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Craniofacial morphological characteristics of Chinese adults with normal occlusion and different skeletal divergence

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SUMMARY The aim of the present study was to examine the craniofacial morphologic characteristics of different vertical dysplasias in a population of Chinese adults with normal occlusion. Sixty-nine subjects (39 males and 30 females) were selected from 800 healthy students between 18 and 24 years of age. Lateral cephalograms were obtained and 27 hard and 10 soft tissue measurements were analysed. The subjects were then divided into three groups: high angle, low angle, or control according to the value of FH–MP. Intraclass correlation coefficient was determined for the repeated measurements. One-way analysis of variance was used to determine the differences between the groups.

The results showed that the low-angle group had a larger cranial basis angle (N–S–Ar) and the high-angle group had a shorter maxilla (Ans–Ptm; $P < 0.01$). The high-angle group displayed vertical hyperdivergency with increased PP–OP, OP–MP, gonial, and lower gonial angles, whereas the low-angle group showed significant hypodivergence with decreased values for all variables ($P < 0.01$). The low-angle group displayed a more protrusive chin and the high-angle group a more retrusive chin ($P < 0.01$). Differences in dentoalveolar measurements in the divergent groups were mainly in the anterior region. Moreover, the low-angle group had a thicker and the high-angle group a thinner lower dentoalveolus ($P < 0.01$). For face height measurements, the main differences in the divergent groups were at the anterior lower third ($P < 0.01$). Soft tissue deviations were less obvious in the high-angle group and in general less significant than those of the hard tissues in both divergent groups.

Significantly different morphological characteristics exist in Chinese adults with vertical dysplasia but normal occlusion. Major skeletal cephalometric changes were found for the lower facial third. The soft tissues showed a well-adapting mechanism of soft tissue coverage for the skeletal dysplasia.

Introduction

Large anatomical variations in skeletal relationship exist in malocclusions as well as in normal occlusion (Casko and Sheperd, 1984; Fishman, 1997). The morphological characteristics of different vertical dysplasia have been researched previously with inconsistent results. Some studies (Nanda, 1988; Nanda and Rowe, 1989) included different age groups ignoring the fact of different craniofacial characteristics between children and adults and that even after early adulthood the craniofacial dimensions still change with an increase in face height (Akgül and Toygar, 2002; Arat and Rübendüz, 2005). Other studies (Muller, 1963; Subtelny and Sakuda, 1964; Nahoum, 1971; Siriwat and Jarabak, 1985) included various malocclusions and did not take into consideration that skeletal dysplasia with different malocclusions had different structural characteristics (Ellis and McNamara, 1984; Celar *et al.*, 1999). Previous research has demonstrated that the facial soft tissues are a dynamic structure that can develop along with, or independent of, their skeletal substructure and may compensate for skeletal dysplasia (Subtelny, 1959; Schendel *et al.*, 1976). Nevertheless, the soft tissue characteristics in different skeletal vertical dysplasia have not previously been studied. Moreover, considerable evidence indicates that large racial variations exist in the incidence of vertical skeletal dysplasia (Proffit *et al.*, 1998; Beane *et al.*, 2003). To date, most investigations published on this aspect have been on Caucasian populations and no study has investigated a Chinese population.

Therefore, the aim of the present study was to examine the craniofacial morphological characteristics of different vertical dysplasias in a population of Chinese adults with normal occlusion. Both skeletal and soft tissue characteristics were investigated to explore the possible adapting/compensating mechanism in different vertical skeletal dysplasia subjects with normal occlusion.

Subjects and methods

Subjects

Ethical approval was obtained from Sichuan University before the start of the study. The sample size for each variable to detect a clinically relevant difference at the power of 80 per cent was estimated. Eight hundred healthy students between 18 and 24 years of age were randomly selected from Sichuan University for the first screening. Subjects were excluded if one of the following diagnoses was present: congenitally missing teeth excluding third molars; moderate to severe crowding; overjet greater than 5 mm; deep overbite (greater than 80 per cent); anterior crossbite; posterior crossbite; and obvious facial asymmetry. The remaining subjects were included if they had an Angle Class I molar relationship (±one-quarter premolar width). The mandibular plane angle (FH–MP) was measured with a conimeter (Medical Factory, Tianjin, China) by the same examiner (DX). Briefly, the infraorbital point and articulation point were determined by eye. The fixed finger of the conimeter (lower) was placed along the mandibular plane, and the flexible finger (upper) was adjusted to fit the line through infraorbital and articulation points (Figure 1). According to the measured values, the subjects were divided into a high-angle (greater than 32 degrees), low-angle (less than 20 degrees), or control (between 20 and 32 degrees) groups. As the sample size was not sufficient to detect gender difference, the data for the male and female subjects were pooled for each group. Lateral cephalograms were taken of all subjects (N = 69) who signed the informed consent (Figure 2).

