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Radiographic assessment of dental anomalies in patients with ectopic maxillary canines

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Background. The aetiology of palatally and labially located ectopic maxillary canines is multifactorial. Accordingly, early prediction of this eruptional disturbance is in most cases not possible.

Aim. The purpose of this study was to analyse dental deviations in cases with either palatal or labial ectopic canines.

Design. Panoramic and intra-oral radiographs from 50 patients with palatally located (38 females and 12 males) and 19 patients with labially located ectopic canines (11 females and 8 males), aged 10 years, 2 months–18 years, 1 month, were analysed. 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.

Results. The study documented that palatally as well as labially located ectopic canines can occur in dentitions without other dental deviations. Dental deviations occurred in approximately two-thirds 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.

Conclusion. Dental deviations may be considered a risk factor for maxillary canine ectopia. Early identification of patients at risk and appropriate interceptive treatment may reduce ectopic eruption of maxillary canines.

Introduction

Ectopic maxillary canines pose a problem in early prediction and early diagnosis as well as in treatment. The problems also concern practical localization of the canine and guidance for prevention based on aetiological insight.

Computerized tomography has contributed to a definition of a more exact location of the ectopic teeth[1,2]. Thus, it can be documented with accuracy whether the maxillary canines are located palatally or labially. Reliable diagnostic criteria for predicting and preventing this condition have yet to be defined.

Most studies concentrate on surgical removal of mucosa covering the canine and on the succeeding orthodontic treatment[3–5]. Additionally, the question of extraction/non-extraction of the primary canines has been in focus[6,7], and guidelines for this practice have been presented for palatally located canines[8].

The aetiology of ectopic maxillary canines appears to be multifactorial and the cases of ectopia different. In that connection, genetic explanations for the condition have been presented[9,10]. The condition has also been associated with reduced space[11,12] and abnormal dentoskeletal features[13,14]. It has been suggested that labial ectopia is more commonly related to insufficient arch length[11], whereas palatal ectopia is associated with other dental anomalies[15]. Meanwhile, a subclassification of cases with ectopic maxillary canines according to a combination of phenotypic and genotypic characteristics appears to be lacking. Accordingly, scientifically based diagnostic tools, relevant for early prediction, diagnostics, and treatment planning, are important.

Several papers have been published on resorption of incisor roots associated with ectopic canines[7,16–20]. Associated with this abnormal pattern of resorption, tooth morphological

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deviations such as anomalies in number of teeth, size, and position of teeth have been reported[10,21–24]. A controlled study of associated dental anomalies has suggested a common genetic origin of the following conditions: agenesis of the second premolars, small size of lateral maxillary incisors, infraocclusion of primary molars, enamel hypoplasia, and palatal displacement of maxillary canines[15]. Analysis of dental maturity in patients with canine ectopia found that approximately half of the subjects with palatal displacement exhibited a late-developing dentition, whereas the timing of dentition in the remaining subjects appeared to be normal[25]. As labial displacement was not associated with a retarded dental development, the results support the idea that there are different aetiologies for the occurrence of labial versus palatal ectopia in maxillary canines, and also that the aetiology behind palatal ectopia may be different[25].

None of the existing studies has taken the embryological developmental fields in the dental arches[26] into consideration. It is known that the maxillary incisor region, which is a part of the embryological frontonasal developmental field, has a different developmental origin at the embryonic neural crest than the canine–premolar field[26]. The maxillary canines erupt at the border area between these two developmental fields. Another example of a permanent tooth erupting at a border area between two fields is the first maxillary molar, erupting at the borderline between the canine/premolar field and the molar field. It is interesting that within a group of 30 patients with ectopic eruption of the first molar, 23% of those patients had ectopic canines[27]. This observation is important for early identification of cases, which may later develop palatal or labial ectopia of maxillary canines. Still, additional parameters for predicting ectopia are needed.

The finding of a connection between resorption provoked by pressure from orthodontic appliances and the occurrence of dental malformations[28] is of interest when considering that pressure from the erupting canine might result in resorption of incisors. Thus, there is reason to believe that the prevalence of dental anomalies in the frontonasal field, in which the incisors are located, can be higher in dentitions with ectopic eruption than in dentitions with normal canine eruption.

It is expected that different appearances of dentitions in which palatally or labially located ectopic maxillary canines occur have different aetiological backgrounds.

The purpose of this study was to analyse radiographic evidence of dental deviations in the maxillary incisor region and in the dentition in general in cases with palatally or labially located ectopic canines.

Materials and methods

Panoramic and intra-oral radiographs from 69 patients with ectopic maxillary canines were analysed. The patient group constituted all patients with palatally or labially located ectopic canines, referred to as specialized surgery unit in the Århus Community Dental Service within a 2-year period. The majority of the patients were Caucasians, but specific information about ethnicity was not given. The radiographs were all taken in connection with the patients' reference to surgery. After radiography, all patients had undergone surgical treatment and most also orthodontic treatment.

The radiographs were divided into three groups according to dental deviations in the maxillary incisor field and the dentition in general. Due to late maturation, the third molars were not analysed.

