Dentistry
ISSN: 2161-1122

Research Article Open Access

Skeletal, Dentoalveolar and Soft Tissue Parameters in Individuals with Palatal Maxillary Canine Displacement

Wazwaz F[1], Al Maaitah EF[2], Abu Alhaija ES[3]* and Borgan BE[4]

[1]*Master Student, Department of Preventive Dentistry, Faculty of Dentistry, Jordan University of Science and Technology, P.O. Box 3030, Irbid, 22110, Jordan*
[2]*Assistant Professor of Orthodontics, Department of Preventive Dentistry, Faculty of Dentistry, Jordan University of Science and Technology, P.O. Box 3030, Irbid, 22110, Jordan*
[3]*Professor of Orthodontics, Department of Preventive Dentistry, Faculty of Dentistry, Jordan University of Science and Technology, P.O. Box 3030, Irbid, 22110, Jordan*
[4]*Specialist Orthodontist, Private practice, P.O. Box 2414, Amman, 11181, Jordan*

Abstract

Background: Studies reported on the skeletal relationship in subjects with palatally displaced canines were minimal.

Aim: To determine skeletal, dentoalveolar and soft tissue parameters in subjects with palatally displaced canines and to compare them with subjects with normally erupting canines.

Material and Methods: A total of 120 lateral cephalograms for palatally displaced canines subjects were collected (70 females, 50 males; age 17.17 ± 3.09 years). A control sample with no canine displacement matched the study group were included. Lateral cephalograms were traced and measurements were calculated.

Results: Majority of palatally displaced canines subjects (62%) had Class I skeletal and (33%) class II division 2 incisor relationships. Palatally displaced canines subjects had smaller maxillary and mandibular body lengths, smaller Mx-Mn and SN-Mn angles, reduced AFH, increased inter-incisal angle, smaller mandibular anterior and posterior dentoalveolar heights and retrusive upper and lower lips compared with the controls.

Conclusions: Palatally displaced canines occurred mostly in Class I skeletal and class II division 2 incisor relationships with reduced vertical dimensions, short maxilla and mandibular body, small dentoalveolar heights and retruded upper and lower lips.

Keywords: Palatally; Canine; Displacement

Introduction

Displacement or ectopic eruption of the canine was defined as the divergence from the normal path of eruption; the canine can either erupt in an unusual position or become impacted buccally or palatally [1]. The maxillary canine tooth is second to mandibular third molar in its frequency of impaction [2,3]. The reported prevalence for maxillary canine impactions varies from 0.8-2.8% [4]. The displaced canine is placed palatal to the dental arch in 85% of cases and labial/buccal in 15% of cases [5].

Palatally and buccally impacted or displaced canines are considered as two completely different phenomena, where the etiology for one differs from the other [6-8]. Buccally displaced canines is thought to be a form of crowding and results from insufficient space in the upper arch [7]. However, the aetiology of palatally displaced canines (PDCs) is obscure, but probably multifactorial. Several etiological factors have been suggested including arch dimension, mesiodistal width of teeth, tooth morphology and tooth size–arch length relationship, rate of root resorption of deciduous teeth, trauma of the deciduous tooth bud, disturbances in tooth eruption sequence, availability of space in the arch, rotation of tooth buds, premature root closure [9-11].

Kuftinec and Shapira reported that maxillary excess can be associated with PDC [12]. McConnell et al. [13] found an association between PDCs and maxillary transverse deficiency. Langberg and Peck [14] reported no statistically significant difference in either anterior or posterior maxillary arch widths between subjects with PDC and controls.

Studies reported on the skeletal relationship in subjects with PDCs were minimal. It has been reported that majority of subjects with PDCs had Class I skeletal relationship (52%) followed by class II (31%) and class III (17%) skeletal relationships [9]. This may reproduce closely the three sagittal skeletal classes in orthodontic population. However, based on the incisor classification, it was reported that PDCs were more common in Class II division 2 malocclusions [10,15], while others reported that PDCs were more common in subjects with Class I malocclusion [11,16]. Vertically, it has been found that PDCs were associated with hypodivergent vertical measurements [9] and occlusal deep bite in male subjects [11,17].

This retrospective study was conducted to determine the skeletal, dentoalveolar and soft tissue parameters in subjects with PDCs, and to compare them with subjects having normally erupting canines.

Material and Methods

An ethical approval for the conduction of this study was obtained from the Institution of Research Board (IRB)/ XXX University of Science and Technology (XUST).

