ORIGINAL RESEARCH

Distribution of Various Maxilla-Mandibular Positions and Cephalometric Comparison in Chinese Skeletal Class II Malocclusions

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Abstract

Aim: To obtain the distribution of different maxilla-mandibular characteristics in Chinese skeletal class II mixed dentition patients and to compare the differences of cephalometric variables among different maxilla-mandibular types.

Materials and methods: A cross-sectional study was conducted among 310 skeletal class II patients in mixed dentition. The patients were divided into 6 groups according to SNA and SNB angle of the cephalogram. A total of 38 cephalometric measurements were measured on their cephalograms. Differences among groups were tested by one-way analysis of variance.

Results: There were 34 (10.97%) patients in group I, 10 (3.23%) in group II, 4(1.29%) in group III, 69 (22.26%) in group IV, 133 (42.90%) in group V, and 60 (19.35%) in group VI. In all, 14.19% of the patients exhibited maxillary protrusion (MxP), and 62.26% exhibited mandibular retrusion (MnR) with either normal or retruded maxilla. Groups II and III were excluded for statistical comparison due to a limited sample size. Statistical differences were found in 25 cephalometric measurements among the other 4 groups. Patients with MnR (groups V and VI) exhibited bigger sella angle, gonial angle, Frankfort mandibular plane angle, and smaller mandibular body length and ramus height than patients without MnR (p value < 0.05).

Conclusion: The most common etiology forming skeletal class II malocclusion in Chinese children was MnR, which was mainly caused by the small size and hyperdivergent growth direction of mandible.

Clinical significance: The study presents various cephalometric characteristics of Chinese skeletal class II malocclusions. The results indicated that for the early orthodontic treatment of Chinese class II children with mixed dentition, orthodontists might emphasize more importance to mandibular length augmentation and growth direction change in mandible.

Keywords: Cephalometrics, Craniomaxillofacial characteristics, Growth evaluation, Mixed dentition, Skeletal class II.

The Journal of Contemporary Dental Practice (2020): 10.5005/jp-journals-10024-2897

Introduction

Skeletal class II malocclusion is a common type of discrepancy in children with mixed dentition. As a sagittal discrepancy problem, it has different discrepancy mechanisms based on the anteroposterior position of maxilla and mandible. There are six types: maxilla protrusion with normal mandible (MxP and MnN), maxilla protrusion with protruded mandible (MxP and MnP), maxilla protrusion with retruded mandible (MxP and MnR), normal maxilla and mandible (MxN and MnN), normal maxilla with retruded mandible (MxN and MnR), and retruded maxilla and mandible (MxR and MnR).[1]

Children with mixed dentition have relatively more growth potential.[2] Better use of the growth potential could achieve more effective and stable outcomes. In Chinese children with mixed dentition seeking for orthopedic treatment, the most common malocclusion is the skeletal class II malocclusion.[3] The correction of skeletal class II malocclusion includes both skeletal and dental effect. The ideal treatment effect that the orthodontists expect is skeletal effect such as mandibular length augmentation and condyle growth.[4] Application of functional appliances (FAs), especially during the pubertal growth phase, could bring an extent of skeletal effect and dental effect,[5,6] but unavoidably, and some side effects. The side effects of FAs include increase of occlusal plane and gonial angle (Ar-Go-Me), proclination of lower incisors, and retroclination of upper incisors.[7,8] There are about 10 different FAs and their modified devices,[9] and the treatment effects and side effects vary with different appliances. Different types of patients should be treated with appropriate approaches in order to get more skeletal effects and fewer side effects. Accurate analysis of facial types and discrepancy etiology is very important for the treatment plan.

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How to cite this article: Xiong X, Huang Y, Liu W, *et al.* Distribution of Various Maxilla-Mandibular Positions and Cephalometric Comparison in Chinese Skeletal Class II Malocclusions. J Contemp Dent Pract 2020;21(8):822–828.

Source of support: This research was supported by the National Natural Science Foundation of China to Jun Wang (No. 81771114 and No. 81970967).

