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The different cephalometric assesment of anterior open bite

Chia-Tze Kao and Tsui-Hsien Huang

Anterior open bite (AOB) is a complex problem, representing one of the most challenging tasks in orthodontic treatment. To develop an ethnic specific population norm of craniofacial skeletal pattern with potential diagnostic and clinical value for treating AOB patients, a cephalometric study was conducted, using the Sassouni plus analysis, Steiner analysis, Tweed analysis and Kim's ODI method, on a randomly selected group of Taiwanese patients with diagnosed AOB. The AOB group consisted of 23 males and 25 females, normal group consisted of 35 males and 25 females in their twenties and thirties. Various parameters of the craniofacial skeletal pattern of patients with AOB were measured, and were compared with values taken from normal group as well as to published values taken from an anterior open bite group of Westerns. Our results seem to support the following generalizations: 1. The structures of the AOB group after comparing with the normal group showed that the maxilla is in retrusive position, the mandible is rotated downward and backward, the anterior lower facial height is increased, maxillary central incisor is procumbency, mandibular central incisor is flare, inter-incisors angle is acute and the mandibular plane angle is steep. 2. The LGA is the most representative parameter of AOB in the modified Sassouni analysis. The higher GoGn-SN angle is the character of the AOB structure in Steiner analysis. The increased FMA and decreased FMIA is the signs of AOB on the Tweed analysis, and the ODI measurement by Kim's method is a good indicator of the AOB analysis. From several different commonly used cephalometric analyses, there are particulary existed one measurement which can express the AOB structure.

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Introduction

Anterior open bite (AOB), one of the most difficult orthodontic problems to correct, was defined as the absence of vertical contact between the maxillary and mandibular incisors at the centric relation.[1] A dental open bite is one that is limited to the anterior region in an individual with good facial proportion.[2] Whereas the hallmark of a skeletal open bite are increased anterior facial height, a steep mandibular plane and excessive eruption of posterior teeth.[3] Skeletal open bite is subdivided into two groups, complete overbite and incomplete overbite. The latter, also called pseudo open bite, is characterized by the fact that patients' caraniofacial skeletons are different from those of normal pattern, especially in the vertical dimension.[4]

Cephalometry has been used as a research tool in dentistry for evaluating the orthodontic treatment and describing facial growth. A certain set of angular and linear measurements are taken from tracing the oriented lateral and frontal radiographic head film. There are many cephalometric analyses available: Sassouni analysis is an archial individualized cephalometric appraisal of malocclusion.[5] The Steiner analysis is one of the popular cephalometric tracing methods.[6] The Tweed triangle analysis is one of which can diagnose malocclusion easily[7] and Kim's ODI has proved to be a good reference in anterior open bite cases.[8] This study uses the above methods to evaluate the adult AOB structures.

One must start the diagnosis with recognition of any skeletal problems that exist, then you can do a good treatment plane.[9] In the case of an open bite malocclusion, this may be caused by a number of etiology factors.[10,11,12,13,14,15] It is conceivable that the craniofacial patterns of AOB result from complicated pathogenetic mechanisms and a possible imbalance or inadequate function of growth factors. There is, however, no widely accepted method to determine the presence of an open bite tendency.[16] The previous study of the adult anterior open bite by quadrilateral analysis showed apparently abnormalities in the maxilomandibular complex causing changes in vertical dimension of facial pattern are involved in AOB.[17]

The purpose of this study are to evaluate what is the differences between various cephalometric analyses in the diagnosis of adult AOB and try to find what measurements can give the clinician a good guidance to diagnose AOB tendency.

