"Wits" appraisal in Southern Chinese children

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The most widely used and possibly the simplest method of determining the antero-posterior relationship between the maxillary and mandibular apical bases is by calculating the angle ANB.[1] Dental undergraduates are frequently taught this technique because the points are easily located and theoretically highly reproducible. However, clinical experience in Hong Kong has revealed that the cephalometric landmark nasion (N) is difficult to identify on Southern Chinese patients. The shallow nasal bridge of these subjects results in superimposition of the tarsal plates of the upper eyelids over the fronto-nasal suture. Soft tissue profile data has revealed a flatness of the nose-nasion-forehead region in Hong Kong Chinese children.[2] The possible error in the identification of nasion correspondingly affects the angles SNA and SNB, and more importantly ANB, from which the magnitude of the skeletal disharmony is determined. Interpretation of the angular measurement of ANB is distorted in cases where nasion is markedly deviated in position from the "average."[3]

The degree of antero-posterior jaw disharmony in a subject can be measured by the drawing of perpendicular lines from the occlusal plane (O) to points A and B, and measuring the distance between the points AO and BO.[4] This method was originally described by Jenkins[5] and for convenience has been referred to as the "Wits" appraisal. As point N is not involved in this analysis, all errors associated with its identification, as well as the inconsistencies in the angle ANB due to varying horizontal and vertical positions of N are irrelevant.

The purpose of this study was to gather baseline data for the "Wits" appraisal and to evaluate its suitability for the analysis of skeletal disharmonies in Southern Chinese children.

Abstract

The sagittal difference between the maxillary and mandibular apical bases in orthodontic diagnosis and treatment planning can be evaluated by means of the angle ANB or alternatively, by means of the "Wits" appraisal. The lateral cephalometric radiographs of a randomly selected sample of 101 Southern Chinese children aged 10-15 years, with 55 males and 46 females were traced and analyzed by the standardized method taught to dental undergraduates. The "Wits" appraisal and angulation of the A-B line to the functional occlusal plane were added in order to generate data relevant to the local population, on whom the flatness of the nose-nasion-forehead region imposes a genuine difficulty in the identification of the cephalometric landmark nasion. Data analyses were performed under different categories with respect to age groups, 10-12 years and 13-15 years; the types of malocclusion and sex. It was found that both the angular and linear measurements were comparable to the existing norms established for the Chinese population. The "Wits" appraisal values have to be modified in order to be applicable to this population with -4.9 millimeters and -4.5 millimeters being the normal values for male and female children respectively.

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Key Words

"Wits" appraisal • Chinese children

Table 1
The data obtained from the cephalometric radiographs of 101 Chinese children aged 10-15 years.

		Male (n=55)		Female (n=46)		P
		mean	±SD	mean	±SD	value
Angle in degrees	SNA	81.08	3.59	80.91	3.86	0.821 n.s.
	SNB	77.87	3.86	77.70	3.34	0.808 n.s.
	ANB	3.21	2.41	3.24	2.37	0.950 n.s.
	CANB	3.49	2.44	3.55	2.08	0.890 n.s.
	MMPA	27.68	5.96	27.64	5.66	0.972 n.s.
	LIMN	99.22	7.45	96.11	7.95	0.046 *
	UIMX	120.09	6.09	120.05	7.12	0.978 n.s.
	UI/L1	113.03	8.83	116.20	8.79	0.075 n.s.
Distance in mm.	UFH	54.55	3.15	52.74	2.96	0.004 **
	LFH	63.56	5.25	62.15	4.73	0.162 n.s.
	TFH	118.12	6.66	114.89	6.49	0.016 *
	WITS	-4.88	3.61	-4.47	4.19	0.594 n.s.
	SN	65.90	3.28	64.75	2.58	0.056 n.s.
Proportion as %	L/TFHP	53.76	2.25	54.06	1.87	0.481 n.s.

n.s. = not significant *0.05>P>0.01 **0.01>P>0.001

Materials and methods

Two hundred lateral cephalometric radiographs were randomly selected from the 1605 films available in the department's files. All of the lateral cephalometric radiographs had been taken in a standardized manner, with ear-rods placed in the external auditory meati to stabilize the head. The patient was told to look straight ahead into a wall-mounted mirror and to adjust his head so that the plumb-line mounted in front of the mirror bisected the vertical midline of the face. The head was adjusted so that the Frankfort plane was horizontal. Distances between the anode, the mid-sagittal plane and the film were set at 150 centimeters and 13 centimeters respectively, giving a magnification factor of 8.8 percent.