Conflict of interest: None

For the analysis of facial types and discrepancy mechanisms, cephalogram is the mainly used approach.[10] The proportion varies in different racial and ethnic groups. Cephalometric studies showed 27% of dental class II patients had mandibular retrusion, and 57.3% of the patients had maxillary protrusion (MxP).[11] However, Pancherz reported that ~48 to 49% of Caucasian skeletal class II children at the age of 8 to 10 years had mandible retrusion (MnR).[12] The proportion varies in different racial and ethnic groups. The Mongoloid population, such as Chinese, Korean, Japanese, are apt to develop backward rotated mandible.[13,14] In all, 12.9% of Chinese adult skeletal class II patients exhibited MxP and 60.8% exhibited MnR.[15] For Chinese skeletal class II patients, with relatively more common MnR and smaller mandible, the treatment priority should be different. Therefore, for Chinese skeletal class II children, the application of FAs might be more important. However, the distribution of different types in Chinese skeletal class II patients with mixed dentition have not been explored. Analysis of the proportion and relevant etiology will help to understand the formation of skeletal class II malocclusion and determine the focus of follow-up research.

Thus, the aims of this study were to analyze the distribution of different maxilla-mandibular characteristics in Chinese skeletal class II mixed dentition patients and to compare the differences of cephalometric variables among different maxilla-mandibular types.

Materials and Methods

Subjects

This retrospective study was carried out at department of orthodontics, West China Hospital of Stomatology. The study protocol was approved by the Institutional Review Board of our Hospital (Approval no.WCHSIRB-D-2019-203). Both the patients seeking for treatment and their parents were informed about the possibility that the patients' records might be used for teaching and research purposes, and informed consent was obtained. A total of 310 patients were included in this study.

In this study, patients' medical records, panoramic radiograph, and cephalograms were selected from the database of our hospital and anonymized for analysis. The norms of ANB, SNA, and SNB angle were derived from the database of our hospital.[16]

A total of 872 patients were screened. The inclusion criteria were as follows: (1) Chinese children between the age of 6 and 12 with dentition containing primary and permanent teeth; (2) patients registered in West China Hospital of Stomatology from May 2018 to August 2019; (3) the ANB angle of pretreatment cephalogram was more than 5°;[16] (4) panoramic radiograph showed the permanent dentition was normally developed, without missing teeth or supernumerary teeth, and the tooth germs were taken into account as well; (5) intraoral examination showed no signs of abnormal tooth morphology such as peg-shaped teeth and fused teeth; and (6) pretreatment records with high-quality cephalograms.

Patients who manifested craniofacial syndromes, clefts, trauma, deformity secondary to systematic disease, and had orthodontic or orthognathic treatment before were excluded. After screening, 310 patients were included; subsequently cephalometric analysis and statistical analysis were performed.

Cephalometry

All the cephalograms were taken at the Department of Radiology in our Hospital according to standardized cephalometric radiographic procedures with natural head position and with teeth in centric occlusion.[17]

The lateral cephalograms were obtained during the first visit, after which they were digitalized and analyzed (Uceph, version 780, Chengdu, China) by independent observers.

The patients were divided into six groups according to SNA and SNB angle of the cephalogram:[16]

Group I ($n = 34$): MxP and MnN, SNA > 85°, 82° ≥ SNB ≥ 76°;

Group II ($n = 10$): MxP and MnP, SNA > 85°, SNB > 82°;

Group III ($n = 4$): MxP and MnR, SNA > 85°, SNB < 76°;

Group IV ($n = 69$): MxN and MnN, 85° ≥ SNA ≥ 79°, 82° ≥ SNB ≥ 76°;

Group V ($n = 133$): MxN and MnR, 85° ≥ SNA ≥ 79°, SNB < 76°; and

Group VI ($n = 60$): MxR and MnR, 79° > SNA, SNB < 76°.

The cephalometric reference plane was the Frankfort horizontal (FH) plane. The definitions of landmarks and measurements are presented in Table 1 and Figure 1. There were 35 measurements, classified into five categories (Table 2):

