Comparison of Cephalometric Hard and Soft Tissues of Adolescents with Angle Class II Division 1 Malocclusion between Northern Chinese Population and Northern Indian Population

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Objective: *To determine if there was a difference in hard and soft tissue between northern Chinese and northern Indian adolescents with Angle Class II division 1 malocclusion.*
Method: *A total of 40 Angle Class II division 1 patients, including 20 boys and 20 girls aged 10 to 13 years with no prior treatment, were selected from northern China and northern India, respectively. Overall, 80 cephalometric data were analysed based on two-sample t-test with SPSS software.*
Results: *The Chinese subjects had larger anterior facial height and mandibular plane angle. Analysis of dentoalveolar complex showed that the Chinese subjects had more proclined incisors, protruding upper lips and more upper posterior tooth height than that of the Indian subjects. The length of the maxilla and mandible was larger in the Indian subjects than that of the Chinese subjects, but the length of mandible was not significantly different between the two groups.*
Conclusion: *Compared with the Indian subjects, the Chinese subjects with Class II division 1 malocclusion had less prognathic maxillas, more protruding lips, steeper mandibular plane angles and more proclined maxillary incisors. Within the same gender, the Indian boys had more protruded faces and Indian girls had more protruded maxillas, steeper mandibular plane angles and fuller lips.*
Key words: *Class II division 1 malocclusion, Chinese adolescents, Indian adolescents, cephalometrics, hard and soft tissue*
Chin J Dent Res 2017;20(1):33–42; doi: 10.3290/j.cjdr.a37740

Class II malocclusions may result from numerous combinations of skeletal and dental disorders. Some reports have indicated that the maxilla in Class II division 1 patients was more protrusive and the mandible was normal in size and position[1]. Other studies found that the maxilla was in a normal position in relation to the cranial base while the mandible was retrusive[2]. Others found that Class II skeletal pattern is due to both maxillary protrusion and mandibular retrusion[3]. It seems that ethnic backgrounds of the samples used in these studies have played a role in determining the craniofacial characteristics of the Class II pattern. Other studies also showed a higher correlation between the patient and his immediate family than data from random pairings of unrelated siblings, thus supporting the concept of polygenic inheritance for Class II division 1 malocclusions. Due to the globalisation trend, the population of immigrants increased every year. An increased number of people were receiving orthodontic treatment abroad. Studies about differences of craniofacial skeletal and soft tissue among races attracted lots of attention, especially in immigrant nations such as Malaysia[4-7]. Chinese

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This study was funded by the Nature Science Foundation of China (NSFC: 81171008).

and Indian are the two largest populations in the world, therefore it would be necessary to compare the differences between the two populations, in order to offer a guidance for clinical work and provide more specific information regarding this type of malocclusion among Chinese and Indian subjects.

Material and methods

Chinese sample

The Chinese sample comprised 20 boys and 20 girls between 10 and 13 years. The data were collected from the patient documents at the Department of Orthodontics of Dalian Hospital of Stomatology, in Liaoning Province.

Indian sample

The Indian sample comprised 20 boys and 20 girls between 10 and 13 years. The records were collected from different orthodontists' clinics in the cities of the north Indian provinces Haryana, Punjab, Himachal Pradesh and the union territory of Chandigarh.

The subject inclusion criteria were:

- The mesiobuccal cusp of the permanent maxillary first molar occludes mesially to the buccal groove of the permanent mandibular first molar.

