soc. Orthod.* 74-77.