Table 1: Cephalometric landmarks and measurements definitions

Landmark	*Definition*
Orbitale (Or)	The lowest point on the average of the right and left borders of the bony orbit
Porion (P)	The midpoint of the line connecting the most superior point of the radiopacity generated by each of the two ear rods
Sella (S)	The center of sella turcica
Nasion (N)	The most anterior point of the frontonasal suture
Articulare (Ar)	Intersection of the lateral radiographic image of the posterior border of the ramus with the base of the occipital bone
Go (Gonion)	Midpoint of the angle of the mandible, found by bisecting the angle formed by the mandibular plane and a plane through articulare, posterior and along the portion of the mandibular ramus inferior to it
Anterior nasal spine (ANS)	Sharp median process formed by the forward prolongation of the two maxillae at the lower margin of the anterior aperture of the nose
Posterior nasal spine (PNS)	The most posterior point at the sagittal plane on the bony hard palate
Pogonion (Pog)	The most anterior point on the chin
Menton (Me)	The most inferior point on the mandibular symphysis in the midline
Gnathion (Gn)	The lowest, most anterior midline point on the symphysis of the mandible
Upper first molar (UMT)	Maxillary first molar mesial cusp
Upper incisor incisal, Edge (UIE)	The incisal tip of the maxillary central incisor
Lower first molar (LMT)	Mandibular first molar mesial cusp
Lower incisor incisal, Edge (LIE)	The incisal tip of the mandibular central incisor
Soft tissue nasion (N′)	Intersection of the anterior cranial base plane and the forehead soft tissue border
Soft tissue pogonion (Pog′)	The most anterior point on the chin in the midsagittal plane

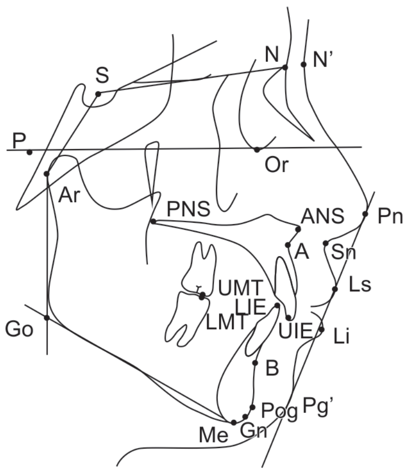

Fig. 1: The cephalometric landmarks used in this study

Cranial measurements: sella angle (N-S-Ar, °), articular angle (S-Ar-Go, °), S-N (mm), and S-Ar (mm).

Maxillary, mandibular, and maxillomandibular skeletal measurements: gonial angle (°), upper gonial angle (°), lower gonial angle (°), PP-FH (°), PP-MP (°), FH-NPo (Facial Angle) (°), mandibular body length (mm), ramus height (mm), A-N Perp distance (mm), Pog-N Perp distance (mm), and S-N/Go-Me (%).

Vertical relationship measurements: SN-MP (°), FMA (°), anterior facial height (mm), upper anterior facial height (N-ANS, mm), lower anterior facial height (ANS-Me, mm), posterior facial height (S-Go, mm), and facial height index (%).

Dental measurements: IMPA (°), FMIA (°), U1-SN (°), U1-L1 (interincisal angle, °) SN-OP (°), MP-OP (°), U6-PP (mm), and L6-MP (mm).

Soft tissue measurements: nasolabial angle (°), soft tissue facial angle (FH-N′Pg′, °), facial convexity angle (N′-Sn-Pg′, °), UL-EP (mm), and LL-EP (mm).

Table 2: Comparison of cephalometric measurements of groups I, IV, V, and group VI ($x \pm s$)

