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ORIGINAL ARTICLE

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Sagittal, vertical and transversal dimensions of the maxillary complex in patients with ectopic maxillary canines

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Structured Abstract

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Objectives – To analyse the craniofacial maxillary complex in cases with labially and palatally located ectopic canines, subgrouped accordingly: Group I: no deviations in the dentition; Group IIa: deviations in the maxillary incisors only; Group IIb: deviations in the dentition in general.

Setting and Sample Population – Sixty nine patients (mean age 13 years 6 months) with palatally or labially located ectopic canines.

Material and Methods – Profile radiographs and dental casts were analysed. The patients were subgrouped according to a previous registration of dental deviations registered radiographically. Maxillary cross-arch transversal width was analysed on dental casts. Sagittal and vertical dimensions were registered cephalometrically on profile radiographs.

Results – In the patient sample the maxillary cross-arch transversal width (from first maxillary molar left to first maxillary molar right), was significantly larger than the normal mean (0.65 mm, 95% CI: 0.02–1.28, $p = 0.043$). The sagittal length N-S was significantly shorter (–0.97, 95% CI:–1.72– –0.22, $p = 0.002$). The vertical length ANS-N length was also significantly shorter (–0.79, 95% CI:–1.65– –0.02, $p = 0.047$). The remaining variables were non-significant. Tests for interaction between groups (I, IIa and IIb) and palatal/labial ectopic location did not demonstrate significance.

Conclusion – In patients with ectopic maxillary canines, the maxillary complex is shorter sagittally as well as vertically, while it is wider transversally.

Key words: Canine; cephalometry; eruption; human; three-dimensional

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Introduction

Canine ectopia is a dental anomaly, which has been associated with lack of space (1–3), other dental anomalies (4–8), deviations in dental maturity (9) and dentoskeletal features (10). Ectopic canines appear to be palatally or labially located and are presumed to have a genetic origin (11, 12).

In a recent study on maxillary canine ectopia a classification of ectopies according to dental morphology resulted in three groups: teeth without anomalies (30%); dental anomalies in the maxillary incisors (26%); and general deviations in the dentition (44%) (8).

The recent study by Sørensen et al. (8) was a clinical study based on panoramic radiograph and dental cast analysis. These studies contribute to an improved evaluation of aetiology, diagnostics and prediction of maxillary canine eruption. The biological interpretation of the eruption process is not fully understood, but it is hypothesized that the epithelial layer of Malassez does influence the eruption process (13). With regards to the aetiology of ectopic canines, it can be assumed that the periodontal membrane with its ectodermal cell layer does not function normally. This ectodermal insufficiency may be reflected in ectodermal morphological dental deviations such as invaginations, narrow crowns, short roots and taurodontic molars. If it is so, the aetiology behind maxillary canine ectopia will be different from the aetiology behind maxillary canine ectopia in dentitions without deviations.

Cases with canine ectopia are often referred for orthodontic treatment. Subsequently, a profile radiograph is available in most cases. These profile radiographs are primarily used for diagnosing jaw position and jaw morphology (14). Also, computerized tomography has recently been used in diagnostics and treatment planning (15, 16). It is hypothesized that the ectopic position of the canines is associated with lack of space for the eruptional pathway in the maxillary complex.

The purpose of the present study was to analyse the size and morphology of the craniofacial maxillary complex in cases with ectopic canines by evaluating sagittal and vertical dimensions on profile radiographs and transversal dimensions on dental casts. The purpose was also to relate the craniofacial dimensions to subgrouping of the material divided according to tooth morphology and development (8).

Materials and methods

Profile radiographs and dental casts from 69 patients with ectopic maxillary canines were analysed.

The patient group constituted all patients with palatally or labially located ectopic canines, referred to a specialized surgery unit in the Municipal Dental Service of Aarhus within a 2-year period. The majority of the patients were Caucasians, but specific information about ethnicity was not given.

The patients were subgrouped according to a previous registration of dental deviations registered radiographically. These groups were:

- Group I: No deviations in the dentition.
- Group IIa: Deviations in the dentition within the maxillary incisors only.
- Group IIb: 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.

Dental casts

Impressions of the upper and lower jaw of these patients were taken in connection with the patients' referral to surgery. The casts from the upper jaws comprised the material of the present study. Maxillary cross-arch transversal width (from first maxillary molar left to first maxillary molar right), MW6-6, was analysed according to Hesby et al. (17).