Material and method

The sample with AOB was composed of 23 males and 25 females with the cessation of growth confirmed by wrist films with an age range from 20 to 30 years of age. The sample was selected from different local dental clinics and was based upon the following criteria: 1. A negative overbite depth (<0 mm, the rang of this study is from -2 to -5 mm, mean -2.45 mm), 2. no prior orthodontic treatment, 3. at least 28 natural teeth present, 4. no prosthesis, 5. no traumatic injury to the jaws and 6. Ethnic Taiwan race. The normal sample was consisted of 35 males and 25 females also with an age range from 20 to 30 years. The sample was based upon the following criteria: 1. A normal overbite and overjet, 2. class I molar and canine relationship, 3. no prior orthodontic treatment, 4. at least 28 natural teeth present, 5. no prosthesis, 6. no traumatic injury on jaws and 7. Ethnic Taiwanese. All cephalometric points were taken at the same dental hospital by the same technologist. All cephalograms were identified by one trained dentist and then checked by a

second investigator to verify the accessory of the tracing. In this study the analyses used were, 1. the modified Sassouni method[18] combined with 2. Steiner analysis,[6] 3. Tweed analysis[7] and 4. Kim's ODI (overbite depth indicator).[19] If the landmarks were bilatero-occlusal and did not coincide with each other on the cephalogram, the midpoint was chosen.

The Steiner analysis is required the measurement of the sella-nasion-A point angle (SNA), sella-nasion B point angle (SNB), sella -nasion-symphysis centre angle (SND), the angle and distance of upper central incisor to nasion-A point line (1-NA), the angle and distance of lower central incisor to nasion-B point line (T-NB), the inter-incisor angle of the upper central incisor and the lower central incisor (1-T). (Figure 1)

The Tweed analysis measures the Frankfort mandibular plane angle (FMA), Incisor mandibular plane angle (IMPA) and the angle of mandibular incisor with Frankfort plane (FMIA). (Figure 2)

The overbite depth indicator (ODI) is defined as the angle of the A-B plane to the mandibular plane combined with the angle of the palatal plane to Frankfort horizontal plane. (Figure 3)

The landmarks used by modified Sassouni method in this study were as follows (figure 4): SOr: supra orbital roof; N: nasion; A: subspinale; B: supramentale; Me: menton; Te temporale; RO: roof orbitale; Cl: clinoidale; Cr: cribriform; Sp: sella posterior; Go: gonion; Ar: articulare; ANS: anterior nasal spine. PNS: posterior nasal spine. The planes were drawn in the following: the plane parallel to the supraorbital plane (Parallel plane); the palatal plane (ANS-PNS); the occlusal plane (the midpoint of interincisor edge to the midpoint of inter molar cusp) and the mandibular plane (Me-Go). The locus O was defined as the area of most common intersection of all the above four major planes. The arcs were constructed as follows: Anterior arc: with the point of compass set on the point O, draw an arc from nasion through all the four planes. Basal arc: from the center O, constructs an arc extending from A point to the level of B point. Midfacial arc: from the center O, constructs an arc from Te to the occlusal plane. Posterior arc: from center O, constructs an arc from Sp down to the mandibular plane. All measurements included the followings: anterior nasal spine to anterior arc (ANS-Ant arc); A point to anterior arc (A-Ant arc); pogonion point to anterior arc (Pog-Ant arc); anterior nasal spine to menton point (ANS-ME); superior orbital roof to anterior nasal spine (SOr-ANS); maxilla central incisor to anterior arc (1-Ant arc); cribriform point to anterior arc (Cr-Ant arc); anterior nasal spine to posterior nasal spine (ANS-PNS); maxilla first molar to middle arc (6-Mid Arc); anterior arc to posterior arc (Ant arc-Post arc); pogonion to gonial point (Pog-Go); gonial point to posterior arc (Go-Post arc); total gonial angle (TGA); upper gonial angle (UGA); lower gonial angle (LGA); upper lip angle (ULA); posterior facial height (PFH); incisor mandibular plane angle (IMPA).

The statistical analysis of the parameters was under taken by means of the SAS software. The significance of the mean difference between the groups was subjected to the student t-test. The correlation of all the parameters were also calculated.