Records of 3000 patients available in the archive of the Dental Teaching Center of XXX University of Science and Technology were screened by one investigator (F.W.) for the presence of palatal

***Corresponding author:** Elham S Abu Alhaija, Department of Preventive Dentistry, Faculty of Dentistry, Jordan University of Science and Technology, P.O. Box 3030, Irbid, 22110, Jordan, Tel: 00962 2720 1000 ext: 23569; Fax: 00962 27201080; E-mail: elham@just.edu.jo

Received October 21, 2013; **Accepted** December 04, 2013; **Published** December 06, 2013

Citation: Wazwaz F, Al Maaitah EF, Abu Alhaija ES, Borgan BE (2013) Skeletal, Dentoalveolar and Soft Tissue Parameters in Individuals with Palatal Maxillary Canine Displacement. Dentistry 3: 177. doi:10.4172/2161-1122.1000177

displacement of the maxillary canine. Canine was defined as palatally displaced if it was positioned palatal to the line of the arch whether it was impacted or erupted (at least 3 mm). Diagnosis of displacement was made using the subjects' own dental records (intra oral and OPT radiographs, file notes and study casts). Dental records for all subjects were available as part of their comprehensive orthodontic treatment.

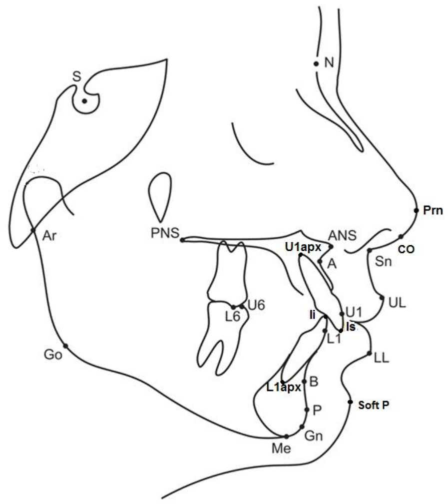

Figure 1: Cephalometric points used in the analysis. sella (S), nasion (N), pronasale (Prn), nasal columella (Co), subnasale (Sn), upper lip (UL), lower lip (LL), soft tissue pogonion (Soft P), A point, B point, anterior nasal spine (ANS), posterior nasal spine (PNS), upper incisor apex (U1apx), lower incisor apex (L1apx), incision superius (Is), incision inferius (Ii), pogonion (P), gnathion (Gn), menton (Me), gonion (Go), articulare (Ar), the most labial point on the crown of the mandibular central incisor (L1), the most labial point on the crown of the maxillary central incisor (U1), the point located on the tip of the mesiobuccal cusp of the maxillary first molar (U6) and the point located on the tip of the mesiobuccal cusp of the mandibular first molar (L6).

A total of 120 lateral cephalograms (LCs) for subjects with PDCs (70 females, 50 males) were collected. Age ranged between 15 and 25 years (average age was 17.17 ± 3.09 years). A control group with no maxillary canine displacement matched the study group by age (average age was 17.34 ± 3.23 years), gender and skeletal relationship (Table 1) (based on the ANB angle) was included. All selected subjects were Caucasians, had no missing teeth, no malformed maxillary lateral incisors and no craniofacial abnormalities that may affect the shape or the size of the craniofacial structures. LCs was taken using an Orthoslice 1000 C (Trophy, Marne La Vallee Cedex 2, France) cephalostat at 64 KV, 16 mA and 0.64 seconds exposure according to the standard technique. The LCs was scanned into digital format using a scanner (Epson Explession 1000XL, Epson A3 Transparency unit, model: EU-88, Power Rating). Images with 360 dpi resolution were obtained. All the images were then compressed in 8-bit JPEG-100 format and imported into the tracing software (Orthalis V4.0 software). Magnification of radiographs was corrected and calibrated according to the magnification factor, using the radiopaque ruler (calibration marker) before tracing. LCs was traced digitally using Orthalis V4.0 software (Software Dental Suite 2003, Diedendorf, France) by the same investigator (F.W.). All measurements were automatically calculated by the tracing software and rounded out to the nearest 0.01. Twenty five cephalometric points were registered yielding 10 angular and 19 linear measurements (Figure 1 and Table 2).

	Palatally displaced canines (PDC)			Control group		
	Females	Males	Total	Females	Males	Total
Class I (ANB 2 -4°)	45 (37%)	29 (25%)	74 (62%)	45 (37%)	29 (25%)	74 (62%)
Class II (ANB>4°)	12 (10%)	9 (7%)	21 (17%)	12 (10%)	9 (7%)	21 (17%)
Class III (ANB<2°)	13 (11%)	12 (10)	25 (21%)	13 (11%)	12 (10)	25 (21%)
	70 (58%)	50 (42%)	120 (100%)	70 (58%)	50 (42%)	120 (100%)

Table 1: Skeletal classification in PDC and control subjects.