Cephalometric method

The profile radiographs were taken in a cephalostat with a film-to-focus distance of 180 cm and a film-to-median plane distance of 10 cm. Corrections were made for the constant linear enlargement of 5.6%.

The reference points for measuring the sagittal and vertical analyses were: N – nasion, S – sella, PNS – posterior nasal spine, ANS – anterior nasal. The following dimensions of the maxillary jaw complex were registered: the sagittal dimensions distance N-S and PNS-ANS, and the vertical dimension ANS-N. Also the maxillary prognathia angle, S-N-ANS, was measured.

Normal values for comparison, N-S and maxillary prognathia (18); PNS-ANS and ANS-N (19); maxillary cross-arch width (17), were from patients of Scandinavian (18) and of primarily northern European descend (17).

Statistics

Descriptive statistics for the tooth sizes and dental deviations are presented 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.

Error of the method

The reliability of the variables described was assessed by re-measurement of 20 dental casts and of 20 lateral radiographs selected at random. The casts and radiographs were measured again after 2 weeks and the differences between the two sets of recordings were calculated. No significant differences between the two sets of recordings were found by paired t-test.

Results

Maxillary complex in ectopic canine cases

In all cases the transversal distance MW6-6 was significantly larger than for published control values (0.65 mm, 95% Cl: 0.02–1.28, $p = 0.043$), as shown in Table 1.

In the sagittal dimension, the N-S length was significantly shorter than for published control values (−0.97, 95% Cl: −1.72– −0.22, $p = 0.002$), while the PNS-ANS length was within normal values. In the vertical dimension, the ANS-N length was significantly shorter than normal (−0.79, 95% Cl: −1.65– −0.02, $p = 0.047$). The maxillary prognathia was non-significant as shown in Table 1. Thus, the size of the maxillary complex in patients with ectopic canines was significantly enlarged transversally, while it was smaller sagittally and vertically (Table 1).

Maxillary complex in ectopic canine cases without and with dental deviations

Statistical analysis using a linear model of the transversal width MW 6–6 minus normal value (17), the length N-S, the length PNS-ANS and the length ANS-NS, for the entire dataset could not demonstrate significant differences between the groups (I, IIa and IIb) nor between palatally and labially located ectopic canines. The results are shown in Tables 2 and 3. Tests for interaction between groups (I, IIa and IIb) and palatal/labial ectopic location could not demonstrate significance.

Discussion

The present study shows that the craniofacial maxillary complex is significantly different in the sagittal, vertical

Table 2. **p-values for the linear model including group (I, IIa and IIb) and palatal/labial as explanatory variables**

Variable	Group (I, IIa, IIb)	Palatal/labial ectopia
MW6-6 width	0.96	0.50
Maxillary prognathia	0.65	0.16
N-S length	0.51	0.99
PNS-ANS length	0.12	0.73
ANS-N length	0.94	0.38

Table 1. **Transversal, sagittal and vertical dimensions in the total dataset compared to normal standards**

Variable	N	Mean	Std dev	Lower 95% CL for mean	Upper 95% CL for mean	p-value
MW6-6 width	65	0.65	2.55	0.02	1.28	0.0430*
Maxillary prognathia	58	−0.36	3.20	−1.20	0.48	0.3951
N-S length	56	−0.97	2.80	−1.72	−0.22	0.0119*
PNS-ANS length	58	−0.11	2.60	−0.80	0.57	0.7438
ANS-N length	58	−0.79	2.94	−1.65	−0.02	0.0458*

The table illustrates the observed value minus the normal control value for the entire dataset.
*Indicates that the variable differs significantly from normal value. Different N-values are caused by difficulties in defining landmarks in some radiographs.

Table 3. *p*-values for the linear model including palatal and labial positions as explanatory variables

