A Roentgenographic Cephalometric Study of Prognathism in Chinese Males and Females*

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The study of craniofacial relations and variations in man has long been a subject of investigation in physical anthropology. For decades skulls and heads of living subjects were measured with the object of clarifying similarities and differences between various population groups.[1-8]

Roentgenographic cephalometry owed its inception to the multitude of anthropometric studies on the inter- and intraracial variations of the form of the head and face. A great deal of roentgenographic cephalometric material is now available for many ethnic groups and includes excellent data on Swedes,[9-12] American whites,[13-16] and negroes,[17-19] Japanese,[20-22] Australian aborigines[23-26] and others.[27,28]

The studies of craniofacial morphology in the Chinese, however, have been made mainly on skull collections.[29-35] Only two reports have used the lateral roentgenogram in studying the craniofacial profile in Chinese subjects, based on generally accepted orthodontic analyses.[17,36]

Cotton, Takano and Wong[17] found that the American Chinese presented a retrognathic (Class II) facial pattern when compared with Downs' values of normal variations for white children. They therefore concluded that the Downs' analysis based on values for whites could not be applied directly to the Chinese or to children of other ethnic groups.

The other roentgenographic cephalometric study on the Chinese was that of Hong.[36] His material included thirty male and twelve female young adults who possessed functional and esthetic dentitions. Hong obtained from his sample standards of the following analyses: Downs, Wylie, Graber and Donovan, Wylie-Johnson and Björk. The main characteristics of the Chinese craniofacial and denture patterns were briefly discussed and compared with similar studies of Caucasian and Japanese subjects. However, no roentgenographic cephalometric study of the width dimension using posteroanterior roentgenograms on Chinese subjects is available.

This investigation was undertaken to provide more information and better understanding of the craniofacial and denture patterns in the Chinese. A three-dimensional study was carried out using both the lateral and P.A. roentgenograms. This paper will present only the findings of the craniofacial profile in relation to prognathism, with emphasis on the sex differences of the variables studied. The width dimension will be presented in a separate paper.

Material and Method

The material for this study comprised standardized lateral head roentgenograms of one hundred and seven young adult Chinese. Most of the sample eighty-four male and twenty-three female subjects were undergraduate or graduate students of the University of Adelaide, South Australia.

Selection of Subjects

The following principles were adopted for the selection of subjects

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from a total preliminary sample of 253 subjects:

1. The willingness of subjects to participate in this project.
2. The absence of observable dental and craniofacial deformity.
3. No history of previous orthodontic treatment.
4. Young adults basically of Chinese ethnic descent.

The majority of overseas students in Australian Universities come from neighbouring Afro-Asian countries. Of all the overseas students in Adelaide, students from Malaya, Singapore and Hong Kong constituted the largest numbers. That resulted in the sample consisting of one hundred one subjects from Malaya, Singapore and Hong Kong together with six other subjects from North Borneo, Sarawak and Taiwan.

Ethnic Group of Sample

The determination of ethnic group of each subject was facilitated by the recording of the place of birth of the subject, and that of his or her father and grandparent. It was found that ninety-four out of the total one hundred and seven subjects had grandparents who originally came from China. Although the material consisted of students who came from many countries and cities in Southeast Asia, ethnographically, they could be classified as 'Chinese' adults with a recent ancestry originating principally from the southeastern parts of China.

Mean Age of Sample

The date of birth of each subject was recorded and the exact age to the nearest month was subsequently calculated. All the subjects were young adults, the oldest in the male group being 29 years of age and the youngest 18 years and three months. The corresponding ages of the female group were 27 years and seven months and 18 years and two months. The mean ages of the male and female groups were 23 years one month and 21 years and six months respectively.

The recording, listing, processing of data and tabulation of results were carried out by means of punch cards and other computing facilities. The roentgenographic techniques used followed closely accepted methods described in the literature. There were slight modifications which will be described in more detail.