Cephalometrics

The subjects were positioned in the natural head position. All cephalograms were taken by one experienced technician in a cephalostat (Sirona, Düsseldorf, Germany). All tracings were performed by the same investigator (DX) using the WinCeph 8.0 cephalometric software program (Rise Co., Ltd, Sendai, Japan). Fifteen cephalograms were randomly selected and were traced twice with a 2 week interval to determine intra-observer agreement. The conimeter measurements were compared with the cephalometric measurements. When there was a difference between the two, the cephalometric measurements were used to adjust the group selection. Twenty-seven hard (Figure 3a) and 10 soft (Figure 3b) tissue measurements were used in the present study. The definitions of these measurements are described in Table 1.

Statistical analysis

All statistical analyses were performed with the Statistical Package for Social Sciences (version 16, SPSS Inc., Chicago, Illinois, USA). To determine intra-observer reliability, intraclass correlation coefficient (ICC) was determined for the repeated measurements. Descriptive statistics for each measurement were calculated. Since the data were normally distributed, multiple comparison tests (one-way analysis of variance) and Tukey's tests were used to determine the differences among and between the three groups.

Results

Twenty-six of the 37 variables had significant (24) or close to a sufficient (2) sample size to detect a clinically relevant difference at the power of 80 per cent. This accounts for 70 per cent of all variables. ICC of the cephalometric tracing was 0.91. One hundred and fifty-three of the 800 subjects remained after application of the exclusion criteria. Eighty-nine subjects fulfilled the inclusion criteria. Informed consent was obtained from 69 subjects (dropout rate 13.7 per cent). The three groups are described in Table 2.

Hard tissues

The craniofacial structures above the palatal plane showed only mild discrepancy in subjects with vertical dysplasia (Table 3). Most deviations existed in structures below the palatal plane.

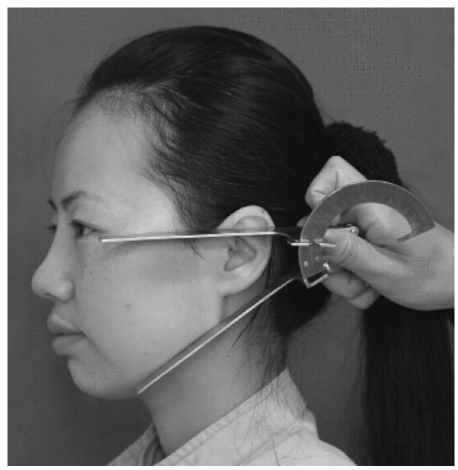

Figure 1 The conimeter used to estimate the mandibular plane angle.

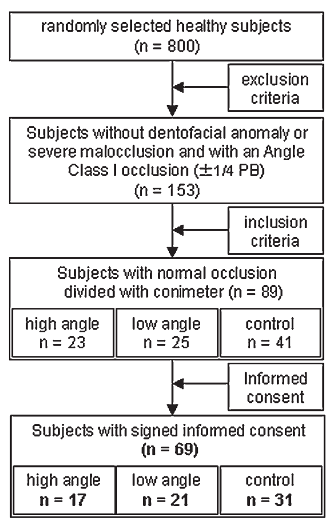

Figure 2 A flowchart of the selection of study subjects.

