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Dentoskeletal features in mixed dentition children with displaced maxillary canines in a southern Italian population

ABSTRACT

Aim *To analyse the prevalence and the distribution of displaced, buccal/palatal maxillary canines, and the association with sagittal and vertical skeletal relationships in a southern Italian population.*
Materials and methods *Consecutive records of patients were examined. Inclusion criteria were: age 7–12 years, 1–2 cervical vertebral maturation (CVM) stage, initial dental casts, intraoral photographs, panoramic, lateral and periapical radiographs. Subjects with at least one canine in Lindauer II, III or IV sector and/or α angle >31° were included in displaced maxillary canine (DMC) group, whereas those with both canines in sector I and α angle ≤31° were used as control group (CTR). According to canine bulges and/or x-ray examinations, DMC were then divided in palatal and buccal displaced canines (PDC/BDC). Sagittal and vertical skeletal relationships were evaluated using ANB and SN/GoMe angles. Chi-square tests were performed to compare the prevalence rates of skeletal features.*
Results *The sample consisted of 123 children, 40 DMC and 83 CTR. The DMC group included 11 PDC and 29 BDC subjects. The M:F ratio was 1:3 in PDC and BDC, 1:1 in CTR group. The unilateral-to-bilateral ratio was 1:1 and 3:1 in PDC and BDC subjects. The most common sector combination regarding unilateral and bilateral displacements was "II" and "II,II". PDC occurred more in Class I and in hyperdivergents, whereas BDC in Class I or II and in normodivergents.*
Conclusions *DMC occurred more often in females than in males. BDC was more common than PDC and unilateral displacements occurred more frequently than bilateral ones. No significant correlation with skeletal features was observed.*

Keywords *α angle; Displaced maxillary canines; Lindauer sectors; Skeletal relationships.*

Introduction

A frequent problem in clinical orthodontics is the impaction of the maxillary permanent canine, involving approximately 2% of patients seeking orthodontic treatment [Shapira and Kuftinec, 1998; Ericson and Kurol, 1998; Perillo et al., 2012; Laganà et al., 2013; Lucchese at al., 2012]. Maxillary canines with an open apex root, an anomalous intraosseous position prior to the expected time of physiological eruption and an incomplete morphological development, can be defined displaced [Peck et al., 1994; Baccetti et al., 2007). Displaced maxillary canines (DMCs) are classified according to their position in palatal displaced canines (PDCs) and buccal (BDCs). PDC characteristically leads to tooth impaction, while BDC usually results in eruption. DMC is more common in females than in males due to a possible involvement of sexual chromosomes in the etiology of tooth malposition [Peck et al., 1994].

BDC and PDC are considered as different entities. BDC are strongly associated with crowding [Mucedero et al., 2011] and insufficient space in the upper arch [Jacoby, 1983]. Two hypotheses have been proposed to explain the PDC aetiology: the "guidance" hypothesis and the "genetic" one. According to the guidance concept, the dental anomalies, frequently involving lateral incisors, lead to a canine displacement [Litsas and Acar, 2011; Becker et al., 1981; Becker et al., 1984; Brin et al., 1986; Zilberman et al., 1990; Becker et al., 2002; Sacerdoti and Baccetti, 2004]. Otherwise, Peck supported a genetic aetiology of PDC, validated by the concomitant presence of further tooth anomalies and familial occurrence [Peck et al., 1994].

Nevertheless, the correlation of PDC and BDC with craniofacial skeletal features on sagittal (skeletal Class I, II or III) and vertical (normodivergent, hypodivergent or hyperdivergent) planes has been rarely described in the literature.

Thus, the aim of the present study was to analyse the prevalence and the distribution of PDC and BDC in a sample of mixed dentition children, and to investigate the association with sagittal and vertical skeletal relationships.

Materials and methods

Consecutive records of patients who were seeking orthodontic treatment at the Division of Orthodontics, University of Campania "Luigi Vanvitelli", Italy, between January 2013 and January 2014, were collected from the available files in order to be examined. Approval for this retrospective study was granted by the Institutional Review Board of the University of Campania "Luigi Vanvitelli" and the parents of all children involved in the study signed an informed consent to the privacy (Aut.n.9/2013). The inclusion criteria were age: between 7 and 12 years, mixed dentition, cervical vertebral maturation (CVM) stage [Baccetti et al., 2008] between 1 and 2, initial dental casts, intraoral photographs, panoramic, lateral x-ray and periapical x-rays when necessary.