Measurements	*GI (n = 34)*	*GIV (n = 69)*	*GV (n = 133)*	*GVI (n = 60)*	*p*
Cranial measurements					
N-S-Ar (°)	119.197 ± 4.8716	121.620 ± 4.3181	125.088 ± 3.8672	128.417 ± 4.3790	0.000***
S-Ar-Go (°)	152.547 ± 5.3424	150.874 ± 14.7090	150.358 ± 5.2182	148.902 ± 5.6986	0.240
S-N (mm)	59.162 ± 3.7201	60.174 ± 4.5391	60.980 ± 4.8464	59.948 ± 4.3521	0.147
S-Ar (mm)	30.788 ± 2.5506	31.235 ± 3.3530	31.089 ± 3.7132	29.498 ± 3.3808	0.016*
Maxillary, mandibular and maxillomandibular skeletal measurements					
Gonial angle (°)	121.626 ± 6.2711	120.355 ± 5.8506	122.258 ± 6.0081	124.828 ± 7.0089	0.001**
Upper gonial angle (°)	46.974 ± 3.3377	48.103 ± 15.2105	46.858 ± 3.3924	46.857 ± 3.5293	0.735
Lower gonial angle (°)	74.641 ± 4.8512	74.230 ± 4.3721	75.401 ± 4.4315	77.973 ± 5.8076	0.000***
PP-FH (°)	0.335 ± 3.3737	0.061 ± 3.2640	0.310 ± 3.5715	−0.963 ± 3.1914	0.102
PP-MP (°)	26.432 ± 5.0115	27.001 ± 5.2106	28.411 ± 5.0399	31.828 ± 5.9304	0.000***
FH-NPo (Facial Angle) (°)	85.918 ± 3.3186	84.400 ± 2.2479	82.903 ± 2.8125	82.088 ± 2.3452	0.000***
Mandibular body length (mm)	60.959 ± 4.2724	62.054 ± 5.4837	60.549 ± 5.1136	58.233 ± 5.2490	0.001**
Ramus height (mm)	39.518 ± 3.1176	39.033 ± 5.8186	38.692 ± 3.9566	37.330 ± 3.8783	0.065
A-N Perp distance (maxillary skeletal) (mm)	3.124 ± 3.0054	0.483 ± 2.0335	−0.049 ± 2.6478	−1.833 ± 2.3368	0.000***
Pog-N Perp distance (mand. skeletal) (mm)	−6.850 ± 5.5424	−9.546 ± 3.9840	−12.374 ± 5.0959	−13.695 ± 4.2233	0.000***
S-N/Go-Me (%)	96.082 ± 8.1939	96.910 ± 7.5442	99.765 ± 6.0968	102.723 ± 7.7084	0.000***
Vertical relationship measurements					
SN-MP (°)	33.335 ± 5.0289	34.404 ± 4.4918	37.687 ± 4.4394	42.063 ± 5.7939	0.000***
FMA (°)	26.735 ± 5.9613	27.233 ± 4.4354	28.689 ± 4.8483	30.893 ± 5.4483	0.000***
Anterior facial height (mm)	102.541 ± 4.8120	104.632 ± 8.2218	106.538 ± 8.5353	106.607 ± 8.0810	0.036*
Upper anterior facial height, N-ANS (mm)	46.356 ± 2.6656	47.567 ± 3.4740	48.765 ± 4.5107	48.218 ± 3.4777	0.008**
Lower anterior facial height, ANS-Me (mm)	55.203 ± 3.4811	55.807 ± 5.5889	56.037 ± 4.9425	56.392 ± 5.6307	0.737
Posterior facial height (S-Go) (mm)	68.250 ± 3.8592	68.041 ± 7.7363	67.414 ± 6.1875	64.328 ± 5.7124	0.003**
Facial height Index (%)	66.629 ± 3.8770	65.083 ± 5.9671	63.304 ± 3.4535	60.383 ± 3.4987	0.000***
Dental measurements					
IMPA (°)	97.868 ± 7.7346	97.570 ± 5.1673	99.262 ± 6.2497	95.285 ± 7.4341	0.009**
FMIA (°)	55.385 ± 7.2962	55.203 ± 5.8499	52.048 ± 5.9452	53.813 ± 6.1375	0.001**
U1-SN (°)	108.209 ± 9.9821	109.213 ± 8.0640	104.566 ± 8.3296	102.717 ± 10.5305	0.000***
U1-L1 (interincisal angle) (°)	120.585 ± 14.0433	118.812 ± 9.1669	118.478 ± 10.8300	119.937 ± 13.7186	0.727
SN-OP (°)	18.800 ± 3.9969	19.726 ± 3.9418	22.013 ± 3.6525	24.667 ± 3.6695	0.000***
MP-OP (°)	14.574 ± 4.1280	14.681 ± 4.2908	15.678 ± 4.2563	17.397 ± 5.5670	0.003**
U6-PP (mm)	16.506 ± 1.8918	16.162 ± 2.4600	16.208 ± 2.3649	16.197 ± 2.5863	0.912

Contd…

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Measurements	*GI (n = 34)*	*GIV (n = 69)*	*GV (n = 133)*	*GVI (n = 60)*	*p*
L6-MP (mm)	27.553 ± 1.9274	27.932 ± 2.5256	28.056 ± 2.6646	27.470 ± 2.2129	0.408
Soft tissue measurements					
Nasolabial A (°)	105.768 ± 10.3170	101.013 ± 12.6922	104.005 ± 10.3897	102.408 ± 12.1932	0.155
FH-N′Pg′ (S.T. facial angle) (°)	85.918 ± 3.3186	84.400 ± 2.2479	82.903 ± 2.8125	82.088 ± 2.3452	0.000***
N′-Sn-Pg′(facial convexity angle) (°)	156.806 ± 5.2693	160.967 ± 4.8152	158.986 ± 4.2796	160.233 ± 4.3701	0.000***
UL-EP (mm)	4.729 ± 2.3498	3.878 ± 2.0479	4.568 ± 2.0878	3.698 ± 1.9396	0.011*
LL-EP (mm)	4.871 ± 2.6719	3.716 ± 2.8761	4.867 ± 2.6372	4.440 ± 2.3261	0.027*