The cephalostat used was the same as the one described by Brown.[25] The main structure of the cephalostat was constructed of lightweight cast aluminum as it was designed originally for field surveys. The cephalostat was provided with an aluminum wedge 250 mm × 65 mm × 20 mm tapering to 1 mm. The wedge was placed during exposures of lateral films between the facial profile and the cassette in order to produce a good soft tissue profile.

The anode to median sagittal plane distance was constant at 180 cm. The median sagittal plane to film distance was arbitrarily set at 13 cm. The linear magnification of median sagittal plane structures produced by the above distance was calculated to be 7.2 percent. All linear measurements obtained from the lateral head plates were subject to an enlargement of 7.2 percent at the median sagittal plane and were converted to actual life values by the use of a program on the computer. In this way both sets of original data and corrected measurements were recorded on punch cards and made readily available when required.

Only two exposures were taken of each subject; these were taken in the maximum intercuspal occlusal position for both the lateral and posteroanterior views.

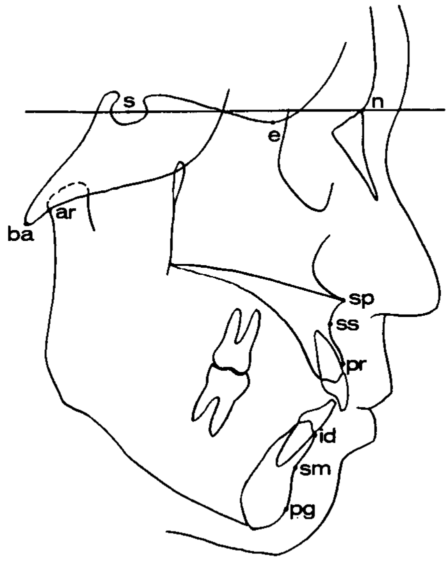

Fig. 1 Reference points. articulare (ar), basion (ba), ethmoidale (e), infradentale (id), nasion (n), pogonion (pg), prosthion (pr), sella (s), spinal point (sp), subspinale (ss), and supramentale (sm).

Lateral Roentgenograms

Unless otherwise indicated, all reference points and reference lines were taken from a list of reference points for for lateral roentgenogram interpretation used by the orthodontic department of the Royal Dental College, Copenhagen and quoted by Lindegard.[11] All reference points were situated in the median sagittal plane (MSP) or were projected on that plane. Midpoints were used for double projections of right and left sides.

The reference points are shown in Figure 1.

Variables Studied

The study of the profile of the Chinese subjects, with particular reference to prognathism, was based mainly on measurements selected after Björk's analysis.[9] However, a number of other measurements were added where it was thought that these would reveal special characteristics, or where they merited further investigations.

The variables studied in this section could be divided into three groups as follows:

(1) Angles of prognathism.

- Maxillary basal prognathism (s-n-ss);
- Maxillary alveolar prognathism (s-n-pr);
- Mandibular alveolar prognathism (s-n-id);
- Mandibular basal prognathism (s-n-sm);
- Maxillary alveolar prognathy (pr-n-ss);
- Mandibular alveolar prognathy (id-n-pg).

For comparative purposes, two alternative angles of maxillary and mandibular basal prognathism, used by some workers, were also included, namely:

- Maxillary basal prognathism (2) — (s-n-sp);
- Mandibular basal prognathism (2) — (s-n-pg).

(2) Radiographic gnathic index.

- Total median cranial base length (ba-n);
- Total upper face length (ba-pr);
- Gnathic index; 100 (ba-pr) / (ba-n).

(3) Cranial base.

- Median cranial base angle (n-s-ba);
- Median internal cranial base angle (e-s-ba);
- Lateral cranial base angle (n-s-ar);
- Anterior median cranial base length (n-s);
- Anterior median internal cranial base length (e-s);
- Median posterior cranial base length (s-ba);
- Posterior lateral cranial base length (s-ar).