Result

In the Steiner analysis, the adult AOB anormaly group when comparing with the normal group showed that with the exception of the T-NB degree, all of the other measurements were showed statistical differences ($p<0.05$) when compared with the value of the normal group. (Table 1)

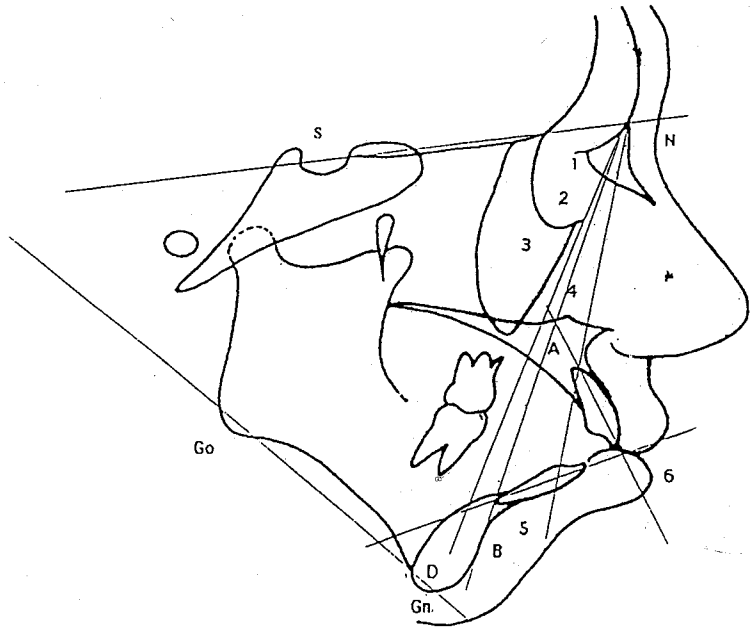


Figure 1. Steiner's analysis.
S: mid point of pituitary fossa;
N: nasion;
SN: cranial base plane;
Go: gonion;
Gn: gnathion;
A: point of greastest convexity on the anterior of the maxilla;
B: point of greatest convexity on the anterior of the mandible;
1: SNA; 2: SNB; 3: SND; 4: 1-NA; 5: T-NB; 6: 1-T; 7: GoGn-SN.

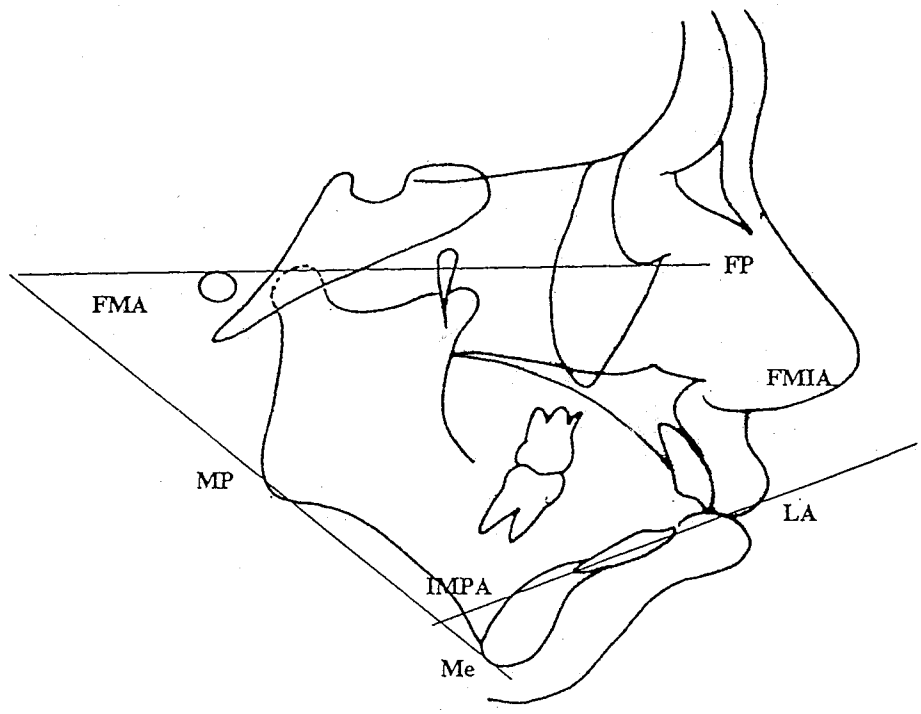


Figure 2. Tweed analysis.
Frankfort plane (FP): Line from the upper border of the external auditory meatus to the lower border of the orbit.
Mandibular plane (MP): line tangential to the lower border of the mandible. LA: long axis of the mandibular incisor.

