

A study of Steiner cephalometric analysis for Chinese children with maxillary protrusion

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We examined the facial characteristics of Chinese children with maxillary protrusion using Steiner analysis. Fifty boys and 50 girls were selected from a clinic in Shanong, China, who were classified by Hellman's developmental stage III C and chronological age stage IV. Angular and linear measurements were determined. In comparison with pre-existing measurement values for Chinese, the ANB angle, U1 to NA (mm), U1 to NA (angle), Po to NB and \angle GoGn to SN values for the Chinese subjects were significantly larger for stage IIIC, while the SNB angle, SND angle, Interincisal angle, \angle Occl to SN, and SL values were significantly smaller. Compared to measurement values for Japanese, SNA angle, ANB angle, U1 to NA (mm), U1 to NA (angle), \angle GoGn to SN, and SE were larger, and the SNB angle, SND angle, L1 to NB (angle), Interincisal angle, \angle Occl to SN, and SL were smaller. These results demonstrate that the maxilla of Chinese in maxillary protrusion did not show overgrowth while the mandible showed undergrowth. Nevertheless, the clockwise rotation of the mandible of Chinese was smaller than that of Japanese. Based on the above findings, it was suggested that maxillary protrusion in Chinese is easier to treat than in Japanese. (J Osaka Dent Univ 2021; 55: 65-72)

Key words : DCephalometric radiography ; Steiner analysis ; Chinese children ; Maxillary protrusion

INTRODUCTION

Since Broadbent¹ introduced the roentgenographic cephalometric analysis, this diagnostic method has been used in numerous studies of craniofacial growth, development, function, and ethnicity-related characteristics.²⁻⁴ At present, measurement methods have been standardized for Caucasians and Japanese, and have been applied in clinical orthodontics.⁵⁻⁸ These methods have enabled the evaluation of the morphological characteristics of the maxillofacial region, development patterns, and the relationship between the dental arch and the maxillofacial region. Among these methods is the Steiner analysis⁹ which focuses on the relationship among the ANB angle, the U1 to NA angle, and the L1 to NB angle. The method also focuses on the position of the incisal edge of the maxillary and mandibular central incisors with respect to the NA and NB lines. It also serves as a benchmark for treatment

methods as it establishes the occlusal relationship of the anterior teeth according to the ANB angle for each case. Nevertheless, age, sex, race, individual differences, and growth should still be considered. In particular, there are only a handful of studies that have examined the relationship between the maxillofacial complex and dentition among Chinese. Several reports^{10,11} have been made on the standard values in school children with normal occlusion; however, no systematic study has been conducted on the maxillofacial morphology of maxillary protrusion during the growth period. Our study aimed to grasp the morphological characteristics of maxillary protrusion in Chinese and establish guidelines for clinical orthodontics. With this purpose in mind, we compared and examined each value measured using the Steiner analysis which is a widely accepted benchmark for orthodontic treatment.

MATERIALS AND METHODS

Subjects

Among patients at Hellman's developmental stage IIIC¹² who were primarily diagnosed with maxillary protrusion at an orthodontic clinic in Shanong, China, a total of 100 patients (50 boys and 50 girls) were selected who had an overjet of at least 4 mm, an ANB angle greater than 4°, no abnormalities in the number or morphology of the teeth, and no history of orthodontic treatment. The age and gender

distribution is shown in Table 1.

