Differences between dentitions with palatally and labially located maxillary canines observed in incisor width, dental morphology and space conditions

**Introduction**

The aetiology behind ectopic maxillary canines appears to be multifactorial. Genetic explanations have been given for maxillary canine ectopia [Peck et al., 1994; Segura et al., 2002]. Also, reduced space [Chaushu et al., 2003; Langberg and Peck, 2000] and abnormal dentoskeletal development [Basdra et al., 2001; Sacerdoti and Bacetti, 2004] have been associated with maxillary canine ectopia. Tooth morphological deviations such as anomalies in number, size and position of teeth, have also been reported in maxillary canine ectopia cases [Segura et al., 2002, Bjerklin et al., 1992; Chaushu et al., 2002; Leifert and Jonas, 2003; Paschos et al., 2005].

With regards to space in the maxillary dental arch, it has been suggested that labial ectopia is more commonly related to insufficient arch length [Chaushu et al., 2003], whereas palatal ectopia is associated with other dental anomalies [Bacetti, 1998a; 1998b]. Analyses of dental maturity in patients with canine ectopia demonstrated late development of the dentition in half of the subjects with palatal displacement, whereas tooth maturation in patients with labial ectopia was associated with normal dental morphology [Becker and Chaushu, 2000]. Accordingly, the cases with labially located maxillary ectopic canines differ in several aspects from cases with palatally located maxillary ectopic canines.

A recent study of 69 cases with canine ectopia documented that palatally as well as labially located ectopic canines can occur in dentitions without other dental anomalies [Sørensen et al., 2009]. This study also revealed that dental deviations occurred in approximately 2/3 of all cases, more often in females, and in cases with palatally located canines. More than half of the females with palatally located canines had deviations in the maxillary incisors and in the dentition in general. The dental deviations registered were: crown and root malformations, agenesis and eruption deviations. Registrations were performed in the maxillary incisor field and in the dentition in general [Sørensen et al., 2009]. In a recent study the sagittal, vertical and transversal dimensions in the maxillary complex were studied in cases with ectopic maxillary canines [Larsen et al., 2009]. The registered changes in the maxillary dimensions were not associated with dental deviations [Larsen et al., 2009]. Seemingly, no studies have elucidated how space conditions in the dental arch are associated with different aspects of malformations in the dentition.

The hypothesis of the present study is that an association exists between space available in the maxillary arch and deviations in the dentition.

The aim of the present study was to analyse the space available in the maxillary dental arch in patients with labially and palatally located ectopic maxillary canines.
and to evaluate whether the available space is associated with incisor widths and occurrences of crown and root deviations in the dentition.

**Materials and methods**

**Registration of tooth sizes**
Dental casts from 69 patients, mean age 13 years 6 months, with ectopic maxillary canines were analysed, 50 females and 19 males. The patient group comprised all patients with palatally or labially located ectopic canines referred to a specialised surgery unit under the Municipal Dental Service of Århus, Denmark, within a 2-year period. The majority of the patients were Caucasians, but specific information about ethnicity was not available. Impressions of the upper and lower jaw of these patients were taken in connection with referral to surgery. The casts from the upper jaws of these patients were used for measurement of tooth sizes.

The mesiodistal widths of each premolar, canine and incisor were measured and compared with normal standards given by Townsend [1983]. The mesiodistal widths of the impacted canine were calculated from average size norms, also given by Townsend [1983].

**Registration of dental deviations**
Based on panoramic radiographs from the same patients, the dentitions were grouped accordingly:
- Group I: No deviations in the dentition.
- Group Ia: Deviations in the dentition within the maxillary incisors only.
- Group Ib: Deviations in the dentition in general. The deviations were: invaginations; narrow or screwdriver-shaped crowns; taurodontic molar roots; short premolar and/or molar roots and slender premolar and/or molar roots.

**Registration of space**
Space available in the maxillary dental arch was calculated according to Proffit and Fields [2000] by subtracting the total tooth sizes of incisors, canines and premolars from the lengths of the arch segments. Four arch segments were measured; two from the mesial approximal surfaces of the first permanent molars to the distal surfaces of the lateral incisors and two from the distal surfaces of the lateral incisors to the mesial surfaces of the central incisors [Proffit and Fields, 2000; Al-Nimri and Gharaibeh, 2005]. Each segment was measured individually (Fig. 1) and the added sizes of teeth within each segment were subtracted from the length of the segment.

**Space related to deviations in the dentition**
The material was divided into one group with labially and one with palatally located ectopic canines. In each group the available space was subgrouped according to dental deviations, groups I, Ia and Ib.

**Statistics**
Descriptive statistics for tooth sizes and dental deviations are present by the mean and 95% confidence limits for the mean and the p-value for the T-statistic. A general linear model was used for tests comparing the groups. The model included age and gender and tested for possible interactions. All calculations were done using SAS (version 2.1, SAS Institute, Cary, NC, USA). P values less than 5% are considered significant.