Group	Palatal	Variable	N	Mean	Lower 95% CL for mean	Upper 95% CL for mean	*p*-value
I	Labial	Max trans width	5	−0.63	−3.46	2.21	0.5731
		Max prog	5	−1.82	−6.91	3.27	0.3774
		N-S length	5	0.78	−1.45	3.10	0.4038
		PNS-ANS length	5	0.28	−2.70	3.26	0.8069
		ANS-N length	5	0.22	−3.31	3.75	0.8711
	Palatal	Max trans width	15	1.23	−0.31	2.77	0.1093
		Max prog	15	−0.18	−1.53	1.17	0.7796
		N-S length	14	−0.95	−3.08	1.18	0.3521
		PNS-ANS length	15	0.01	−1.17	1.19	0.9905
		ANS-N length	15	−0.92	−2.97	1.13	0.3520
IIa	Labial	Max trans width	7	0.39	−0.93	1.72	0.4934
		Max prog	5	−0.38	−4.24	3.48	0.7981
		N-S length	4	−1.42	−4.90	2.05	0.2832
		PNS-ANS length	5	1.64	−1.84	5.12	0.2613
		ANS-N length	5	−0.04	−2.96	2.88	0.9715
	Palatal	Max trans width	11	0.49	−0.86	1.84	0.4389
		Max prog	10	0.46	−2.28	3.20	0.7132
		N-S length	10	−1.75	−3.25	−0.25	0.0273*
		PNS-ANS length	10	0.53	−1.51	2.57	0.5718
		ANS-N length	10	−1.37	−3.27	0.53	0.1382
IIb	Labial	Max trans width	5	1.05	−2.79	4.88	0.4907
		Max prog	4	−1.93	−10.03	6.18	0.5047
		N-S length	4	−2.80	−7.75	1.97	0.1583
		PNS-ANS length	4	−1.40	−8.34	5.54	0.5667
		ANS-N length	4	−0.88	−5.68	3.93	0.6028
	Palatal	Max trans width	22	0.62	−0.68	1.92	0.3296
		Max prog	19	−0.22	−1.64	1.21	0.7538
		N-S length	19	−0.56	−1.81	0.69	0.3560
		PNS-ANS length	19	−0.84	−1.98	0.30	0.1398
		ANS-N length	19	−0.82	−2.19	0.54	0.2213

Max trans width, maxillary transversal width; Max prog, maxillary prognathia.
*Indicates that the variable differs significantly from normal value.

and transversal planes in patients with palatally and labially ectopic canines. It can be discussed whether ectopia is the result of the deviant growth of the maxillary complex or whether deviation in eruption is independent from morphology of the maxillary complex.

There are several previous studies on the interrelation between dental deviations and craniofacial deviations. In one study on patients with multiple agenesis it was found that there was an association between number of missing teeth and especially the mandibular morphology and location (20). Another study on arrested eruption of the permanent mandibular second molars showed that these patients had an increased sagittal jaw relationship and that specifically the mandibular prognathia was less than normal (21). Also, Tabatabaie et al. (22) documented several significant associations between dental deviation in the maxillary incisor in Solitary Median Maxillary Central Incisor (SMMCI) cases and craniofacial dimensions. Thus, previous studies have documented developmental associations and connections between dental deviations and jaw development.

The classification of ectopic canine cases according to morphological characteristics observed in the dentition does not seem to be decisive for understanding space conditions in the maxillary complex elucidated in the present study. Only the sagittal length S-N is significantly different between the groups divided according to dental deviations. The S-N dimensions were normal in cases without dental deviations (Group I), while the S-N dimensions was significantly shorter in cases with morphological deviations in the maxillary incisors (Group IIa). This observation supports findings of a close interrelationship between deviations in the maxillary incisors and the S-N dimension (22). This interrelationship could be caused by a common embryological development from the frontonasal neural crest cells forming the premaxillary field as well as the midaxial part of the anterior cranial fossa (23).

For comparison, normal standards were used from patients of Scandinavian (18) and of primarily northern European descend (17). Still, Danish standard values from children of comparable ages and from the same geographical areas as the ectopic canine group would have been preferred. Such standards were not available and were not obtainable due to ethical reasons.

The significant dimensional differences in the craniofacial maxillary complex observed in cases with ectopic canines are only obvious when cases with palatally located ectopic canine cases are compared with labially ectopic canine cases. The differences in craniofacial values between labial and palatal location within the groups I, IIa and IIb support registered differences. In a study on dental casts from 34 patients with palatally impacted maxillary canines, Al-Nimri and Gharaibeh (3) concluded that excess palatal width and anomalous lateral incisors may contribute to the aetiology of palatal canine impaction. The present study concludes that also the space available in the maxillary arch as well as the length of the anterior cranial fossa (S-N dimension) and the maxillary height (N-SNA) are important parameters in the evaluation of aetiology.

The present study suggests that in the diagnostics of ectopic canine cases dental and skeletal parameters as well as space in the maxillary arch must be evaluated. The results of this evaluation should form the basis of prediction, diagnostics and treatment planning including decisions on early extractions of primary canines and should also form the basis for evaluation of treatment results.