Methods

We measured the following 14 Steiner analysis items shown in Fig. 1 using cephalometric images of 100 stage IIIC subjects and 78 in stage IV. In addition, we measured the Tweed triangle, overbite, and overjet. The Student's *t*-test was performed on each measurement value, and a comparative analysis was performed using pre-existing measurement values for Chinese,^{10, 11} Japanese,¹³ and

Table 1 Subjects in the present study

Subjects	Stage IIIC	Stage IV	Guo	Wang	Japanese
Number	100 (50 M, 50 F)	78 (40 M, 38 F)	96 (50 M, 46 F)	69 (34 M, 35 F)	90 (40 M, 50 F)
Range of ages	10 y 9 m-15 y 1 m	11 y 0 m-13 y 10 m	11 y 0 m-13 y 0 m	12 y 0 m-12 y 11 m	7 y 11 m-12 y 4 m
Mean age	12 y 3 m	11 y 11 m	12 y 4 m	12 y 6 m	10 y 9 m

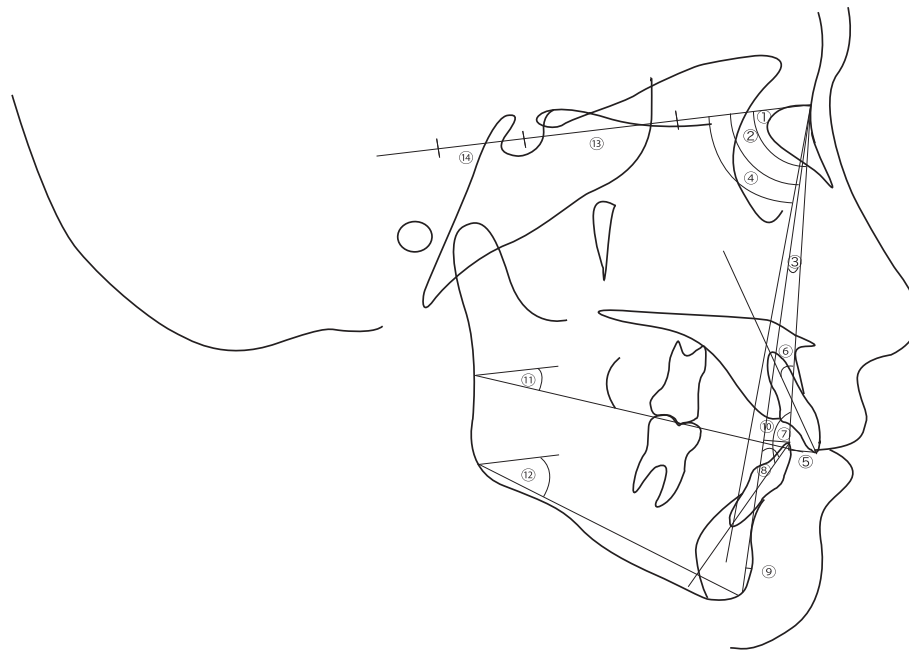


Fig. 1 Measurements on the lateral cephalogram. ① \angle SNA (angle), ② \angle SNB (angle), ③ \angle ANB (angle), ④ \angle SND (angle) (angle formed by the SN plane and the line through the point (D) of the center of the mass of cross-section of the body of the symphysis and S), ⑤ U1 to NA (mm) (shortest distance from edge of the maxillary central teeth to the NA line), ⑥ \angle U1 to NA (angle) (angle formed by the NA line and the axis of the maxillary central incisor), ⑦ L1 to NB (mm) (shortest distance from edge of the mandibular central incisor to the NB line), ⑧ \angle L1 to NB (angle) (angle formed by the NB line and the axis of the mandibular central incisor), ⑨ Pog to NB (mm) (shortest distance from Po to the NB line), ⑩ \angle Interincisal (angle), ⑪ \angle Occlusal to SN (angle), ⑫ \angle GoGn to SN (angle), ⑬ SL (mm) (distance from S to the point (L) of the intersection formed by a line from the most anterior point of the mandible (Po) to the SN plane), ⑭ SE (mm) (distance from S to the point (E) of the intersection formed by a line from the most distal point of the head of the condyle perpendicular to the SN plane).