**Results**

**Gender and age distribution**
Fifty females and 19 males were included in the study (no significant difference between groups, p=0.10, chi-square test). The median age at inclusion was 13 years ranging from 8 to 18 (no significant differences between groups p=0.40).

**Tooth sizes compared to dental deviations**
Tooth sizes were compared to dental deviations (groups
smaller than normal (p=0.0001), while this was not seen in cases with labially located canines.

### Space compared to location of ectopic canines

The space available in cases with labially located ectopic canines was less than normal, though not significant (p=0.0731) (Table 3). The space was larger in cases with palatally located ectopic canines (p=0.0636). When labially and palatally located canine cases were compared, the available space was significantly different (p=0.019).

### Inclusion of dental deviations in space analysis of ectopic canines

When available space in labially and palatally located canine cases was subgrouped according to occurrence of dental deviations, it appeared that the palatally located canine cases with general deviations in the dentition (Group IIb) had significantly more space than the other groups of palatally located canine cases (Table 4).

### Summary of results

The study showed that cases with ectopic maxillary canines, based on space and dentition, can be

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**Table 1** - I, Ia and IIb: subdivision of the material according to occurrence of dental deviations.

| Variable                | Group | N  | Mean | Lower 95% CL for mean | Upper 95% CL for mean | Pr>|t|
|-------------------------|-------|----|------|-----------------------|-----------------------|-------|
| Central incisor width   | I     | 20 | -0.11| -0.31                 | 0.09                  | 0.26  |
|                         | Ia    | 20 | -0.09| -0.32                 | 0.14                  | 0.44  |
|                         | IIb   | 18 | -0.65| -1.14                 | -0.16                 | 0.0120*|
| Lateral incisor width   | I     | 20 | -0.09| -0.32                 | 0.14                  | 0.44  |
|                         | Ia    | 18 | -0.65| -1.14                 | -0.16                 | 0.0120*|
|                         | IIb   | 24 | -0.56| -0.86                 | -0.26                 | 0.0009*|

**Table 2** - Lateral incisor width compared with normal standards.

| Canine location | Mean | Lower 95% CL for mean | Upper 95% CL for mean | Pr>|t|
|-----------------|------|-----------------------|-----------------------|-------|
| Labial          | 0.11 | -0.20                 | 0.43                  | 0.4552|
| Palatal         | -0.49| -0.71                 | -0.28                 | <.0001|

**Table 3** - (-): reduced space available. (+): excess of space available.

| Canine location | Mean | Lower 95% CL for mean | Upper 95% CL for mean | Pr>|t|
|-----------------|------|-----------------------|-----------------------|-------|
| Labial          | -1.62| -3.42                 | 0.08                  | 0.0731|
| Palatal         | 1.27 | -0.08                 | 2.61                  | 0.0636|

**Table 4** - I, Ia and IIb: subdivision of the material according to occurrence of dental deviations.

| Variable                | Group | N  | Mean | Std dev | Lower 95% CL for mean | Upper 95% CL for mean | Pr>|t|
|-------------------------|-------|----|------|---------|-----------------------|-----------------------|-------|
| Labial                  | I     | 5  | -3.30| 2.68    | -6.63                 | 0.04                  | 0.05  |
|                         | Palatal| 14 | 0.53 | 4.27    | -2.99                 | 0.04                  | 0.65  |
|                        | Ia    | 5  | 0.58 | 4.34    | -4.60                 | 3.43                  | 0.73  |
|                         | Palatal| 10 | 2.06 | 4.36    | -1.06                 | 5.18                  | 0.17  |
|                        | IIb   | 5  | 0.80 | 3.72    | -3.82                 | 5.42                  | 0.65  |
|                         | Palatal| 22 | 2.88 | 3.53    | 1.31                  | 4.45                  | 0.001*|

I, Ia and IIb). Special focus was given to the incisors.

**Maxillary central incisor:** In all three groups the central incisors were within the normal range (Table 1).

**Maxillary lateral incisor:**
- Group I: The width of the lateral incisor was within normal values (p=0.44) (Table 1, Fig. 2).
- Group Ia: The width of the lateral incisor was significantly smaller than normal (p=0.012) (Table 1, Fig. 2).
- Group IIb: The width of the lateral incisor was significantly smaller than normal (p=0.0009) (Table 1, Fig. 2).

As a conclusion, the groups were significantly different (p=0.016), showing that group I differed from groups Ia (p=0.0055) and IIb (p=0.039), whereas no difference was seen between groups Ia and IIb (p=0.34).