Planes and lines	**Skeletal cephalometric measurements**
Mandibular plane Mn: constructed from Go to Me. Maxillary plane Mx: constructed from ANS to PNS. SN: line constructed from S to N. AP: line constructed from A to P. L1axis: line constructed from Ii to L1apx. U1axis: line constructed from Is to U1apx. Ricketts E-plane: line constructed from Prn to soft P.	SNA: SN to NA angle. SNB: SN to NB angle. ANB: NA to NB angle. Mx.Mn: mandibular plane to maxillary plane angle. SN.Mn: SN to mandibular plane angle. Gonial angle: angle between Ar, Go and Me points. Go-Gn: distance between Go and Gn. Ar-Go: distance between Ar and Go. Ar-Gn: distance between Ar and Gn. ANS-PNS: distance between ANS and PNS. UAFH (upper anterior face height): distance from N to ANS. LAFH (lower anterior face height): distance from ANS to Me. TAFH (total anterior face height): distance from N to Me. PFH (total posterior face height): distance from S to Go. Wits appraisal: based on a perpendicular projection of points A and B to the bisecting plane of Mx.Mn planes angle along which the linear difference between these points is measured.
Dentoalveolar cephalometric measurements	**Soft-tissue cephalometric measurements**
U1axis.Mx: angle between U1axis and maxillary plane. Is-Mx: perpendicular distance between Is and maxillary plane. U6-Mx: perpendicular distance between U6 and maxillary plane. L1axis.Mn: angle between L1axis and mandibular plane. Ii-Mn: perpendicular distance between Ii and mandibular plane. L6-Mn: perpendicular distance between L6 and mandibular plane. Ii-AP: perpendicular distance between Ii and AP line. Overbite: vertical distance between Is and Ii. Overjet: horizontal distance between Is and Ii. Interincisal angle: angle between U1axis and L1axis.	Nasolabial angle: angle between Co, Sn and UL points. UL- E plane: perpendicular distance between upper lip and E-plane. LL- E plane: perpendicular distance between lower lip and E-plane.

Table 2: Definitions of the lines, planes, and measurements used in the analysis.

Statistical analysis

Data analysis was carried out using the Statistical Package for Social Science (SPSS) computer software (SPSS 15.0, SPSS Inc., Chicago, USA). Means and Standard deviations were calculated for all the measured variables. Independent t-test was used to detect gender differences and differences between the two groups. The P value was predetermined to 0.05 as the level of significance.

Error of the method

Thirty LCs were selected randomly and retraced by the same examiner after 1 month interval. Dahlberg's formula [18] was used to calculate the standard error of the method. Error ranged from 0.37° for ANB angle to 0.90° for UI/Max angle and from 0.39 mm for overjet to 0.92 mm for TAFH. Houston coefficient of reliability [19] was calculated and was above 90% for all measured variables.

Results

PDC group

Type of malocclusion: Table 1 shows distribution of subjects with PDCs according to their skeletal relationships. Seventy four subjects (62%) had Class I skeletal relationship, 21 (17%) subjects had Class II and 25 (21%) subjects had Class III. According to incisor classification,

	Female (PDC) Mean (SD)	Male (PDC) Mean (SD)	Mean Difference	Significance (P value)
Skeletal				
SNA (°)	81.94 (3.57)	82.20 (3.44)	-0.25	0.678
SNB (°)	78.67 (3.68)	79.65 (3.59)	-0.98	0.120
ANB (°)	3.27 (2.09)	2.54 (2.44)	0.73	0.054
Wits (mm)	-3.52 (3.08)	-4.13 (3.96)	-.61	0.291
Mx.Mnd (°)	25.88 (5.36)	26.38 (5.80)	-0.50	0.592
SN.Mnd (°)	34.55 (5.68)	33.39 (5.80)	1.16	0.239
UAFH (mm)	48.83 (2.99)	49.46 (3.66)	-0.63	0.251
LAFH (mm)	60.49 (4.13)	64.15 (5.29)	-3.66	0.000***
TAFH (mm)	107.43 (5.38)	111.93 (7.19)	-4.50	0.000***
PFH (mm)	70.73 (5.07)	75.33 (6.00)	-4.59	0.000***
Ar-Go (mm)	43.53 (4.28)	46.83 (4.53)	-3.30	0.000***
Go-Gn (mm)	66.76 (4.65)	69.02 (5.58)	-2.26	0.008**
Ar-Gn (mm)	98.77 (5.53)	103.57 (7.19)	-4.80	0.000***
Ar.Go.Me (°)	128.27 (5.50)	128.42 (5.81)	-0.15	0.875
ANS-PNS (mm)	48.10 (2.98)	49.28 (3.55)	-1.18	0.030*
Dentoalveolar				
UI/Mx (°)	109.93 (6.99)	109.60 (6.81)	0.33	0.785
LI/Mnd (°)	92.93 (7.17)	92.91 (7.36)	0.02	0.989
UI/LI (°)	131.27 (10.69)	131.11 (9.38)	0.16	0.928
Is-Mx (mm)	26.18 (2.50)	27.09 (2.72)	-0.91	0.041*
U6-Mx(mm)	20.11 (2.05)	21.11 (2.42)	-1.00	0.008**
Ii-Mn (mm)	37.20 (2.49)	39.54 (2.95)	-2.34	0.000***
L6-Mn (mm)	27.11 (2.47)	29.46 (3.07)	-2.35	0.000***
LI-APog(mm)	2.31 (2.46)	2.80 (2.86)	-0.49	0.268
O.J (mm)	3.04 (1.87)	2.41 (2.06)	0.63	0.060
O.Bite (mm)	2.73 (1.89)	2.61 (2.24)	0.118	0.730
Soft tissue				
Co.Sn.UL (°)	100.01 (10.76)	97.87 (10.04)	2.14	0.241
UL.E-Plane (mm)	-3.49 (2.49)	-3.09 (2.58)	-0.40	0.349
LL-E-Plane (mm)	-1.11 (2.29)	-0.57 (2.97)	-0.54	0.204