Group I: No deviations in the dentition, illustrated in Figure 1. Group IIa: Deviations in the dentition within the maxillary incisor field only, illustrated in Figure 2. Group IIb: Deviations in the dentition in general, illustrated in Figure 3.

Each of these three groups was divided according to occurrence of palatally and labially located ectopic canines.

The following conditions were regarded as deviations in the dentition:

1 Deviations in morphology: invaginations, narrow or screwdriver-shaped crowns, taurodontic molar roots, short premolar and/or molar roots and slender premolar and/or molar roots. Invaginations were registered in teeth with fillings at the normal locations of invaginations and in teeth with radiographically distinct enamel notching in the same

Table 1. The dentition in 69 cases with palatally and labially located ectopic canines.

		Group I No dental deviations		Group IIa Maxillary incisor deviations*		Group IIb General dental deviations**	
		n	%	*n*	%	*n*	%
Palatal	Female *n* = 38	9	24	8	21	21	55
	Male *n* = 12	6	50	3	25	3	25
Labial	Female *n* = 11	3	27	3	27	5	46
	Male *n* = 8	3	38	4	50	1	12

*Including agenesis of two lateral incisors.
**Including agenesis of five lateral incisors and 12 premolars.

area. Narrow or screwdriver-shaped crowns were registered in incisors where the incisal width was shorter than the width at collum. Taurodontic root shapes were registered according to criteria defined by Schulze[29]. Only the distinct taurodontic forms, mesotaurodontia and hypertaurodontia, were recorded in order to avoid misinterpretation. Short roots occurred in single-rooted teeth when the length of the root was equal to or shorter than the height of the crown. Slender roots were narrow roots.

2 Agenesis was registered except for the third molars.

3 Eruptional deviations such as arrested eruption and ectopic eruption (not including the canine ectopia) were regarded as deviations in the dentition, whereas smaller eruptional deviations were not.

Results

Distribution of the 69 cases according to dental deviations and location of ectopic canines is shown in Table 1. Fifty patients had palatally located canines: 38 females (mean age 13 years, 7 months; range 11 years, 0 months to 16 years, 9 months) and 12 males (mean age 13 years, 10 months; range 10 years, 6 months to 16 years, 8 months).

Nineteen patients had labially located canines: 11 females (mean age 11 years, 10 months; range 10 years, 2 months to 15 years, 10 months) and 8 males (mean age 13 years, 10 months; range 11 years, 9 months to 18 years, 1 month).

Thus, this study showed that the prevalence of palatinally located canines is higher than the prevalence of labially located canines. The study also showed that the prevalence of ectopia is higher in females than in males. Furthermore, it is documented that palatally as well as labially located ectopic canines can occur in dentitions without other dental deviations. Dental deviations occurred in approximately two-thirds 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 (Table 1).

The deviations in the incisor region were: invaginations (16 patients), narrow crowns (14 patients), and malformed roots (19 patients). In the premolar/molar regions, taurodontic root shapes were registered in 16 patients, and eruptional deviation and short premolar roots in six patients.

Discussion

The study documented that palatally as well as labially located ectopic canines can occur in dentitions without other dental deviations. It also showed that dental deviations occurred in approximately two-thirds of all cases studied and most often in the incisor regions. Registration of dental deviations is therefore relevant in the early prediction of dentitions developing canine ectopia. The registration of minor dental deviations such as invaginations is difficult to register on orthopantomograms. Therefore,

Fig. 1. Orthopantomogram of a boy taken at the age of 16 years, 8 months when referred to surgery for treatment of palatally located ectopic maxillary canines. The dentition appears with normal morphology, and all teeth except the third molars are present. This orthopantomogram is an example from group I characterized by normal tooth morphology and all teeth present (except third molars).

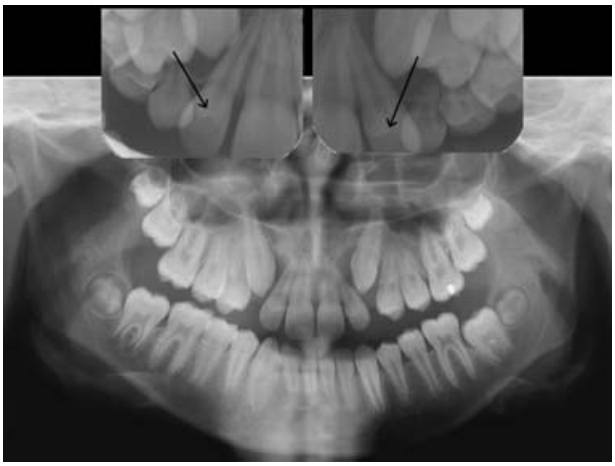

Fig. 2. Orthopantomogram of a boy with labially located ectopic canines taken at the age of 13 years, 1 month. Invagination is seen in the left and right maxillary lateral incisors, radiographed 1 month before the orthopantomogram was taken. The invaginations are marked (arrows) on the dental radiographs inserted in the orthopantomogram. Except for these incisor deviations, tooth number and tooth morphology are normal. This orthopantomogram is an example from group IIa characterized by deviations in the maxillary incisor region and otherwise normal dental conditions.

intra-oral radiographs supplemented the registration. Even then, invagination can be difficult to diagnose with certainty. In cases of uncertainty, the tooth morphology was considered normal.