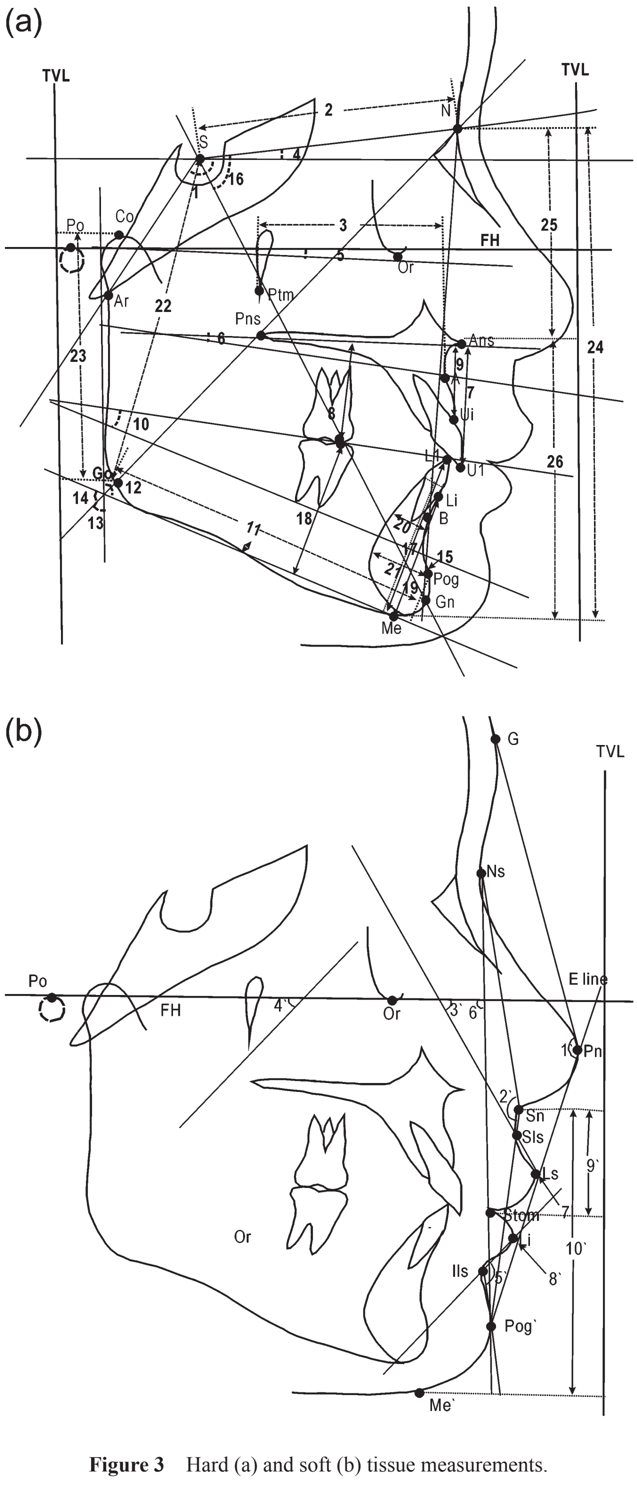

Figure 3 Hard (a) and soft (b) tissue measurements.

Cranial base and maxilla

The low-angle group had a larger cranial base angle (N–S–Ar) than the high-angle group ($P < 0.01$) and the control ($P < 0.05$). The high-angle group had a significantly shorter maxilla (Ans–Ptm) than the other two groups ($P < 0.01$).

Mandible

All mandibular-related variables showed significant differences between the two divergent groups ($P < 0.01$), except for the length of the mandibular corpus (Go–Po), the thickness of the mental symphysis (TMS), and lower posterior dentoalveolar height (L6–MP), where similar values were found. Compared with the controls, the differences in the high- and low-angle groups deviated in the opposite directions.

Skeletal

The high-angle group displayed significant vertical hyperdivergency with increased PP–OP, OP–MP, gonial, and lower gonial angles ($P < 0.01$), whereas the low-angle group showed significant hypodivergence with decreased values for all variables ($P < 0.01$). Inclination of the ramus in the low-angle group was less than in the controls (lower gonial angle), but no difference existed between the high-angle and control groups. The low-angle group displayed a more protrusive chin (Po–NB) than the controls, while the high-angle group showed a more retrusive chin ($P < 0.01$). Moreover, the low-angle group showed a significantly thicker mandibular alveolus than the high-angle and control groups ($P < 0.01$). The high-angle group showed more clockwise rotation of the mandible (*Y*-axis) than the controls ($P < 0.01$). No such difference was observed in the low-angle group.

Dentoalveolar

Upper posterior dentoalveolar height (U6–PP) was larger in the high- than in the low-angle group ($P < 0.05$), but neither was different from the controls. In the anterior region, the high-angle group displayed increased upper (U1–PP and Ui–PP) and lower (L1–MP and Li–MP) dentoalveolar heights compared with the controls ($P < 0.01$); the low-angle group showed only decreased upper dentoalveolar height ($P < 0.01$). Compared with the control group, the low-angle group had a thicker lower (thickness of mandibular alveolus) and high-angle group a thinner dentoalveolus ($P < 0.01$).

