Original Article

The effect of displaced canine on the dentoskeletal and soft tissue development of the face: A cephalometric study

ABSTRACT

Introduction: To analyze the skeletal features of patients with maxillary canine impaction.

Materials and Methods: Pretreatment lateral cephalograms of 30 patients in buccally displaced canine group (BDCG), 15 in palatally displaced canine group (PDCG), 30 in impacted canine group (ICG), and 50 in control reference sample (control group [CG]) were used to analyze the selected dentoskeletal characteristics. One-way analysis of variance was used to identify the differences in angles among the four groups (BDCG, PDCG, ICG, and CG). The differences in the relative distribution among the groups were tested by Pearson's Chi-square test. Independent samples *t*-test was used to test the significance of differences between the two groups.

Results: In BDCG, retrognathic maxilla, tip up maxilla, retrognathic mandible, skeletal Class II, and horizontal growth pattern were the significant factors. In PDCG, skeletal Class II and hypodivergent were significant factors. In ICG, retrognathic maxilla, retrognathic mandible, hypodivergent relationships are poorly significant factors. The nasolabial angle and Steiner's S line were insignificant in all groups except the ICG where acute nasolabial angle is poorly significant.

Conclusion: When compared to controls, canine impaction(s) revealed a trend toward retrognathic maxilla, retrognathic mandible, skeletal Class II, and hypodivergent skeletal relationship.

Keywords: Buccally displaced canine group, impacted canine group, palatally displaced canine group

INTRODUCTION

The maxillary permanent canines act as the cornerstone of occlusion and play a key role in smile designing. Any morphological defect or eruption anomaly, affecting the maxillary permanent canine, has a negative impact on the smile and facial esthetics of the individual.[1-3] Impaction is defined as a cessation of eruption of a tooth caused by a physical barrier in the eruption path or "the abnormal position of the tooth."[4] The tooth impaction is the infraosseous position of the tooth after the expected time of eruption, whereas the anomalous infraosseous position of the canine before the expected time of eruption is defined as a displacement.[5] Maxillary canines are among the last teeth to develop and have the longest period of development. They also have the longest and most devious path of eruption from the formation point lateral of the pisiform fossa to the final position in the dental arch.[6] Permanent maxillary canines are the second most frequently impacted teeth; the prevalence of their impaction is 1%–2% in the general population. This makes the maxillary canine the second most commonly impacted tooth, after third molars.[7-9] Nearly 85% of impacted maxillary permanent cuspids are palatal impactions, and 15% are labial impactions.[10-12] The prevalence of impaction

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Access this article online	
	Quick Response Code
Website: www.orthodrehab.org	
DOI: 10.4103/ijor.ijor_32_17	

How to cite this article: Singh S, Batham PR, Garg A, Virang B, Pereira Kalia UD. The effect of displaced canine on the dentoskeletal and soft tissue development of the face: A cephalometric study. Int J Orthod Rehabil 2018;9:14-22.

appears to be higher in females compared to males, with the reported ratio ranging from 1.3:1 to 3.2:1.[13] Palatally erupting or impacted maxillary canines occur twice as often in females than males, have a high family association, and are 5 times more common in Caucasians than Asians. It is not unusual for maxillary canine impaction to occur bilaterally, although unilateral ectopic eruptions are more frequent.[14] Individuals with canine impactions demonstrated profound maxillary deficiency located in anterior portion of the dental arch. No significant difference in arch form was noted.[15] Studies showed that palatally displaced canines show prognathic maxilla, a significant skeletal Class I facial profile with retroclination of maxillary central incisors and hypodivergent relationship whereas buccally displaced canine shows retrognathic maxilla, skeletal Class III facial profile with retroclination of maxillary incisors.[16] The 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 reduced upper and lower lips.[17] There are many literatures available on diagnosis, prevalence, frequency, etiology, and associated developmental anomalies and maxillary transverse discrepancy of canine impaction. There are limited literatures found on dentoskeletal morphology of hard and soft tissue development of face of buccally displaced canine group (BDCG), palatally displaced canine group (PDCG), and impacted canine group (ICG) together. Besides there are limited studies available for this orthodontically important anomaly, the results are likely to yield clinically useful information about the risk factors, early diagnosis, and eventual treatment planning of maxillary permanent displaced canines.

The purpose of this study is to evaluate the effect of displaced canine on the dentoskeletal and soft tissue development of face of BDCG, PDCG, and ICG using cephalometric parameters.

MATERIALS AND METHODS

A cross-sectional clinical study was designed and conducted obtaining the approval of the Institutional Ethics Committee at the Department of Orthodontics and Dentofacial Orthopedics. Patients of 14–28 years' age group were examined clinically for displaced permanent canine, i.e., buccally and palatally impacted. For patients who have buccally and palatally displaced permanent canines, a lateral cephalogram was taken, and for clinically missing permanent canine cases, an orthopantomograph was taken to determine the type of impaction, i.e., unilateral and bilateral impaction or for missing teeth. Patients with a history of trauma or extraction of any primary or permanent teeth, orofacial clefts or any hereditary, and syndromic or systemic manifestations were excluded from the study.

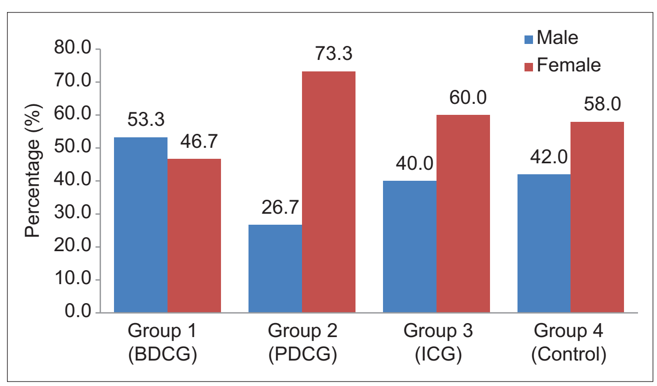
The lateral cephalograms of each of the 50 controls and 75 displaced canine cases were hand traced with a 0.3 mm pencil on a ultrathin 0.003″ transparent matte acetate transparent sheet. 75 All the cephalometric radiographs were evaluated on a masked, illuminated viewbox in a room with reduced lighting and were measured manually. The cephalometric measurements were performed by the same investigator [Graphs 1 and 2].