The arithmetic mean, the standard error of the mean, the standard deviation and the range of variation were calculated for each of the above variables. The mean values of the male and female subjects were compared and the sex differences were tested statistically to see if they differed significantly from zero, using the Student's t-test with 105 degrees of freedom. The difference between the male and female sample means was declared significant (denoted by **) when the probability that it would be exceeded by chance was less than one percent ($p<0.01$). If the probability that the mean difference would be exceeded by chance was less than five percent but greater than one percent, it was declared probably significant (denoted by *).

The angles of prognathism of the Chinese male subjects were compared with those reported for other racial groups, namely the Mongoloids, Caucasoids, Negroids and Australoids. The interrelationship of the various angles of prognathism was investigated by total correlation analyses. In addition, the associations between the angles of prognathism and the gnathic index, the cranial base lengths and angulations were studied by the same method. As the male sample far exceeded the female sample in number, it was used to compute the correlation coefficients, unless otherwise stated. Using the Fisher's table of r values with 82 degrees of freedom, a correlation coefficient was declared significant (**) or probably significant (*) if the probability that it would be exceeded by chance was less than one percent ($p<0.01$) or greater than one percent but less than five percent ($0.01<p<0.05$), respectively. The significant correlations were arbitrarily classified as "high," "moderate" or "low" when the values of $r=0.80$; $0.80>r=0.40$; or $0.40>r$, respectively, regardless of sign.[37]

The measurement errors of this study were estimated by analyzing two series of double determination tests after the method of Dahlberg[38] using fifteen repeat tracings and repeat roentgenograms of fifteen male subjects taken at periods from one day to four weeks after the initial records were taken. Twenty-six linear and angular measurements were selected, making a total of 780 double determinations in each series. Results showed that the total errors of the method in the present study were very small and should not affect the sample means and variances to any significant extent.

Results

The angular measurements of prognathism and alveolar prognathy of eighty-four male and twenty-three female Chinese subjects are summarized in Table I. The mean values of male subjects were compared with other population groups including Japanese,[21] Swedes,[9,10] Australian aborigines [23,24,25] and the South African Bantus[27] and the results are shown on Table II. Most of the data on Table II have been extracted from a previous comparison by Barrett et al.[24] in an assessment of interpopulation differences of prognathism.

The radiographic gnathic index was calculated from values of the component parts and summarized in Table III. The ba-n and ba-pr lengths were significantly greater in the males than the females ($p<0.01$). However, the gnathic index was higher in the females, the sex differences being statistically significant at the five percent level probability.

The correlation coefficients within the prognathic angles and between these angular measurements and the gnathic index and upper facial length for the male subjects are shown on Table IV.

Most of the correlation coefficients were in the high to moderate category except the correlation coefficients of ba-pr length with the other variables. All

VARIABLE	SEX	M ± M	s	RANGE	t
Maxillary prog-nathism s - n - ss	M	80.7 ± 0.45	4.1	68.5 - 91.5	0.75
	F	81.4 ± 0.65	3.1	77.5 - 89.0	
s - n - sp	M	85.8 ± 0.49	4.5	73.5 - 99.5	-1.07
	F	86.9 ± 0.59	2.9	82.5 - 94.0	
s - n - pr	M	84.9 ± 0.44	4.0	74.5 - 93.5	0.83
	F	85.7 ± 0.70	3.4	81.5 - 93.5	
Mandibular prognathism s - n - id	M	82.1 ± 0.46	4.3	70.0 - 92.5	0.05
	F	82.1 ± 0.69	3.3	75.5 - 87.5	
s - n - sm	M	79.3 ± 0.47	4.4	68.0 - 89.5	0.25
	F	79.5 ± 0.69	3.3	72.5 - 85.5	
s - n - pg	M	79.6 ± 0.47	4.4	68.5 - 90.0	0.18
	F	79.5 ± 0.70	3.4	72.5 - 85.0	
Alveolar prognathy pr - n - ss	M	4.2 ± 0.15	1.3	1.5 - 7.5	0.25
	F	4.2 ± 0.25	1.2	2.0 - 7.0	
id - n - pg	M	2.8 ± 0.17	1.5	0.5 - 7.5	0.22
	F	2.7 ± 0.36	1.7	-0.5 - 6.0	

None of the sex differences in mean values is statistically significant.