Caucasians.¹⁴

RESULTS

Upon comparing 50 boys and 50 girls with maxillary protrusion in this study, we found out that U1 to NA (mm), U1 to NA (angle), \angle Occ to SN, and SL were significantly larger, and the SND angle was significantly smaller in boys than in girls. Furthermore, comparing the measured values of 100 subjects (50 boys and 50 girls with maxillary protrusion) to existing measurements for Chinese, we found out that the ANB angle, U1 to NA (mm), U1 to Na (angle), Po to NB, \angle GoGn to SN, and SE were significantly larger than the values for Chinese measured by Guo.¹⁰ Furthermore, the SNB angle, SND angle, L1 to NB (mm), Interincisal angle, \angle Occl to SN, and SL were significantly smaller. Moreover, upon comparing the measurements to Wang,¹¹ the ANB angle, U1 to NA (mm), U1 to NA (angle), L1 to NB (mm), L1 to NB (angle), Po to NB, and \angle GoGn to SN were significantly larger and the SNB angle, SND angle, Interincisal angle, \angle Occl to SN, and SL were significantly smaller. Compared to Miura's measurements¹³ of Japanese, the SNA angle, ANB angle, U1 to NA (mm), U1 to NA (angle), \angle GoGn to SN, and SE were significantly larger, while the SNB angle, SND angle, L1 to NB (angle), Interinci-

sal angle, \angle Occl to SN, and SL were significantly smaller (Tables 2-5).

Next, we compared all 100 subjects in this study with 78 subjects who were at stage IV of their chronological age. We found no significant differences in any of the items. Furthermore, we compared the measured values of the 50 boys in this study and 48 boys who were at stage IV of their chronological age, and we found that the 50 boys had significantly larger U1 to NA (mm), Occl to SN, and SL. When the 50 girls in this study were compared with 38 girls in stage IV of their chronological age, we found that the 50 girls had a larger Interincisal angle, and SL, and a significantly smaller U1 to NA (mm). The 78 subjects who were in stage IV of their chronological age had a significantly larger ANB angle, U1 to NA (mm), U1 to Na (angle), Po to NB, \angle GoGn to SN, and SE compared to the val-

Table 3 Measurements for stage IIIC males and females

Parameter	IIIC (M) n=50	IIIC (F) n=50	IIIC (M and F) n=100
FMA (angle)	27.33±3.14	27.68±3.01	27.50±3.07
FMIA (angle)	54.40±5.01	52.92±5.44	53.68±5.25
IMPA (angle)	98.27±4.80	99.40±5.13	98.82±4.97
Overbite (mm)	6.62±1.42	6.02±1.44	6.33±1.46
Overjet (mm)	5.46±1.00	5.15±1.22	5.31±1.12

Table 2 Comparison of measurements for males and females in stage IIIC

Parameter	IIIC (M) n=50	IIIC (F) n=50	IIIC (M and F) n=100	t-test (IIIC M and IIIC F)
\angle SNA (angle)	80.96±2.64	81.52±3.04	81.24±2.84	NS
\angle SNB (angle)	75.23±2.59	75.70±3.09	75.46±2.84	NS
\angle ANB (angle)	5.74±1.02	5.82±0.93	5.78±0.97	NS
\angle SND (angle)	72.82±2.96	75.70±3.09	72.94±3.54	*
U1 to NA (mm)	7.86±3.70	6.41±2.41	7.15±3.20	*
U1 to NA (angle)	30.52±7.84	29.41±6.38	29.98±7.15	*
L1 to NB (mm)	7.82±2.84	7.14±2.57	7.49±2.72	NS
L1 to NB (angle)	30.09±5.75	30.31±7.05	30.20±6.39	NS
Po to NB (mm)	0.91±1.57	1.11±1.80	1.01±1.68	NS
Interincisal (angle)	113.93±8.48	114.38±8.44	114.15±8.42	NS
Occl to SN (angle)	18.47±4.65	17.31±4.75	17.90±4.71	*
GoGn to SN (angle)	35.71±2.74	35.27±3.41	35.50±3.08	NS
SL (mm)	37.49±6.47	35.54±6.94	36.54±6.69	*
SE (mm)	23.91±8.69	23.55±10.90	23.73±9.70	NS

Mean±SD, NS : Not significant, * p <0.05.

