CHAPTER V
DISCUSSION

Normal occlusion

The characteristics of craniofacial structures of the Northern Thai adults with normal occlusion in the present study and those of the Thai norm adults (Suchato and Chaiwat, 1984) and the Caucasian norm adults (Bell et al., 1980). were summed up in Table 12.

The anteroposterior relationship of maxilla to anterior cranial base in the Northern Thai and Thai samples were more prognathic than that in the Caucasian samples. The anteroposterior relationship of mandible to anterior cranial base in the Northern Thai samples was more prognathic than that in the Thai and Caucasian samples. Hence, the ANB angle in the Northern Thai group was less than that in the others.

The Wits value of the Northern Thai adults with normal occlusion was - 3.1 millimeters for the males and -3.6 millimeters for the females, which was similar to that of the Thai adults with normal occlusion (Sorathesn, 1988); -3.24 millimeters and -3.32 millimeters for the males and females, respectively. While the Wits value of the Northern Thai adults showed more negative value than that of the Caucasian adults in Jacobson' s study (1975) for either sex. The Wits value based upon the Caucasian adults with excellent occlusion was -1.0 millimeters for males and 0 millimeter for females. It indicated that the mandible of Northern Thai adults with normal occlusion was more anteriorly to the maxilla than that of Caucasian adults with normal occlusion. The ANB angle was corresponded with the Wits appraisal that the mandible in Northern Thai adults was more prognathic than that in Caucasian adults.

Table 12 The dentoskeletal structures of Northern Thai, Thai and Caucasian adults with normal occlusion

Variables		Northern Thai (present study) (n=70)	Thai (Suchato and Chaiwat) (n=100)	Caucasian (Bell et al.)
SKELETAL				
SNA	(deg)	83.6±3.0	84.2±3.6	82±4
SNB	(deg)	82.2±3.0	81.3±3.6	79±3
ANB	(deg)	1.4+1.5	2.9±2.5	3±2
SN-PP	(deg)	9.2±3.1	8.5±3.0	7±3
SN-GoGn	(deg)	28.9±4.5	29.4±5.6	32±5
PP-GoGn	(deg)	19.7±4.5	20.9±5.2	-
Ar-GoGn	(deg)	119.7±4.9	-	123±5
NSGn	(deg)	67.9±3.3	67.7±3.3	-
DENTAL				
UI-NA	(deg)	24.2±5.2	22.2±5.9	22±6
LI-NB	(deg)	31.1±4.7	30.4±5.6	25±6
UI-SN	(deg)	107.8±5.4	-	104±6
LI-GoGn	(deg)	100.1±6.0	-	95±7
UI-LI	(deg)	121.6±15.5	124.7±8.0	-

The maxilla of the Northern Thai and Thai samples had more posterior rotation than that of the Caucasian samples. While the mandible of the Northern Thai and Thai samples had more anterior rotation than that of the Caucasian samples. It was implied that the mandibular growth of the Caucasian adults was more downward and backward than that of the Northern Thai and Thai adults. The gonial angle of the Northern Thai samples was lesser than that of the Caucasian samples. The decrease in the size of the gonial angle might contribute mainly to the flattening tendency of the mandibular plane growth (Chang et al., 1993).

The inclination of maxillary and mandibular incisors were more proclined in the Northern Thai samples than in the Thai and Caucasian samples. It may be the compensation to the small ANB angle in the Northern Thai samples with normal facial appearance. Thus the Northern Thai adults with normal occlusion had tendency to be bimaxillary skeletal and dental protrusion compared to the Caucasian adults.

The facial heights and the dentoalveolar heights of the Northern Thai adults with normal occlusion in the present study would be compared with those of the Thai norm adults (Dechkunakorn et al., 1994), the Chinese norm adults (Chang et al., 1993), and the Caucasian norm adults (Scheideman et al., 1980) in Table 13. The Northern Thai norm adults seemed to demonstrate slightly greater the facial heights and the dentoalveolar heights than the other groups. The discrepancies might have resulted because of the differences in the ethnic groups, methods of measurements, and criteria for sample selection. However, the mean values, especially the facial heights, the dentoalveolar heights and the facial proportions of the Northern Thai adults with normal occlusion in this study can be used as reference norms in the vertical analysis which defined the degree of vertical deformity.