TABLE I

Angular measurements of prognathism and alveolar prognathy of 84 male and 23 female Chinese adults obtained from tracings of lateral roentgenograms. Values are in degrees and expressed as arithmetic mean ± error of the mean (M ± EM), standard deviation (s) and range of variation (Range). Sex differences between mean values were determined by Student t test and the values of t are shown. None of the sex differences in mean values is statistically significant.

	MATERIAL	s-n-sp M	s-n-sp s	s-n-ss M	s-n-ss s	s-n-pr M	s-n-pr s	s-n-id M	s-n-id s	s-n-pg M	s-n-pg s	pr-n-ss M	pr-n-ss s	id-n-pg M	id-n-pg s	s-n-sm M	s-n-sm s
Mongoloid	Chinese	85.8	4.5	80.7	4.1	84.9	4.0	82.1	4.3	79.6	4.4	4.2	1.3	2.8	1.5	79.3	4.4
	Japanese	87.7	3.8	83.0	3.3	85.5	3.1	82.4	2.8	79.6	3.1	2.5	-	2.8	-	-	-
Caucasoid	Swedes	88.2	4.2	-	-	84.8	4.1	82.3	4.4	81.7	4.4	-	-	-	-	-	-
	Swedes	87.1	3.7	82.0	3.7	84.3	3.7	81.6	3.7	80.7	3.9	2.3	1.0	0.9	1.7	79.3	3.7
Australoid	Australian Aborigines	88.7	4.0	87.1	3.8	91.8	3.7	86.5	3.9	81.3	4.0	4.6	1.8	5.2	1.5	83.1	3.8
	Australian Aborigines	86.8	4.4	-	-	94.2	3.9	88.7	3.6	83.0	3.7	-	-	-	-	-	-
Negroid	Bantus	88.8	4.0	86.8	4.9	90.6	3.7	86.1	3.8	82.0	4.0	3.8	-	4.0	-	81.8	4.0

TABLE II

Comparison of mean values in degrees of angular measurements of prognathism and alveolar prognathy of the present study with other population group. The arithmetic mean (M) and standard deviation (s) of the mean values are shown.

VARIABLE	SEX	M ± (M)	s	Range	t
ba - n	M	101.3 ± 0.43	3.9	92.3 - 113.3	6.74**
	F	95.1 ± 0.85	4.1	87.6 - 102.5	
	M&F	100.0 ± 0.45	4.7	87.6 - 113.3	
ba - pr	M	94.8 ± 0.54	5.0	81.1 - 106.7	3.03**
	F	91.3 ± 0.92	4.4	83.0 - 99.7	
	M&F	94.1 ± 0.49	5.1	81.1 - 106.7	
Gnathic Index	M	93.6 ± 0.44	4.1	84.0 - 101.8	2.60*
	F	96.0 ± 0.73	3.5	89.7 - 103.5	
	M&F	94.1 ± 0.39	4.1	84.0 - 103.5	

TABLE III

The radiographic gnathic index for 84 male and 23 female Chinese subjects studied. The linear and angular measurements are in mm and degrees respectively. Data are expressed as the arithmetic mean ± error of the mean (M ± EM), standard deviation (s), and range of variation (Range). The statistical significance of sex differences between mean values was tested by the Student t test and the level of significance indicated by asterisks. **Significant at the 1 percent level. *Significant at the 5 percent level.

the correlation coefficients were statistically significant at the one percent level probability except one which was significant at the five percent level.