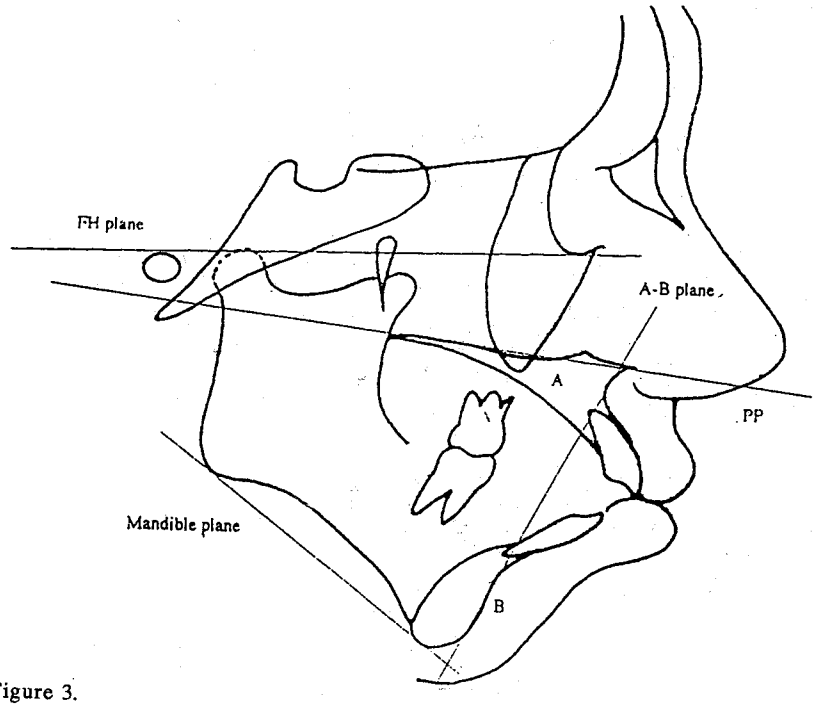
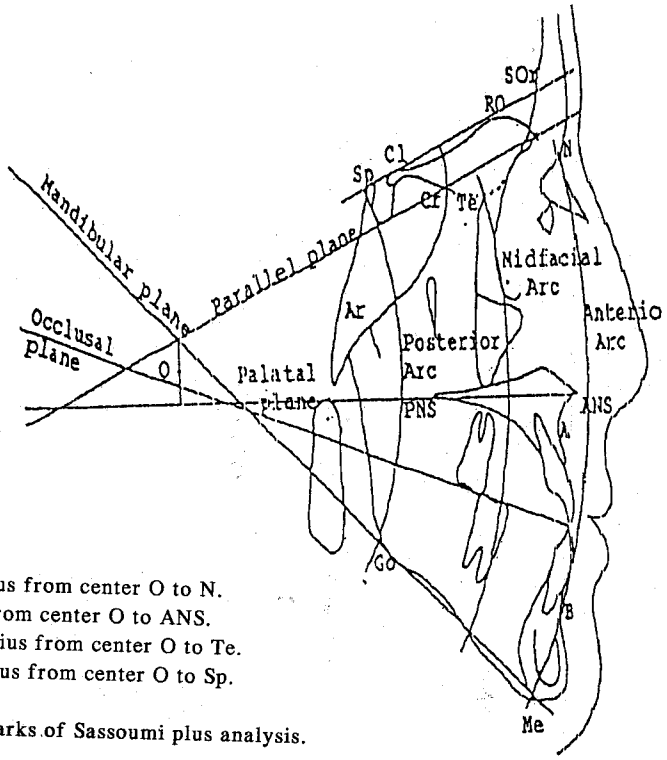


Figure 3.
Kim's analysis (overbite depth indicator ODI)
AB Plane: Line joining points A & B from Steiner's analysis,
FP: Frankfort plane.
PP: Palatal plane. MP: Mandibular plane.
ODI: The sum of the angle formed by 1: The mandibular and A-B plane. and 2: The Frankfort and palatal plane.