The cephalometric parameters evaluated to estimate the craniofacial skeletal relationship were as follows: sagittal parameters: sella-nasion-A point angle (SNA), sella-nasion-B point angle (SNB), A point-nasion-B point angle (ANB), upper incisor-sella-nasion (UI/SN); whereas vertical parameters: sella-nasion, gonion-gnathion plane angle (SN ^ GoGn); sella-nasion-anterior nasal spine-posterior nasal spine plane angle (SN ^ ANS-PNS); anterior nasal spine-posterior nasal spine plane-gonion-gnathion plane angle (ANS-PNS ^ GoGn) and posterior facial height (sella-gonion), anterior facial height (nasion-menton) ratio (PFH/AFH) of Jaraback, to evaluate the craniofacial skeletal divergence.

Cephalometric parameters evaluated to estimate the craniofacial soft tissue relationship were Nasolabial angle (Cm-Sn-Ls degree) and S line of Steiner (line extending from the soft tissue contour of the chin to the middle of S formed by the lower border of the nose) used to evaluate craniofacial soft tissue divergence [Table 1].

Statistical analysis

Results on continuous measurements presented on mean ± standard deviation with 95%. The intra- and inter-group comparisons were used to identify the significance



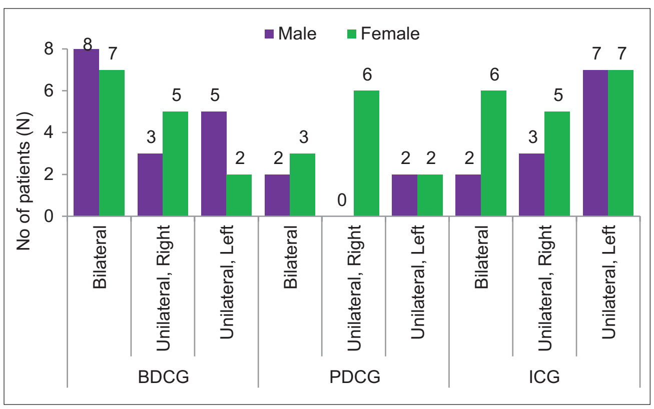
Graph 1: The sex distribution of selected patients and controls in studied groups (buccally displaced canine group, palatally displaced canine group, impacted canine group, and control group)

of differences in various selected cephalometric measurements. Assuming the normality of the distributions, one-way analysis of variance (ANOVA) was used to identify the differences in angles among the four groups (BDCG, PDCG, ICG, and CG). All selected angles were divided into respective diagnostic subcategories. The differences in the relative distribution of the various diagnostic subcategories among the four groups were tested by Pearson's Chi-square test. Independent samples *t*-test was used to test the significance of differences between the two groups, such as BDCG and CG, PDCG and CG, and ICG and CG, for all selected cephalometric measurements. Ninety-five percent confidence limits of normal Class I lateral cephalograms were calculated to identify the range (minimum–maximum) among normal controls. $P > 0.05$ was considered statistically insignificant, but the value from $P < 0.06$ to $P < 0.09$ was considered suggestively or poorly significant. The value from $P < 0.05$ to $P < 0.02$ was considered statistically significant whereas from $P < 0.01$ to $P < 0.0001$ was considered statistically highly/strongly significant.

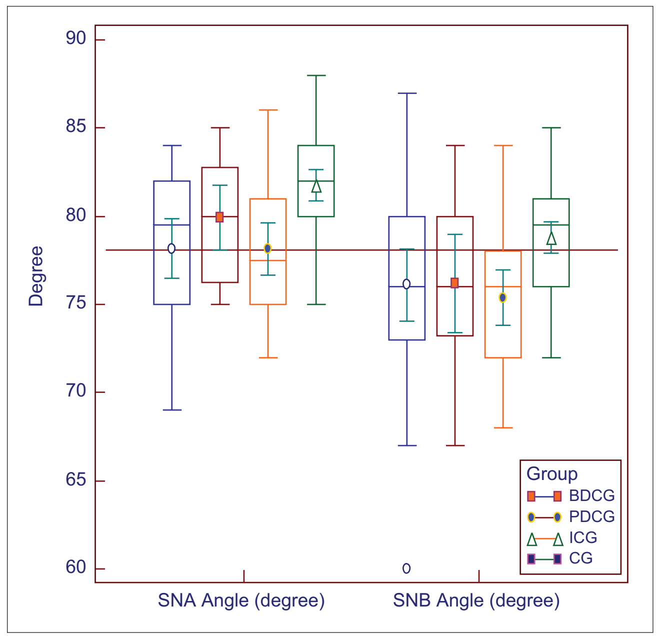
RESULTS

Table 2 shows the distribution of dentoskeletal features and statistical determination of differences in observed proportions of various diagnostic subcategories of angles: SNA, SNB, ANB, ML-SN, and UI-SN among four groups. The statistical agreement projected that cephalometric measurement differences of angles such as SNA, SNB, ANB, and ML/SN among patients were the significant factors of cephalometric features that displaced groups [Graphs 3 and 4].