Face height

Upper face height (N–ANS) did not show any difference among the three groups. Compared with the normal group, the low-angle group had increased posterior face (S–Go; $P < 0.05$) and ramus (Co–Go) heights ($P < 0.01$), decreased anterior face height (N–Me) and anterior lower face height (ANS–Me; $P < 0.01$), as well as an increased face height index (FHI; $P < 0.01$). The high-angle group showed a decreased ramus height ($P < 0.05$), decreased FHI ($P < 0.01$), and slightly increased anterior lower face height ($P = 0.03$). No difference was observed in posterior, anterior, or upper anterior face height between the high-angle and control groups.

Table 1 Definition of the hard tissue (1–27) and soft tissue variables (1′–10′).

	Variable	Definition
Hard tissues		
1	N–S–Ar (°)	Cranial base angle, angle between SN plane and S–Ar line
2	S–N (mm)	Length of the anterior cranial base, distance from S to N point
3	A–Ptm (mm)	Length of the maxilla, A–Ptm distance at the Frankfort horizontal (FH) plane
4	SN–FH (°)	Angle between SN and the FH
5	FH–PP (°)	Angle between FH and palatal plane (ANS–PNS)
6	PP–OP (°)	Angle between ANS–PNS and occlusal plane (OP)
7	U1–PP (mm)	Upper anterior tooth height, distance of upper incisal edge to ANS–PNS
8	U6–PP (mm)	Upper posterior tooth height, distance of the upper first molar mesial cusp to ANS–PNS
9	Ui–PP (mm)	Upper anterior dentoalveolar height, distance of the upper alveolar edge to ANS–PNS
10	OP–MP (°)	Angle between the OP and mandibular plane (MP)
11	Go–Pog (mm)	Length of the mandibular body, distance between Go–Pog at MP
12	Gonial angle (°)	Angle between the posterior tangent line of ramus and MP
13	Upper gonial angle (°)	Upper part of the gonial angle divided by Go–N line
14	Lower gonial angle (°)	Lower part of the gonial angle divided by Go–N line
15	Pog–NB (mm)	Perpendicular distance of Pog to NB
16	*Y*-axis angle (°)	Angle between S–Gn line to SN
17	L1–MP (mm)	Lower anterior tooth height, perpendicular distance of the lower incisal edge to MP
18	L6–MP (mm)	Lower posterior tooth height, distance of the lower first molar mesial cusp to MP
19	Li–MP (mm)	Lower anterior dentoalveolar height, distance of the lower alveolar edge to MP
20	TMA	Thickness of mandibular alveolus, defined by a line parallel to MP at the level of the lower incisor apex
21	TMS	Thickness of mental symphysis, defined by a line through Pog and parallel to MP
22	S–Go (mm)	Posterior face height, S–Go distance at the true vertical plane (TVP)
23	Co–Go (mm)	Mandibular ramus height, height of mandibular ramus at the true vertical plane
24	N–Me (mm)	Anterior face height, N–Me distance at the TVP
25	N–ANS (mm)	Upper anterior face height, N–ANS distance at the TVP
26	ANS–Me (mm)	Lower anterior face height, ANS–Me at the TVP
27	S–Go/N–Me	Face height index, ratio of S–Go to N–Me
Soft tissues		
1′	G–Pn–Pog′ (°)	Total facial convex angle, angle from G to Pn and to Pog′
2′	G–Sn–Pog′ (°)	Facial convex angle, angle from G to Sn and to Pog′
3′	Sls–Ls–FH (°)	Upper labial angle of inclination, angle between Frankfort plane and Sls–Ls line
4′	Ils–Li–FH (°)	Lower labial angle of inclination, angle between Frankfort plane and Ils–Li line
5′	Pog′–Ils–Li (°)	Mentolabial sulcus angle, angle from Pog′ to Ils and to Li
6′	FH–Ns–Pog′ (°)	Angle between Frankfort plane and Ns–Pog′ line
7′	Ls–E line (mm)	Upper lip convexity, distance of Ls to E line
8′	Li–E line (mm)	Lower lip convexity, distance of Li to E line
9′	Sn–Stoma (mm)	Upper lip height, distance of Sn to stoma at the TVP
10′	Sn–Me′ (mm)	Lower face height, distance of Sn to Me′ at the TVP

Table 2 Study subjects.