Mixed dentition was defined as a period in which the maxillary canines were unerupted and at least the primary second molars were still present [Lindauer et al., 1992]. The exclusion criteria were craniofacial malformations, cleft lip or palate, history of dental trauma, oral neoformations and other oral cavity pathologies or inadequate records.

For each subject, the following parameters were analysed:

– presence of palatal and/or buccal DMCs;
– sagittal and vertical skeletal relationships.

Initial dental casts and intraoral photographs were used to verify the absence of canines in the upper arch and/or the presence of canine bulges. Panoramic x-rays were used to confirm these data and to classify canines according to the sectors of Lindauer (Fig. 1) and α angle of Power and Short (Fig. 2) [Lindauer et al., 1992; Power and Short, 1993].

Subjects with at least one canine in sectors II, III, IV and/or α angle >31° were included in the DMC group, whereas those with both canines in sectors I and α angle <31° were used as control group (CTR). DMC were divided into PDC and BDC groups, according to the presence of canine bulges and/or the periapical x-rays [Jacobs, 1999; Ericson and Kurol, 1987], which were performed when clinical palpation was not sufficient. Sagittal and vertical skeletal relationships were evaluated using the lateral cephalometric x-ray considering the ANB and SN/GoMe angles. The sagittal skeletal relationship was defined Class I, II or III if ANB was between 0° and 4°, >4°, and <0°, respectively. The vertical skeletal relationship was defined normodivergent, hyperdivergent, and hypodivergent when SN/GoMe angle was between 28° and 36°, >36°, and <28°, respectively [Schindel and Duffy, 2007].

All the measurements were hand-traced, under natural light, using 0.5 mm lead on 0.003 mm matte acetate tracing paper by one investigator (GF). The examiner did not exceed to analyse eight cases per day to avoid eye fatigue and to minimise subjective errors.

Statistical analysis

Means and standard deviations of all measurable variables were calculated for each group. Chi-square tests were performed to compare the prevalence rates of sagittal and vertical skeletal features of each group. P values less than 0.05 were considered significant.

Method error study

Reproducibility of x-ray measurements was estimated by duplicating the determination of all measurements in 20 randomly selected cases and by using the Dahlberg's formula to test the error study.

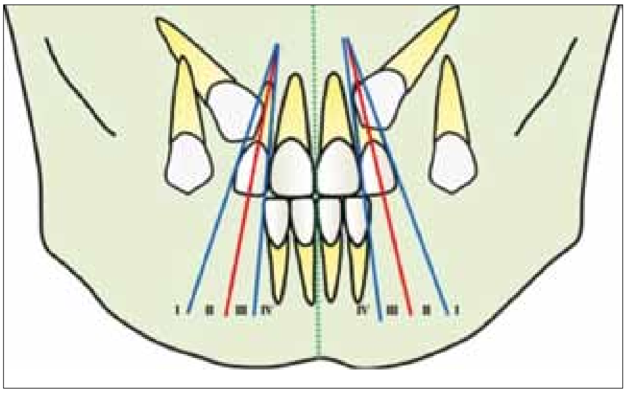

FIG. 1 Sectors of Lindauer.

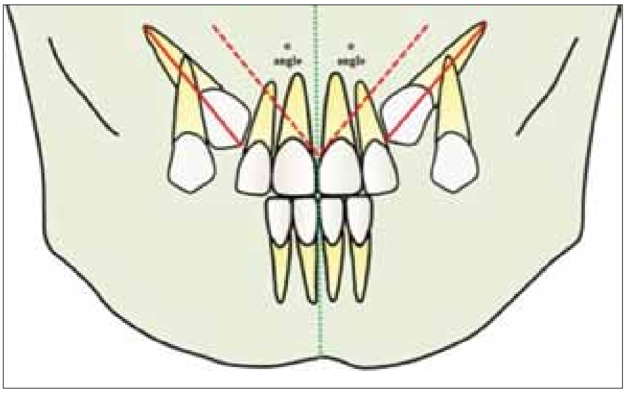

FIG. 2 α angle of Power and Short.

Groups	Total	Male	Female	Age
	n (%)	n (%)	n (%)	μ ± SD
Total	123 (100)	54 (43.9)	69 (56.1)	9.21 ± 1.66
CTR	83 (67.5)	43 (51.8)	40 (48.2)	9.00 ± 1.49
DMC	40 (32.5)	11 (27.5)	29 (72.5)	9.67 ± 1.92

TABLE 1 Characteristics of the samples; CTR (Control Group), DMC (Displaced Maxillary Canines); n=subjects.