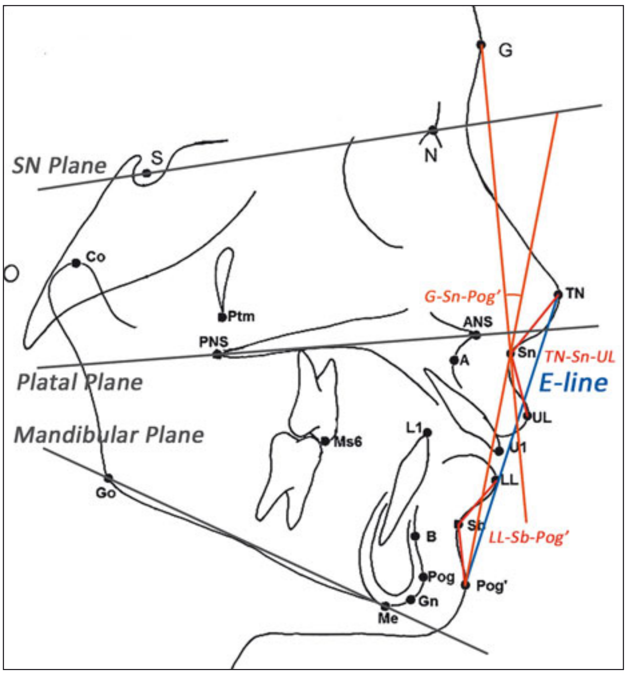

Fig 1 The cephalometric tracings in the present study.

- Bilateral distal molar relationship of more than a half cusp width when the deciduous lower second molar were still present.
- Proclination of maxillary front teeth with an overjet of more than 4 mm.
- No history of orthodontic treatment.

Valid consent was obtained from all patients before orthodontic diagnosis and treatment.

Cephalometric analysis

Cephalometric lateral skull radiographs were taken as follows: Each subject stood with their head in a natural position with their teeth held in centric occlusion under standard conditions. The head was fixed by fitting the ear rods of the cephalostat in the external auditory meatus. Cephalometric radiographs were digitised.

All tracings were performed by the same investigator (NR) using the WinCeph 7.0 cephalometric software program (Rise Co Ltd, Sendai, Japan). All data were measured repeatedly and average values were analysed. Cephalometric analysis comprised the 22 variables (12 angular and 10 linear measurements). Of these 22 variables, 16 were hard tissue and 7 were soft tissue variables (Tables 1, 2 and Figure 1).

Statistical analysis

All statistical analyses were performed with the Statistical Package for Social Sciences (version 20, SPSS Inc, Chicago, Illinois, USA). Two-sample t-tests were used to analyse the race and gender differences.

Mean, standard deviation and *P* value were calculated for each variable for each subject and values are significant at $P < 0.05$.

Results

The mean and standard deviation values measured from the subjects were presented in Tables 3, 4, and 5.

Prognathic maxilla, as indicated by higher SNA angle, was seen in Indian children. Significant difference of SNA angle was found between the Indian boys and Chinese boys, and the Indian girls and Chinese girls ($P < 0.05$), but no significant difference was found if both the sexes were combined to form a single variable ($P > 0.05$). Retrognathic mandible, as indicated by reduced SNB angle, was seen in Chinese children in general, but there was no significant difference between the two groups in this study.

Table 1 Description of different cephalometric landmarks used in the study

Landmark	Definition
Sella (S)	The centre of the pituitary fossa of the sphenoid bone.
Nasion (N)	The most anterior point on the frontonasal suture.
Anterior nasal spine (ANS)	The most anterior point on the maxilla at the level of the palate.
Posterior nasal spine (PNS)	The most posterior point on the bony hard palate.
Point A (A) subspinale	The most posterior point on the curvature of the maxilla between the ANS and the alveolar crest.
Point B (B) supramentale.	The most posterior point on the curvature of the mandible between pogonion (Pg') and the mandibular alveolar crest.
Pogonion (Pog)	Most anterior point of the bony chin in the median plane.
Gnathion (Gn)	The most anterior and inferior point on the bony chin in the midline.
Gonion (Go)	The most posterior and inferior point on the angle of the mandible.
Menton (Me)	The lower most point on the mandibular symphysis in the midline.
Condylon (Co)	The most superior and posterior point on the outline of the condylar head.
Upper 1st molar cusp tip (MS6)	The mesio-buccal cusp tip of maxillary first molar.
Palatal plane (PP)	Line joining ANS and PNS.
Glabella (G)	The most prominent point in the midsagittal plane of the forehead.
Subnasal (Sn)	The point at which the nasal septum between the nostrils merges with the upper cutageous lip in the midsagittal plane.
Labrale superius (UL)	The most anterior point on the convexity of the upper lip.
Labrale inferius (LL)	The most anterior point on the convexity of the lower lip.
Soft tissue pogonion (Pog')	The most anterior point of the soft tissue chin in the mid-sagittal plane.
Pronasal (TN)	The most prominent or anterior (tip) of the nose.
E- line	E-Line is drawn from Pronasale (TN) to soft tissue pogonion (Pg') and lip prominence with reference to this line is assessed.
Inferior labial sulcus (Sb)	The point of greatest concavity in the midline of the lower lip between Labrale inferius (LL) and soft tissue pogonion (Pg'). Also known as labiomental sulcus.