Point:
Sor: supraorbital
N: nasion
A: subspinale
B: supramentale
Me: nentom
Te: temporale
Ro: roof orbitale
Cl: chinoidale
Cr: cribiform
Sp: sella posterior
Go: gonion
Ar: antioulars
ANS: anterior nasal spine
PNS: posterior nasal spine
Arc:
Anterior arc: arc formed with radius from center O to N.
ANS arc: arc formed with radius from center O to ANS.
Midfacial arc: arc formed with radius from center O to Te.
Posterior arc: arc formed with radius from center O to Sp.

Figure 4. The cephalometric landmarks of Sassoumi plus analysis.

Table 1. Anterior openbite (AOB) malocclusion compared with Norm of Taiwanese, analysed by Steiner method, Tweed method and ODI measurements.

	Norm		AOB		AOB		Norm
	male n=35	t(A) p	male n=23	t(B) p	female n=25	t(C) p	female n=25
SNA	83.92/3.86	3.813 ***	79.47/3.34	-0.216 NS	79.76/4.50	2.345 *	82.12/2.94
SNB	80.419/3.11	2.654 *	78.00/2.75	0.791 NS	76.96/4.61	3.442 ***	80.12/2.63
SND	77.76/3.41	2.403 *	75.27/3.41	0.935 NS	73.96/4.73	3.585 ****	77.15/2.43
1-NA (mm)	3.72/2.07	-8.625 ****	9.67/2.44	-0.954 NS	11.68/7.90	-4.398 ****	5.07/1.62
1-NA (degree)	22.53/5.06	-8.063 ****	34.33/3.66	1.268 NS	30.44/11.48	-2.373 *	25.12/4.10
1-NB (mm)	5.71/2.44	-4.334 ****	9.93/4.03	-1.16 NS	12.88/9.30	-4.408 ****	5.12/2.38
1-NB (degree)	25.81/6.31	-1.693 NS	29.87/9.64	-0.64 NS	31.92/9.90	-3.196 **	25.23/5.30
1-1	128.24/7.86	4.656 ****	114.60/11.65	1.856 NS	108.48/9.07	8.49 ****	127.65/7.68
GoGn-SN	30.36/5.10	-6.446 ****	41.00/5.46	-1.67 NS	45.28/8.95	-8.02 ****	30.53/4.22
FMA	25.38/4.93	-8.337 ****	36.93/4.15	-0.435 NS	37.88/7.79	-6.951 ****	25.68/5.13
IMPA	95.56/6.43	-1.68 NS	91.86/10.14	-0.94 NS	94.16/6.43	-1.34 NS	96.32/4.71
FMLA	61.10/7.03	3.08 **	52.23/12.11	1.601 NS	47.16/8.32	6.995 ****	60.78/6.01
ODI	72.06/6.42	3.19 **	65.93/6.49	-0.393 NS	66.80/6.93	3.312 **	73.25/6.08

(A): Comparision between norm and AOB in male.
(B): Comparision between AOB of male and female.
(C): Comparision between norm and AOB in female.
*: statistically significant difference at $p<0.05$
**: statistically significant difference at $p<0.01$
***: statistically significant difference at $p<0.001$
****: statistically significant difference at $p=0.0001$
NS: no statistically significant difference.

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Table 2. Cephalometric parameters of the anterior openbite and the normal analysed by Sassouni analysis.