The following criteria were applied to each film before it was included in the study:

(i) the patient was of Southern Chinese descent;
(ii) no observable craniofacial abnormalities were noted;
(iii) no previous orthodontic treatment had occurred;
(iv) first permanent molars, primary molars or premolars were in occlusion as assessed from the dental models;
(v) the lateral cephalometric radiograph was taken with teeth in centric occlusion;
(vi) the patient was in the "orthodontic" age range of 10-15 years (the age range when children are most commonly assessed for definitive orthodontic treatment); and
(vii) permanent maxillary and mandibular incisors had erupted with normal morphology.

Ninety-nine films did not satisfy the above criteria and were consequently rejected. The remaining 101 films represented 55 males and 46 females and these were divided into two age groups 10-12 years and 13-15 years. All of these lateral cephalometric radiographs were traced by the same investigator (L.S.), using a sharp 3H pencil on acetate tracing paper. The tracings were performed in a darkened room with extraneous light from the viewing box blocked out. Subsequently, every tracing was checked by a second investigator (P.J.D.). Eleven percent of the cephalometric radiographs were randomly selected to be retraced, and rechecked to establish the degree of reproducibility of the two investigators.

The following points were identified and marked on the lateral tracings: sella (S), nasion (N), pogonion (Po), subspinale (A) and supramentale (B). The maxillary plane (MX), mandibular plane (MN), occlusal plane (O), and lines representing the long axes of the most proclined incisors in the maxilla and mandible, AO and BO lines which were defined as perpendicular lines from the occlusal plane to subspinale and supramentale respectively, were drawn.

The occlusal plane was drawn through the region of maximum cuspal interdigitation in the manner described by Jenkins[5] and Jacobson.[4]

The upper and lower face heights (UFH, LFH) were measured as perpendicular lines from the maxillary plane to nasion and menton respectively. The distance between the lines AO and BO on the occlusal plane giving the "Wits" measurement was measured to the nearest millimeter. The angles SNA, SNB, the maxillary-mandibular planes angle (MMPA), the maxillary incisor angle to the maxillary plane (UIMX), the mandibular incisor angle to the mandibular plane (LIMN), and the interincisal angle (UI/LI), were measured to the nearest degree, using a protractor.

The patient's study models were used to classify the occlusion as Class I, Class II division 1,

Class II division 2 or Class III by assessing the general features of the occlusion.

All data were analyzed using SPSS-X on a Sperry Univac 1100/60 main frame computer.

Results

There was no significant difference at the $p<0.05$ level between the males and the females in most of the angular and linear measurements, except for the angle of the mandibular incisor to the mandibular plane (LIMN), and the upper and total face height measurements (UFH and TFH). The males were found to have more proclined mandibular incisors and longer total face height ($p<0.05$). The intersex difference in the upper face height was statistically significant at the $p<0.01$ level, with the males having the longer upper face height (Table 1).

Comparisons between the age groups (Table 2) showed highly significant statistical differences in the total face height measurements ($p<0.001$), while the differences of upper and lower face height measurements were statistically significant at the $p<0.01$ level. However, face height proportions and most of the angular measurements were not significantly different in the two groups, the exceptions being the SNA ($p<0.05$) and SNB ($p<0.01$) angles which were greater in the older age group. In addition, the length of the sella-nasion line was significantly longer in the older age group ($p<0.01$).

Classification of the malocclusions based upon the study models revealed that 59 (58 percent) were Class I, 27 (27 percent) were Class II division 1, three (3 percent) were Class II division 2, and 12 (12 percent) were Class III. Highly significant statistical differences ($p<0.001$) were shown for the angle ANB and corrected ANB, UIMX, LIMN, as well as the UI/LI among the different types of malocclusion.

The "Wits" measurements given in Tables 1 and 2 showed no statistically significant differences between the sexes, or for age groups when analyzed jointly. The norms for the males and females of combined age 10-15 years were -4.9 millimeters and -4.5 millimeters respectively, whereas they were -4.5 millimeters and -4.9 millimeters for children of combined sexes aged 10-12 years and 13-15 respectively. The difference between the "Wits" measurements for the different malocclusions are displayed in Table 3.

The readings from the first and second tracings showed a high degree of reproducibility between the operators and their methods ($p<0.001$).

Table 2
The cephalometric values for 10-12 and 13-15 years old Chinese children.