Clinical relevance

The present study focuses on space analysis in the maxillary complex and concludes that the size of the maxillary complex in patients with ectopic canines is significantly enlarged transversally, while it is smaller sagittally and vertically. The clinical relevance is that not only registration of dental anomalies and of space in the dental arch, as previously described, but also a three-dimensional analysis of space in the maxillary complex can improve diagnostics and treatment in cases with ectopic maxillary canines.

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References

1. Langberg BJ, Peck S. Adequacy of maxillary dental arch width in patients with palatally displaced canines. *Am J Orthod Dentofac Orthop* 2000;118:220–3.
2. Chaushu S, Sharabi S, Becker A. Tooth size in dentitions with buccal canine ectopia. *Eur J Orthod* 2003;25:485–91.
3. Al-Nimri K, Gharaibeh T. Space conditions and dental and occlusal features in patients with palatally impacted maxillary canines: an aetiological study. *Eur J Orthod* 2005;27:461–5.
4. Baccetti T. A controlled study o associated dental anomalies. *Angle Orthod* 1998;68:267–74.
5. Baccetti T. A clinical and statistical study of etiologic aspects related to associated tooth anomalies in number, size, and position. *Minerva Stomatol* 1998;47:655–63.
6. Chaushu S, Sharabi S, Becker A. Dental morphologic characteristics of normal versus delayed developing denititons with palatally displaced canines. *Am J Orthod Dentofacial Orthop* 2002;121:339–46.
7. Leifert S, Jonas IE. Dental anomalies as a microsymptom of palatal canine displacement. *J Orofac Orthop* 2003;64:108–20.
8. Sørensen HB, Artmann L, Larsen HJ, Kjær I. Radiographic assessment of dental anomalies in patients with ectopic maxillary canines. *Int J Paed Dent* 2009;19:108–14.
9. Becker A, Chaushu S. Dental age in maxillary canine ectopia. *Am J Orthod Dentofacial Orthop* 2000;117:657–62.
10. Sacerdoti R, Baccetti T. Dentoskeletal features associated with unilateral or bilateral palatal displacement of maxillary canines. *Angle Orthod* 2004;74:725–32.
11. Peck S, Peck L, Kataja M. The palatally displaced canine as a dental anomaly of genetic origin. *Angle Orthod* 1994;64:249–56.

12. Basdra EK, Kiokpasoglou MN, Komposch G. Congenital tooth anomalies and malocclusions: a genetic link? *Eur J Orthod* 2001;23:145–51.
13. Kjær I, Nolting D. The human periodontal membrane – focusing on the spatial interrelation between the epithelial layer of Malassez, fibers, and innervation. *Acta Odontol Scand* 2009;67:134–8.
14. McSherry P, Richardson A. Ectopic eruption of the maxillary canine quantified in three dimensions on cephalometric radiographs between the ages of 5 and 15 years. *Eur J Orthod* 1999;21:41–8.
15. Walker L, Enciso R, Mah J. Three-dimensional localization of maxillary canines with cone-beam computed tomography. *Am J Orthod Dentofacial Orthop* 2005;128:418–23.
16. Bjerklin K, Ericson S. How a computerized tomography examination changed the treatment plans of 80 children with retained and ectopically positioned maxillary canines. *Angle Orthod* 2006;76:43–51.
17. Hesby RM, Marshall SD, Dawson DV, Southland KA, Casko JS, Franciscus RG et al. Transverse skeletal and dentoalveolar changes during growth. *Am J Orthod Dentofacial Orthop* 2006;130:721–31.
18. Axelsson S, Kjær I, Bjørnland T, Storhaug K. Longitudinal cephalometric standards for the neurocranium in Norwegians from 6 to 21 years of age. *Eur J Orthod* 2003;25:185–98.
19. Riolo ML, Moyers RE, McNamara JA Jr, Hunter WS. *An Atlas of Craniofacial Growth*. Michigan: Ann Arbour; 1974.
20. Nodal M, Kjær I, Solow B. Craniofacial morphology in in patients with multiple congenitally missing permanent teeth. *Eur J Orthod* 1994;16:104–9.
21. Vedtofte H, Andreasen JO, Kjær I. Arrested eruption of the permanent lower second molar. *Eur J Orthod* 1999;21:31–40.
22. Tabatabaie F, Sonnesen L, Kjær I. The neurocranial and craniofacial morphology in children with solitary median maxillary central incisor (SMMCI). *Orthod Craniofacial Res* 2008;11:96–104.
23. Kjær I. Neuro-osteology. *Crit Rev Oral Biol Med* 1998;9:224–44.