Table 4 Measurements for Stage IIIC compared with pre-existing measurement values for Chinese and Japanese

Parameter	IIIC (M) n=50	IIIC (F) n=50	IIIC (M and F) n=100	Chinese (Guo) n=96	Chinese (Wang) n=69	Japanese n=90	t-test (IIIC M and IIIC F)	t-test (IIIC and Guo)	t-test (IIIC and Wang)	t-test (IIIC and Japanese)
∠SNA (angle)	80.96±2.64	81.52±3.04	81.24±2.84	81.5±3.5	82.21±3.24	81.3±3.2	NS	NS	NS	*
∠SNB (angle)	75.23±2.59	75.70±3.09	75.46±2.84	77.7±3.2	79.15±2.92	76.8±3.0	NS	*	*	*
∠ANB (angle)	5.74±1.02	5.82±0.93	5.78±0.97	4.0±1.8	3.07±1.54	4.5±1.7	NS	*	*	*
∠SND (angle)	72.82±2.96	75.70±3.09	72.94±3.54	74.2±3.1	75.83±2.86	73.4±3.1	*	*	*	*
U1 to NA (mm)	7.86±3.70	6.41±2.41	7.15±3.20	6.1±2.0	4.17±1.82	5.9±1.8	*	*	*	*
U1 to NA (angle)	30.52±7.84	29.41±6.38	29.98±7.15	24.2±5.4	22.49±4.25	24.1±4.9	*	*	*	*
L1 to NB (mm)	7.82±2.84	7.14±2.57	7.49±2.72	7.8±2.0	4.76±2.14	7.8±2.1	NS	NS	*	NS
L1 to NB (angle)	30.09±5.75	30.31±7.05	30.20±6.39	31.6±5.5	27.09±6.54	31.2±5.6	NS	*	*	*
Po to NB (mm)	0.91±1.57	1.11±1.80	1.01±1.68	0.3±1.4	-0.11±1.14	0.4±1.3	NS	*	*	NS
Interincisal (angle)	113.93±8.48	114.38±8.44	114.15±8.42	119.9±8.5	127.35±7.93	120.3±8.5	NS	*	*	*
Occl to SN (angle)	18.47±4.65	17.31±4.75	17.90±4.71	18.8±3.8	19.70±3.77	20.0±3.7	*	*	*	*
GoGn to SN (angle)	35.71±2.74	35.27±3.41	35.50±3.08	33.0±4.4	32.79±4.19	36.2±4.5	NS	*	*	*
SL (mm)	37.49±6.47	35.54±6.94	36.54±6.69	42.9±6.7	48.39±5.49	41.1±5.9	*	*	*	*
SE (mm)	23.91±8.69	23.55±10.90	23.73±9.70	20.0±2.9	20.82±2.91	21.0±3.0	NS	*	NS	*