The components of the cranial base lengths as well as the various cranial base angular measurements are shown on Table V. The sex differences were designated by the usual five and one percent probability level signs. The intercorrelation between linear and angular measurements of the cranial base for the male subjects are shown on Table VI, while the correlation coefficients between cranial base and prognathism are shown on Table VII.

Discussion

Angles of prognathism

The maxillary angles of basal and alveolar prognathism (s-n-ss, s-n-sp, and s-n-pr) were slightly greater in the female than in the male subjects (Table I). However, the sex differences were not statistically significant. All of the mandibular prognathic angles were almost identical for both sexes. Similarly, the angles of maxillary and mandibular alveolar prognathy (pr-n-ss, id-n-pg) showed virtually no sex difference at all.

The contention that female subjects of the same ethnic group tend to be more prognathic than the males appears to be well supported by a number of craniometric studies of various population groups.[39-43] Furthermore, the more pronounced prognathism in the female has been described as a secondary sex character by Martin[43] and confirmed by Abbie.[44] Brown,[25] using roentgenographic methods, came to the same conclusion.

As sex differences in the angles of prognathism included in the present study were not statistically significant,

VARIABLE	s - n - sp	s - n - ss	s - n - pr	s - n - id	s - n - pg	s - n - sm	Gnathic Index	ba-pr
s - n - sp	-	+0.81	+0.75	+0.68	+0.66	+0.67	+0.54	+0.23*
s - n - ss	+0.81	-	+0.95	+0.83	+0.65	+0.81	+0.72	+0.40
s - n - pr	+0.75	+0.95	-	+0.89	+0.69	+0.85	+0.78	+0.49
s - n - id	+0.68	+0.83	+0.89	-	+0.80	+0.98	+0.64	+0.37
s - n - pg	+0.66	+0.65	+0.69	+0.80	-	+0.85	+0.48	+0.28
s - n - sm	+0.67	+0.81	+0.85	+0.98	+0.85	-	+0.57	+0.32
Gnathic Index	+0.54	+0.72	+0.78	+0.64	+0.48	+0.57	-	+0.69

TABLE IV

Correlation within the angular measurements of prognathism and between these angular measurements of prognathism and the gnathic index and total upper facial length for 84 male Chinese subjects. All the correlation coefficients are statistically significant at the 1 percent level (p=0.01) except one (marked with *) which was significant at the 5 percent level.

no conclusive evidence could be established. Nevertheless, the mean values of the maxillary angles of prognathism were slightly higher in the female subjects and seemed to confirm a more prognathic tendency in the Chinese females. It should be emphasized, however, that the more prognathic character lay mainly in the maxillary profile as almost identical mandibular angles of prognathism were reported for the two sexes. There was no sex difference in maxillary alveolar prognathy (pr-n-ss). In this respect, it was interesting to note that Brown[25] reported that the greater prognathism of the female resided in the basal and alveolar regions of the jaws but were most apparent in the maxillary "alveolar" region in the Australian aborigines.

Judging from the standard deviations and the ranges of variation, the male subjects appeared to be more variable in facial dimensions than the females. However, the difference in variability between the sexes could have been biased by the male sample size which was three and one-half times greater than that of the female.

The facial profile characteristics in the Chinese male subjects studied were best demonstrated by a comparison with the angles of prognathism reported for other ethnic groups (see Table II). The studies of Chinese, Japanese, Swedes, Australian aborigines and Bantus were classified into four major racial groups, namely the Mongoloid, Caucasoid, Australoid and Negroid.

The mean angle of maxillary basal prognathism (s-n-ss) for the Chinese male subjects was 80.7 degrees which was the smallest value of the groups compared. The low s-n-ss angle in the Chinese was also confirmed by Hong[36] who reported a mean value of 82.0 degrees. This result indicated a retrognathism of the basal bone of the maxilla and could possibly be related to the facial flatness, especially in the upper face, of the Chinese.