Table 3: Means, SDs, mean differences and p values for the skeletal, dental and soft tissue variables for female and male subjects having palatally displaced canine (PDC).

	PDC (Female) Mean (SD)	Control (Female)	Mean Difference Mean (SD)	Significance (P value)
Skeletal				
SNA (°)	82.07 (3.38)	81.43 (3.83)	0.64	0.280
SNB (°)	78.90 (3.45)	77.65 (3.41)	1.25	0.027*
ANB (°)	3.16 (1.99)	3.78 (1.79)	-0.62	0.045*
Wits (mm)	-3.77 (3.13)	-3.28 (2.63)	-0.49	0.301
Mx.Mnd (°)	25.56 (5.08)	27.66 (5.48)	-2.10	0.015*
SN.Mn (°)	34.33 (5.61)	36.69 (5.64)	-2.36	0.011*
UAFH (mm)	49.05 (2.97)	50.03 (2.75)	-0.98	0.038*
LAFH (mm)	60.99 (3.83)	63.35 (4.74)	-2.36	0.001**
TAFH (mm)	108.23 (4.91)	111.46 (6.19)	-3.23	0.000***
PFH (mm)	71.46 (4.95)	70.82 (4.96)	0.64	0.429
Ar-Go (mm)	44.26 (3.98)	43.26 (3.97)	1.00	0.127
Go-Gn (mm)	67.64 (4.51)	69.90 (4.07)	-2.26	0.002**
Ar-Gn (mm)	99.88 (5.00)	101.40 (5.28)	-1.52	0.072
Ar.Go.Me (°)	127.49 (5.48)	128.04 (5.39)	-0.55	0.535
ANS-PNS (mm)	48.48 (2.91)	49.66 (2.45)	-1.18	0.009**
Dentoalveolar				
UI/Mx (°)	110.29 (6.91)	111.73 (7.27)	-1.44	0.215
LI/Mnd (°)	93.00 (7.68)	94.56 (7.22)	-1.56	0.204
UI/LI (°)	131.14 (11.33)	126.04 (12.08)	5.10	0.008**
Is-Mx (mm)	26.36 (2.42)	26.88 (2.48)	-0.52	0.191
U6-Mx(mm)	20.58 (1.84)	20.88 (2.19)	-0.30	0.361
Ii-Mn (mm)	37.43 (2.51)	39.25 (2.55)	-1.82	0.000***
L6-Mn (mm)	27.57 (2.49)	28.94 (2.38)	-1.37	0.001**
LI-APog(mm)	2.39 (2.66)	3.31 (2.38)	-0.92	0.029*
O.J (mm)	3.06 (1.50)	3.35 (1.81)	-0.29	0.276
O.Bite (mm)	2.52 (1.89)	2.47 (1.83)	0.05	0.861
Soft tissue				
Co.Sn.UL (°)	99.02 (10.48)	96.89 (9.49)	2.13	0.196
UL.E-Plane (mm)	-3.86 (2.56)	-2.65 (2.05)	-1.21	0.002**
LL-E-Plane (mm)	-1.30 (2.34)	0.18 (2.79)	-1.47	0.001**

*P<0.05, **P<0.01, ***P<0.001

Table 4: Means, SDs, mean differences and p values for the skeletal, dental and soft tissue variables for the palatally displaced canine (PDC) group compared with the control in female subjects.

40 (33 %) subjects had class II division 2 malocclusion, 30 (25%) subjects had class I, 26 (22%) subjects had class III and 24 (20 %) subjects had class II division 1 malocclusion. Male to female ratio of PDC in our selected sample was 1:1.4.

Gender differences: Table 3 shows the means, standard deviation (SD), mean differences and p values for the skeletal, dental and soft tissue variables for PDC subjects according to gender.

Gender differences were detected in mandibular body (P<0.01), mandibular lengths (P<0.001), maxillary length (P<0.05), TAFH, LAFH, PFH and ramal length (P<0.001) and maxillary and mandibular anterior (Is-Mx and Ii-Mn; P<0.05 and P<0.01, respectively) and posterior (U6-Mx and L6-Mn, P<0.001) dentoalveolar heights.