Table 5 Measurements for stage IIIC with stage IV

Parameter	Stage IIIC M n=50	Stage IIIC F n=50	Stage IIIC M and F n=100	Stage IV M n=40	Stage IV F n=38	Stage IV M and F n=78	t-test Stages IIIC and IV	t-test Stages IIIC M and IV M	t-test Stages IIIC F and IV F
∠SNA (angle)	80.96±2.64	81.52±3.04	81.24±2.84	81.41±2.59	81.52±3.19	81.46±2.88	NS	NS	NS
∠SNB (angle)	75.23±2.59	75.70±3.09	75.46±2.84	75.67±2.61	75.71±3.27	75.69±2.93	NS	NS	NS
∠ANB (angle)	5.74±1.02	5.82±0.93	5.78±0.97	5.74±1.08	5.81±1.01	5.77±1.04	NS	NS	NS
∠SND (angle)	72.82±2.96	75.70±3.09	72.94±3.54	73.24±3.01	73.15±4.32	73.20±3.68	NS	NS	NS
U1toNA (mm)	7.86±3.70	6.41±2.41	7.15±3.20	7.46±3.66	6.36±2.65	6.92±3.24	NS	*	*
U1toNA (angle)	30.52±7.84	29.41±6.38	29.98±7.15	30.30±7.95	29.33±6.94	29.83±7.44	NS	NS	NS
L1toNB (mm)	7.82±2.84	7.14±2.57	7.49±2.72	7.71±2.60	7.20±2.72	7.46±2.65	NS	NS	NS
L1toNB (angle)	30.09±5.75	30.31±7.05	30.20±6.39	30.56±5.39	30.63±7.22	30.59±6.30	NS	NS	NS
PotoNB (mm)	0.91±1.57	1.11±1.80	1.01±1.68	0.74±1.50	0.97±1.75	0.85±1.62	NS	NS	NS
Interincisal (angle)	113.93±8.48	114.38±8.44	114.15±8.42	113.51±8.19	114.16±8.46	113.82±8.27	NS	NS	*
OccltoSN (angle)	18.47±4.65	17.31±4.75	17.90±4.71	18.01±4.74	17.45±4.75	17.73±4.72	NS	*	NS
GoGntoSN (angle)	35.71±2.74	35.27±3.41	35.50±3.08	35.46±2.70	35.19±3.31	35.33±3.00	NS	NS	NS
SL (mm)	37.49±6.47	35.54±6.94	36.54±6.69	37.08±6.44	35.08±7.36	36.11±6.93	NS	*	*
SE (mm)	23.91±8.69	23.55±10.90	23.73±9.70	23.46±9.53	23.10±10.68	23.29±10.04	NS	NS	NS

Table 6 Measurements for stage IV compared with pre-existing values for Chinese and Japanese

Parameter	Stage IV n=78	Chinese (Guo) n=96	Chinese (Wang) n=69	Japanese n=90	t-test SIV and Guo	t-test SIV and Wang	t-test SIV and Japanese
∠SNA (angle)	81.46±2.88	81.5±3.5	82.21±3.24	81.3±3.2	NS	*	*
∠SNB (angle)	75.69±2.93	77.7±3.2	79.15±2.92	76.8±3.0	*	*	*
∠ANB (angle)	5.77±1.04	4.0±1.8	3.07±1.54	4.5±1.7	*	*	*
∠SND (angle)	73.20±3.68	74.2±3.1	75.83±2.86	73.4±3.1	*	*	*
U1toNA (mm)	6.92±3.24	6.1±2.0	4.17±1.82	5.9±1.8	*	*	*
U1toNA (angle)	29.83±7.44	24.2±5.4	22.49±4.25	24.1±4.9	*	*	*
L1toNB (mm)	7.46±2.65	7.8±2.0	4.76±2.14	7.8±2.1	*	NS	NS
L1toNB (angle)	30.59±6.30	31.6±5.5	27.09±6.54	31.2±5.6	NS	*	NS
PotoNB (mm)	0.85±1.62	0.3±1.4	-0.11±1.14	0.4±1.3	*	*	*
Interincisal (angle)	113.82±8.27	119.9±8.5	127.35±7.93	120.3±8.5	*	*	*
OccltoSN (angle)	17.73±4.72	18.8±3.8	19.70±3.77	20.0±3.7	*	*	*
GoGntoSN (angle)	35.33±3.00	33.0±4.4	32.79±4.19	36.2±4.5	*	*	NS
SL (mm)	36.11±6.93	42.9±6.7	48.39±5.49	41.1±5.9	*	*	*
SE (mm)	23.29±10.04	20.0±2.9	20.82±2.91	21.0±3.0	*	*	*

ues for Chinese measured by Guo.¹⁰ Furthermore, the SNB angle, SND angle, L1 to NB (mm), Interincisal angle, ∠Occl to SN, and SL were significantly smaller. Moreover, when compared with the measurements taken by Wang,¹¹ the NA (angle), L1 to NB (angle), Po to NB, ∠GoGn to SN, and SE were larger, while the SNA angle, SNB angle, SND angle, Interincisal angle, ∠Occl to SN, and SL were significantly smaller. When compared with the measurements of Japanese taken by Miura,¹³ the SNA angle, ANB angle, U1 to NA (mm), U1 to Na (angle), Pog to NB, and SE were significantly larger, while SNB angle, SND angle, Interincisal angle, ∠Occl to SN, and SL were significantly smaller.