Table 3 shows distribution of dentoskeletal features and statistical determination of differences in observed proportions of various diagnostic subcategories of angles: SN ^ ANS-PNS, ANS-PNS ^ GOGN, ratio (PFH/AFH), and CM-SN-LS among all four groups. The statistically cephalometric measurement differences of angles such as ANS-PNS ^ GoGn, ratio (PFH/AFH) of Jaraback, and Cm-Sn-Is



Graph 2: Distribution of location of permanent maxillary displaced canine (s) of selected patients with respect to gender in studied three groups (buccally displaced canine group, palatally displaced canine group, and impacted canine group)



Graph 3: Box and whisker diagram showing the distribution and statistical differences of cephalometric measurements of subjects for angles sella-nasion-A point angle, sella-nasion-B point angle and A point-nasion-B point angle using median, quartiles, and error bars

Table 1: The cephalometric parameters evaluated to estimate the craniofacial skeletal relationship

Parameters	Average (°)	Decreased (°)	Increased (°)
SNA	Orthognathic (80-84)	Retrognathic (>80)	Prognathic (<84)
SNB	Orthognathic (78-82)	Retrognathic (<78)	Prognathic (>82)
ANB	Skeletal Class I (0-4)	Skeletal Class II (<4)	Skeletal Class III (<0)
UI/SN	Average inclination (94-100)	Retroinclination (>100)	Proclination (<100)
SN ^ GoGn	Normodivergent (27-37)	Hypodivergent (<27)	Hyperdivergent (>37)
SN ^ ANS-PNS	Average inclination (6-12)	Tip up (<6)	Tip down (>12)
ANS-PNS ^ GoGn	Average inclination (23-28)	Horizontal grower (<28)	Vertical grower (>23)
PFH/AFH	Average grower (62-65)	Vertical grower (>62)	Horizontal grower (<65)
Cm-Sn-Ls	Average (94-110)	Obtuse angle (>110)	Acute angle (>94)

SNA: Sella-nasion-A point angle, SNB: Sella-nasion-B point angle, ANB: A point-nasion-B point angle, UI: Upper incisor, Go-Gn: Gonion-gnathion plane angle, ANS: Anterior nasal spine plane angle, PNS: Posterior nasal spine plane angle, PFH/AFH: Posterior facial height (sella-gonion), anterior facial height (nasion-menton) ratio

Table 2: Distribution of dentoskeletal features and statistical determination of differences in observed proportions of various diagnostic subcategories of angles: Sella-nasion-A point angle, sella-nasion-B point angle, A point-nasion-B point angle, mandibular line-sella-nasion and upper incisor-sella-nasion among four groups

Characteristics and diagnostic subcategories (°)	Displaced canine and control groups				P and LOS
	BDCG (n_1=30), *n* (%)	PDCG (n_2=15), *n* (%)	ICG (n_3=30), *n* (%)	Control (n_4=50), *n* (%)	
SNA					
Retrognathic maxilla	15 (50.0)	6 (40.0)	19 (63.3)	10 (20.0)	χ^2_6=20.20, P<0.003#
Normal maxilla	15 (50.0)	8 (53.3)	8 (26.7)	32 (64.0)	
Prognathic maxilla	0	1 (6.7)	3 (10.0)	8 (16.0)	
SNB					
Retrognathic mandible	17 (56.7)	9 (60.0)	21 (70.0)	15 (30.0)	χ^2=14.56, P<0.03*
Orthognathic mandible	11 (36.7)	5 (33.3)	7 (23.3)	31 (62.0)	
Prognathic mandible	2 (6.7)	1 (6.7)	2 (6.7)	4 (8.0)	
ANB					
Skeletal Class I	19 (63.3)	7 (46.7)	13 (43.3)	41 (82.0)	χ^2=20.18, P<0.003#
Skeletal Class II	5 (16.7)	6 (40.0)	10 (33.3)	9 (18.0)	
Skeletal Class III	6 (20.0)	2 (13.3)	7 (23.3)	0	
ML-SN					
Hypodivergent	8 (26.7)	2 (13.3)	7 (23.3)	8 (16.0)	χ^2_6=15.67, P<0.02*
Normodivergent	12 (40.0)	12 (80.0)	21 (70.0)	37 (74.0)	
Hyperdivergent	10 (33.3)	1 (6.7)	2 (6.7)	5 (10.0)	
UI-SN					
Retroclination	30 (100.0)	15 (100.0)	30 (100.0)	50 (100.0)	NA

The association is significant at the 0.03 and 0.02 LOS. The association is highly significant at the 0.003 LOS. BDCG: Bucally displaced canine group, PDCG: Palatally displaced canine group, ICG: Impacted canine group, LOS: Level of significance, NA: Not applicable, SNA: Sella-nasion-A point angle, SNB: Sella-nasion-B point angle, ANB: A point-nasion-B point angle, UI: Upper incisor, ML: Mandibular line, #: Highly significant, *: Significant

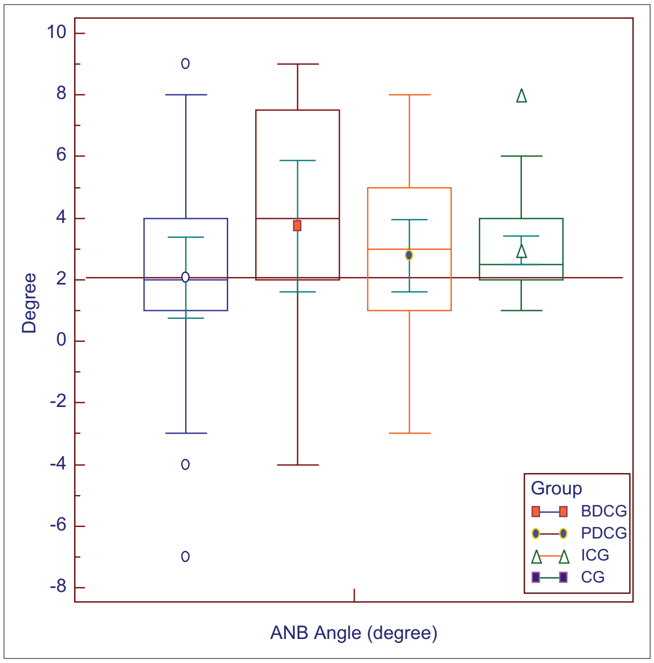
Table 3: Distribution of dentoskeletal features and statistical determination of differences in observed proportions of various diagnostic subcategories of angles: Sella-nasion-anterior nasal spine-posterior nasal spine plane angle, anterior nasal spine-posterior nasal spine plane-gonion-gnathion plane angle, ratio (posterior facial height [sella-gonion], anterior facial height [nasion-menton] ratio) and CM-SN-LS among all four groups