The mean value for the angle of maxillary alveolar prognathism (s-n-pr) for the Chinese subjects studied was 84.9 degrees. This was slightly higher than the angle in one group of Swedes[10] but almost identical with that in another[9] (84.8 degrees). The angle s-n-pr was smaller in Chinese than in the Japanese, Bantus or the Australian aborigines. The value of s-n-pr, although not large, was combined with a small maxillary basal angle of prognathism, producing an apparently large angle of maxillary alveolar prognathy represented by the angle pr-n-ss whose mean value was 4.2 degrees. This value exceeded the means for all other ethnic groups compared except the Australian aborigines.

The mean value for the angle of mandibular prognathism (s-n-id) was similar to that in both the Japanese and Swedes, but was much lower than that reported for the Australian aborigines and the Bantus. This showed that in the Chinese subjects studied alveolar prognathism was more pronounced in the maxilla than in the mandible. Other mandibular prognathic angles in the Chinese male subjects (s-n-pg, s-n-sm) were almost identical to those in the Japanese and very similar to those reported for Swedes. The alternative angle of mandibular basal prognathism (s-n-sm) was the same for both the Chinese and the Swedes at 79.3 degrees. The Australian aborigines together with the Bantus, exhibited bimaxillary prognathism as evidenced by the high maxillary and mandibular basal and alveolar prognathic angles.

One interesting observation pointed out by Brown[25] and confirmed in the present study was that the mean values of the angle s-n-sp varied very little with respect to different ethnic groups.

The lowest reading was found in the Chinese subjects of 85.5° and the highest was 88.8° in the Bantus. The range of the mean values for the four ethnic groups was within 3 degrees. This angle (s-n-sp) was therefore considered to be a poor expression of interpopulation differences in maxillary basal prognathism, when compared with the other angle, namely, s-n-ss. Besides, the anterior nasal spine (sp) varies in length between populations and is diminutive or sometimes absent in the Australian aborigines.[25,45]

Similarly, the mandibular basal prognathic angle (s-n-pg) exhibited a small difference between the various ethnic groups compared. It ranged from 79.6° in the Chinese and Japanese, to 83.0° in the Australian aborigines studied by Craven.[23] In fact, the value reported for a group of Australian aborigines[24] was almost identical with that of a group of Swedes reported by Björk.[9] Barrett et al.[24] concluded that s-n-pg appeared to be relatively constant in all population groups.

In Table IV, it is shown that all the angles of prognathism were highly intercorrelated. In addition, the gnathic index showed a moderate to high correlation with the various angular measurements. As most of the angles of prognathism had two common reference points and shared a great part of the angles subtended, the high degree of correlation was largely to be expected, and little biological significance should be attached to it.

Radiographic gnathic index

As the mean values of the gnathic index for both the male (93.6) and female subjects (96.0) were below 98 (Table III), the Chinese subjects studied were classified as orthognathous. The females, however, almost reached mesognathic limits.

The linear components of the gnathic index (ba-pr, ba-n) were significantly greater in the males than in the females. This was to be expected as the male subjects had greater head and face size. The absolute sex differences in the linear components were obscured in the gnathic index, but it was interesting to record a sex difference in mean index values, significant at the five percent probability level. This result confirmed the findings of Barrett et al.[24] who reported a significant sex difference in gnathic indices in the Australian aborigines, the female value being greater.

Barrett et al. compiled from the data of Buchner[46] and Jørgensen[42] a table consisting of the mean values of gnathic indices of ten population groups including one for the Chinese. A comparison of the gnathic index obtained in the present study showed that the mean values of the male, female and the combined group were the smallest of all ethnic groups. This meant that the Chinese subjects studied were more retrognathic than any other population group listed on the table referred to.

A low value of gnathic index indicated a relative shortness of ba-pr length compared to ba-n length. This could arise from a large ba-n length or a short ba-pr distance. In view of the small s-n-ss and s-n-pr angles compared with other ethnic groups (see Table II) it would appear that a short ba-pr distance was more probably a contributing cause to the low gnathic index value.