In terms of average values, compared to existing measurements of Caucasians,¹⁴ the 100 subjects in this study had a larger ANB angle, U1 to NA (mm), U1 to NA (angle), L1 to NB (mm), L1 to NB (angle), Po to NB, ∠Occl to SN, ∠GoGn to SN, and SE, and a smaller SNA angle, SNB angle, SND angle, and Interincisal angle. The 78 subjects who were at stage IV of their chronological age had a larger ANB angle, U1 to NA (mm), U1 to NA (angle), L1 to NB (mm), L1 to NB (angle), Po to NB, ∠Occl to SN, ∠GoGn to SN, and SE, and a smaller SNA angle, SNB angle, SND angle, Interincisal angle, and SL compared to existing measurements for Caucasians. In terms of the Tweed triangle, FMA

Table 7 Values for Stages IIIC IV, and pre-existing values for Caucasians

Parameter	Stage IIIC M and F n=100	Stage IV M and F n=78	Caucasian
∠SNA (angle)	81.24±2.84	81.46±2.8882	82
∠SNB (angle)	75.46±2.84	75.69±2.9380	80
∠ANB (angle)	5.78±0.97	5.77±1.042	2
∠SND (angle)	72.94±3.54	73.20±3.6876	76
U1toNA (mm)	7.15±3.20	6.92±3.244	4
U1toNA (angle)	29.98±7.15	29.83±7.4422	22
L1toNB (mm)	7.49±2.72	7.46±2.654	4
L1toNB (angle)	30.20±6.39	30.59±6.3025	25
PotoNB (mm)	1.01±1.68	0.85±1.620	0
Interincisal (angle)	114.15±8.42	113.82±8.27131	131
OccltoSN (angle)	17.90±4.71	17.73±4.7214	14
GoGntoSN (angle)	35.50±3.08	35.33±3.0032	32
SL (mm)	36.54±6.69	36.11±6.9351	51
SE (mm)	23.73±9.70	23.29±10.0422	22

for boys and girls was 27.3° and 27.7° (mean 27.5°), FMIA was 54.4° and 52.9° (mean 53.7°), and IMPA was 98.3° and 99.4° (mean 98.8°), respectively. Furthermore, overbite was 6.6 mm for boys and 6.0 mm for girls (mean 6.3), while the overjet was 5.5 mm for boys and 5.2 mm for girls (mean 5.3 mm) (Tables 6 and 7).

DISCUSSION

Materials

Because growth of the facial skeleton is closely related to tooth eruption, Hellman's developmental

stage,¹² which is the physiological age, is usually used to study growth and development. The age of the Chinese subjects ranged from 11 y 0 m to 13 y 0 m as reported by Guo¹⁰ and was 12 y 0 m to 12 y 11 m as reported by Wang.¹¹ In this study, the age of subjects at developmental stage IIIC was 11 y 0 m to 13 y 10 m for boys (mean 11 y 11 m) and was 11 y 0 m to 13 y 9 m for girls (mean 11 y 11 m). These ages were similar to the average age for boys and girls at stage IIIC. Furthermore, the age at stage IV of the chronological age, was 11 y 0 m to 13 y 10 m for boys (mean 11 y 11 m) and was 11 y 0 m to 13 y 9 m for girls (mean 11 y 11 m). These ages were similar to the average age for boys and girls at Stage IIIC. In addition, no significant differences were noted among any of the values that we obtained for Hellman's developmental stage IIIC or the chronological age stage IV. Because of this, we decided to use each value in stage IIIC and IV as the reference value for the Steiner analysis of the measurements for Chinese that we obtained.