**Tooth sizes compared to location of ectopic canines**

A significant difference was seen between the lateral incisor widths in cases with labially and palatally located ectopic canines (p=0.003) (Table 2). In cases with palatally located canines the lateral incisors were significantly smaller than normally (p=0.0001), while this was not seen in cases with labially located canines.

**Space compared to location of ectopic canines**

The space available in cases with labially located ectopic canines was less than normal, though not significant (p=0.0731) (Table 3). The space was larger in cases with palatally located ectopic canines (p=0.0636). When labially and palatally located canine cases were compared, the available space was significantly different (p=0.019).

**Inclusion of dental deviations in space analysis of ectopic canines**

When available space in labially and palatally located canine cases was subgrouped according to occurrence of dental deviations, it appeared that the palatally located canine cases with general deviations in the dentition (Group IIb) had significantly more space than the other groups of palatally located canine cases (Table 4).

**Summary of results**

The study showed that cases with ectopic maxillary canines, based on space and dentition, can be
characterized as follows.

Labially located maxillary canines
- Central incisor width: normal
- Lateral incisor width: normal
- Available space in the dental arch: reduced
- The extent of other dental deviations did not further subdivide the group.

Palatally located maxillary canines
- Central incisor width: normal
- Lateral incisor width: significantly reduced.
- Available space in the dental arch: increased.
- The extent of other dental deviations than ectopia further subdivided this group as the cases with several dental deviations (IIb) had significantly more space than the rest (groups I and Ila).

Discussion

The present study confirms previous studies dealing with differences between dentitions with labially and palatally located canines. In the present study two subgroups have been defined in the cases with palatally located canines, one with reduced incisor width and only slightly reduced space in the dental arch and the other with significantly reduced width combined with general deviations in the dentition and significantly increased space in the dental arch. When these results are compared with the study on the three-dimensional maxillary space analyzed in ectopic canines [Larsen et al., 2009], it is obvious that the space in the alveolar process is more strongly correlated with the dentition than the space in the maxillary complex. These conditions ought to be evaluated in the clarification of aetiology. Even though palatally located ectopic canines have been reported as a genetic disorder [Peck et al., 1994; Segura et al., 2002], information is needed concerning inheritance of the two different phenotypes.

The present study confirms that an association exists between eruption and dental deviation. Thus, Vedtofte et al. [1999] found that patients with arrested eruption of second permanent molars were patients with more dental deviations than seen normally. Also, Nielsen et al. [2006] focused on associations between arrested eruption of first permanent molars and dental deviations. Becktor et al. [2005] documented an association between ectopic eruption of first maxillary molar and ectopic canine eruption.

Furthermore, the association between dental deviations such as invaginations and taurodontic root morphology and the individual tendency to root resorption, described by Kjær [1995], demonstrated the importance of including dental deviations in diagnostics and treatment planning.

The comparison of incisor width in the present study with normal standards from Australians, published by Townsend [1983] could be questionable. Meanwhile, no width measurements of teeth from a Danish population exist. It was accepted to use the standards from the Australian population because there was complete congruence between the width of the central incisors in the study group and the width of the central incisors in the standards from the Townsend study. Still, differences may exist between the widths of the laterals. In that connection it was interesting that the widths of the laterals in the group of labially located ectopic maxillary incisors were similar to the widths from the normal standard used. Only the widths of the laterals differed in patients with palatally located maxillary ectopic canines. In the future, it would be preferable to have access to a large database with width measurements of all teeth in a group of normal dentitions from children with and without indication of orthodontic treatment.

The subdivision of patients with ectopic maxillary canines according to morphological deviations in the incisors and in the remaining dentition formed the basis for the present subdivision of palatally located ectopic canines. It is recommended in future studies to include this classification in the evaluation of cases with ectopia. It may also be useful for prediction of eruptional deviations.

The biological interrelation between dental deviations and deviations in the periodontal functions, registered in eruption disturbances and root resorption, could be associated with the composition or function of the tissue layers surrounding the epithelial layer of Malassez [Kjær and Nolting, 2009]. It is well known that this epithelial layer surrounding the root surface arises from the Hertwig root sheath and that this root sheath is responsible for the morphology of the root.

Conclusion

The present study elaborates on the association between tooth morphology and especially the widths of the lateral maxillary incisors, the space available in the maxillary dental arch and the location of the ectopic canines. A new observation in this study is that the size of the lateral maxillary incisor and the morphology of the dentition in general indicate that an epithelial factor influencing tooth morphology might also influence the deviation of canine eruption. This observation is of importance for early diagnostics.
Furthermore, the study shows a connection between the occurrence of dental malformation and location of an ectopic canine. The more malformed the dentition, the greater is the likelihood of the canine being located palatally.

The study also showed that reduced space is available in labially located canine cases and increased space is available in palatally located canine cases. Most space is available in the alveolar bone in the cases with palatally located canine in which extensive dental deviations are observed.

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