Table 2 Description of the cephalometric measurements used in the study.

Variable	Description
SNA angle	Angle formed between the point sella, nasion and point A, indicating antero-posterior position of maxilla with respect to anterior cranial base.
SNB angle	Angle formed between the point sella, nasion and point B, indicating antero-posterior position ofmandible with respect to anterior cranial base.
ANB angle	Angle formed between the point A, nasion, and the point B indicating the maxillo-mandibular relationship.
PP-MP angle	Angle formed between palatal plane and mandibular plane.
SN-PP angle	Angle formed between sella, nasion and palatal plane.
SN-MP angle	Angle formed between sella, nasion and mandibular plane. Determines mandibular inclination.
Ptm-A (mm)	Distance between Ptm and point A. Length of the maxilla, A–Ptm distance at the Frankfort horizontal (FH) plane.
Co-A (mm)	Distance between condylon and point A. Determines effective length of maxilla.
Go-Me(mm)	Distance between gonion and menton. Determines length of mandible.
Co-Gn (mm)	Distance between condylon and gnathion. Determines effective length of mandible.
Wits apprasial (mm)	Determines the antero-posterior relation of point A and point B with each other.
N-Me	Distance between nasion and menton. Determines height of the face.
(ANS-Me) / (N-Me)	Determines the ratio of lower third of the face (ANS-Me) to the total height of the face (N-Me).
U1-NA	Angle between the long axis of the upper central incisor and the NA plane. Relates the angularity of upper incisors to its apical base.
L1-MP	Angle between the long axis of the lower central incisor and the mandibular plane. Relates the axial inclination of mandibular incisors to mandibular plane.
Ms6-PP	Distance between the mesiobuccal cusp tip of maxillary first molar and PP.
G-Sn-pog’	The angle formed by lines glabella-subnasale and subnasale-soft tissue pogonion (Pog’). Also called facial contour angle.
LL-Sb-Pog’	The angle formed by lines Labrale inferius (LL) - Inferior labial sulcus (Sb) and Inferior labial sulcus (Sb) - soft tissue pogonion (Pog’).
H- plane	Tangent drawn from soft tissue pogonion (Pog’) to Labrale superius (UL)
H - angle	Angle formed between H-plane and NB line.
UL-E line	Distance between Labrale superius (UL) to E-line. Determines upper lip convexity.

Table 3 Comparison of hard and soft tissue cephalometric values of Chinese girls and Indian girls.

Variable	Indian girls		Chinese girls		
	mean	SD	mean	SD	P - value
SNA	81.4100	2.48573	79.3500	3.14919	*.027
SNB	76.8450	2.78652	75.1600	2.98177	.073
ANB	4.5800	2.25146	4.1950	1.68694	.544
PP-MP	26.9350	6.56348	27.0700	4.88102	.942
SN-PP	7.4850	2.59195	11.6200	2.86606	***.000
SN-MP	34.4150	5.87119	38.7150	6.55770	*.035
Ptm-A	47.0150	2.14753	40.8800	3.49716	***.000
Co-A	80.2200	3.55463	75.5400	4.98739	**.002
Go-Me	63.2050	5.58150	60.8800	4.29916	.148
Co-Gn	102.4800	5.97200	100.3800	5.19094	.243
Wits	2.0100	3.43004	-1.2550	3.56082	**.005
N-Me	105.7200	6.28420	111.1200	5.82450	**.008
(ANS-Me)/ (N-Me)	.5650	.04894	.4400	.05026	***.000
U1-NA	26.4050	9.84423	28.4950	6.50388	.433
L1-MP	97.2850	9.51803	97.0700	7.97187	.939
Ms6-PP	17.4000	2.07136	20.1100	1.88062	***.000
G-Sn-Pog’	16.7100	5.10654	13.9850	4.74389	.088
LL-Sb-Pog’	120.9050	16.47018	130.9450	14.35591	*.047
H angle	15.5800	4.96361	14.9550	4.81647	.688
UL-E.plane	-.5500	2.20275	1.8400	1.86700	**.001
LL-E.plane	.5100	2.87089	-.5100	3.97120	.358
TN-Sn-UL	120.1300	5.58505	108.7300	10.87852	***.000

Note: *: $P < 0.05$, significant; **: $P < 0.01$, very significant; ***: $P < 0.001$, highly significant.