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 3: Demographic characteristics of different skeletal types

	GI	*GII*	*GIII*	*GIV*	*GV*	*GVI*
Sex						
Female	21	6	2	38	72	36
Male	13	4	2	31	61	24
Proportion (%)	10.97	3.23	1.29	22.26	42.90	19.35
Mean age (Mean ± SD, year)	9.46 ± 1.01	9.44 ± 0.91	9.27 ± 0.49	9.44 ± 0.95	9.24 ± 1.06	9.11 ± 1.29

The values for angular, linear, and proportion cephalometric measurements in each group were evaluated and compared, which are mentioned below.

Statistical Analysis

The interobserver and intra-observer reliability of cephalometry were tested. For interobserver reliability, 20 randomly selected cephalograms were measured by two observers, and the intraclass correlation coefficient (ICC) was calculated. For intra-observer reliability, 20 randomly selected cephalograms were measured by each examiner for the first time. After a washout period of about 1 month, the same cephalograms were repeatedly measured by the observer, and ICC was also calculated. The examiners were not qualified to measure cephalograms unless ICC was greater than 0.8.

Statistical analysis was performed with SPSS software (version 24.0, SPSS Inc, Chicago, IL, USA). The differences in the cephalometric measurements among the groups were evaluated through one-way analysis of variance (one-way ANOVA) when equal variances were assumed (p value > 0.05), and the Duncan multiple comparisons were performed done at a significance level of p value = 0.05 if the difference was statistically significant in one-way ANOVA (p value < 0.05).

Results

Demographic Characteristics

The 310 patients (175 females and 135 males) included in this study had a mean age of 9.24 ± 1.09 years. The most common sagittal skeletal type was group V (MxN and MnR, 42.90%), followed by group IV (MxN and MnN, 22.26%), and group III (MxN and MnR) was the least (1.29%) (Table 3). The greatest ANB value was observed in group III (Fig. 2). As there were only 4 patients in group III and X patients in group II (MxP and MnP), these two groups were not included in the inferential statistics.

Cranial Measurements

Differences in sella angle and posterior cranial base length were statistically significant, whereas articular angle and anterior cranial base length showed no statistical differences among the 4 groups (Table 2). Group VI exhibited the greatest sella angle and the shortest posterior cranial base length, while group I exhibited the least sella angle (Table 4).

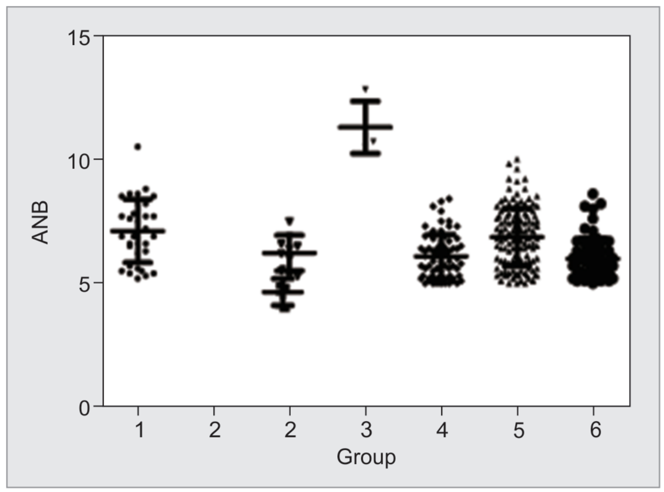

Fig. 2: Distribution of ANB values in types of skeletal class II malocclusions

Maxillary, Mandibular, and Maxillomandibular Skeletal Measurements

Differences in gonial angle, lower gonial angle, PP-MP, FH-NPo (facial angle), mandibular body length, A-N Perp Distance, Pog-N Perp Distance, and S-N/Go-Me were statistically significant, whereas upper gonial angle, PP-FH, and ramus height showed no statistical differences among the 4 groups (Table 2). Group VI exhibited the greatest gonial angle, lower gonial angle, PP-MP, S-N/Go-Me, and the least mandibular body length, A-N Perp Distance. Group I exhibited the greatest facial angle, A-N Perp Distance, and Pog-N Perp Distance.