PDCs vs. control group: Tables 4-6 shows the means, SDs, mean differences and p values for the skeletal, dental and soft tissue variables for PDC and control groups according to gender.

Skeletal parameters

Total group: Antero-posteriorly, subjects with PDCs had smaller maxillary (ANS-PNS) and mandibular body (Go-Gn) lengths compared

Citation: Wazwaz F, Al Maaitah EF, Abu Alhaija ES, Borgan BE (2013) Skeletal, Dentoalveolar and Soft Tissue Parameters in Individuals with Palatal Maxillary Canine Displacement. Dentistry 3: 177. doi:10.4172/2161-1122.1000177

	PDC (Male) Mean (SD)	Control (Male) Mean (SD)	Mean Difference	Significance (P value)
Skeletal				
SNA (°)	82.04 (3.57)	81.48 (3.11)	0.56	0.580
SNB (°)	79.75 (3.32)	78.12 (2.78)	1.63	0.083
ANB (°)	2.29 (2.50)	3.36 (2.13)	-1.07	0.131
Wits (mm)	-4.50 (4.10)	-2.33 (3.25)	-2.17	0.058
Mx.Mnd (°)	26.05 (6.06)	25,94 (5.83)	0.11	0.950
SN.Mnd (°)	33.18 (5.85)	33.83 (5.46)	-0.65	0.697
UAFH (mm)	49.97 (3.73)	53.22 (3.25)	-3.25	0.003**
LAFH (mm)	64.91 (5.10)	66.83 (4.20)	-1.92	0.177
TAFH (mm)	113.38 (7.19)	118.50 (5.48)	-5.12	0.011*
PFH (mm)	76.59 (6.18)	78.89 (5.81)	-2.30	0.198
Ar-Go (mm)	47.94 (4.38)	48.00 (6.17)	-0.06	0.968
Go-Gn (mm)	69.94 (5.62)	73.50 (5.69)	-3.56	0.035*
Ar-Gn (mm)	105.26 (7.34)	107.50 (8.10)	-2.24	0.318
Ar.Go.Me (°)	128.19 (5.90)	126.03 (7.00)	2.16	0.244
ANS-PNS (mm)	49.56 (3.68)	52.83 (3.67)	-3.27	0.004**
Dentoalveolar				
UI/Mx (°)	109.93 (6.24)	108.65 (5.78)	1.28	0.472
LI/Mnd (°)	91.76 (7.18)	93.34 (8.25)	-1.58	0.476
UI/LI (°)	132.25 (8.16)	132.07 (9.58)	0.18	0.941
Is-Mx (mm)	27.24 (2.67)	28.89 (2.59)	-1.65	0.037*
U6-Mx(mm)	21.41 (2.45)	22.33 (3.09)	-0.91	0.244
Ii-Mn (mm)	39.94 (3.05)	40.56 (2.48)	-0.62	0.466
L6-Mn (mm)	29.91 (3.19)	30.22 (2.67)	-0.31	0.726
LI-APog(mm)	2.47 (2.40)	1.17 (2.06)	1.30	0.057
O.J (mm)	2.44 (2.12)	3.28 (1.49)	-0.84	0.143
O.Bite (mm)	2.47 (2.30)	3.28 (1.99)	00.81	0.214
Soft tissue				
Co.Sn.UL (°)	97.11 (9.55)	100.89 (9.76)	-3.78	0.185
UL.E-Plane (mm)	-3.44 (2.67)	-3.22 (2.13)	-0.219	0.765
LL-E-Plane (mm)	-0.91 (2.95)	-1.33 (2.57)	0.42	0.611

*P<0.05, **P<0.01, ***P<0.001

Table 5: Means, SDs, mean differences and p values for the skeletal, dental and soft tissue variables for the palatally displaced canine group compared with the control in male subjects.

with the controls (P<0.001). Vertically, they had smaller Mx-Mn planes angle (P<0.05), smaller SN-Mn planes angle (P<0.01), reduced anterior face heights (UAFH and LAFH) compared with the controls (P<0.01 and P<0.001, respectively).

Figure 2 shows skeletal variables that were significantly different between PDC and control groups.

Females: Antero-posteriorly, females with PDCs had smaller maxillary (ANS-PNS) and mandibular body (Go-Gn) lengths compared with the controls (P<0.01).

Vertically, they had smaller Mx-Mn planes angle (P<0.05), smaller SN-Mn planes angle (P<0.05), reduced anterior face heights (UAFH, LAFH and TAFH) compared with the controls (P<0.05, P<0.001, P<0.001, respectively).

Males: Antero-posteriorly, males with PDCs had smaller maxillary (ANS-PNS; P<0.01) and mandibular body (Go-Gn; P<0.05) lengths compared with the controls vertically, PDC male subjects had smaller UAFH (P<0.01) and TAFH (P<0.05) compared with males in the control group.