		10-12 yr. (n=59)		13-15 yr. (n=42)		P
		mean	±SD	mean	±SD	value
Angle in degrees	SNA	80.29	3.34	82.01	3.97	0.020 *
	SNB	76.97	2.86	78.96	4.25	0.0006 **
	ANB	3.32	2.25	3.08	2.57	0.621 n.s.
	CANB	3.85	1.94	3.06	2.63	0.086 n.s.
	MMPA	28.50	6.34	26.49	4.75	0.086 n.s.
	LIMN	97.42	7.41	98.33	8.39	0.566 n.s.
	UIMX	119.00	5.78	121.58	7.29	0.050 n.s.
	UI/LI	115.08	8.07	113.62	10.08	0.421 n.s.
Distance in mm.	UFH	52.90	3.04	54.88	3.05	0.002 **
	LFH	61.74	5.02	64.58	4.63	0.005 **
	TFH	114.64	6.39	119.48	6.27	0.000 ***
	WITS	-4.52	3.85	-4.94	3.93	0.590 n.s.
	SN	64.68	2.61	66.36	3.30	0.005 **
Proportion as %	L/TFHP	53.81	2.22	54.03	1.89	0.598 n.s.

n.s. = not significant **0.05>P>0.01 **0.01>P>0.001 ***P<0.001

Discussion

In several published studies the occlusal plane was defined as the plane of maximal cuspal interdigitation,[4-6] which originated the "Wits" appraisal. The same plane has also been referred to as the "functional" occlusal plane because it was considered to be the functional plane of the masticatory area. Jacobson[4] has used the term "occlusal plane" although his definition was the same as the earlier studies. The plane of maximal cuspal interdigitation was noted to be concave in many subjects. This observation led Jacobson[7] to recommend that "the most suitable and convenient method of standardizing the plane of occlusion is to join the midpoints of overlap of the mesiobuccal cusps of the first molars and the buccal cusps of the first premolars." Although subsequent studies on Caucasian populations have confirmed Jacobson's findings, comparisons between the results must be considered with caution as some of the authors failed to specify which method of drawing the occlusal plane they used;[8] some even defined their own.[9-11] It is noteworthy that Jacobson's original method has, without justification, been ignored when the "Wits" appraisal has been calculated in

Table 3
The cephalometric values for Chinese children grouped according to the type of malocclusion.

		Class of malocclusion								
		I (n=59)		II_1 (n=27)		II_2 (n=3)		III (n=12)		P value
		mean	±SD	mean	±SD	mean	±SD	mean	±SD	
Angle in degree	SNA	80.91	3.47	81.96	3.86	78.33	2.89	80.00	4.30	0.231 n.s.
	SNB	77.69	3.05	77.83	3.83	72.33	1.53	79.54	4.82	0.019 *
	ANB	3.21	1.96	4.17	2.16	6.00	2.00	0.46	2.59	0.000 ***
	CANB	3.55	1.72	4.13	2.25	7.17	1.25	1.11	2.83	0.000 ***
	MMPA	27.69	4.83	26.67	7.18	26.67	2.31	31.46	6.10	0.057 n.s.
	LIMN	96.56	7.32	102.67	6.70	103.17	9.78	91.63	5.66	0.000 ***
	UIMX	119.32	5.37	123.31	7.28	107.00	6.56	119.75	5.31	0.000 ***
	UI/LI	116.42	8.22	108.04	7.67	123.17	13.14	117.17	6.60	0.000 ***
Distance in mm.	UFH	53.88	3.00	53.00	3.58	57.50	2.78	53.63	2.79	0.122 n.s.
	LFH	62.75	4.50	61.59	5.04	63.17	5.39	66.67	6.24	0.033 *
	TFH	116.64	6.26	114.59	6.56	120.67	7.94	120.29	8.04	0.067 n.s.
	WITS	-5.26	2.82	-2.22	3.43	+3.50	2.60	-9.50	2.18	0.000 ***
	SN	65.18	2.74	66.00	3.09	68.67	4.31	64.13	3.37	0.068 n.s.
Proportion as %	L/TFHP	53.77	1.84	53.71	2.47	52.30	1.25	55.34	1.97	0.044 *

n.s. = not significant *0.05>P>0.01 **0.01>P>0.001 ***P>0.001

subsequent studies. However, in this study of Southern Chinese children the same definition and terminology of the occlusal plane were deliberately adopted so as to avoid confusion and ensure comparability with Jacobson's work.

Based upon data for the "Wits" appraisal based upon subjects with "excellent occlusions," Jacobson[4] proposed the norm to be -1.0 millimeter for males and 0.0 millimeter for females. He stated that the "Wits" reading should be positive for Class II dysplasias and negative for Class III dysplasias. Thus, increased deviations from the norms would indicate more severe anteroposterior jaw disharmonies.