	MALE				FEMALE		
	NORMAL N=35	@	OPEN N=23	#	OPEN N=25	$	NORMAL N=25
	MEAN/SD	t VALUE P	MEAN/SD	t value p	MEAN/SD	t value p	MEAN/SD
ANS-Ant arc	5.71/3.12	-15.88 ***	-6.09/2.43	-1.27 *	-3.76/3.99	-8.88 ***	4.92/2.84
A-Ant arc	3.42/2.61	-14.18 ***	-9.74/4.46	-1.52 NS	-8.32/5.03	-10.4 ***	3.12/2.33
Pog-Ant arc	3.82/2.94	-1.28 NS	2.35/5.66	1.19 NS	0.76/3.43	-3.16 **	3.62/2.91
ANS-Me	82.97/4.42	3.73 ***	77.52/5.51	1.43 NS	66.68/5.01	2.32 *	71.46/3.31
Sor-ANS	74.63/5.63	3.92 ***	66.91/3.23	0.19 NS	72.2/4.95	3.93 ***	75.62/5.45
1-ANS Arc	4.82/3.01	4.05 ***	9.52/5.83	-6.01 NS	8.36/3.47	3.56 ***	4.71/3.81
Ant arc-Cr	54.63/3.88	-6.67 ***	48.17/3.24	-0.99 NS	49.24/4.08	-2.51 *	52.02/3.75
ANS-PNS	56.01/3.84	-5.78 ***	50.87/2.34	1.68 NS	47.96/8.00	-3.99 ***	54.81/3.13
6-Mid Arc	4.31/3.01	-8.88 ***	-3.17/3.33	0.66 NS	-4.00/5.14	-7.06 ***	4.21/2.73
Ant arc-Post arc	76.5/3.00	-7.22 ***	70.61/3.10	0.28 NS	70.20/6.41	-2.54 *	73.82/3.61
Pog-Go	84.82/5.36	-5.21 ***	77.65/4.80	1.92 NS	74.40/6.69	-3.94 ***	80.62/3.83
Go-Post arc	2.67/2.11	6.34 ***	-3.78/5.45	-0.92 NS	-2.44/4.67	5.78 ***	3.71/2.55
TGA	118.94/6.71	2.06 ***	122.61/6.73	-1.49 NS	125.36/6.03	2.87 *	119.91/5.72
UGA	45.32/4.43	-3.36 ***	40.87/5.61	-1.88 NS	43.44/3.77	-3.38 *	46.73/3.01
LGA	73.62/4.52	6.63 ***	81.74/4.69	-0.13 NS	81.92/5.28	6.58 **	73.21/4.03
Upper lip angle	104.71/10.17	1.32 NS	108.35/10.53	-1.43 NS	112.56/9.92	3.96 ***	103.88/4.92
PFH	84.61/3.77	-2.47 *	80.89/7.66	2.11 *	75.96/5.86	-2.52 *	79.32/3.16
IMPA	95.57/6.41	-1.68 NS	91.86/10.14	-0.94 NS	94.16/6.43	-1.34 NS	96.32/4.71

*: statistically significant difference at P<0.05.
**: statistically significant difference at P<0.01.
***: statistically significant difference at P<0.001.
NS: no statistically signifincant difference.
@: Normal male group and openbite group comparison.
#: Openbite male and female groups comparison.
$: Normal female group and openbite female group comparison.
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In the Tweed measurement, the FMA and FMIA showed a statistical difference (P<0.01) compared with the value of the normal group (table 3). The ODI of this study were below the mean of the normal group (P<0.001). (Table 1)

In the Sassouni plus analysis, the adult AOB anormaly group compared with the normal group, the results showed that there were many parameters showing statistical differences (P<0.05) listed following in both sexes: ANS-Ant arc, A-Ant arc, ANS-Me, Sor-

Table 3. The correlation analysis of ODI with different measurements on AOB cephalometry.

	Correlational coefficent
Open	0.03893
SNA	0.48979 **
SNB	0.00129
SND	0.22122
1-NA (mm)	-0.13989
1-NA (degree)	0.20152
T-NB (mm)	0.29963
T-NB (degree)	0.05151
1-T	0.38207 *
Gogn-SN	0.35261 *
FMA	0.09744
IMPA	0.57823 ****
FMIA	0.44206 **
ANS-Ant arc	0.44243 **
A-Ant arc	0.44958 **
Pog-Ant arc	-0.42126 **
ANS-Me	-0.38954 *
SOr-ANS	-0.10291
1-ANS	0.10783
Cr-Ant arc	-0.16653
ANS-PNS	0.30734
6-Mid arc	-0.07541
Ant Arc-Post Arc	0.20078
Pog-Go	-0.15879
Go-Post Arc	-0.03442
TGA	-0.38435 *
UGA	0.02674
LGA	-0.48872 **
ULA	-0.15901
PFH	-0.02834

*: statisitcally significant difference at p<0.05.
**: statisitcally significant difference at p<0.01.
***: statisitcally significant difference at p<0.001.
****: statisitcally significant difference at p=0.0001.