Table 13 The facial heights and dentoalveolar heights of Northern Thai, Thai, Chinese and Caucasian adults with normal occlusion

Variables		Northern Thai (present study)		Thai (Dechkunakorn et al.)		Chinese (Chang et al.)		Caucasian (Scheideman et al.)	
		male (n=35)	female (n=35)	male (n=33)	female (n=28)	male (n=40)	female (n=40)	male (n=32)	female (n=24)
SKELETAL									
TAFH	(mm)	133.06±4.65	130.25±7.25	130.25±7.25	120.99±4.95	133.38±5.40	122.23±3.93	126.40±6.60	119.80±4.5
UAFH	(mm)	59.30±3.22	58.06±3.69	58.06±3.69	53.78±2.85	59.72±2.93	54.47±2.46	56.0 ±3.2	53.70±2.9
LAFH	(mm)	73.77±3.6	72.21±4.91	72.21±4.91	66.80±6.58	73.65±3.74	67.75±3.43	70.40±4.8	66.10±3.4
UAFH/LAFH		0.81±0.06	0.81±0.06	0.81±0.06	0.81±0.05	0.81±0.05	0.81±0.06	0.79±0.50	0.81±0.05
TPFH	(mm)	92.57±4.45	89.67±5.35	89.67±5.35	80.30±5.17	97.63±5.82	84.88±5.32	92.90±5.2	84.20±5.4
UPFH	(mm)	48.64±2.37	45.80±3.65	45.80±3.65	41.34±3.60	45.78±3.42	41.50±3.14	49.0 ±2.5	47.40±2.7
LPFH	(mm)	43.93±4.63	43.83±4.22	43.83±4.22	39.23±4.6	51.83±4.70	39.42±3.71	48.10±4.0	42.10±4.0
TPFH/TAFH		0.70±0.04	0.67±0.04			0.73±0.05	0.69±0.05		
DENTAL									
UADH	(mm)	31.33±2.23	30.07±2.96	30.07±2.96	28.44±2.77	30.49±2.46	28.73±2.34	30.10±2.2	29.40±1.5
LADH	(mm)	45.76±7.65	45.55±3.16	45.55±3.16	41.05±2.74	49.93±2.17	42.60±2.13	43.90±2.9	40.30±2.4
UPDH	(mm)	27.70±1.82	26.83±2.31	26.83±2.31	25.23±2.11	26.97±1.81	24.79±1.49	26.80±2.3	24.70±2.0
LPDH	(mm)	39.63±2.17	37.24±2.72	37.24±2.72	33.48±2.47	39.50±1.93	34.98±1.73	33.80±2.4	30.70±2.3
UPDH/UADH		0.89±0.06	0.90±0.07	0.90±0.07	0.89±0.07				
LPDH/LADH		0.84±0.04	0.82±0.04	0.82±0.04	0.82±0.03				

Normal versus anterior open bite

Skeletal pattern

The cephalometric values of anterior open bite malocclusion and normal occlusion for adults were different in various aspects. The present study indicated that the cranial base angle (NSBa) was not statistically significantly different between the normal and open bite subjects which agreed with the finding of Subtelny and Sakuda (1964). The present data implied that the cranial base flexion was not affected in the open bite subjects. This result was also similar to the study in Class III malocclusion with and without open bite by Ellis and McNamara (1984) showing that there was no significant difference in the NSBa angle between the open bite and non-open bite groups.

The relationship of maxilla to anterior cranial base (SNA) of the open bite group was similar to that of the normal group. The relationship of mandible to anterior cranial base (SNB) in the open bite group was more retrognathic than in the normal group which was in agreement with the finding of Lopez-Gavito et al. (1985). This result would be expected from the clockwise rotation resulting from vertical posterior maxillary excess (Bjork, 1969). In this study, there were varieties of anteroposterior skeletal patterns in the open bite group which corresponded to the studies of Hapak (1964) and Moyer (1975). Nevertheless, the ANB angle was not significantly different between the normal group and the open bite group, but the Wits appraisal was significantly different between both groups. The mean Wits appraisal of the open bite group showed a more negative value than that of the normal group. This might be the effect of some persons with high degree of severity in skeletal Class III open bite.