Cranial base and prognathism

From Table V, it can be seen that the mean values for the linear measurements of the cranial base are significantly greater in the male than in the female subjects, the observed sex differences being statistically significant at the one percent probability level.

The angular bending of the cranial base was more acute in the males than in the females, the sex difference being

VARIABLE	SEX	M ± M	s	RANGE	t
n - s - ba	M F	129.6 ± 0.55 132.0 ± 0.78	5.0 3.7	115.5 - 141.0 124.0 - 140.0	2.10*
e - s - ba	M F	125.8 ± 0.64 128.9 ± 0.74	5.9 3.6	112.5 - 139.0 121.0 - 134.0	2.42*
n - s - ar	M F	122.0 ± 0.57 123.9 ± 0.85	5.3 4.1	109.0 - 133.0 112.5 - 130.0	1.62
n - s	M F	64.9 ± 0.33 61.4 ± 0.47	3.1 2.2	57.8 - 73.6 56.8 - 65.7	5.09**
e - s	M F	35.2 ± 0.34 36.0 ± 0.69	3.1 4.1	27.0 - 41.9 30.7 - 42.7	1.04
s - ar	M F	35.1 ± 0.33 30.8 ± 0.54	3.0 2.6	28.4 - 42.9 26.1 - 36.3	6.30**
s - ba	M F	46.5 ± 0.28 42.9 ± 0.77	2.6 3.7	41.0 - 52.0 38.2 - 55.4	5.30**

TABLE V

Results of angular measurements in degrees and linear measurements in mm of the cranial base size and shape. The data are expressed as arithmetic mean ± error of the mean (M ± EM), standard deviation (s) and range of variation (Range). The statistical significance of the sex differences between mean values was tested by the Student t test and the values of t are shown. **Significant at the 1 percent probability level. *Significant at the 5 percent probability level.

significant at the five percent probability level. The lateral cranial base angle (n-s-ar) was also slightly greater in the female subjects but the sex difference was not statistically significant.

The wider cranial base angulation in the females reported in this study and also by Sarnas,[47] Craven[23] and Brown[25] could possibly be another secondary sex characteristic similar to a prognathic tendency. An alternative explanation could be offered in relation to the retention of a more "foetal" form in the female compared with the male probably due to a shorter period of growth with the earlier onset of puberty in the former.[44,48]

The correlations between the linear and angular measurements of the cranial base for the male subjects are shown on Table VI. Of particular interest was the complete lack of correlation between the anterior cranial base length and the cranial base angulations, whether median or lateral.

The posterior cranial base lengths (s-ba, s-ar) were found to be negatively correlated with the cranial base angulation at the one percent significant level. This probably suggested that the cranial base angulation was more intimately related to the posterior cranial base lengths than with the anterior cranial base length.

VARIABLE	n-s	e-s	s-ar	s-ba	n-s-ba	e-s-ba	n-s-ar
n - s	-	+0.49**	+0.15	+0.14	+0.02	-0.04	-0.03
e - s		-	+0.14	+0.16	-0.07	-0.06	-0.03
s - ar			-	+0.29**	-0.39**	-0.36**	-0.16
s - ba				-	-0.42**	-0.40**	-0.28**
n-s-ba					-	-0.80**	+0.59**
e-s-ba						-	+0.48**

TABLE VI

Intercorrelation between linear and angular measurements of the cranial base for 84 male Chinese subjects. **Significant at the 1 percent level probability. *Significant at the 5 percent level probability.

The correlation between the linear measurements of the cranial base and the angles of prognathism varied from a low significant correlation ($r = -0.28$) to a complete absence of correlation ($r = 0.02$). The anterior median cranial base length was correlated with only one of the angles of prognathism, namely, s-n-sp, at the probably significant level.