Dentoalveolar parameters

Total: Subjects with PDCs had increased inter-incisal angle (UI/LI; P<0.01), smaller mandibular anterior (Ii-Mn; P<0.001) and posterior (L6-Mn; P<0.05) dentoalveolar heights compared with the control group.

Figure 3 shows the dentoalveolar variables that were significantly different between PDC and control groups.

Females: Female subjects with PDCs had increased inter-incisal

	PDC Mean (SD)	Control Mean (SD)	Mean Difference	Significance (P value)
Skeletal				
SNA (°)	82.06 (3.42)	81.44 (3.67)	0.62	0.220
SNB (°)	79.15 (3.42)	77.75 (3.28)	1.40	0.004**
ANB (°)	2.91 (2.18)	3.69 (1.86)	-0.78	0.008**
Wits (mm)	-3.98 (3.44)	-3.08 (2.78)	-0.90	0.047*
Mx.Mnd (°)	25.70 (5.36)	27.30 (5.56)	-1.60	0.039*
SN.Mnd (°)	33.99 (5.68)	36.09 (5.69)	-2.10	0.010*
UAFH (mm)	49.31 (3.22)	50.70 (3.12)	-1.38	0.002**
LAFH (mm)	62.12 (4.58)	64.08 (4.83)	-1.96	0.003**
TAFH (mm)	109.71 (6.10)	112.93 (6.67)	-3.22	0.000***
PFH (mm)	72.94 (5.80)	72.51 (6.08)	0.43	0.610
Ar-Go (mm)	45.32 (4.41)	44.26 (4.88)	1.06	0.105
Go-Gn (mm)	68.31 (4.95)	70.65 (4.66)	-2.34	0.001**
Ar-Gn (mm)	101.43 (6.24)	102.67 (6.43)	-1.24	0.167
Ar.Go.Me (°)	127.69 (5.59)	127.62 (5.78)	0.07	0.928
ANS-PNS (mm)	48.79 (3.17)	50.33 (3.05)	-1.54	0.001**
Dentoalveolar				
UI/Mx (°)	110.19 (6.70)	111.09 (7.07)	-0.90	0.358
LI/Mnd (°)	92.64 (7.53)	94.30 (7.41)	-1.66	0.120
UI/LI (°)	131.46 (10.50)	127.30 (11.81)	4.16	0.009*
Is-Mx (mm)	26.61 (2.52)	27.30 (2.62)	-0.69	0.058
U6-Mx(mm)	20.82 (2.06)	21.19 (2.46)	-0.36	0.252
Ii-Mn (mm)	38.15 (2.90)	39.52 (2.58)	-1.37	0.001**
L6-Mn (mm)	28.25 (2.90)	29.21 (2.48)	-0.96	0.014*
LI-APog(mm)	2.42 (2.58)	2.86 (2.47)	-0.44	0.217
O.J (mm)	2.88 (1.72)	3.34 (1.74)	-0.46	0.064
O.Bite (mm)	2.51 (2.01)	2.64 (1.89)	-0.13	0.637
Soft tissue				
Co.Sn.UL (°)	98.47 (10.22)	97.73 (9.63)	0.74	0.600
UL.E-Plane (mm)	-3.74 (2.59)	-2.77 (2.07)	-0.97	0.005**
LL-E-Plane (mm)	-1.19 (2.52)	-0.14 (2.80)	-1.05	0.006**

*P<0.05, **P<0.01, ***P<0.001

Table 6: Means, SDs, mean differences and p values for the skeletal, dental and soft tissue variables for the palatally displaced canine (PDC) group compared with the control.

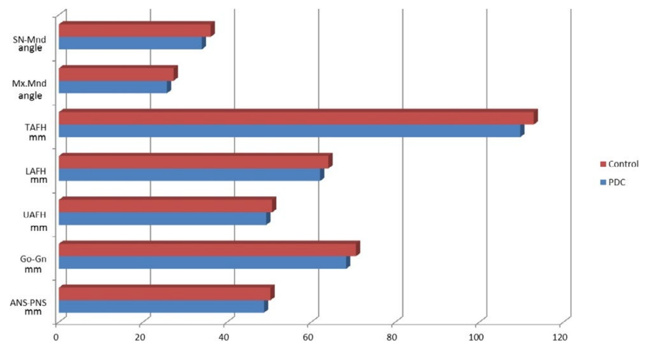

Figure 2: Significantly different skeletal variables in PDC and control groups.

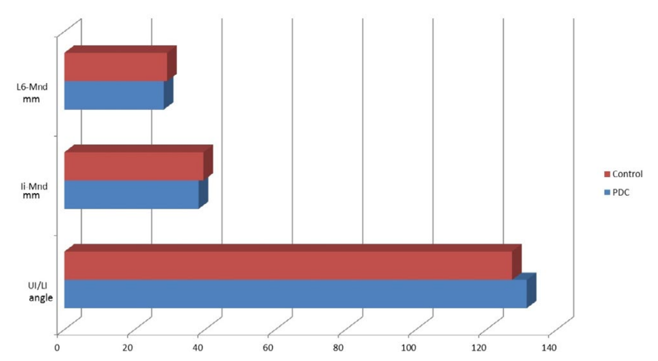

Figure 3: Significantly different dentoalveolar variables in PDC and control groups.