Data from German children aged 10 and 14 years showed that the "Wits" appraisal is not constant, but that it increased with age.[11] This was contradicted by a study of subjects over the age range of five to 25 years which showed no significant change in the "Wits" appraisal between child and adulthood.[12] The findings of the present study support the fact that allowances for growth are not necessary, and that the "Wits" value remains a constant value. It has been suggested that a change in the inclination of the occlusal plane is the reason the difference between the lines AO and BO remains constant, in spite of progressive mandibular growth.[13]

Analysis utilizing the conventional intracranial reference planes in lateral cephalometric radiographs, taken in the natural head posture,[2] indicate comparable ANB values between Chinese and Caucasian males which is in agreement with several previous studies.[14-21] Similarly, the normal value of 3.2 degrees for the angle ANB in the present group of Chinese children was found to be comparable with the Caucasian standards of between two degrees and four degrees. However, when the true horizontal was the reference line for AB assessment of the sagittal skeletal pattern, it clearly showed that Chinese males were skeletally Class III as compared with Caucasians.[22] The true caudal angulation of the nasion-sella line to the true vertical

in natural head posture, and of the other intracranial reference planes reveals a true morphologic and ethnic difference on both a Southern Chinese population in Hong Kong[22] and a Taiwanese male population.[23]

Bimaxillary dental and alveolar protrusion has been clearly demonstrated to be a characteristic feature in Southern Chinese.[2] Besides the maxillary protrusion, maxillary jaw base length, face heights, ramus height, squarish craniofacial outlines,[17] denture widths[24] and shorter sella-nasion length[25-26] have been shown to be associated with prognathism in Chinese subjects. Because of this higher prevalence of prognathism among the Chinese children, the "Wits" appraisal is only applicable to the Southern Chinese patient if a modification is made to the Caucasian value. Published results for Chinese cephalometric studies have been based upon highly selected, small samples of subjects possessing Class I occlusions and pleasing profiles.[14,22,27] When unselected sample groups were studied, only a small number of variables were considered.[28,29] The only comprehensive lateral cephalometric analysis of Southern Chinese was based on films taken in "natural head posture.[2] To facilitate comparability with other clinical studies, and to show the relevance of the results with patients under treatment, analysis of radiographs taken in a standardized position is more useful. In addition, the present sample was not selected according to malocclusion or profile.

Although it would be advantageous to directly compare investigations into the correlation between "Wits" appraisal and the angle ANB, for which a relationship has been shown, it is at a relatively low level with a range of 0.60 to 0.67.[10,12,30] The authors agreed that the inter-individual variables affecting the angle ANB and the "Wits" measurement would make a perfect correlation unlikely and that the analysis is mathmetically complex.[31] As there is probably little clinical application of such a technique the correlation between these two assessment techniques was not investigated in the present study.

The "Wits" appraisal is a linear measurement, an adjunctive diagnostic aid in assessing the antero-posterior skeletal dysplasia, and not an analysis *per se*.[7] Moreover, as pointed out by Jacobson,[32] no single parameter in cephalometrics should be relied upon as the sole absolute value.

The findings from this investigation of Southern Chinese children suggest that the most appropriate values for males would be -4.9 millimeters and -4.5 millimeters for females. Such a correction is probably due to the prognathism which is shown by the Southern Chinese. The findings from this study of Southern Chinese children do not support the existence of a one millimeter discrepancy between the sexes as reported by Jacobson.[4]

Summary

The sagittal difference between the maxillary and mandibular apical bases in orthodontic diagnosis and treatment planning can be evaluated by means of the angle ANB or alternatively, by means of the "Wits" appraisal. The lateral cephalometric radiographs of a randomly selected sample of 101 Southern Chinese children aged 10-15 years, with 55 males and 46 females were traced and analyzed by the standardized method taught to dental undergraduates. The "Wits" appraisal and angulation of the A-B line to the functional occlusal plane were added in order to generate data relevant to the local population, on whom, the flatness of the nose-nasion-forehead region imposes a genuine difficulty in the identification of the cephalometric landmark nasion. Data analyses were performed under different categories with respect to age groups, 10-12 years and 13-15 years; the types of malocclusion and sex. It was found that both the angular and linear measurements were comparable to the existing norms established for the Chinese population. The "Wits" appraisal values have to be modified in order to be applicable to this population with -4.9 millimeters and -4.5 millimeters being the normal values for the male and female children respectively.

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