Characteristics and diagnostic subcategories (°)	Displaced canine and control groups				P and LOS
	BDCG (n_1=16), *n* (%)	PDCG (n_2=10), *n* (%)	ICG (n_3=10), *n* (%)	Control (n_4=25), *n* (%)	
SN ^ ANS-PNS					
Tip down	4 (13.3)	0	7 (23.3)	3 (6.0)	χ^2_6=11.35, P<0.08$
Average	22 (73.3)	14 (93.3)	17 (56.7)	35 (70.0)	
Tip up	4 (13.3)	1 (6.7)	6 (20.0)	12 (24.0)	
ANS-PNS ^ GoGn					
Horizontal grower	10 (33.3)	5 (33.3)	14 (46.7)	15 (30.0)	χ^2_6=18.66, P<0.005#
Average	11 (36.7)	6 (40.0)	11 (36.7)	34 (68.0)	
Vertical grower	9 (30.0)	4 (26.7)	5 (16.7)	1 (2.0)	
Ratio (PFH/AFH)					
Horizontal grower	10 (33.3)	6 (40.0)	7 (23.3)	16 (32.0)	χ^2_6=17.09, P<0.009#
Average	9 (30.0)	2 (13.3)	15 (50.0)	29 (58.0)	
Vertical grower	11 (36.7)	7 (46.7)	8 (26.7)	5 (10.0)	
CM-SN-LS					
Obtuse	10 (33.3)	0	5 (16.7)	20 (40.0)	χ^2_6=16.15, P<0.02*
Normal	14 (46.7)	14 (93.3)	21 (70.0)	22 (44.0)	
Acute	6 (20.0)	1 (6.7)	4 (13.3)	8 (16.0)	

The mean differences are poorly/suggestively significant at the 0.08 LOS. The association is significant at the 0.02 LOS. #The association is highly significant at the 0.005 and 0.009 LOS. BDCG: Bucally displaced canine group, PDCG: Palatally displaced canine group, ICG: Impacted canine group, LOS: Level of significance, ANS: Anterior nasal spine plane angle, PNS: Posterior nasal spine plane angle, PFH/AFH: Posterior facial height (sella-gonion), anterior facial height (nasion-menton) ratio, Go-Gn: Gonion-gnathion plane angle, SN: Sella-nasion, $: Poorly/suggestively significant, *: Significant

among patients were the significant factors of cephalometric features that displaced groups.

Table 4 shows comparison of various diagnostic subcategories of angles: SNA, SNB, ANB, ML/SN, and UI/SN between BDCG



Graph 4: Box and whisker diagram showing the distribution and statistical differences of cephalometric measurements of subjects for angle A point-nasion-B point angle using median, quartiles, and error bars (95% confidence interval of mean) among groups (buccally displaced canine group, palatally displaced canine group, impacted canine group, and control group)

and control group (CG). The SNA, SNB, ANB, and ML/SN were the significant factors among patients of BDCG.

Table 5 shows comparison of various diagnostic subcategories of angles: SN^ANS-PNS, ANS-PNS^GOGN, ratio (PFH/AFH), and Cm-Sn-Ls between BDCG and CG. The SN^ANS-PNS and ratio (PFH/AFH) of Jaraback were the significant factors that observed carefully while treating patients of BDCG orthodontically.

Table 6 shows comparison of various diagnostic subcategories of angles: SNA, SNB, ANB, ML/SN, and UI/SN between PDCG and CG. The SN^ANS-PNS and ratio (PFH/AFH) of Jaraback were the significant factors that observed carefully while treating patients of BDCG orthodontically.

Table 7 shows comparison of various diagnostic subcategories of angles: SN^ANS-PNS, ANS-PNS^GOGN, ratio (PFH/AFH), and Cm-Sn-Ls between PDCG and CG. The SN^ANS-PNS, ANS-PNS^GoGn, ratio (PFH/AFH) of Jaraback, and Cm-Sn-Ls were not the significant factors among patients of PDCG.

Table 8 shows comparison of various diagnostic subcategories of angles: SNA, SNB, ANB, ML/SN, and UI/SN between impacted displaced canine group and CG. The SNA, SNB, and ML/SN were the factors among patients of impacted displaced canines may observe carefully while treating patients orthodontically.

Table 4: Comparison in various diagnostic subcategories of angles: Sella-nasion-A point angle, sella-nasion-B point angle, A point-nasion-B point angle, mandibular line/sella-nasion and upper incisor/sella-nasion between buccally displaced canine group and control group

Angle (°)	Diagnostic subcategory	Mean±SD		*t*	LOS (*P*)
		BDCG (°)	CG (°)		
SNA	Retrognathic maxilla	74.47±3.25	76.80±1.23	2.16	<0.05*
	Normal maxilla	81.87±1.55	82.28±1.55	0.85	>0.05**
	Prognathic maxilla	-	85.88±1.13	NA	NA
SNB	Retrognathic mandible	72.41±4.15	74.80±1.52	2.10	<0.05*
	Normal mandible	80.00±1.27	80.06±1.32	0.14	>0.05**
	Prognathic mandible	86.00±1.41	84.00±1.16	1.89	>0.05**
ANB	Skeletal Class I	2.32±0.95	2.39±1.12	0.25	>0.05**
	Skeletal Class II	7.40±1.34	5.56±1.01	2.92	<0.02*
	Skeletal Class III	−3.17±2.14	-	NA	NA
ML/SN	Hypodivergent	24.25±1.39	22.00±1.85	2.75	<0.02*
	Normodivergent	31.00±2.41	30.76±3.04	0.25	>0.05**
	Hyperdivergent	41.00±3.20	39.60±0.55	0.96	>0.05**
UI/SN	Retroclination maxilla	71.23±9.50	75.18±6.84	2.15	<0.05*