In the vertical relationships, the presented result showed that the palatal plane angle (SN-PP) in the open bite group was relatively smaller than in the normal group, but it was not significant. This observation corroborated to the findings of Subtelny and Sakuda (1964), Cangialosi (1984). In addition to the studies by Nahoum (1971) and Lopez-Gavito et al. (1985), they found that the palatal plane angle (SN-PP) was significantly lesser in the open bite subjects than in the normal subjects. In the present study, the SN-PP angle of the anterior open bite subjects was in normal range (6.1° - 12.3°), 48 subjects (68.6%) ; less than lower limit of normal range (0° - 6°), 15 subjects (21.4%); and more than upper limit of normal range (12.5° - 15.5°), 7 subjects (10%). Thus the palatal plane in the open bite group had a tendency to incline upward anteriorly, it might be due to the small SN-PP angle of 15 subjects.

The present study indicated apparently that the mandibular plane angle (SN-GoGn), the palatomandibular plane angle (PP-GoGn) were actually steeper in the open bite subjects than in the normal subjects. These results indicated that most of the anterior open bite deformity arised inferiorly to the palatal plane. The gonial angle (Ar-GoGn) and the Y-axis angle (NSGn) were also greater in the open bite subjects than in the normal subjects. These findings were in consistent with many studies (Subtelny and Sakuda,1964; Nahoum, 1971; Cangialosi, 1984; Lopez-Gavito et al., 1985). The present data indicated that the increased value in the PP-GoGn angle seemed to be mainly due to a downward and backward tipping of the mandibular plane and a shortened ascending ramus. The shortened ascending ramus (Ar-Go) in the open bite subjects was in agreement with the study of Subtelny and Sakuda (1964). With the extremely downward and backward rotation of mandible, consequently, the result of such growth pattern would increase a lower anterior facial height and/or decrease a ramus height (Isaacson et al., 1971). Isaacson et al. (1971) suggested that the case of backward-rotating high mandibular plane angle had a tendency toward open bite.

With regard to the vertical facial height, the present study showed that the total anterior facial height (TAFH) was significantly greater in the open bite group than that in the normal group. It was notable that the increase in the total anterior facial height (TAFH) occurred primarily in the lower anterior facial height (LAFH). The lower anterior facial height (LAFH) was significantly greater in the open bite group than that in the normal group, whereas, the upper anterior facial height (UAFH) was relatively small in the open bite group but no significant difference between both groups was found. These findings were in agreement with most studies (Hapak, 1964; Schudy, 1964; Subtelny and Sakuda, 1964; Frost et al., 1980; Cangialosi, 1984; Nanda, 1988), but were not in agreement with the findings of Nahoum (1971) which reported that the upper anterior facial height was shorter in the open bite subjects than in the normal subjects. However, Lopez-Gavito et al. (1985) concluded that a total anterior facial height did not show significant differences between the normal and open bite groups, but the open bite group exhibited a significantly reduced upper anterior facial height, and an increased lower anterior facial height.

The total posterior facial height (TPFH) was significantly shorter in the open bite group than that in the normal group. This agreed with the reports of Nahoum et al. (1972), Schendel et al. (1976), Frost et al. (1980) and Cangialosi (1984). It was important to realize that a decrease in the total posterior facial height (TPFH) occurred primarily in the lower posterior facial height (LPFH). The lower posterior facial height (LPFH) was significantly shorter in the open bite group than that in the normal group, but no significant difference was found in the upper posterior facial height (UPFH). This was in accordance to an increase in the total anterior facial height and a decrease in the total posterior facial height that most of the deformity occurred below the level of the palate. In contrast, Subtelny and Sakuda (1964) and Lopez-Gavito et al. (1985) reported that the posterior facial height was similar in both normal and open bite groups. Ellis and McNamara (1984) found that there was no significant difference in posterior facial height between Class III open bite and Class III non open bite groups.

With regard to the facial proportion, the present data displayed that the open bite group showed a decrease in the UAFH/LAFH ratio. This was confirmed by the studies of Nahoum (1971), Nahoum et al. (1972) and Cangialosi (1984). The TPFH/TAFH ratio also exhibited significantly lesser in the open bite group than that in the normal group, while the UPFH/LPFH ratio exhibited significantly greater in the open bite group. A decrease in the TPFH/TAFH ratio was in agreement with the finding of Cangialosi (1984).