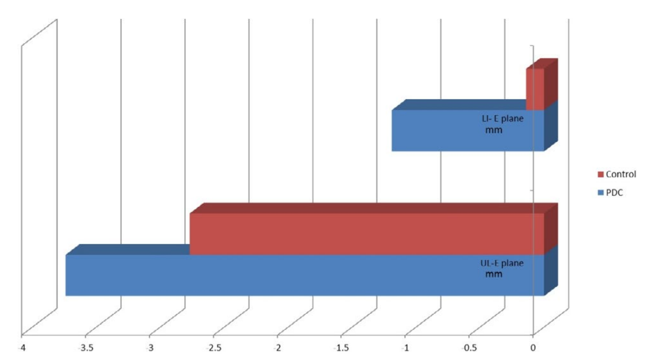

Figure 4: Significantly different soft tissue variables in PDC and control groups.

angle (UI/LI; P<0.01), smaller mandibular anterior (Ii-Mn; P<0.001) and posterior (L6-Mn; P<0.001) dentoalveolar heights and retrusive lower incisors relative to A-Pog line (P<0.05) compared with the control group.

Males: Maxillary anterior dentoalveolar height (Is-Mx) was significantly smaller in males with PDC compared with those in the control group (P<0.05)

Soft tissue parameters

Total sample: Subjects with PDCs had retrusive upper and lower lips relative to Ricketts E-plane compared with the control group (P<0.01).

Figure 4 shows the soft tissue variables that were significantly different between PDC and control groups.

Females: Female subjects with PDCs had retrusive upper and lower lips relative to Ricketts E-plane compared with the control group (P<0.01).

Males: No significant differences in soft tissue measurements were detected between males with PDC and those in the control group.

Discussion

This study was carried out to investigate the skeletal, dentoalveolar and soft tissue features associated with maxillary PDCs using lateral cephalometric analysis.

The study and the control groups were matched by age and gender to avoid any influence of age and gender differences on the measurements of the craniofacial structures.

Lateral cephalograms were analyzed using computer software. It has been found that digital cephalometric analysis can be reliably chosen as a routine diagnostic tool [20].

In this study, male: female ratio was 1:1.4 which agrees with the unequal distribution between males and females for PDCs reported by others [8,21-23]. This may suggest a genetic component in the etiology of this tooth displacement with a possible involvement of the sex chromosomes.

The results of the present study showed that PDCs were found most frequently in subjects with Class I skeletal relationship which was in agreement with another reported study [9]. Again this may represent the normal distribution of the three skeletal classes in orthodontic population. Also our study showed that PDC was more frequent in class II division 2 incisor relationships which also was reported in other studies before [10,15]. This supports the idea that incisor relationship may not correlate well with the underlying skeletal relationship.

In this study, maxillary length was smaller in PDC group compared with the controls. Whether this is a cause for canine displacement or an effect it is not clear yet. The finding of this study was in disagreement with that reported by Larsen et al. [24] who found no significant difference in maxillary length (ANS-PNS) between subjects with maxillary canine displacement and the control subjects. This disagreement may be due to the inclusion of both PDCs and buccally displaced canines in their study. Also, they used a relatively small sample size (69 patients) of adolescent (average age was 13 years) not adult subjects.

Mandibular body length (Go-Gn) was significantly smaller in PDC subjects compared with the controls in this study. This may be expected since PDC subjects tend to have class I skeletal relationship and they were found to have reduced maxillary length.

In this study, vertical linear and angular measurements were reduced in subjects with PDCs. This was in agreement with another study [9] that revealed a significant association between vertical craniofacial features and PDCs; the prevalence rate for hypodivergent cases in subjects with PDCs was three times greater than in control subjects. Also, this was in agreement with Larsen et al. [24] who concluded that the size of the maxillary complex in patients with maxillary canine displacement was significantly smaller vertically.

Subjects with PDCs were found to have significantly increased inter incisal angle (UI/LI) than controls, although over bite was not statistically significantly different. This may be explained by the fact that PDCs were found more in Class II division 2 incisors [10,15] in which inter incisal angle usually tend to be increased.

In this study, maxillary anterior and posterior dentoalveolar heights were reduced in PDC subjects. This was in disagreement with Anic-Milosevic et al. [11] who found that there was no statistically significant difference between the subjects with PDCs and the control group with regard to palatal height. However, the way they used to assess palatal height was different from what was used in this study to assess the dentoalveolar height. They used dental casts and measured perpendicular distance from a connecting line between the midpoints of the fissures of both upper molars to the surface of the palate, and by using dental casts they included soft tissues in their measurements which may have affected their results.