Vertical Relationship Measurements

Differences in SN-MP, FMA, anterior facial height, upper anterior facial height(N-ANS), posterior facial height(S-Go), and Facial Height

Table 4: Duncan multiple range test for group comparison

Measurements	*Homogeneous subsets with statistically significant difference (p < 0.05)**
N-S-Ar (°)	1 < 4 < 5< 6
S-Ar (mm)	6 < (1, 5, 4)
Gonial angle (°)	(4, 1, 5) < 6
Lower gonial angle (°)	(4, 1, 5) < 6
PP-MP (°)	(1, 4, 5) < 6
FH-NPo (Facial angle) (°)	(6, 5) < 4 < 1
Mandibular body length (mm)	6 < (5, 1, 4)
A-N Perp distance (Maxillary skeletal) (mm)	6 < (5, 4) < 1
Pog-N Perp distance (Mand. skeletal) (mm)	(6, 5) < 4 < 1
S-N/Go-Me (%)	(1, 4) < 5 < 6
SN-MP (°)	1 < 4 < (5, 6)
FMA (°)	(1, 4) < (4, 5) < 6
Anterior facial height (mm)	(1, 4) < (4, 5, 6)
Upper anterior facial height, N-ANS (mm)	(1, 4) < (4, 6, 5)
Posterior facial height (S-Go) (mm)	6 < (5, 4 ,1)
Facial height index (%)	6 <5 < 4 < 1
IMPA (°)	(6, 4, 1) < (4, 1, 5)
FMIA (°)	(5, 6) < (6, 4, 1)
U1-SN (°)	(6, 5) < (1, 4)
SN-OP (°)	(1, 4) < 5 < 6
MP-OP (°)	(1, 4, 5) < 6
FH-N′Pg′ (S.T. facial angle) (°)	(6, 5) < 4 < 1
N′-Sn-Pg′ (Facial convexity angle) (°)	1 < (5, 6) < (6, 4)
UL-EP (mm)	(6, 4) < (4, 5) < (5, 1)
LL-EP (mm)	(4, 6) < (6, 5, 1)

Index were statistically significant, whereas lower anterior facial height (ANS-Me) showed no statistical differences among the 4 groups (Table 2). Facial Height Index had the most effective ability to discriminate the differences among the 4 groups compared to other variables related to vertical relationship (Table 4). Group I exhibited the greatest posterior facial height, facial height index, and the least SN-MP, FMA, anterior facial height, and upper anterior facial height (Table 4).

Dental Measurements

Differences in IMPA, FMIA, U1-SN, SN-OP, and MP-OP were statistically significant, whereas Interincisal Angle, U6-PP, and L6-MP showed no statistical differences among the 4 groups (Table 2). Group VI exhibited the greatest SN-OP, MP-OP, and smaller IMPA than group V. Group V showed smaller FMIA and U1-SN than groups I and IV (Table 4).

Soft Tissue Measurements

Differences in FH-N′Pg′ (S.T. Facial Angle), N′-Sn-Pg′ (Facial convexity angle), UL-EP, and LL-EP were statistically significant, whereas nasolabial angle showed no statistical differences among the 4 groups (Table 2). Group I exhibited the greatest S.T. facial angle and the least facial convexity angle. Group V showed smaller FMIA and U1-SN than groups I and IV (Table 4). Group VI showed smaller

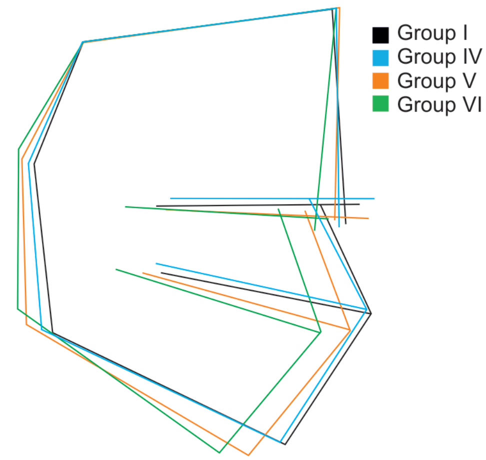

Fig. 3: Mean profilograms of group I (MxP and MnN, black line), group IV (MxN and MnN, blue line), group V (MxN and MnR, yellow line), and group VI (MxR and MnR, green line)

UL-EP than group V. Group V showed smaller UL-EP than group I. Group IV showed smaller LL-EP than groups V and I.