ANS, 1-ANS, Ant arc-Cr, ANS-PNS, 6-Mid arc, Ant arc-Post arc, Pog-Go, UGA, LGA and PFH; Female group only: Pog-Ant arc and Upper lip angle (table 2).

In a correlational analysis between the ODI with all measurements, the results showed that IMPA had the highest correlation value ($r=0.5782$, $p<0.0001$) with the ODI. The SNA, 1-T, GoGn-SN, FMA, FMIA, ANS-Ant Arc, A-Ant Arc, Pog-Ant Arc, ANS-Me, TGA and LGA were showed at a different level of correlation ($p<0.05$). (table 3)

Discussion

In the Steiner analysis, comparing AOB group with normal group, there are existed many statistically different measurements. The SNA and SNB values of AOB group are smaller than the corresponding values of the normal group, in turn the measurements of AOB showed that the maxilla and the mandible are in a retrusive position relative to the cranial base. The 1-NA and T-NB value of AOB group are larger than that of the normal group, and the maxillary incisor and the mandibular incisor are in a protrusive position. Compare to the normal group, the AOB group is smaller in interincisor angle, and the dental relation is more protrusive; the AOB group is also smaller in SND, and mandible is more retrusive. The mandibular plane angle is higher in AOB groupand the mandible is in clockwise roation. These agree with other investigations that the mandibular plane angle incrases in openbite cases.[20,21,22]

In the Tweed analysis, the FMA is larger ($p<0.0001$) and the FMIA ($P<0.001$) is smaller in the AOB anormal group. The structure of the AOB showed the mandible is in a more clockwise growth direction. When measured using the Frankfort plane, the mandibular incisor is in a more flared position. The reason that the AOB samples IMPA value shows no difference with the normal group may be that there is compensation of mandible in a backward an downward direction, that is, the Gonion angle is increased especially in cases with a lower gonion angle (LGA). The assumption is the same as the result of Sassoui analysis in this study. Actually, if there is no backward rotation of the mandible, the IMPA of AOB group shall be larger than the value of the normal group. From this point of view the result of the clockwise rotation of mandibular are similar to the AOB mandible plane angle represented in the Steiner analysis.

In ODI measurement, there existed differences ($p<0.01$) between the AOB anormaly group and the normal group. The norm established by Kim, on 119 white patients was 74.5 +/- 6.07 degrees.[19] The difference between these two figures is significant at the 0.001 level. According to Kim's criteria, all samples of this study do have an open bite tendency. It is coincidence with the clinical expression of AOB. The result seems to supprot the study of Wardlaw, that ODI value is a good indicator of AOB diagnosis.[8]

The different morphologic structures of the adult AOB anormaly and the normal groups analysed by the modified Sassouni method are shown as follows:

In maxilla antero-posterior relationship, ANS-Ant arc and A-Ant arc measurements, the adult AOB maxilla is in a more retrusive position than the position of the normal group. The result is same as the result of the smaller SNA in AOB group on above finding. In mandibular antero-posterior relationship, only are in female group of the AOB show that the mandible is in a more retrusive position than the position of the normal group. In vertical relationship, the anterior upper facial height of the AOB group is smaller than the value of the normal group. The anterior lower

facial height of the AOB is larger than the value of the norm. The results are similar to Toutountzakis's posterior anterior cephalograph study of the open bite, in which lower facial height was found to be significantly increased in both male and female group.[23] In Huang's study of long face syndrome of Chinese,[24] the facial height was increased by anterior lower facial growth which in turn was caused by the maxillary overgrowth.[24] In our study, the anterior lower facial height do increase but cannot attribute to the source of this increase. In the modified Sassouni analysis, the maxillary first molar is in a more retrusive position than the position of the normal group. It may be explained that backward position of the maxillary first molar causes a wedge effect on the jaws. The wedge effect will cause the bite opening. There are similarites to the result of the maxillary first molar overgrowth on long face syndrome.[24] In maxillary central incisor position and 1-ANS arc measurement are larger than the measurement of the norm. The maxillary central incisor is in a more protrusive position. The result is same as the presentation of 1-NA measurement on Steiner analysis. In maxillary and mandibular length comparison, both values of the AOB group are smaller than that of the normal group. In gonion angle comparison, the upper gonion angle of AOB is smaller than that of the normal group, whereas the lower gonion angle of the AOB is larger than that of the normal group. It suggests that the mandible is in a downward and backward growth direction. The result is same as the other study on AOB mandibular growth pattern.[21,22,25] The Nahoum and Subtenly studies found that the posterior facial height of AOB is smaller in the female group.[25,26] Wheras our study found that both the male and female AOB groups' posterior facial height is smaller than the normal group. It may be caused by the short ramus with large gonial angle.