Maxillary protrusion

A study by Susami *et al.*¹⁵ revealed that malocclusion also changes with age. According to their report, among the age-related changes in malocclusion reported in Japanese, maxillary protrusion was extremely rare in the primary dentition. However, protrusion increases slightly by the time the central incisors and first molars begin to erupt. Furthermore, once the central incisors and first molars have completely erupted, the protrusion increases by three-fold compared to when the eruption started. Although the protrusion increases slightly during the replacement period of the buccal segment, the incidence of maxillary protrusion does not change significantly after that period. In addition, all types of maxillary protrusion where the individual feels a protruding sensation of the teeth, including bimaxillary protrusion, should be taken into account. However, the feeling of tooth protrusion is experienced not only when the overjet is large, but also when the overjet of the anterior teeth is small. This is also related to overbite, wherein the larger

the overbite, the greater the feeling of tooth protrusion. However, factors that determine the feeling of tooth protrusion include not only the extent of overjet and overbite, but also cephalometric landmarks. The horizontal and vertical positional relationships between points A and B, the outer shape of the mandibular symphysis, the positional relationship of the upper and lower lips, and the relative positional relationships of the pronasale, subnasale, supramentale, pogonion, and other measurements are also major factors.

Generally, maxillary protrusion is roughly classified into the skeletal and denture types, which are limited to the teeth and alveolar region, and the functional type, which is caused by abnormal jaw movement. Otani *et al.*¹⁶ used \angle U1-SN, \angle L1-SN, SNA angle, SNB angle, distances A-Ptm, and Go-Me as measurement items to classify the condition of the jaw during maxillary protrusion. Giving priority to skeletal classification, the following 6 types were enumerated, 1) maxillary anterior teeth with labial inclination, and normal mandibulomaxillary size and position, 2) mandibular anterior teeth with labial inclination, and normal maxillary and mandibular size and position, 3) maxilla in the mesial position but with normal maxillary size, 4) maxilla in the mesial position and large in size, 5) mandible is in the posterior position and small in size, and 6) mandible is in the posterior position, but of normal size. In addition to these classifications, in terms of denture pattern, a merged type involving 1) and 2) may occur. In terms of the skeletal pattern, a merged type involving either 3) or 4) and 5) or 6) may occur. In this study, the Steiner analysis included the SNA and SNB angles. We believe that \angle U1-SN can be evaluated by U1 to NA (mm) and U1 to NA (angle), and that \angle L1-SN can be evaluated by L1 to NA (mm) and the L1 to NA (angle), and that Go-Me can be evaluated by SL.

Comparison with pre-existing measurement values

The main purpose of this study was to understand the morphological characteristics of maxillary protrusion in Chinese. To date, we have performed or-

thodontic diagnosis and treatment using different criteria based on the material we obtained. Moving forward, orthodontic treatment for Chinese requires the clarification of morphological characteristics of Chinese with maxillary protrusion. In addition, it is necessary to set acceptable treatment goals for Chinese by grasping their normal values. In this study, we compared the values we obtained with existing measurements, and used measurements obtained at Hellman's developmental stage IIIC and chronological age stage IV since the age groups detailed in the materials we collected were similar. In comparison with existing measurements for Chinese, the measurements at stage IIIC were compared with the reports of Guo¹⁰ and Wang.¹¹ We found that the ANB angle, U1 to NA (mm), U1 to NA (angle), Po to NB, \angle GoGn to SN, and SE were significantly larger while the SNB angle, SND angle, Interincisal angle, \angle Occl to SN, and SL were significantly smaller.