We infer that the most common etiology forming skeletal class II malocclusion in Chinese children was MnR, which was mainly caused by the small size and hyperdivergent growth direction of mandible.

Discussion

In this study, we described the proportion of different facial types in Chinese skeletal class II patients with mixed dentition and analyzed the differences in craniomaxillofacial characteristics. Patients with MxP and MnP (group II) and patients with MxP and MnR (group III) had a small proportion which was 3.23% and 1.29%, respectively. In all, 62.26% of the patients exhibited MnR with either normal or retruded maxilla, suggesting a large portion of mandibular deficiency and clockwise rotation. There were statistical differences in 25 cephalometric measurements among groups I, IV, V and VI. Each facial type showed unique craniomaxillofacial characteristics to some extent.

Our study showed only 15.49% of the sample exhibited maxillary protrusion, which was quite different from several previous studies.[18,19] The most possible reason might be the ethnic difference. The Caucasian population had relatively protrusive maxilla,[20] and compared to Caucasian, Chinese had smaller mandible and steeper mandibular plane.[21] The facial types of group I and group IV did not show excessive discrepancies in vertical measurement. The maxilla in group I showed excessive forward growth. Thus, for the treatment of group I, restricting the growth of maxilla with anchorage might be critical.

About three-fifth of the sample showed mandible retrusion. Compared to group IV, group V possessed greater clockwise-rotated mandible (Fig. 3). And for group VI, this trend was more obvious. Group VI exhibited the greatest PP-MP, FMA, SN-OP and MP-OP, which suggests the clockwise rotation might start from the palatal and get more obvious at the occlusal plane. Our findings are in agreement with Fushima et al.[22] who reported that steep cant of posterior occlusal plane was strongly correlated with small, retruded mandible with backward rotation.

It is interesting that around one-fifth of the sample exhibited MxR and MnR. And this type showed the biggest sella angle and shortest posterior cranial base. Louis[23] revealed that patients with longer posterior cranial bases had more retruded mandibles. As the difference in sella angle was more remarkable, we could infer that maybe the shorter posterior cranial base in group VI was to compensate for the bigger sella angle. Besides, the size of mandible in group VI was the smallest, and in vertical measurements, group VI had the biggest SN-MP and FH-MP. Thus, if orthopedic treatment could alter the growth direction and amount of mandible, guiding it to grow counterclockwise would be critical.[24] For severe retruded and small mandible, it might be better to wait for orthognathic surgery and not to intervene early. For the treatment strategy of mild to moderate MxR and MnR, restricting the maxillary might need to be avoided, and in order to get a normal craniomaxillary relationship, promoting the growth of maxillary and creating enough space for mandible growth and counterclockwise rotation could be considered.

A remarkable advantage of this study is the large sample size. Compared to historic studies, more comprehensive cephalometric measurements were used to describe the features of different facial types from different aspects. We found that the main factor causing skeletal class II malocclusion in Chinese children with mixed dentition was MnR, which exhibited a relatively small size and clockwise-rotation tendency of mandible. Thus, the importance of FAs for Chinese class II children should be reconsidered thoroughly. There might be more need for length augmentation and growth direction change of mandible in Chinese children. Several studies reported the favorable effects of FAs in Mongoloid children and young adults.[25–27] With more clinical trials in the future confirming the effects of FAs in Mongoloid population, especially Chinese, the application of FAs could be encouraged.

One major limitation of this study was that the relative jaw relationship was determined by ANB angle. The ANB angle is mostly used by clinicians, and it is directly related to the cranial base, which helps us to illustrate mechanisms. However, based on some studies, ANB angle did have some fallacies,[28] as it might be influenced by sagittal position of point N, length of anterior cranial base, maxillary rotation, and vertical distance between point A and B as well as point N and B. In our study, the length of anterior cranial base showed no significant differences in each group. And we evaluated A-N Perp Distance, Pog-N Perp Distance according to McNamara analysis,[29] which showed a similar trend with SNA and SNB. The error caused by ANB angle was relatively small.

Conclusion

This cross-sectional study showed that the most common etiology forming skeletal class II malocclusion in Chinese children was mandibular retrusion, which was mainly caused by the small size and hyperdivergent growth direction of the mandible. For the early orthodontic treatment of Chinese class II children with mixed dentition, orthodontists should emphasize mandibular length augmentation and growth direction change of mandible.

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