Dental pattern

In the open bite group, the upper and lower anterior teeth situated more proclined than that in the normal group. Consequently, the interincisal angle (UI-LI) was more acute in the open bite group than in the normal group which implied more convex profile in the open bite group than the normal group. However, Nielsen (1991) stated that in some patients with anterior open bite, the anterior teeth might become more retroclined with time. Isaacson et al. (1971) reported that there was open bite instead of overbite when the SN-MP angle was increased.

Interestingly, another possible factor for an open bite deformity was the development of dentoalveolar areas. The present investigation showed that the distance between the upper molar dentoalveolar height (UPDH) was significantly greater in the open bite group than that in the normal group. This was in agreement with Subtelny and Sakuda (1964), Sassouni and Nanda (1964), Sassouni (1969), and Lopez-Gavito et al. (1985). The maxillary posterior alveolar process made a more important contribution to vertical facial development than the mandibular posterior alveolar process (Isaacson et al., 1971). Nahoum et al. (1972), on the contrary, found that the maxillary molar dentoalveolar height was not affected in an open bite deformity.

It was notable that the open bite group in this study displayed a decreased lower molar dentoalveolar height (LPDH) compared to the normal group which corresponded with the findings of Sassouni and Nanda (1964), and Nahoum et al. (1972). However, Subtelny and Sakuda (1964) and Lopez-Gavito et al. (1985) noted that there was no significant difference in lower molar dental height between open bite and normal samples.

With regard to the anterior dentoalveolar height , this study revealed that the upper anterior dentoalveolar height (UADH) and the lower anterior dentoalveolar height (LADH) did not show significant differences between the normal and open bite groups. This was concordance with the studies of Subtelny and Sakuda (1964) and Nahoum et al. (1972) which suggested that excessive eruption of the anterior dentoalveolar segment was not found in either the maxillary or mandibular incisor regions in the open bite cases. In contrast to the findings of other studies (Schendel et al., 1976; and Fields et al., 1984), the UADH and the LADH were greater in the persons with open bite than in the normal persons. In addition, Lopez-Gavito et al. (1985) concluded that the anterior dentoalveolar height in the maxillary region was increased with dentoalveolar hyperplasia in the open bite subjects, but that in the mandibular incisor region it was similar in both normal and open bite subjects. From these findings, it was deduced that undereruption of the incisors vertically was not a primary factor in the open bite. The present findings indicated that in the open bite group, the malocclusion was not due to an underdevelopment of the anterior dentoalveolus, but instead, adaptations had occurred to, perhaps, trying to overcome the open bite condition by a slight overeruption of the maxillary and mandibular incisors. Hence, the LPDH/LADH ratio was significantly lesser in the open bite group than that in the normal group.

Consequently, in this study, the presence of upper posterior dentoalveolar hyperplasia could greatly contribute to the open bite deformity. In addition, the lower posterior dentoalveolar hyperplasia would be especially detrimental to open bite deformity. Nanda (1990) concluded that the inclination of the palatal plane and its constancy with age suggested that downward and backward rotation of the mandible in open bite subjects may be precommitted in response to dentoalveolar compensatory changes with the center of rotation at the molars.

Soft tissue pattern

When the soft tissue was evaluated, it was found that the upper lip length ($Sn\text{-}Stm_S$) and the maxillary incisor exposure ($Stm_S\text{-}UI$) were not significantly different between the normal and open bite groups. Schendel et al. (1976) found that there was no difference in the upper lip length between the normal and open bite groups, however, the maxillary incisor exposure was greater in the open bite group. Frost et al. (1980) also noted that the maxillary incisor exposure was significantly longer in the open bite subjects than in the normal subjects. Isaacson et al. (1971) suggested that the high mandibular plane angle cases which had a tendency toward open bite did not necessarily have short upper lip, but they had longer maxillary alveolar processes. Thereafter, Blanchette et al. (1996) concluded that the vertical height of the upper lip was longer in the long-face subjects which could have been a compensatory mechanism for the subjects to perform a lip seal.

In the present study, most of the anterior open bite adult samples had the aberrations in skeletal parts combined with dental parts. Only three samples (4.3%) were classified as the dental anterior open bite (Table 14); the first one with short UADH, the second one with short UADH associated with proclination of upper and lower incisors, and the third one with only proclination of upper and lower incisors. Two assumptions which were possible for development of combination of skeletal and dental open bites were; first, there were skeletal open bite at an early age and maintained or increased during the progression of growth associated with insufficient dental compensations. Second, there were dental open bite (normal skeletal structures) with persistent of abnormal tongue position and/or tongue habit from an early age till adult, thereafter, it became combined skeletal and dental open bite.