Groups	Total	Male	Female	Age
	n (%)	n (%)	n (%)	μ ± SD
Total	40 (100)	11 (27.5)	29 (72.5)	9.67 ± 1.92
CTR	11 (27.5)	3 (27.3)	8 (72.7)	11.81 ± 1.10
DMC	29 (72.5)	8 (27.6)	21 (72.4)	8.87 ± 1.49

TABLE 2 Characteristics of the DMC (Displaced Maxillary Canine) samples; PDC (Palatal Displaced Canine), BDC (Buccal Displaced Canine); n=subjects.

	Unilateral n (%)					Bilateral n (%)						
Sectors	I	II	III	IV	Total	I,I	I,III	II,II	II,III	II, IV	III,III	Total
DMC	4 (14.8)	15 (55.6)	6 (22.2)	2 (7.4)	27	3 (23)	2 (15.4)	5 (38.5)	1 (7.7)	1 (7.7)	1 (7.7)	13
PDC	1 (16.7)	2 (33.3)	1 (16.7)	2 (33.3)	6	1 (20)	0	1 (20)	1 (20)	1 (20)	1 (20)	5
BDC	3 (14.3)	13 (61.9)	5 (23.8)	0	21	2 (25)	2 (25)	4 (50)	0	0	0	8

TABLE 3 Unilateral and bilateral distribution of DMC (Displaced Maxillary Canine), PDC (Palatal Displaced Canine), BDC (Buccal Displaced Canine); n=subjects.

	Sagittal relationship n (%)			Vertical relationship n (%)		
	Cl I	Cl II	Cl III	Normo	Iper	Ipo
CTR	39 (47)	38 (45.8)	6 (7.2)	40 (48.2)	36 (43.4)	7 (8.4)
DMC	23 (57.5)	16 (40)	1 (2.5)	24 (60)	13 (32.5)	3 (7.5)
P	0.649	0.837	0.554	0.604	0.559	0.851

TABLE 4 Prevalence and distribution of sagittal and vertical craniofacial features. CTR (Control Group), DMC (Displaced Maxillary Canines); n=subjects.

	Sagittal relationship n (%)			Vertical relationship n (%)		
	Cl I	Cl II	Cl III	Normo	Iper	Ipo
CTR	39 (47)	38 (45.8)	6 (7.2)	40 (48.2)	36 (43.4)	7 (8.4)
DMC	23 (57.5)	16 (40)	1 (2.5)	24 (60)	13 (32.5)	3 (7.5)
P	0.649	0.837	0.554	0.604	0.559	0.851

TABLE 5 Prevalence and distribution of sagittal and vertical craniofacial features. CTR (Control Group), DMC (Displaced Maxillary Canines); n=subjects.

Results

Records of 150 patients were selected, 27 subjects were excluded for craniofacial malformations, cleft lip or palate, dental trauma, oral neoformations or cysts, other oral cavity pathologies and incomplete or inadequate records. One hundred twentythree patients met the criteria and were included in the study. The characteristics of the sample are reported in Table 1 and 2.

The error study was 0.4°, 0.3° and 0.4° for ANB, SN/GoMe and α angle, respectively. All values are considered very low, unlikely to be clinically significant. Uni- and bilateral distribution of DMCs is shown in Table 3. In DMC, PDC and BDC groups, unilateral-to-bilateral ratio was approximately 2:1, 1:1 and 3:1, respectively. The most common sector for unilateral displacements was "II", whereas the most common combination for bilateral displacements was "II, II". The distribution of sagittal and vertical craniofacial features is shown in Table 4 and 5. No statistically significant differences were found in both vertical and sagittal craniofacial features between DMC and CTR groups as between PDC and BDC groups.