Table 4 Comparison of hard and soft tissue cephalometric values of Chinese and Indian boys.

Variable	Indian boys		Chinese boys		
	mean	SD	mean	SD	P - value
SNA	81.9500	2.61121	80.9250	3.46515	.297
SNB	77.2100	2.70670	76.5250	3.66877	.506
ANB	4.7300	2.45745	4.4000	1.88205	.636
PP-MP	28.2450	5.69630	27.4000	4.69490	.612
SN-PP	6.6750	3.08611	9.7750	3.67951	**.006
SN-MP	34.9400	5.30456	37.1900	4.04265	.140
Ptm-A	48.8950	3.30748	43.2850	3.11672	***.000
Co-A	83.5550	5.74167	78.5250	4.75858	**.005
Go-Me	65.5450	5.15930	63.3250	3.23336	.111
Co-Gn	106.6900	7.62861	107.5750	6.90399	.703
Wits	2.9950	2.97542	-.7500	2.67788	***.000
N-Me	110.4350	7.23720	113.5250	3.93525	.102
(ANS-Me)/ (N-Me)	.5750	.04443	.4550	.06863	***.000
U1-NA	28.5400	8.74043	29.1000	9.07802	.844
L1-MP	95.6300	6.43077	94.9000	9.07222	.771
Ms6-PP	18.6100	3.14524	21.1000	2.74629	**.011
G-Sn-Pog’	20.5850	7.84765	14.7250	4.36938	**.006
LL-Sb-Pog’	119.5750	17.61536	128.8500	13.72004	.071
H angle	16.8200	9.46231	16.1750	4.12079	.781
UL-E.plane	-.6300	3.65212	1.8250	2.68659	*.020
LL-E.plane	1.3900	4.65594	-.6000	3.92227	.152
TN-Sn-UL	125.7950	11.05938	114.3250	12.38874	**.004

Note: *: $P < 0.05$, significant; **: $P < 0.01$, very significant; ***: $P < 0.001$, highly significant.

Table 5 Comparison of hard and soft tissue cephalometric values of Chinese and Indian adolescents of age 10 to 13 years with class 2 div. 1 malocclusion.

Variable	Indian		Chinese		
	mean	SD	mean	SD	P - value
SNA	81.6800	2.53116	80.1375	3.36412	*.023
SNB	77.0275	2.71775	75.8425	3.37144	087
ANB	4.6550	2.32753	4.2975	1.76715	.441
PP-MP	27.5900	6.10207	27.2350	4.73002	.772
SN-PP	7.0800	2.84273	10.6975	3.38681	***.000
SN-MP	34.6775	5.52925	37.9525	5.43219	**.009
Ptm-A	47.9550	2.91248	42.0825	3.48910	***.000
Co-A	81.8875	5.00683	77.0325	5.04327	***.000
Go-Me	64.3750	5.43591	62.1025	3.95354	*.036
Co-Gn	104.5850	7.09024	103.9775	7.04435	.702
Wits	2.5025	3.20836	-1.0025	3.12028	***.000
N-Me	108.0775	7.10329	112.3225	5.05521	**.003
(ANS-Me)/ (N-Me)	.5700	.04641	.4475	.05986	***.000
U1-NA	27.4725	9.25197	28.7975	7.80067	.491
L1-MP	96.4575	8.06130	95.9850	8.50091	.799
Ms6-PP	18.0050	2.69909	20.6050	2.37670	***.000
G-Sn-Pog’	18.6475	6.82330	14.3550	4.51720	**.001
LL-Sb-Pog’	120.2400	16.84581	129.8975	13.90092	**.007
H angle	16.2000	7.48445	15.5650	4.46723	.646
UL-E.plane	-.5900	2.97716	1.8325	2.28354	***.000
LL-E.plane	.9500	3.84381	-.5550	3.89615	.086
TN-Sn-UL	122.9625	9.11110	111.5275	11.85130	***.000

Note: *: $P < 0.05$, significant; **: $P < 0.01$, very significant; ***: $P < 0.001$, highly significant.