Table 14 The skeletal. dental and soft tissue characteristics of three dental anterior open bite samples

Variables		Normal mean	Dental anterior open bite samples		
			No.1	No.2	No.3
SKELETAL					
NSBa	(deg)	131.1	126	134	132.5
SNA	(deg)	83.593	83	88	89
SNB	(deg)	82.236	82.5	86	86.5
ANB	(deg)	1.386	0.5	2	2.5
WITS	(mm)	-3.35	-8.0	-4.5	-3.5
SN-PP	(deg)	9.207	10	7	1
SN-GoGn	(deg)	28.886	29	29.5	23.5
PP-GoGn	(deg)	19.679	19	22.5	22.5
Ar-GoGn	(deg)	119.74	120	128.5	121
NSGn	(deg)	67.879	67.5	65	66.5
Ar-Go	(mm)	53.071	51	47.5	58
TAFH	(mm)	128.87	121	119	131
UAFH	(mm)	57.764	58	53.5	53.5
LAFH	(mm)	71.114	63	65.5	77.5
UAFH/LAFH		0.815	0.921	0.817	0.69
TPFH	(mm)	87.85	83	80	98
UPFH	(mm)	46.721	47	45.5	51
LPFH	(mm)	41.129	36	34.5	47
UPFH/LPFH		1.153	1.306	1.319	1.085
TPFH/TAFH		0.682	0.686	0.672	0.748
DENTAL					
UI-NA	(deg)	24.25	24	44	28
LI-NB	(deg)	31.114	21.5	39	42.5
UI-SN	(deg)	107.81	107	132	117.5
LI-GoGn	(deg)	100.11	90	104	113
UI-LI	(deg)	121.6	134	95	107
Overbite	(mm)	2.257	-1	-2.5	-0.5
UADH	(mm)	30.5	23.5	25	34
LADH	(mm)	44.693	38	41.5	47.5
UPDH	(mm)	27.007	22.5	26.5	29
LPDH	(mm)	37.743	32	31.5	40.5
UPDH/UADH		0.889	0.957	1.06	0.853
LPDH/LADH		0.832	0.842	0.759	0.853
SOFT TISSUE					
$Sn\text{-}Stm_s$	(mm)	25.264	20.5	22.5	26
$Stm_s\text{-}UI$	(mm)	2.029	0	1.5	3.5

Sexual dimorphism

The SN-PP angle and the SN-GoGn angle were significantly different between sexes in the Northern Thai adults with normal occlusion, which were in agreement with the observations in the Thai adults (Suchato and Chaiwat, 1984) and in the Caucasian adults (Scheideman et al., 1980). However, no such sex differences for these angles were found in the open bite group. These results suggested that the morphologic differences in the open bite group might have overpowered the sexual dimorphism.

The present study in the Northern Thai adults was in agreement with the other studies in Thai (Dechkunakorn et al., 1994), Chinese (Chang et al.,1993), and Caucasian (Scheideman et al., 1980) adults that the normal males had larger the facial heights and the dentoalveolar heights than the normal females (Table 13).

This study showed that in spite of the differences in the mean values of the UAFH and the LAFH between the normal males and the normal females, there was no sex difference in the UAFH/LAFH ratio. Moreover, the Northern Thais, Thais, Chineses and Caucasians had a similar UAFH/LAFH ratio which was 0.8 : 1 (Table 13). These investigations revealed that in normal occlusion, the vertical anterior facial proportion of Northern Thai, Thai, Chinese and Caucasian adults were similar.

With regard to the UPDH/UADH ratio and the LPDH/LADH ratio (Table 13), the present data showed similar values between the normal males and the normal females. The mean values in these ratios of Northern Thai normal adults were similar to those of Thai normal adults that reported by Dechkunakorn et al. (1994).

Most of the vertical dimensions in the normal males were greater than those in the normal females. Therefore, the analysis of vertical dimensions should be applied separately by using the cephalometric values for males and females.