*The mean difference is significant at the 0.05 LOS. **The mean differences are not significant (insignificant) at the 0.05 LOS. NA: Not applicable, BDCG: Buccally displaced canine group, CG: Control group, LOS: Level of significance, SD: Standard deviation, SNA: Sella-nasion-A point angle, SNB: Sella-nasion-B point angle, ANB: A point-nasion-B point angle, UI: Upper incisor, ML: Mandibular line

Table 5: Comparison in various diagnostic subcategories of angles: Sella-nasion-anterior nasal spine-posterior nasal spine plane angle, anterior nasal spine-posterior nasal spine plane-gonion-gnathion plane angle, ratio (posterior facial height [sella-gonion], anterior facial height [nasion-menton]) and CM-SN-LS between buccally displaced canine group and control group

Angle (°)	Diagnostic subcategory	Mean±SD		*t*	LOS (*P*)
		BDCG (°)	CG (°)		
SN^ANS-PNS	Tip up	3.25±0.50	4.67±0.49	4.97	<0.001#
	Average	7.82±1.56	8.63±1.66	1.83	>0.05**
	Tip down	16.00±1.41	15.33±1.16	0.66	>0.05**
ANS-PNS^GoGn	Horizontal grower	17.20±3.74	16.73±3.86	0.30	>0.05**
	Average	25.73±1.35	26.35±1.50	1.23	>0.05**
	Vertical grower	32.33±3.32	38.00±0.00	1.62	>0.05**
Ratio (PFH/AFH)	Horizontal grower	72.33±2.59	70.57±3.80	1.29	>0.05**
	Average	64.00±1.03	63.91±1.17	0.21	>0.05**
	Vertical grower	57.70±1.90	59.72±1.80	2.00	<0.06$
CM-SN-LS	Obtuse	116.90±3.78	116.30±3.77	0.41	>0.05**
	Normal	104.64±4.05	103.18±5.87	0.81	>0.05**
	Acute	84.00±6.57	85.25±8.86	0.29	>0.05**

#The mean difference is highly significant at the 0.001 LOS, $The mean difference is poorly/suggestively significant at the 0.06 LOS, **The mean differences are not significant (insignificant) at the 0.05 LOS. BDCG: Buccally displaced canine group, CG: Control group, LOS: Level of significance, SD: Standard deviation, ANS: Anterior nasal spine plane angle, PNS: Posterior nasal spine plane angle, Go-Gn: Gonion-gnathion plane angle, PFH/AFH: Posterior facial height (sella-gonion), anterior facial height (nasion-menton) ratio, SN: Sella-nasion

Table 6: Comparison in various diagnostic subcategories of angles: Sella‑nasion‑A point angle, sella‑nasion‑B point angle, A point‑nasion‑B point angle, mandibular line/sella‑nasion and upper incisor/sella‑nasion between palatally displaced canine group and control group

Angle (°)	Diagnostic subcategory	Mean±SD		*t*	LOS (*P*)
		PDCG (°)	CG (°)		
SNA	Retrognathic maxilla	76.50±1.38	76.80±1.23	0.45	>0.05**
	Normal maxilla	81.88±1.73	82.28±1.55	0.65	>0.05**
	Prognathic maxilla	85.00±0.00	85.88±1.13	0.73	>0.05**
SNB	Retrognathic mandible	72.89±3.52	74.80±1.52	1.86	<0.07$
	Normal mandible	80.60±0.89	80.06±1.32	0.87	>0.05**
	Prognathic mandible	84.00±0.00	84.00±1.16	0.0	NA
ANB	Skeletal Class I	2.29±1.38	2.39±1.12	0.22	>0.05**
	Skeletal Class II	7.50±1.64	5.56±1.01	2.85	<0.02*
	Skeletal Class III	−2.50±2.12	-	NA	NA
ML/SN	Hypodivergent	25.50±0.71	22.00±1.85	2.53	<0.02*
	Normodivergent	32.50±3.75	30.76±3.04	1.63	>0.05**
	Hyperdivergent	41.00±0.00	39.60±0.55	2.33	<0.08$,##
UI/SN	Retroclination maxilla	75.00±9.84	75.18±6.84	0.08	>0.05**

$The mean difference is poorly/suggestively significant at the 0.0 7 and 0.08 LOS, *The mean difference is significant at the 0.05 LOS, **The mean differences are not significant (insignificant) at the 0.02 LOS, ##Number of hyerdivergent (ML/SN) subjects were 1 and 5 and thus df was 4 therefore the *t*=2.33 indicated poorly significance while *t*=2.53 indicated significant since subjects were 2 and 8 and thus df was 8. NA: Not applicable, PDCG: Palatally displaced canine group, CG: Control group, LOS: Level of significance, SNA: Sella‑nasion‑A point angle, SNB: Sella‑nasion‑B point angle, ANB: A point‑nasion‑B point angle, UI: Upper incisor, ML: Mandibular line, SD: Standard deviation

Table 7: Comparison in various diagnostic subcategories of angles: Sella‑nasion‑anterior nasal spine‑posterior nasal spine plane angle, anterior nasal spine‑posterior nasal spine plane‑gonion‑gnathion plane angle, ratio (posterior facial height [sella‑gonion], anterior facial height [nasion‑menton]) and CM‑SN‑LS between palatally displaced canine group and control group