Group	*N*	Age	Male	Female	FH–MP angle
High angle	17	20.6 ± 1.2	10	7	14.7 ± 3.0
Low angle	21	20.6 ± 1.7	13	8	37.3 ± 2.8
Control	31	20.7 ± 1.2	13	7	24.0 ± 2.5

Soft tissues

Five variables, namely, protrusion of the nose (G–Pn–Pog′) and the face (G–Sn–Pog′), inclination of the upper lip (Sls–Ls–FH), protrusion of the upper lip (Ls–E line), and height of the upper lip (Sn–Stoma) did not show any difference among the three groups (Table 4). The low-angle group had a more concave mental sulcus (Pog′–Ils–Li), larger lower facial third ($P < 0.01$), and larger inclination of the lower lip (Ils–Li–FH; $P < 0.05$) than the other two groups; such differences did not exist between the high-angle and control groups. The low-angle group showed a more protrusive lower lip (Li–E) than the high-angle group ($P < 0.01$), but neither was different from the controls. The high-angle group exhibited a more retrusive chin (FH–Ns–Pog′) than the other two groups ($P < 0.01$). This variable was not different between the control and low-angle groups.

Discussion

This is the first study that appears to have investigated the craniofacial morphology of different vertical dysplasias in a population of Chinese adults with normal occlusion. The craniofacial structures above the palatal plane showed only a mild discrepancy in subjects with vertical dysplasia. Most deviations existed in structures below the palatal plane. Moreover, the divergent groups showed most discrepancy from the controls in the anterior regions.

No consistent results exist in the literature on the cranial base and maxillary structures of subjects with different vertical skeletal patterns. Some studies suggest that larger cranial base angles and corresponding positional deviations

Table 3 Hard tissue measurements.

	Low angle (L)	Control (C)	High angle (H)	ANOVA	L-C	H-C	L-H
	($n = 21$)	($n = 31$)	($n = 17$)				
N–S–Ar	130.1 ± 5.6	125.9 ± 5.1	123.3 ± 3.9	**	*	NS	**
S–N (mm)	64.2 ± 3.6	63.5 ± 2.8	62.0 ± 4.7	NS	NS	NS	NS
A–Ptm (mm)	49.5 ± 3.7	48.2 ± 2.7	44.3 ± 3.2	**	NS	**	**
SN–FH (°)	7.1 ± 4.2	7.8 ± 3.3	5.1 ± 3.2	NS	NS	NS	NS
FH–PP (°)	2.9 ± 3.1	1.7 ± 2.5	4.1 ± 4.1	NS	NS	NS	NS
PP–OP (°)	1.4 ± 3.9	5.8 ± 3.8	9.0 ± 3.8	**	**	*	**
U1–PP (mm)	25.4 ± 2.8	28.2 ± 2.2	31.0 ± 2.9	**	**	**	**
U6–PP (mm)	22.4 ± 2.2	24.0 ± 2.0	25.0 ± 3.4	**	NS	NS	*
Ui–PP (mm)	14.5 ± 2.3	17.6 ± 2.1	19.9 ± 2.3	**	**	**	**
OP–MP (°)	9.1 ± 3.6	18.0 ± 4.4	24.1 ± 4.0	**	**	**	**
Go–Po (mm)	76.3 ± 5.1	76.4 ± 5.3	73.5 ± 6.9	NS	NS	NS	NS
Gonial angle (°)	103.9 ± 5.6	120.7 ± 6.5	129.4 ± 7.1	**	**	**	**
Upper gonial angle (°)	41.6 ± 3.1	45.4 ± 4.3	45.9 ± 4.4	**	*	NS	**
Low gonial angle (°)	62.4 ± 3.4	75.3 ± 3.4	83.6 ± 4.1	**	**	**	**
Po–NB (mm)	1.3 ± 1.3	−0.2 ± 1.8	−2.4 ± 2.0	**	*	**	**
Axis (°)	60.0 ± 3.4	61.0 ± 2.8	67.8 ± 3.3	**	NS	**	**
L1–MP (mm)	38.3 ± 3.4	40.8 ± 2.2	43.1 ± 3.9	**	NS	NS	**
L6–MP (mm)	32.0 ± 3.6	31.4 ± 3.5	30.8 ± 3.5	NS	NS	NS	NS
Li–MP (mm)	30.2 ± 3.4	32.4 ± 2.1	36.4 ± 4.1	**	NS	**	**
Thickness of mandibular alveolus (mm)	9.3 ± 1.8	7.3 ± 1.6	5.2 ± .9	**	**	**	**
Thickness of mental symphysis (mm)	14.2 ± 2.3	13.4 ± 1.3	13.0 ± 1.7	NS	NS	NS	NS
S–Go (mm)	85.4 ± 8.1	78.5 ± 7.9	74.9 ± 7.6	**	*	NS	**
Co–Go (mm)	57.2 ± 6.4	49.8 ± 6.1	44.1 ± 5.0	**	**	*	**
N–Me (mm)	111.7 ± 6.9	120.4 ± 6.6	124.7 ± 0.6	**	**	NS	**
N–Ans (mm)	52.3 ± 2.8	53.3 ± 3.0	53.0 ± 5.0	NS	NS	NS	NS
Ans–Me (mm)	59.4 ± 5.7	67.1 ± 4.2	71.8 ± 6.1	**	**	*	**
S–Go/N–Me	0.8 ± 0.1	0.7 ± 0.1	0.6 ± 0	**	**	**	**