In the present study, a significant trend toward sexual dimorphism was evident for almost linear measurements in the open bite group. The facial heights and the ramus height were significantly greater in the males than that in the females for the open bite group. These findings corroborated with the findings of Nanda and Rowe (1988) which revealed that the total anterior facial height and the lower anterior facial height in the open bite group showed significant differences between sexes. However, these results were not supported the observations of Nanda and Rowe (1988) who revealed that no sexual dimorphism was evident for the upper anterior facial height, the total posterior facial height and the ramus height. They suggested that strong influences of developmental patterns in the anterior open bite masked many expected sexual dimorphisms.

The intersex differences were also evident for the LADH, UPDH and LPDH in the open bite group, while there were sexual dimorphisms for the UADH, UPDH, and LPDH in the normal group. These results were not confirmed the findings of Janson et al. (1994) who found no significant difference between sexes for the UADH, LADH, UPDH and LPDH in the excessive lower anterior facial height persons, whereas the normal lower anterior facial height male and female subgroups presented significantly sex differences for the UADH, LADH and LPDH. The possible explanation for this was that the environmental or neuromuscular factors leading to excess or short lower anterior facial height might have overpowered the sex difference. Therefore, the present results suggested that the characteristics of open bite and the sex had equal influences to the facial height, the dentoalveolar height and the ramus height.

Anteroposterior skeletal types in anterior open bite

There were significant differences for the SNB angle, SN-GoGn angle, PP-GoGn angle, NSGn angle, ramus height, LI-NB, LI-GoGn, UI-LI, UADH, LADH, LPDH, UPDH/UADH ratio and upper lip length among the skeletal Class I, Class II, and Class III open bite groups (Table 8). The anterior open bite, facial heights and upper posterior dentoalveolar height were not significantly different among three skeletal patterns in the open bite group. However, Nahoum et al. (1972) reported that there were significant differences for the TAFH and UAFH between the Class II and Class III open bite subjects. The present data displayed that the UPDH was significantly longer in the open bite group than the normal group, and it was revealed that the UPDH in the skeletal Class I, Class II and Class III open bite groups were longer than the normal group. Nevertheless, some characteristics of anterior open bite were different among three skeletal patterns. The skeletal Class II open bite subjects had more retrognathic mandible, more posterior rotation of mandible, more vertical growth of mandible and shorter ramus height than the skeletal Class III and Class I open bite subjects. It was in agreement with the observation of Nahoum et al. (1972) that the PP-GoGn angle was significantly greater in the skeletal Class II open bite group than in the skeletal Class III open bite group. Additionally, the lower anterior teeth were more proclined in the skeletal Class II open bite subjects than the skeletal Class III and Class I open bite subjects. The UADH, LADH and LPDH were longer in the skeletal Class II opoen bite subjects than the skeletal Class III open bite subjects. Although, there was no significant difference in the upper lip length between the normal and open bite groups, but the upper lip length in the skeletal Class II open bite subjects was longer than skeletal Class III and Class I open bite subjects and the normal subjects. It was notable that most of severity of anterior open bite were presented in skeletal Class II.

Correlation

The correlation analysis for selected cephalometric values in the normal and open bite groups was shown in Table 9 and Table 10 respectively. The correlation between vertical angular measurements and linear measurements will be discussed. In both normal and open bite groups, the palatal plane angle (SN-PP) was positively correlated with the upper anterior facial height (UAFH) and the UAFH/LAFH ratio, but was negatively correlated with the lower anterior facial height (LAFH), the total posterior facial height (TPFH) and upper posterior facial height (UPFH). The mandibular plane angle (SN-GoGn) was positively correlated with the UPFH/LPFH ratio, but was negatively correlated with the total posterior facial height (TPFH), the lower posterior facial height (LPFH), the ramus height and the TPFH/TAFH ratio in both groups. Additionally, in both the normal and open bite groups the palatomandibular plane angle (PP-GoGn) showed significantly positive correlations to the lower anterior facial height (LAFH) and the UPFH/LPFH ratio, but showed significantly negative correlations to the total posterior facial height (TPFH), the lower posterior facial height (LPFH), the UAFH/LAFH ratio, the TPFH/TAFH ratio and the ramus height.

In the open bite group, the SN-GoGn and PP-GoGn angles were positively correlated with the UADH and LADH. This suggested that the greater anterior dentoalveolar height would cause the steeper mandibular plane angle and palatomandibular plane angle. The lower anterior dentoalveolar height (LADH) in the open bite group was positively correlated with all anterior facial heights (TAFH, UAFH, LAFH), while no significant correlation was found in the normal group.