Angle (°)	Diagnostic subcategory	Mean±SD		*t*	LOS (*P*)
		PDCG (°)	CG (°)		
SN^ANS‑PNS	Tip up	5.00±0.0	4.67±0.49	0.65	>0.05**
	Average	7.86±1.61	8.63±1.66	1.48	>0.05**
	Tip down	-	15.33±1.16	NA	NA
ANS‑PNS^GoGn	Horizontal grower	13.40±4.28	16.73±3.86	1.63	>0.05**
	Average	25.00±1.79	26.35±1.50	1.98	>0.05**
	Vertical grower	33.25±6.50	38.00±0.00	0.65	>0.05**
Ratio (PFH/AFH)	Horizontal grower	73.52±5.30	70.57±3.80	1.46	>0.05**
	Average	63.50±2.12	63.91±1.17	0.46	>0.05**
	Vertical grower	59.00±1.16	59.72±1.80	0.85	>0.05**
CM‑SN‑LS	Obtuse	-	116.30±3.77	NA	NA
	Normal	102.64±4.88	103.18±5.87	0.29	>0.05**
	Acute	87.00±0.0	85.25±8.86	0.19	>0.05**

The mean difference is highly significant at the 0.001 LOS, The mean difference is poorly/suggestively significant at the 0.06 LOS, **The mean differences are not significant (insignificant) at the 0.05 LOS. NA: Not applicable, PDCG: Palatally displaced canine group, CG: Control group, LOS: Level of significance, SD: Standard deviation, ANS: Anterior nasal spine plane angle, PNS: Posterior nasal spine plane angle, Go‑Gn: Gonion‑gnathion plane angle, PFH/AFH: Posterior facial height (sella‑gonion), anterior facial height (nasion‑menton) ratio, SN: Sella‑nasion

Table 9 shows comparison of various diagnostic subcategories of angles: SN^ANS‑PNS, ANS‑PNS^GOGN, ratio (PFH/AFH), and Cm‑Sn‑Ls between impacted displaced canine group and CG. The SN^ANS‑PNS, ANS PNS^GoGn, ratio (PFH/AFH) of Jaraback, and Cm‑Sn‑Ls but were not the significant factors among patients of impacted canines.

Table 10 shows comparison of angles: SNA, SNB, ANB, ML/SN, and UI/SN of permanent maxillary displaced canine(s) among studied groups. The statistical comparison among four groups (BDCG, PDCG, ICG, and CG) showed highly significant differences with respect to two measurements, namely SNA and SNB while significant differences for angle UI/SN angle but no statistical differences for angles ANB and ML/SN.

Table 11 shows comparison of angles: SN^ANS‑PNS, ANS‑PNS^GOGN, ratio (PFH/AFH) of Jaraback, and Cm‑Sn‑Ls for permanent maxillary displaced canine (s) among groups. The statistical comparison among all four groups showed no significant differences with respect to four measurements, namely SN^ANS‑PNS, ANS‑PNS^GoGn, ratio (PFH/AFH) of Jaraback, and Cm‑Sn‑Ls angles among patients of all four groups.

DISCUSSION

There are many literatures available on diagnosis, prevalence, frequency, etiology, and associated developmental anomalies and maxillary transverse discrepancy of canine impaction. There are limited literatures found on dentoskeletal morphology of hard and soft tissue development of face of BDCG, PDCG, and ICG together. Besides this, there are limited studies available for this orthodontically important anomaly. Female is more common in BCDG and PDCG,[18] but in the present study, male is common in BDCG and female is common in PDCG and ICG. In the present study, prevalence rate BDCG 40% followed by ICG 40% and PDCG is 20%, Impacted maxillary permanent cuspids, i.e. palatal impaction is 85% and buccally/labially 15%.[8‑11,18,19] This study shows that BDCG is having retrognathic maxilla, retrognathic mandible and skeletal Class II, retrocliantion of incisor is statistically significant. However, other studies reported that no significant associations were found between BDC and the skeletal features, except for increased ANB angle.[20] BDC did not demonstrate significant associations with any specific craniofacial pattern in the sagittal plane (skeletal Class I, II, or III) when compared with the CG.[21] In the present study, BDCG show results of hypodivergent of ML/SN, horizontal grower in PFH/AFH is significant whereas tip up maxilla among the subject is highly significant, while study only reported that a significant association between BDC and vertical craniofacial features.[22]

Table 8: Comparison in various diagnostic subcategories of angles: Sella-nasion-A point angle, sella-nasion-B point angle, A point-nasion-B point angle, mandibular line/sella-nasion and upper incisor/sella-nasion between impacted displaced canine group and control group

Angle (°)	Diagnostic subcategory	Mean±SD		*t*	LOS (*P*)
		ICG (°)	CG (°)		
SNA	Retrognathic maxilla	75.58±1.84	76.80±1.23	1.89	<0.07$
	Normal maxilla	81.50±1.51	82.28±1.55	1.28	>0.05**
	Prognathic maxilla	85.33±0.58	85.88±1.13	0.78	>0.05**
SNB	Retrognathic mandible	73.33±2.94	74.80±1.52	1.78	<0.08$
	Normal mandible	79.00±1.00	80.06±1.32	2.00	<0.06$
	Prognathic mandible	84.00±0.00	84.00±1.16	0.0	NA
ANB	Skeletal Class I	2.54±1.05	2.39±1.12	0.42	>0.05**
	Skeletal Class II	6.20±1.03	5.56±1.01	1.37	>0.05**
	Skeletal Class III	−1.71±0.76	-	NA	NA
ML/SN	Hypodivergent	23.71±1.50	22.00±1.85	1.95	<0.07$
	Normodivergent	32.19±2.96	30.76±3.04	1.73	>0.05**
	Hyperdivergent	43.50±4.95	39.60±0.55	2.01	>0.05##,**
UI/SN	Retroclination maxilla	70.07±10.9	75.18±6.84	2.58	<0.02*

$The mean difference is poorly/suggestively significant at the 0.07 and 0.08 LOS, *The mean difference is significant at the 0.05 LOS, **The mean differences are not significant (insignificant) at the 0.05 LOS, ##Number of hyerdivergent (ML/SN) subjects were 2 and 5 and thus df was 5 therefore the t=2.01 indicated insignificance while t=1.95 indicated poorly significant since subjects were 7 and 8 and thus df were 15. NA: Not applicable, ICG: Impacted canine group, CG: Control group, LOS: Level of significance, SD: Standard deviation, SNA: Sella-nasion-A point angle, SNB: Sella-nasion-B point angle, ANB: A point-nasion-B point angle, UI: Upper incisor, ML: Mandibular line