Discussion

The aim of the present study was to analyse the prevalence and the distribution of displaced, either buccal or palatal, maxillary canines, in a sample of consecutive mixed dentition children, and to investigate the association with sagittal and vertical skeletal relationships. According to a previous research study [Schindel and Duffy, 2007], the optimal timing to evaluate DMC is during the early mixed dentition when the canine begins its intraosseous movement into the dental arch. As reported in Table 1 and 2, the prevalence of DMC was 32.52%. Considering the DMC rate, 27.5% were PDC and 72.5% were BDC. These values confirm that BDC is more common than PDC with a ratio of 3:1. The M:F ratio was approximately 1:3 in DMC, PDC and BDC groups, whereas it was 1:1 in controls. This data confirmed that DMC occurs more frequently in females than in males, thus supporting the genetic hypothesis of DMC aetiology [Peck et al., 1994; Sacerdoti and Baccetti, 2004]. In addition, results showed more DMC subjects with unilateral (67.5%) than bilateral (32.5%) displacements (Table 3), as reported in literature [McConell et al., 1996]. The distributions of unilateral (54.5%) and bilateral (45.5%) displacements in PDC were similar, while unilateral displacements in BDC (72.4%) exceeded the value of bilateral (27.5%) according to the literature value [Mucedero et al., 2001]. Moreover, sector II was the most common for both unilateral and bilateral displacements, according to another research study [Sacerdoti and Baccetti, 2004]. Sagittal and vertical skeletal relationships showed the same distribution in DMC and CTR. No statistically significant differences were reported (Table 4). The comparison of skeletal features between PDC and BDC indicated that skeletal Class I occurred more frequently in PDC (81.82%) than in BDC (48.28%), whereas skeletal Class II were less frequent in PDC (18.18%) than in BDC (48.28%). However, no statistically significant differences were found, in agreement with previous studies [Mossey et al., 1994; Basdra et al., 2001; Franchi et al., 1989]. Moreover, normodivergents occurred more frequently in BDC (68.97%) than in PDC (36.36%), hyperdivergents occurred more frequently in PDC (45.46%) than in BDC (27.59%) and hypodivergents occurred more frequently in PDC (18.18%) than in BDC (3.44%). These results did not confirm the existence of significant differences in vertical craniofacial features between BDC and PDC, contrarily to what has been reported by Cernochova [2012].

These data confirmed the difficulty to compare different samples and methods [Perillo et al., 2011a; d'Apuzzo et al., 2013; Perillo et al., 2011b]. A limitation of this study is the use of panoramic x-rays to determine buccal or palatal displaced maxillary canines. Previous research suggested that 2D and 3D images of impacted maxillary canines can produce different diagnoses and treatment plans [Haney et al., 2010]. Moreover, a randomised clinical trial was not performed in this retrospective study because it was unethical to expose patients to CBCT without clinical or radiological reasons [Alqerban et al., 2014]. Finally, multicentric research study should be useful to gather wider samples by applying the same methodologies.

Conclusions

- DMC occurred more often in females than in males
- BDC was more common than PDC
- Unilateral displacements occurred more frequently than bilateral ones
- No statistically significant differences between the groups according to sagittal and vertical skeletal features were found.