The posterior lateral cranial base length (s-ar) was correlated at the probably significant level with two mandibular angles of prognathism, but was not associated with the maxillary prognathic angles. The posterior median cranial base length (s-ba), however, was correlated at the probably significant level with s-n-ss, s-n-pr, s-n-id and s-n-sm. All the above correlation coefficients were positive, indicating that the longer the posterior cranial base length, the greater the angles of prognathism. This result was of interest especially when studied in relation to the findings presented in Table VI which show that the s-ar and s-ba distances were significantly but negatively correlated with the median cranial base angulation, n-s-ba. In other words, the longer the posterior cranial base length, the more acute would be the median cranial base angle, which, in turn produced greater angles of prognathism.

Turning to the correlation of the total median cranial base length (ba-n) with the angles of prognathism in Table VII, the most conspicuous feature appeared to be the negative signs of all the correlation coefficients in this column. Although most of the coefficients were of low magnitude, they indicated that a shortening of the total cranial base length would tend to increase the angles of prognathism. This was in accord with the findings of Björk in that a shortening of the cranial base produced a prognathic face.

The correlation coefficients between the median cranial base angulation

VARIABLE	s - n - sp	s - n - ss	s - n - pr	s - n - id	s - n - pg	s - n - sm	Gnathic Index
n - s	-0.22*	-0.19	-0.08	-0.13	-0.05	-0.14	-0.02
e - s	-0.06	+0.03	+0.10	+0.06	-0.03	+0.02	+0.12
s - ar	+0.09	+0.12	+0.18	+0.21	+0.27*	+0.23*	+0.06
s - ba	+0.19	+0.26*	+0.24*	+0.24*	+0.20	+0.25*	-0.14
ba - n	-0.28**	-0.24*	-0.19	-0.20	-0.16	-0.19	-0.15
n-s-ba	-0.44**	-0.52**	-0.55**	-0.52**	-0.40**	-0.52**	-0.12
e-s-ba	-0.45**	-0.53**	-0.56**	-0.56**	-0.47**	-0.57**	-0.15
n-s-ar	-0.28**	-0.34**	-0.34**	-0.41**	-0.35**	-0.41**	-0.08

TABLE VII

Correlation between the angles of prognathism, gnathic index and the cranial base length and angulation in 84 male adult Chinese subjects. **Significant at the 1 percent level. *Significant at the 5 percent level.

(n-s-ba) and the angles of prognathism were negative and significant at a moderate to low level. An almost identical set of values existed when e-s-ba was used. The correlation coefficients of the lateral cranial base angulation (n-s-ar) were slightly lower, but again, they were all negatively significant at the one percent level of probability. This result confirmed that increased prognathism could be due, at least in part, to the angular bending of the cranial base.

Summary

The main conclusions of the present study are summarized as follows:

1. The Chinese facial profile was retrognathic compared with other population groups.
2. The retrognathism was most marked in the maxilla but smaller intergroup differences were present in the mandibular profile.
3. The Chinese possessed moderate maxillary alveolar prognathy associated with procumbent maxillary anterior teeth in a small maxillary jaw base.
4. The gnathic indices of males and females fell within the orthognathous class and were lower than ten other population indices compared.
5. Females tended to be more prognathic than males as shown by slightly higher angles of maxillary prognathism and facial convexity.
6. The sex difference in the radiographic gnathic index was significant at the five percent level and confirmed the more prognathic tendency in females.
7. Males were more variable in the metrical characters of the face than females.
8. All the angles of prognathism were highly intercorrelated.
9. The Chinese had low facial convexity and a relatively flat facial profile.
10. Females possessed more obtuse cranial base angulations which may indicate a secondary sex character.
11. The component parts of the cranial base lengths varied in their relationship to cranial base deflection and prognathism.
12. There was only a slight tendency for increased prognathism to be related to shorter total cranial base length.
13. Increased prognathism was associated with increased cranial base angulation.
14. The maxillary and mandibular angles of prognathism (s-n-sp, s-n-pg) remained relatively constant in all population groups.

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