To our knowledge, this was the first study to look at the soft tissue parameters in subjects with PDCs. Upper and lower lips were significantly retruded relative to the Ricketts E-plane. These soft tissue findings may be explained by the presence of short maxilla and mandible where upper and lower lips will follow the underlying hard tissues.

Conclusions

1. Most subjects (62%) with PDCs had Class I skeletal relationship and (33%) class II division 2 incisor relationship.
2. Subjects with PDCs had reduced vertical dimensions, short maxilla, short mandibular body, small dentoalveolar heights, increased inter-incisal angle and retruded upper and lower lips.

Acknowledgement

The study was supported by grant number 107/2010 from the Deanship of Research/XXX University of Science and Technology.

References

1. Chaushu S, Bongart M, Aksoy A, Ben-Bassat Y, Becker A (2009) Buccal ectopia of maxillary canines with no crowding. Am J Orthod Dentofacial Orthop 136: 218-223.
2. McSherry P, Richardson A (1999) Ectopic eruption of the maxillary canine quantified in three dimensions on cephalometric radiographs between the ages of 5 and 15 years. Eur J Orthod 21: 41-48.
3. Sambataro S, Baccetti T, Franchi L, Antonini F (2005) Early predictive variables for upper canine impaction as derived from posteroanterior cephalograms. Angle Orthod 75: 28-34.
4. Shah R, Boyd M, Vakil T (1978) Studies of permanent tooth anomalies in 7886 Canadian individuals. I: impacted teeth. Dent J 44: 262-264.
5. Ericson S, Kurol J (1987) Radiographic examination of ectopically erupting maxillary canines. Am J Orthod Dentofacial Orthop 91: 483-492.
6. Thilander B, Jakobsson S (1968) Local factors in impaction of maxillary canines. In: Acta Odontol Scand 26: 145-168.
7. Jacoby H (1983) The etiology of maxillary canine impactions. Am J Orthod 84: 125-132.
8. Oliver R, Mannion J, Robinson J (1989) Morphology of the lateral incisor in cases of unilateral impaction of the maxillary canine. Br J Orthod 19: 9-16.
9. Sacerdoti R, Baccetti T (2004) Dentoskeletal Features Associated with Unilateral or Bilateral Palatal Displacement of Maxillary Canines. Angle Orthod 74: 725-732.
10. Al-Nimri K, Gharaibeh T (2005) Space conditions and dental and occlusal features in patients with palatally impacted maxillary canines: an aetiological study. Eur J Orthod 27: 461-465.
11. Anic-Milosevic S, Varga S, Mestrovic S, Lapter-Varga M, Slaj M (2009) Dental and occlusal features in patients with palatally displaced maxillary canines. Eur J Orthod 31: 367-373.
12. Kuftinec M, Shapira Y (1995) The impacted maxillary canine: I. Review of concepts. ASDC J Dent Child 62: 317-324.
13. McConnell TL, Hoffman DL, Forbes DP, Jensen EK, Wientraub NH (1996) Maxillary canine impaction in patients with transverse maxillary deficiency. ASDC J Dent Child 63: 190-195.
14. Langberg BJ, Peck S (2000) Tooth-size reduction associated with occurrence of palatal displacement of canines. Angle Orthod 70: 126-128.
15. Basdra E, Kiokpasoglou M, Stellzig A (2000) The Class II division 2 craniofacial type is associated with numerous congenital tooth anomalies. Eur J Orthod 22: 529-535.
16. Brin I, Becker A, Shalhav M (1986) Position of the maxillary permanent canine in relation to anomalous or missing lateral incisors: a population study. Eur J Orthod 8: 12-16.
17. Leifert S, Jonas E (2003) Dental anomalies as a microsymptom of palatal canine displacement. J Orofac Orthop 64: 108-120.
18. Dahlberg G (1940) Statistical methods for medical and biological students. Interscience Publications, New York.
19. Houston W (1983) The analysis of errors in orthodontic measurements. Am J Orthod 83: 382-390.
20. Santoro M, Jarjoura K, Cangialosi T (2006) Accuracy of digital and analogue cephalometric measurements assessed with the sandwich technique. Am J Orthod Dentofacial Orthop 129: 345-351.
21. Dachi S, Howell F (1961) A survey of 3,874 routine full-mouth radiographs. Oral Surg Oral Med Oral Pathol 14: 1165-1169.
22. Becker A, Smith P, Behar R (1981) The incidence of anomalous lateral incisors in relation to palatally displaced cuspid. Angle Orthod 51: 24-29.
23. Bishara S (1992) Impacted maxillary canines: A review. Am J Orthod Dentofacial Orthop 101: 159-171.
24. Larsen H, Sorensen H, Artmann L, Christensen I, Kjaer I (2010) Sagittal, vertical and transversal dimensions of the maxillary complex in patients with ectopic maxillary canines. Orthod Craniofac Res 13: 34-39.