References

› Alqerban A, Jacobs R, van Keirsbilck P, Aly M, Swinnen S, Fieuws S, et al. The effect of using CBCT in the diagnosis of canine impaction and its impact on the orthodontic treatment outcome. J Orthodont Sci 2014;3:34-40.
› Baccetti T, Crescini A, Nieri M, Rotundo R, Pini Prato GP. Orthodontic treatment of impacted maxillary canines: An appraisal of prognostic factors. Prog Orthod 2007;8(1):6-15.
› Baccetti T, Franchi L, De Lisa S, Giuntini V. Eruption of the maxillary canines in relation to skeletal maturity. Am J Orthod Dentofacial Orthop 2008;133(5):748-751.
› Basdra EK, Kiokpasoglou MN, Komposch G. Congenital tooth anomalies and malocclusions: a genetic link? Eur J Orthod 2001;23(2):145-151.
› Becker A, Smith P, Behar R. The incidence of anomalous maxillary lateral incisors in relation to palatally-displacedcuspids. Angle Orthod 1981;51(1):24-29.
› Becker A, Zilberman Y, Tsur B. Root Length of lateral incisors adjacent to palatally-displaced maxillary cuspids. Angle Orthod 1984;54(3):218-225.
› Becker A, Sharabi S, Chaushu S. Maxillary tooth size variation in dentitions with palatal canine displacement. Eur J Orthod 2002;24(3):313-318.
› Brin I, Becker A, Shalhav M. Position of maxillary permanent canine in relation to anomalous or missing lateral incisors: a population study. Eur J Orthod 1986;8(1):12-16.
› Cernochova P, Izakovicova-Holla L. Dentoskeletal characteristics in patients with palatally and buccally displaced maxillary permanent canines. Eur J Orthod 2012;34(6):754-761.
› d'Apuzzo F, Fabiani G, Raucci G, De Gregorio F, D'Anna T, Perillo L. Problematiche associate all'inclusione del canino mascellare. Dental Cadmos 2015;2:70-76.
› Ericson S, Kurol J. Radiographic examination of ectopically erupting maxillary canines. Am J Orthod Dentofacial Orthod 1987;91(6):483-492.
› Ericson S, Kurol J. Early treatment of palatally erupting maxillary canines by extraction of the primary canines. Eur J Orthod 1998;10(4):283-295.
› Franchi L, Vichi M, Defraia E, Gigli G. Indagine epidemiologica sulla inclusione dei canini superiori. Proceedings of the 10th S.I.D.O Meeting 1989.
› Haney E, Gansky SA, Lee JS, Johnson E, Maki K, Miller AJ, Huang JC. Comparative analysis of traditional radiographs and cone-beam computed tomography volumetric images in the diagnosis and treatment planning of maxillary impacted canines. Am J Orthod Dentofacial Orthop 2010;137(5):590-597.
› Jacoby H. The etiology of maxillary canine impactions. Am J Orthod 1983;84(2):125-132.
› Jacobs SG. Localization of the unerupted maxillary canine: How to and when to. Am J Orthod Dentofacial Orthop 1999;115(3):314-322.
› Laganà G, Masucci C, Fabi F, Bollero P, Cozza P. Prevalence of malocclusions, oral habits and orthodontic treatment need in a 7- to 15-year-old schoolchildren population in Tirana. Prog Orthod 2013;14:12.
› Lindauer SJ, Rubenstein LK, Hang WM, Andersen WC, Isaacson RJ. Canine impaction identified early with panoramic radiographs. J Am Dent Assoc 1992;123(3):91-97.
› Litsas G, Acar A. A review of early displaced maxillary canines: etiology, diagnosis and interceptive treatment. The Open Dent J 2011;5:39-47.
› Lucchese A, Bertacci A, Chersoni S, Portelli M. Primary enamel permeability: a SEM evaluation in vivo. Eur J Paediatr Dent 2012;13(3):231-235.
› McConell TL, Hoffman DL, Forbes DP, Janzen EK, Weintraub NH. Maxillary canine impaction in patients with transverse maxillary deficiency. ASDC J Dent Chil 1996;63(3):190-195.
› Mossey PA, Campbell HM, Luffingham JK. The palatal canine and the adjacent lateral incisor: a study of a west of Scotland population. Br J Orthod 1994;21(2):169-174.
› Mucedero M, Ricchiuti MR, Cozza P, Baccetti T. Prevalence rate and dentoskeletal features associated with buccally displaced maxillary canines. Eur J Orthod 2001;35(3):305-309.
› Mucedero M, Ricchiuti MR, Cozza P, Baccetti T. Prevalence rate and dentoskeletal features associated with buccally displaced maxillary canines. Eur J Orthod 2011;35(3):305-309.
› Peck S, Peck L, Kataja M. The palatally displaced canine as a dental anomaly of genetic origin. Angle Orthod 1994;64(4):249-256.
› Perillo L, Castaldo M.I, Cannavale R, Longobardi A, Grassia V, Rullo R, Chiodini P. Evaluation of long-term effects in patients treated with Fränkel-2 appliance. Eur J Paediatr Dent 2011a;12(4):261-266.
› Perillo L, Femminella B, Farronato D, Baccetti T, Contardo L, Perinetti G. Do malocclusion and Helkimo Index ≥5 correlate with body posture? J Oral Rehabilit 2011b;38:242-252.
› Perillo L, Padricelli G, Isola G, Femiano F, Chiodini P, Matarese G. Class II malocclusion division 1: a new classification method by cephalometric analysis. Eur J Paediatr Dent 2012;13(3):192-6.
› Power SM, Short MB. An investigation into the response of palatally displaced canines to the removal of deciduous canines and an assessment of factors contributing to favourable eruption. Br J Orthod 1993;20(3):215-223.
› Sacerdoti R, Baccetti T. Dentoskeletal features associated with unilateral or bilateral palatal displacement of maxillary canines. Angle Orthod 2004;74(6):725-732.
› Schindel RH, Duffy SL. Maxillary transverse discrepancies and potentially impacted maxillary canines in mixed-dentition patients. Angle Orthod 2007;77(3):430-435.
› Shapira Y, Kuftinec MM. Early diagnosis and interception of potential maxillary canine impaction. J Am Dent Assoc 1998;129(10):1450-1454.
› Zilberman Y, Cohen B, Becker A. Familial trends in palatal canines, anomalous lateral incisors, and related phenomena. Eur J Orthod 1990;12(2):135-139.