Data are shown as the mean ± standard deviation. L-C, H-C, and L-H were analysis of variance (ANOVA) post hoc tests between the groups. NS, not significant. *$P < 0.05$, **$P < 0.01$.

Table 4 Soft tissue measurements.

	Low angle (L)	Control (C)	High angle (H)	ANOVA	L-C	H-C	L-H
	($n = 21$)	($n = 31$)	($n = 17$)				
′G–Pn–Pog′ (°)	149.5 ± 5.7	149.5 ± 5.7	149.0 ± 6.3	NS	NS	NS	NS
′G–Sn–Pog′ (°)	170.1 ± 5.2	172.6 ± 4.8	169.9 ± 5.9	NS	NS	NS	NS
′Sls–Ls–FH (°)	66.1 ± 7.8	64.7 ± 9.1	70.6 ± 9.5	NS	NS	NS	NS
′Ils–Li–FH (°)	48.9 ± 10.2	57.1 ± 10.9	52.3 ± 6.0	*	*	NS	NS
′Pog′–Ils–Li (°)	131.4 ± 9.7	145.1 ± 11.6	153.6 ± 11.3	**	**	NS	**
′FH–Ns Pog′ (°)	93.5 ± 3.5	92.0 ± 3.6	87.5 ± 4.1	**	NS	**	**
′Ls–E line (mm)	−1.2 ± 2.4	−1.0 ± 1.9	−0.2 ± 1.7	NS	NS	NS	NS
′Li–E line (mm)	0.8 ± 2.3	−0.8 ± 2.3	−2.4 ± 2.0	**	NS	NS	**
′Sn–Stoma (mm)	21.7 ± 2.9	23.0 ± 1.7	22.5 ± 3.0	NS	NS	NS	NS
′Sn–Me′ (mm)	66.0 ± 5.1	72.0 ± 4.9	74.8 ± 7.1	**	**	NS	**

Data are shown as the mean ± standard deviation. L-C, H-C, and L-H were analysis of variance (ANOVA) *post hoc* tests between the groups. NS, not significant. *$P < 0.05$, **$P < 0.01$.

of the mandible are associated with an open bite (Atherto, 1965; Sassouni, 1969; Cangialosi, 1984; Fields *et al*., 1984). Others, however, found no difference in the cranial base angle between a normal and open bite group (Subtelny and Sakuda, 1964; Knott, 1969, 1971). The present study showed that the hyperdivergent skeletal subjects had a smaller cranial base angle and shorter maxillary length than the hypodivergent subjects. Previous studies (Brodie, 1955; Muller, 1963; Nahoum, 1971, 1975; Siriwat and Jarabak, 1985) reported a relative deficiency in the maxillary vertical dimension in open bite subjects and increased upper anterior face heights in deep bite subjects. However, Schendel *et al.* (1976) reported excessive vertical height of the maxilla in open bite subjects and also that OP–SN angle decreased from the high-angle group to the average to the low-angle group (Isaacson *et al.*, 1971). In the present study, no vertical differences were found among the three groups above the palatal plane, including inclination of the cranial base plane, palatal plane, and upper face height, in agreement with previous studies (Hapak, 1964; Subtelny and Sakuda, 1964; Ellis and McNamara, 1984; Fields *et al.*, 1984) showing normal upper facial dimensions in long-face subjects, and a similar palatal plane angle in open and deep bite subjects.