The present study showed that the anterior open bite had moderate correlations ($p<.01$) with the SN-GoGn and the PP-GoGn angles, and the SN-GoGn angle had very high correlation with the PP-GoGn angle ($r=0.846$). The steep mandibular plane angle and the steep palatomandibular plane angle might contribute to the increase in the anterior open bite. This study was in agreement with the study of Schendel et al. (1976) which suggested that open bite was not necessarily associated with the long face syndrome; in fact, some persons had open bite , while others did not. It was notable that no significant correlation was found between the open bite and the inclination of incisors. Ludwig (1967) also found that there was no significant correlation between the variable factors concerned with the overbite and interincisal angle.

Variables associated with the anterior open bite

The present study indicated that the anterior open bite in this sample could occur as the PP-GoGn angle increased and/or the UPDH/UADH ratio increased and/or the LPDH/LADH ratio increased and/or the UI-SN angle increased. The SN-GoGn angle was removed from the predictive equation, even though, this angle was correlated with the anterior open bite, because the SN-GoGn angle had strong correlation with the PP-GoGn angle ($r=0.846$) and the PP-GoGn angle may have more power than the SN-GoGn angle. Thus, the PP-GoGn angle was selected as the first variable and the SN-GoGn angle was eliminated from the stepwise multiple regression analysis. However, it should be realized that other skeletal and dental variables may be used for evaluating the anterior open bite in the different sample groups. This stepwise multiple regression analysis demonstrated that more than one cephalometric variables can be described the associated morphology more completely than a single variable. Cangialosi (1984) found that in the anterior open bite subjects, the SN-PP, SN-GoGn, PP-GoGn and Ar-GoGn angles, and the TPFH/TAFH ratio remained relatively constant with age in the anterior open bite subjects. In addition, Nanda (1988), and Nanda and Rowe (1988) suggested that the pattern of anterior vertical facial proportion was established at an early age and maintained during the progression of growth. Consequently, it would appear that it is possible to anticipate the vertical facial development of child at an early age.

Clinical implication

The observations reported in this study on the anterior open bite have disclosed the disparate morphologic characteristics between the normal and open bite subjects. A knowledge of the differences in skeletal and dental morphologies is also helpful in diagnosis and planning treatment for the adult open bite patients. Anterior open bite is among the malocclusions that are most difficult to treat, and it tends to recur (Graber, 1989). Some anterior open bites closed spontaneously, others did not (Finlay and Richardson, 1995). Frost et al. (1980) stated that one should design and modify the treatment to correct the deformity at its origin. Identification of the site of origin of a deformity is the key to planning treatment for the patient with a dentofacial deformity. In particular, it is important to distinguish between the open bite conditions those are due to skeletal dysplasia and those resulting from dentoalveolar causes or combination. However, the difficulty arises in the numerous intermediate cases where the distinction among them is not clear. The anterior open bite problem in many patients may be multifactorial, and subsequent problems with similar appearance may have different causes (Insoft et al., 1996).

In anterior open bite treatment, orthodontist should avoid the use of any mechanics which tend to extrude upper and lower posterior teeth, to rotate the mandible downward and backward, to increase lower anterior facial height and to decrease the UAFH/LAFH ratio. In fact, most of the anterior open bite subjects have greater upper anterior dentoalveolar height and lower anterior dentoalveolar height than the normal subjects. Therefore, orthodontic extrusion of the anterior teeth may be inappropriate treatment for skeletal open bite cases, with the exception of some cases of dental anterior open bite who had short upper anterior dentoalveolar height. However, some dental anterior open bite subjects had proclination of upper and lower anterior teeth, thus the lingual tipping of anterior teeth is being employed as an alternative approach. The findings of this study demonstrated an inverse correlation between the UAFH/LAFH ratio and the upper posterior dentoalveolar heights. For the vertical relationships, the proportions of the face are more important than absolute measurements, consideration should be directed to the UAFH/LAFH ratio and to the dentoalveolar height when planning treatment. Thus, in cases with decreased UAFH/LAFH ratio value, the upper posterior dentoalveolar heights will usually be increased as well, consequently extruding forces on the upper posterior teeth should be avoided.