The ODI is proved to be a good indicator in diagnosing AOB by Waldlaw.[8] All measurements in this study were tested with ODI by correlational analysis. In correlational analysis of all parameters with the ODI shows that ODI has strongest negative correlation with the LGA ($r=-0.48872$, $P<0.001$). It means that in the openbite tendency cases the ODI and LGA are in reverse correlation. In AOB morphologic findings proved that the LGA of AOB group is really larger than that of normal group. In openbite tendency cases, LGA is a good diagnosing reference. In this study the IMPA has the highest positive correlational coefficient with the ODI ($r=0.57283$, $P<0.001$). IMPA value should become smaller in AOB case because the ODI becomes smaller. But in IMPA of Sassouni analysis, comaprison with the normal group, there is no statistical difference in AOB male and female groups. It might related to the backward growth of the mandible. The FMIA have a strong positive correlation with ODI. The morphologic expression of FMIA in AOB group is smaller than the FMIA of the normal group. Clinically, it is shown that the mandibular incisor is procumbent in AOB group. If the Frankfort plane is same, it is reasonable that why the FMIA will be small in AOB cases. The correlation analysis of ODI with SNA ($r=0.48979$, $P<0.01$). and ODI with 1-T ($r=0.38297$, $P<0.05$) shows positive correlation. The SNA value of the Steiner analysis in AOB group is smaller than the value of the normal group. It also agrees the retrusive maxilla in AOB. It contradicts the findings reported by Hapak in a study of 52 white patients in 1964 and Jones in a study of 32 black patients in 1989.[18,27] The varience may be caused by differences in the sample. In this study the AOB samples are all adults but not in the other studies. The inter-incisors angle is smaller in AOB group.

The facial pattern of AOB are mostly seen with convex profile. The Go-Gn to SN plane have a statistical correlation with ODI ($r = 0.35261$, $p < 0.05$). In AOB group the mandibular plane angle is greater than the angel of the normal group. Clinically, the appearance of AOB facial height is shown to be long. From the above correlation analysis, ODI is really an important factor in diagnosing the AOB tendency.

We may get the following conclusions from this study:

1. The morphologic structures of the adult Taiwan AOB sample are as follows: high mandibular plane angle, high mandibular-Frankfort plane angle, increased lower gonial angle, long anterior face height and bimaxillary dental protrusion.
2. The phenotype of adult AOB by different assesments show that the abnormal structures in AOB are similar.
3. The authors suggest that LGA is the most representative parameter of the AOB in the Sassouni analysis. The higher GoGn-SN angle is the character of the AOB structure is Steiner analysis. The increased FMA and decreased FMIA is the signs of the AOB on Tweed analysis. ODI measurement by Kim's method is a good indicator of the AOB analysis.

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不同測牖分析方法用於開咬之比較

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前方開咬於咬合不正治療屬於較複雜之問題。本研究收集開咬樣本23名男性，25名女性，利用測牖分析方法中之Steiner分析、Tweed分析、Kim分析和Sassouni分析，對開咬作分析比較。結果顯示：1. 開咬與正常咬合之差異爲開咬之上顎骨位置較爲後縮，下顎骨向下向後旋轉生長，前下臉長度增加，上顎門牙外翻，下顎門牙向唇側傾，上下顎門牙門角變小，下顎平面角變大。2. 在開咬分析最具特點之表現，Sassouni分析爲下方下顎骨角變大；Steiner分析爲下顎平面角變大；Tweed分析爲FMA變大，FMIA變小；Kim分析overbite depth indicator (ODI) 變小。由上述不同之測牖分析比較，不同之方法均有某些測量值足以代表開咬之特徵，對於開咬結構之剖析亦是相似。

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