In this study, 100 subjects who were at stage IIIC were compared with 78 subjects who were at stage IV of their chronological age. No significant differences were observed among any of the items. Similar results were obtained by comparison with existing measurements for Chinese. Although small differences were found with the exiting measurements for Chinese used in this study, we think that these were due to differences in the age when the data was collected. We found that maxillary protrusion in Chinese had morphological characteristics such as the absence of maxillary overgrowth, and recession and expansion of the mandible in the skeletal type. Regarding the denture type, we found that although the labial inclination of the maxillary anterior teeth was remarkable, there was no labial inclination of the mandibular anterior teeth. We also found that the occlusal plane was flatter than that for the standard value. When compared with existing measurements of Japanese, the ANB angle, U1 to NA (mm), and U1 to NA (angle) showed significantly larger values, while the SNB angle, Interincisal angle, \angle Occl to SN, \angle GoGn to SN, and SL showed significantly smaller values in both stages IIIC and IV.

In comparison with the measured values for Caucasians, the ANB angle, U1 to NA (mm), U1 to NA (angle), Po to NB, \angle Occl to SN, \angle GoGn to SN, and SE showed larger values, while the SNB angle, SND angle, Interincisal angle, and SL showed smaller values. From these results, in the skeletal system, the maxillary protrusion in Chinese had no maxillary overgrowth as in Japanese, while the mandibular undergrowth and labial inclination of the maxillary anterior teeth were remarkable. Furthermore, the maxilla of Chinese is reported to be more active than that of Japanese and Caucasians.¹⁷ However, in maxillary protrusion, the maxillary overgrowth was not observed in Chinese, and it was found that clockwise mandibular rotation was smaller than in Japanese but larger than in Caucasians. In dentistry, although the labial inclination of the maxillary anterior teeth in Chinese was smaller than that in Japanese, we found that the tendency for maxillary protrusion was greater than in Caucasians.

We found that although the occlusal plane was less inclined than in Japanese, it was more inclined than in Caucasians. Based on the above, we found that utilizing the mandibular growth and development was better than restraining the maxillary growth and development when performing orthodontic treatment for maxillary protrusion in Chinese. In addition, because the labial inclination of the mandibular anterior teeth was at a standard value, selecting the treatment with only tooth extraction in the maxilla was a rational manner for orthodontic treatment involving tooth extraction. Furthermore, the inclination angles of the mandibular plane and the occlusal angle were steep compared to that of Caucasians. However, since it was flatter than for Japanese, this suggests that the treatment of maxillary protrusion for Chinese will be easier than for Japanese.

CONCLUSION

A correct diagnosis method is the most important factor in orthodontic treatment. It is important to know standard values in order to arrive at a logical diagnosis. Although there are several analyses in

clinical orthodontics, the Steiner analysis is one of the most common and widely used. It is well known that there are many skeletal and dental differences among races. If we want to use analytical methods correctly, we must know the standard values for our own race. Although many reports have detailed the standard values for Chinese, the differences among the reports were far too many. These differences resulted in confusion and misunderstanding. The purpose of this study was to compare the differences between the measured values we collected and the published measured values in order to clarify the inexplicable, and determine standard values. We collected samples according to different criteria, used them in this study, and calculated the standard values for Chinese. As orthodontists, we are duty-bound to do our best to finish the treatment and should never arbitrarily decide when to stop treatment. We have continuously performed research based on these concepts and ideals.

We concluded that when evaluating the data obtained, it is necessary to consider not only the data of one ethnic group, but also that of others. The maxilla of Chinese with normal occlusion shows remarkable anterior growth. However, the maxilla in anterior protrusion did not show overgrowth, while the mandible showed undergrowth. Nevertheless, although the clockwise rotation of the mandible in Chinese was larger than that in Caucasians, it was smaller than that in Japanese. Based on the above findings, we think that maxillary protrusion in Chinese is easier to treat than in Japanese.

This study was conducted with the approval of the Ethics Committee of Osaka Dental University (Approval No.110801).

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest associated with this manuscript.

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