Table 9: Comparison in various diagnostic subcategories of angles: Sella-nasion-anterior nasal spine-posterior nasal spine plane angle, anterior nasal spine-posterior nasal spine plane-gonion-gnathion plane angle, ratio (posterior facial height [sella-gonion], anterior facial height [nasion-menton]) and CM-SN-LS between impacted displaced canine group and control group

Angle (°)	Diagnostic subcategory	Mean±SD		*t*	LOS (*P*)
		ICG (°)	CG (°)		
SN^ANS-PNS	Tip up	4.17±2.04	4.67±0.49	0.83	>0.05**
	Average	9.24±2.25	8.63±1.66	1.10	>0.05**
	Tip down	15.29±1.25	15.33±1.16	0.06	>0.05**
ANS-PNS^GoGn	Horizontal grower	16.50±4.75	16.73±3.86	0.15	>0.05**
	Average	26.09±1.58	26.35±1.50	0.50	>0.05**
	Vertical grower	33.40±5.60	38.00±0.00	0.75	>0.05**
Ratio (PFH/AFH)	Horizontal grower	68.56±3.11	70.57±3.80	1.23	>0.05**
	Average	63.75±1.03	63.91±1.17	0.46	>0.05**
	Vertical grower	57.86±2.68	59.72±1.80	1.36	>0.05**
CM-SN-LS	Obtuse	119.00±3.16	116.30±3.77	1.47	>0.05**
	Normal	104.95±4.66	103.18±5.87	1.09	>0.05**
	Acute	76.00±5.48	85.25±8.86	1.89	<0.08$

$The mean difference is poorly/suggestively significant at the 0.08 LOS, **The mean differences are not significant (insignificant) at the 0.05 LOS. ICG: Impacted canine group, CG: Control group, LOS: Level of significance, SD: Standard deviation, ANS: Anterior nasal spine plane angle, PNS: Posterior nasal spine plane angle, Go-Gn: Gonion-gnathion plane angle, PFH/AFH: Posterior facial height (sella-gonion), anterior facial height (nasion-menton) ratio, SN: Sella-nasion

The study showed that skeletal Class II is significant, retrognathic mandible is poorly significant and nonsufficient SNA in PDCG. The study was supported that statistically significant associations between PDC and SNB, ANB.[20] PDCG was found most frequently in patients with Class I skeletal relationship.[17,23] This study showed that PDC was more frequent in Class II division 2 incisor relationships. In the present study, PDCG show hypodivergent relationship of ML/SN while the present research indicated that the diagnostic subcategory differences with respect to angles such as SN^ANS-PNS, ANS-PNS^GoGn, ratio (PFH/AFH) of Jaraback were not the significant factors among patients in PDCG. Statistically significant SN^GoGN, SN^ANS-PNS, ANS-PNS^GoGn, PFH/AFH, while no significant associations emerged between PDC and SNA, SNBa and the growth parameters of Jarabak.[20] Three times higher prevalence rate for hypodivergent cases in the PDC patients compared to the control cases.[23] Individuals with PDCs were found to have significantly increased interincisal angle (UI/LI) than controls. Although overbite was not statistically significantly different. PDCs were found more in Class II division 2 incisors in which interincisal angle usually tends to be increased.[24]

The study shows that ICG has poorly significant orthognathic mandible and SNA and nonsignificant ANB. PMC impaction cases to be associated with the retrognathic mandible, skeletal Class II, retroclined mandibular when compared to CG.[25,26] The diagnostic subcategory differences with respect to angles such as SN^ANS-PNS, ANS-PNS^GoGn, and ratio (PFH/AFH) of Jaraback were not the significant factors among impacted canines' patients while UI/SN study supported that retroclined mandibular and maxillary incisors occurred significantly most frequently and proclined mandibular incisors significantly least frequently in "IG." There is a significant association of mandibular canine impaction with retroclined maxillary incisors too. As Class II division 2 malocclusion (Class II/2) is typically associated with retroclined incisors.[27,28]

In the present study, results showed that there is no statistically significant association with BDCG, PDCG, and ICG in soft tissue parameters, and other studies showed that upper and lower lips were significantly retruded relative to the Ricketts E-plane [Table 12]. These soft tissue findings may

Table 10: Comparison in angles: Sella-nasion-A point angle, sella-nasion-B point angle, A point-nasion-B point angle, mandibular line/sella-nasion, and upper incisor/sella-nasion of permanent maxillary displaced canine(s) among studied groups

Parameter (°)	Group	Mean spread (°), mean±SD	95% CI for mean (°)		P (LOS)
			LB	UB	
SNA angle	BDCG	78.17±4.52	76.48	79.85	F=8.52, P<0.001#
	PDCG	79.93±3.35	78.08	81.79	
	ICG	78.13±3.93	76.67	79.60	
	CG	81.76±3.15	80.86	82.66	
SNB angle	BDCG	76.10±5.54	74.03	78.17	F=4.97, P<0.003#
	PDCG	76.20±5.06	73.40	79.00	
	ICG	75.37±4.18	73.81	76.93	
	CG	78.80±3.15	77.90	79.70	
ANB angle	BDCG	2.07±3.49	0.76	3.37	F=1.26, P>0.05**
	PDCG	3.73±3.85	1.60	5.86	
	ICG	2.77±3.14	1.60	3.94	
	CG	2.96±1.64	2.49	3.43	
ML/SN angle	BDCG	32.53±7.10	29.88	35.19	F=1.13, P>0.05**
	PDCG	32.13±4.81	29.47	34.80	
	ICG	30.97±5.65	28.86	33.08	
	CG	30.24±5.25	28.75	31.73	
UI/SN angle	BDCG	71.23±9.50	67.68	74.78	F=2.70, P<0.05*
	PDCG	75.00±9.84	69.55	80.45	
	ICG	70.07±10.90	66.00	74.14	
	CG	75.18±6.84	73.24	77.12	