Skeletal class II base relationship, as shown by higher ANB angle, is the relationship of maxilla to the mandible. It was more in Indians than in Chinese, but it was not statistically significant ($P > 0.05$).

In both boys and girls, the angle between the anterior cranial base (SN) and the mandibular plane angle (SN–MP) in the Chinese sample was greater than in the Indian sample. Besides, N-Me, which signifies the anterior facial height of Chinese, was also more than Indian. And the differences were very significant ($P < 0.01$). The angle of mandibular plane to the palatal plane is more or less the same in both races.

The length of the maxilla was greater in Indian children than their Chinese counterparts, and the difference was highly significant ($P < 0.001$). The length of mandible was not significantly different between Indians and Chinese if it was compared between Chinese boys and Indian boys or Chinese girls and Indian girls. But it was significant if it was compared between the Chinese population group and the Indian population group in this study ($P < 0.05$).

The total anterior facial height was significantly larger in the Chinese sample compared with the Indian sample ($P < 0.01$). The difference was not significant in boys. It was very significant between Chinese and Indian girls and between Chinese and Indians in general in this study.

The ratio of lower anterior facial height as compared to the total anterior facial height was smaller in Chinese population compared to Indians. This suggested that the Chinese population had longer lower facial height compared to Indians. Chinese had proclined upper incisors and the difference was highly significant in girls and in the population in general ($P < 0.001$). The mandibular incisors of the Chinese subjects were more upright than Indians, although the difference was not significant.

Facial contour angle (G-Sn--Sn-Pog’) of Indians was significantly greater than Chinese ($P < 0.01$) which suggested either prognathic maxilla or retrognathic mandible, except boys in which difference was not significant ($P > 0.05$). Nasolabial angle was significantly bigger ($P < 0.001$) in Indian girls and Indians in general compared to their Chinese counterparts, and there was also a significant difference in boys ($P < 0.01$). Chinese have more protruding upper lips than Indians. Mentolabial angle (LL-Sb--Sb-Pog’) was greater in Chinese with very significant difference ($P < 0.01$) between Chinese and Indian population, and significant difference between girls ($P < 0.05$).

Discussion

Class II division 1 cases occur more frequently (14.9% to 24%)[8]. Two thirds of the patients with Class II division 1 malocclusion were reported to have an associated significant skeletal discrepancy[9]. Former studies on population norms showed there were some ethnic differences in the facial morphology between Chinese and Caucasians[10,11]. Many investigators have attempted to establish cephalometric norms for Pacific Rim populations, including Japanese, Korean, and Chinese[8, 12,13]. In such diverse and vast countries like India and China, the Class II malocclusion is a common malocclusion with a prevalence ranging between 5% and 29%[14]. Therefore, what is the difference between adolescents with Class II division 1 malocclusion in these two countries? No data are available for the comparison of facial morphology between Indians and Chinese with Class II division 1 malocclusion. This is the first time comparing cephalometric hard and soft tissue values of 10 to 13-year-old Chinese and Indians subjects with Class II division 1 malocclusion.

Cephalometric analysis for orthodontic treatment planning has traditionally been based upon hard tissue relationships. A cephalometric analysis identifies skeletally derived and dentoalveolar malocclusions[15]. The few reported studies on soft tissue analysis using cephalometric radiographs have been limited to Caucasians and some other racial groups[16,17]. Yet establishing soft tissue norms in different populations is equally important, particularly when these values are known to differ between racial groups[17]. Extensive cephalometric studies have been carried out to determine the heritability of certain craniofacial parameters in Class II division 1 malocclusions[10,18]. These investigations showed that, in the Class II patient, the mandible was significantly more retruded than in Class I patients, with the body of the mandible smaller and overall mandibular length reduced. It turned out that ANB angle was more in Indians than Chinese but it was not significant. Significant difference of SNA angle was found between Indian boys and Chinese boys, and between Indian girls and Chinese girls. Retrognathic mandible, as indicated by reduced SNB angle, was seen in Chinese children in general, but there was no significant difference between the two populations. This analysis may remind orthodontists of different characters in soft and hard tissue between the two races, to pay more attention to make personalised diagnoses and treatment plans, especially when using a foreign thesis for reference.