The present results serve as a basis for a phenotypic subgrouping of patient cases with palatally and labially located ectopic maxillary canines. This subgrouping ought to be related to other parameters of importance for developing maxillary canine ectopia such as spacing, craniofacial morphology, and occlusion, which have not been considered in this study. The purpose of the present phenotypic subgrouping was to identify risk factors and accordingly create possibilities for early prediction, early diagnostics, and early treatment of canine ectopia. The subgrouping is also of importance for insight into aetiology.

Meanwhile, it is difficult to determine what the biological common denominator is for abnormal eruption and abnormal morphology. In a recent study, the presence of an ectodermal cell layer, which has arisen from the epithelial layer of Malassez, has been demonstrated in the periodontal membrane[30]. This finding could indicate an ectodermal factor in the periodontal membrane as being of importance for tooth eruption as well as for tooth morphology, and thus being the common denominator. Both taurodontia and invagination are deviations known to be caused by deviant ectoderm[31,32].

In cases with ectopic eruption of the first permanent molar erupting between the canine/premolar and molar fields, ectopic eruption of the permanent canine erupting between the incisor and canine/premolar fields has been described in 23% of the cases[27]. A field in the dentition is a region in the dental arch characterized by the same origin at the neural crest and accordingly with the same innervation[26]. Recently, Parner *et al.*[33] documented a close relationship between eruptional times of teeth within the same field. This interrelationship in tooth eruption times was not seen between teeth belonging to

Fig. 3. Orthopantomogram of a girl taken at the age of 12 years, 6 months when referred to surgery for treatment of palatally located ectopic maxillary canines. The dentition appears with malformation in the maxillary incisor region (invagination of the right lateral and malformed crown of the left lateral), as well as in the dentition in general. First maxillary permanent molars and all second permanent molars are taurodontic. Ectopic eruption of two second premolars is seen. This orthopantomogram is an example from group IIb characterized by deviations in the dentition in general including the upper incisor region.

different fields. Studies such as this give rise to speculation on how eruption is regulated within developmental fields. As canines as well as first molars cross the borderlines between dental fields during ectopic eruption, one may presume that a common pathological factor exists in cases where both maxillary canines and first molars erupt ectopically. This factor involved in the eruption pattern could be associated with general deviations in the epithelial layer of Malassez and the function of this layer during eruption.

This study documented that palatally and labially located ectopic maxillary canines can occur in dentitions without dental deviations. The type of ectopia in these dentitions may have a different aetiology than the type of ectopia in cases with deviations in the dentitions. In a future study on patients with ectopic canines, it ought to be clarified whether or not deviations in dental morphology are associated with space problems and/or deviations in craniofacial dimensions, growth, and occlusion. Another aspect that should be elucidated is the maturation and migration path of the canines[34], and also the treatment outcome[8] in the different cases of canine ectopia.

A previous study on dental maturity in cases with canine ectopia concluded that the aetiology behind palatal and labial ectopia is different and that also a different aetiology may be seen within patients with palatal ectopia[25]. This study confirms these statements, even though the size of the material, particularly concerning the group with labial ectopia, is too small for any significant conclusions regarding aetiology. It would be interesting to investigate whether the differences within the group of patients with palatal ectopia[25] are associated with differences in dental deviations observed in this study.

Important knowledge in this study is that more than two-thirds of the dentitions in cases with ectopic canines have several distinct deviations in tooth morphology, tooth eruption, and/or tooth number. But the study does not allow for clear distinctions between the three groups analysed. Dental deviations among incisors can be registered early. Therefore, this registration is a valuable supplement to the previous registration of ectopic first maxillary molar eruption as an early risk factor for prediction of ectopic canine eruption[27]. Still, this study does have limitations. It is based only on a radiographic analysis, and dental age is not assessed. Other aspects, which should be considered together with dental malformations, are craniofacial morphology, occlusion, and available space in the maxillary dental arch.

This study has added new knowledge to the early prediction of ectopic canines and also to considerations on the aetiology. Still, future studies on craniofacial morphology, occlusion, and space analysis have to be added to the results in this study for obtaining a sufficient phenotypic characteristic of the palatally and labially located ectopic canines.

What this paper adds

- Palatally and labially located ectopic canines can occur in dentitions without other dental deviations.
- Dental deviations occur in more than two-thirds of all cases with ectopic canines and most often in cases with palatally located canines.
- Dental deviations occurred more often in females than in males.

Why this paper is important to paediatric dentists

- It is important to predict ectopic eruption of maxillary canines because early prediction can provide optimal treatment and prevent resorption of the permanent incisors. From this study, it can be recommended to give special attention to dental deviations such as invaginations, crown, and root deviations including taurodontic molar roots and agenesis as possible risk factors associated with ectopic eruption of maxillary canines.

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