#The mean differences are highly significant at the 0.003 and 0.001 LOS, **The mean differences are not significant at the 0.05 LOS, *The mean differences are significant at the 0.05 LOS. SD: Standard deviation, LOS: Level of significance, LB: Lower bound, UB: Upper bound, BDCG: Buccally displaced canine group, CG: Control group, ICG: Impacted canine group, PDCG: Palatally displaced canine group, CI: Confidence interval, SNA: Sella-nasion-A point angle, SNB: Sella-nasion-B point angle, ANB: A point-nasion-B point angle, UI: Upper incisor, ML: Mandibular line

be explained by the presence of short maxilla and mandible where upper and lower lips will follow the underlying hard tissues.[17]

In the study assuming the normality of the distributions, one-way ANOVA was used to identify the differences in angles among the four groups (BDCG, PDCG, ICG, and CG) and the result showed that SNA and ANB and ANSPNS-GoGN, PFH/AFH is highly significant, whereas SNB and ML/SN and Nasolabial angle is significant. However, according to ANOVA test, PDC patients have more significant SNA and significant 1/SN, ML/SN, and Spl/ML angles compared to control.[16] There are no significant differences with respect to four measurements, namely SN ^ ANS-PNS, ANS-PNS ^ GoGn, ratio (PFH/AFH) of Jaraback, and Cm-Sn-Ls angles among patients of all four groups.

CONCLUSION

Based on the results of the present study, it can be concluded that as follows:

Table 11: Comparison in angles sella-nasion-anterior nasal spine-posterior nasal spine plane angle, anterior nasal spine-posterior nasal spine plane-gonion-gnathion plane angle, ratio (posterior facial height [sella-gonion], anterior facial height [nasion-menton]) of Jaraback and CM-SN-LS for permanent maxillary displaced canine(s) among groups

Parameter (°)	Group	Spread (°), mean±SD	95% CI for mean (°)		P (LOS)
			LB	UB	
SN ^ ANS-PNS angle	BDCG	8.30±3.73	6.91	9.69	F=1.73, P>0.05**
	PDCG	7.67±1.72	6.72	8.62	
	ICG	9.63±4.22	8.06	11.21	
	CG	8.08±2.88	7.26	8.90	
ANS-PNS ^ GoGn angle	BDCG	24.87±6.77	22.34	27.39	F=0.47, P>0.05**
	PDCG	23.33±8.94	18.38	28.29	
	ICG	22.83±7.61	19.99	25.68	
	CG	23.70±5.45	22.15	25.25	
Ratio (PFH/AFH) angle	BDCG	64.47±6.51	62.04	66.90	F=1.25, P>0.05**
	PDCG	65.41±7.76	61.11	69.70	
	ICG	63.30±4.38	61.67	64.94	
	CG	65.62±4.33	64.39	66.85	
CM-SN-LS angle	BDCG	104.60±12.62	99.89	109.31	F=0.50, P>0.05**
	PDCG	101.60±6.20	98.17	105.03	
	ICG	103.43±12.91	98.61	108.25	
	CG	105.56±12.18	102.10	109.02	

**The mean differences are not significant (insignificant) at the 0.05 LOS. SD: Standard deviation, LOS: Level of significance, LB: Lower bound, UB: Upper bound, CI: Confidence interval, BDCG: Buccally displaced canine group, CG: Control group, ICG: Impacted canine group, PDCG: Palatally displaced canine group, ANS: Anterior nasal spine plane angle, PNS: Posterior nasal spine plane angle, Go-Gn: Gonion-gnathion plane angle, PFH/AFH: Posterior facial height (sella-gonion), anterior facial height (nasion-menton) ratio, SN: Sella-nasion

- There is a significant association with retrognathic maxilla, retrognathic mandible, and skeletal Class II in BDCG
- BDCG also shows significant hypodivergent skeletal relationship with tip up maxilla and retroclination of incisors
- Whereas skeletal Class II and hypodivergent skeletal relationship are significant while retrognathic mandible is poorly significant in PDCG
- There is positive association retroclination of incisors are while retognathic maxilla, retrognathic mandible, hypo divergent relationship is poorly significant association in ICG
- Nasolabial angle and Steiner's Soft tissue are insignificant in BDCG, PDCG, and ICG
- Female is more common in BDCG and PDCG whereas male is more common in ICG
- Bilateral displacement is commonly seen in BDCG and PDCG, whereas unilateral displacement is commonly seen in ICG.

Financial support and sponsorship

Nil.

Table 12: Distribution of Steiner's S-line with respect to maxilla and statistical determination of differences in observed proportions of various diagnostic subcategories among four groups

Diagnostic subcategories (S-line)	Displaced canine and control groups				Total
	BDCG (%)	PDCG (%)	ICG (%)	Control (%)	
Protrusive maxilla	1 (3.3)	0	2 (6.7)	3 (6.0)	6 (4.8)
Normal maxilla	19 (63.3)	10 (66.7)	15 (50.0)	37 (74.0)	81 (64.8)
Retrusive maxilla	10 (33.3)	5 (33.3)	13 (43.3)	10 (20.0)	38 (30.4)
Total	30 (100.0)	15 (100.0)	30 (100.0)	50 (100.0)	125 (100.0)

χ^2_6 =6.46 and $P>0.05$ (insignificant). Distribution of Steiner's S-line with respect to upper lip and statistical determination of differences in observed proportions of various diagnostic subcategories shows in Table 12. The differences in proportions were not statistically significant among four groups (BDCG, PDCG, ICG, and CG). The s-line differences of subjects found not to be associated significantly with groups. BDCG: Buccally displaced canine group, CG: Control group, ICG: Impacted canine group, PDCG: Palatally displaced canine group

Conflicts of interest

There are no conflicts of interest.

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