The most commonly used cephalometric analyses were based on samples of Caucasian individuals.

Norms define an ideal status dependent on age, gender, and ethnicity[19]. These studies have shown ethnic differences among these three groups, as well as substantial morphological variations when compared with Caucasians. Such studies include comparisons of native-born Japanese[20] and Turkish[21] adults with normal (near ideal) occlusions and well-balanced faces with a matched group of Caucasians subjects. Some cephalometric studies of the Chinese are based on samples of Taiwanese, Hong Kong and southern Asian Chinese (Malaysia and Singapore) [22,23]. Few have studied the characteristics of skeletal Class II malocclusions in specific ethnic groups[24-26]. Because there are three main ethnicities in Malaysia, Purmal et al studied the differences between the Malaysian Indian and Malaysian Chinese, which provided guidance for our study[7]. Some results differed when comparing Purmal's data with ours. These may be linked to the selection of samples as Purmal studied adults aged 18 to 25 with Angle Class I molar relationship, while in our study, the sample was limited to young children from 10 to 13 years with Angle Class II molar relationship because the vast majority of orthodontic patients were of this age group. The fact that patients' data in different regions of China may vary a lot should also be taken into account. In our study, maxillary prognathism did not show significant differences between the races. However, smaller values were recorded for the mandibular prognathism measurement in Indian subjects compared to the Chinese samples. Mandibular retrusion may be the reason for increased soft tissue convexity for Indian samples.

It is important to take into account the variation in the craniofacial morphology between different races or population during orthodontic diagnosis and treatment planning. The current study developed and compared cephalometric measurements of soft tissue facial profile of a sample of Indian and Chinese children. In India, class II malocclusion has been reported to be relatively more prevalent in north Indian children compared to south Indian children[27,28]. However its prevalence in India was low compared to those reported in China[27-29]. The current study indicated significant differences in craniofacial morphology between individuals of typical Chinese and Indian ancestry. Furthermore, there were significant gender differences in both ethnic samples. Some significant differences showed only when compared among samples of the same gender. G-Sn-Pog' was observed larger in Indian boys, which indicated more protruded faces in Indian boys than Chinese boys. For girls, SNA and was observed larger and SN-MP and LL-Sb-Pog' angle was observed smaller in Indian girls, which may indicate that Indian girls had more protruded maxillas, steeper mandibular plane angles and fuller lips.

The large variation in the prevalence of malocclusion in varying regions of India and China can be due to variations in ethnicity, nutritional status, religious beliefs and dietary habits. Previous studies indicated that facial proportions show little age and sex variation for patients with a pleasing profile and normal occlusion in various ethnic groups[30-32]. Although we tried to avoid these influences while designing the research, further investigations of these two groups, such as differences of skeletal malocclusion, variations of growth with or without orthodontic treatment, are still required.

Conclusion

Compared with Indians, Chinese with Class II division 1 malocclusion have less prognathic maxillas, more protruding lips, steeper mandibular plane angles and more proclined maxillary incisors. When compared within samples of the same gender, Indian boys had more protruded faces and Indian girls had more protruded maxillas, steeper mandibular plane angles and fuller lips. The results suggested that even for the same kind of malocclusion, characters of soft and hard tissues vary with different races and orthodontists should adjust the treatment plans with the variations.

Conflicts of interest

The authors reported no conflicts of interest related to this study.

Author contribution

Dr Naman RANA carried out the experiment, analysed data and prepared the manuscript; Dr Yin Ying QU prepared the manuscript; Ms Yao WEI completed the data analysis; Dr Lin LIU designed the study and revised the manuscript.

(Received April 03, 2016; accepted Oct 17, 2016)

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