In later stage of development, the severe skeletal open bite problem must be considered from the standpoint of facial esthetics, function, dental occlusion and reasonable long term stability. Orthodontic treatment alone may be limited in obtaining ideal facial and dental corrections in severe skeletal open bite problems, and certainly surgical correction alone may be less than ideal for obtaining a total resolution of the patient's existing problems. Consequently, one-sided approaches to multifacted problem often produce compromised results (Arvystas, 1977). Nahoum (1977) stated that patients with an UAFH/LAFH ratio below 0.650 are poor risks for conventional orthodontic treatment and that a surgical procedure should be considered in these cases.

Several surgical techniques were developed to aid in the correction of skeletal anterior open bite, including three pieces sectioning of the maxilla, subapical osteotomies, and corticotomies (Insoft et al., 1996). In a severe skeletal Class II or Class III with a large vertical discrepancy, surgery must be considered, if correction and not camouflage is the desired end. However, there is no one method of treating all skeletal open bite by one surgical or orthodontic method. Each case must be evaluated and resolved individually (Bilodeau, 1995).

Many factors have been discussed in the etiology of open bite, such as an unfavorable growth pattern, pernicious oral habits, tongue and orofacial muscle activity, postural relationships of the tongue and lips, enlarged lymphatic tissue and nasal airway obstruction and head posture. (Subtelny and Sakuda, 1964; Bjork, 1969; and Proffit, 1978). One approach to the treatment of skeletal open bite is to control all subsequent growth so that the mandible will rotate in a counterclockwise direction, upward and forward. Successful early treatment of these problems in the mixed dentition can prevent the worsening of the facial profile. The elimination of anterior open bite can also improve tongue function and lip seal. Several interceptive modalities, including myofunctional therapy, crib appliances, spurs and functional appliances have been suggested as treatment of anterior open bite. High-pull headgear to the maxillary molars is another common approach to open bite treatment. The rationale for this treatment is to intrude the maxillary molars and allow the mandible to autorotate, thereby closing the anterior open bite (Baumrind, 1978). Ngan et al. (1992) reported treatment of skeletal Class II open bite in the mixed dentition with a removable activator and headgear. The effects of these appliances included reduction of forward growth of the maxilla and reduction of forward and downward movement of the maxillary posterior teeth which allowed the mandibular posterior teeth to erupt more vertically. This resulted in decreasing overjet and open bite. They suggested that the clinician's awareness of the differences between dental and skeletal open bite and the proper timing for intercepting these malocclusions will facilitate subsequent orthodontic treatment. Early initiation of orthodontic treatment might be beneficial in persons with relatively large lower facial heights because these subjects appeared to reach their adolescence at an early age (Nanda, 1988 and Blanchette et al., 1996). If the choice of treatment mechanics requires orthopedic modifications of the jaws, then the initiation of treatment is preferable before the adolescent growth spurt.

Errors and Limitations

1) Lateral cephalograms in this study were obtained from various sources. Thus, the technics and magnification factors might be different.
2) Tracing and measurement errors could be occurred in each lateral cephalogram by an investigator.
3) Small to moderate sample sizes were provided. This sample sizes might be not discovered if such differences exist especially in each skeletal pattern of anterior open bite group.
4) Number of each sex was not balanced in each group that might be a source of bias.

Suggestion

Since prevalence of anterior open bite malocclusion in the Thai population had not been reported, the epidemiological study in this area should be performed. Further study should be increased sample size, and balanced of sex in each group especially in the subgroups for reliable interpretations. It must be kept in mind that the findings from the present study were obtained from the adult anterior open bite subjects. Thus, these results can not be completely applied in the anterior open bite in children. In the future, a comparison study should be initiated for anterior open bite malocclusion and normal occlusion between children and adults by dividing them into subgroups to investigate the differences of dentofacial patterns of which the result can be applied in the timing of orthodontic treatment and the treatment planning. Longitudinal study will be a valuable clinical guide if one can predict whether growth changes would be likely to maintain or accenuate anterior open bite malocclusion. Predictive equation for anterior open bite should be tested reliability in clinic. This may be applied for predicting anterior open bite tendency in children in order to be realized orthodontists in treatment planning. The possibility in the future for an early identification or detection of vertical dysplasias and realization of their subsequent proportionate growth can lead to an effective early intervention.