Previous studies on dentoalveolar compensation in subjects with vertical skeletal dysplasia showed inconsistent results. Subtelny and Sakuda (1964); Nahoum *et al.* (1972), and Opdebeeck *et al.* (1978), who selected samples according to overbite, reported that the vertical height of the maxillary incisors and molars (U1–PP and U6–PP) in open-bite subjects was significantly greater but that the mandibular incisors and molars (L1–MP and L6–MP) were comparable with the controls. Other authors (Bell, 1977; Opdebeeck and Bell, 1978) selecting samples according to the mandibular plane angle concluded that the vertical height of the molars and incisors in short-face subjects was smaller in both jaws. The present study showed that dentofacial structures below the palatal plane contributed mostly to the discrepancies in vertical dysplasia and that the high-angle group had a hyperdivergent and the low-angle group a hypodivergent lower facial third. This is in agreement with most previous studies (Muller, 1963; Sassouni and Nanda, 1964; Sassouni, 1969).

Different dentoalveolar compensation mechanisms were observed in the high- and low-angle skeletal groups. In the high-angle group, dentoalveolar height increased in both jaws, whereas in the low-angle group, it decreased only in the upper anterior region. This difference may suggest different treatment considerations for high- and low-angle patients, i.e. the low-angle group had a thicker lower alveolus, indicating that the lower incisors may allow more buccolingual movement. Interestingly, the length of the mandibular corpus and TMS were similar among all three groups, suggesting that vertical dysplasia had little effect on sagittal development of the mandibular body. The fact that the high-angle group showed a more retrusive chin and the low-angle group a more protrusive chin is a reflection of the clockwise or counter-clockwise rotation of the mandibular plane in the two divergent groups, respectively.

Both the high- and low-angle groups showed significant deviations in gonial angle compared with the controls, in agreement with most previous studies (Sassouni and Nanda, 1964; Sassouni, 1969; Nahoum, 1972; Schendel *et al.*, 1976, Opdebeeck and Bell, 1978; Cangialosi, 1984; Fields *et al.*, 1984; Siriwat and Jarabak, 1985). In the present study, gonial angle was further divided into the upper and lower parts by Go–N in an attempt to reflect the inclination of the mandibular ramus and mandibular plane, respectively. The results suggest that the low-angle group had significant deviations in the inclination of both, while the high-angle group showed deviations only in the inclination of the mandibular plane.

There were no differences among the three groups in upper anterior face height. Ramus height decreased from the low to the average to the high-angle group, and anterior and lower anterior face height increased from the low to the average to the high-angle group. This was coincident with a previous study (Isaacson *et al.*, 1971). These results suggest that ramus height and lower anterior face height contribute mainly to the variations in different vertical skeletal dysplasia.

Soft tissue differences corresponded in general with the findings of the bony structures but with less significance. The low-angle group had a more protrusive lower lip, a more concave mental groove, and smaller lower anterior face height than the controls. Such changes did not exist in the high-angle group. The only soft tissue deviation in the high-angle group was a less retrusive chin. This might suggest that the soft tissues in the high-angle group were more able to compensate for the abnormalities in the hard tissues.

In the present research, the sample size was insufficient. However, for studies of this nature, it is quite difficult to estimate the final outcome at the start of the investigation. It is the first to have studied the craniofacial morphology of different vertical dysplasias in a population of Chinese adults with normal occlusion. It is believed that the results are valuable for the design of future research with larger sample sizes.

It has to be acknowledged that in the present study, the pre-selection of subjects was based on different mandibular planes and not by different vertical facial types. It is possible that algorithms exist by which variations in vertical facial morphology can be delineated. However, the primary goal of the present study was to examine the craniofacial morphology of different vertical dysplasia, which is most often characterized by significant deviations in the mandibular plane angles.

Conclusions

There are significantly different morphological characteristics in Chinese adults with vertical dysplasia but normal occlusion. Major skeletal cephalometric changes exist in the lower facial third.

The soft tissues in Chinese adults with vertical dysplasia but normal occlusion showed, in general, less significant variations indicating a well-adapting mechanism of soft tissue coverage for the skeletal dysplasia.

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