CHAPTER IV
RESULTS

The results of this study will be presented as followed :

Part I. Means, standard deviations and standard errors of cephalometric measurements for the normal and open bite subjects, and the two-way analysis of variance of each cephalometric measurement for both the normal and open bite groups of either sex.

Part II. Comparisons of cephalometric measurements between the normal males and females, and between the open bite males and females.

Part III. Comparisons of the cephalometric measurements among the skeletal Class I, Class II and Class III in the open bite group.

Part IV. Correlation analyses between the dentofacial measurements for both the normal and open bite groups.

Part V. Stepwise multiple regression analysis for the anterior open bite

Part I. Means, standard deviations and standard errors of the cephalometric measurements for the normal and open bite subjects and the two-way analysis of variance of each cephalometric measurement for both the normal and open bite groups of either sex.

The means, standard deviations and standard errors of the cephalometric measurements for the normal and open bite groups (combined sexes) were shown in Table 2. Because there were two factors in this study (type of occlusion and sex), each factor was measured at two levels (normal vs open bite and male vs female). Therefore, the two-way analysis of variance (two-way ANOVA) was performed to compare means of cephalometric measurements for the main effects of type of occlusion and sex, and the interaction effect between type of occlusion and sex. The results of two-way ANOVA were displayed in Table 3.

I.1. Skeletal pattern

Anteroposterior relationship

There was significant difference in the cranial base angle (NSBa) by sex ($p<.05$) but no obvious difference by type of occlusion. Furthermore, there was no significant interaction effect, which implied that the difference in NSBa angle by sex was the same for the normal group and the open bite group. For the anteroposterior position of maxilla (SNA), there was no significant difference by sex and by type of occlusion. In addition, there was no significant interaction effect as well.

There was significant effect of type of occlusion on the anteroposterior position of mandible (SNB) after controlling the effect of sex ($p<.05$) but no significant effect of sex after controlling the effect of type of occlusion on the SNB angle. Furthermore, there was no significant interaction effect, which meaned that the difference in the SNB angle by type of occlusion was the same for both sexes. The SNB angle was greater in the normal group than that in the open bite group.

Table 2 Means, standard deviations and standard errors of the cephalometric measurements in the normal and open bite samples (sex combined)

Variables		Normal (n=70)			Open bite (n=70)		
		$\bar{X}$	SD	SE Mean	$\bar{X}$	SD	SE Mean
SKELETAL							
NSBa	(deg)	131.1	5.013	0.599	130.31	5.773	0.69
SNA	(deg)	83.593	3.008	0.369	82.6	3.392	0.405
SNB	(deg)	82.236	3.002	0.359	80.636	4.318	0.516
ANB	(deg)	1.386	1.516	0.181	1.964	3.485	0.417
WITS	(mm)	-3.35	2.469	0.295	-6.271	5.342	0.639
SN-PP	(deg)	9.207	3.075	0.367	8.457	3.176	0.38
SN-GoGn	(deg)	28.886	4.474	0.535	39.05	5.749	0.687
PP-GoGn	(deg)	19.679	4.512	0.539	30.593	5.708	0.682
Ar-GoGn	(deg)	119.74	4.966	0.594	129.14	5.574	0.666
NSGn	(deg)	67.879	3.273	0.391	71.836	4.309	0.515
Ar-Go	(mm)	53.071	4.527	0.541	48.143	5.137	0.614
TAFH	(mm)	128.87	6.27	0.749	130.57	7.671	0.917
UAFH	(mm)	57.764	3.212	0.384	56.321	3.471	0.415
LAFH	(mm)	71.114	4.67	0.558	74.25	5.761	0.689
UAFH/LAFH		0.815	0.061	0.007	0.762	0.063	0.008
TPFH	(mm)	87.85	6.502	0.777	80.293	6.847	0.818
UPFH	(mm)	46.721	3.086	0.369	46.414	3.431	0.41
LPFH	(mm)	41.129	5.184	0.62	33.886	5.279	0.631
UPFH/LPFH		1.153	0.159	0.019	1.4	0.229	0.027
TPFH/TAFH		0.682	0.039	0.005	0.615	0.042	0.005
DENTAL							
UI-NA	(deg)	24.25	5.157	0.616	32.171	6.928	0.828
LI-NB	(deg)	31.114	4.705	0.562	35.814	8.505	1.017
UI-SN	(deg)	107.81	5.378	0.643	114.61	7.899	0.944
LI-GoGn	(deg)	100.11	6.019	0.719	96.55	9.373	1.12
UI-LI	(deg)	121.6	15.48	1.85	110.29	11.853	1.417
Overbite	(mm)	2.257	1.003	0.12	-2.871	1.791	0.214
UADH	(mm)	30.5	2.572	0.307	31.079	3.228	0.386
LADH	(mm)	44.693	5.8	0.693	45.629	3.65	0.436
UPDH	(mm)	27.007	1.944	0.232	27.65	2.726	0.326
LPDH	(mm)	37.743	2.879	0.344	36.286	3.312	0.396
UPDH/UADH		0.889	0.062	0.007	0.893	0.079	0.009
LPDH/LADH		0.832	0.036	0.004	0.796	0.044	0.005
SOFT TISSUE							
Sn-Stm_s	(mm)	25.264	2.107	0.252	25.414	2.752	0.329
Stm_s-UI	(mm)	2.029	1.154	0.138	1.55	2.483	0.297

Table 3 Two-way analysis of variance for the main effects of sex, type of occlusion (normal and open bite) and the interaction effect

Variables	F - value		
	Sex	Occlusion	Sex by occlusion
SKELETAL			
NSBa (deg)	6.692*	1.643	0.068
SNA (deg)	0.142	3.252	0.558
SNB (deg)	0.73	5.191*	0
ANB (deg)	0.624	0.842	0.723
WITS (mm)	0.489	14.752***	0
SN-PP (deg)	3.131	2.263	1.193
SN-GoGn (deg)	4.376*	123.509***	0.564
PP-GoGn (deg)	1.003	140.732***	0.007
Ar-GoGn (deg)	0.316	109.025***	3.454
NSGn (deg)	1.281	33.213***	0.253
Ar-Go (mm)	37.275***	28.672***	0.002
TAFH (mm)	84.202***	12.655***	0.34
UAFH (mm)	35.089***	2.615	0.01
LAFH (mm)	55.415***	30.386***	0.422
UAFH/LAFH	3.565	27.655***	0.038
TPFH (mm)	99.259***	44.937***	0.347
UPFH (mm)	51.213***	0.332	0.465
LPFH (mm)	45.977***	61.558***	0.051
UPFH/LPFH	6.959**	44.111***	0.661
TPFH/TAFH	12.387***	84.843***	0.561
DENTAL			
UI-NA (deg)	0.2	58.379***	1.093
LI-NB (deg)	0.629	13.450***	0.104
UI-SN (deg)	0.443	35.169***	0.352
LI-GoGn (deg)	0.108	7.044**	0.695
UI-LI (deg)	1.024	21.576***	0.787
Overbite (mm)	1.289	431.826***	2.888
UADH (mm)	7.245**	2.369	0.371
LADH (mm)	9.424**	3.212	0.252
UPDH (mm)	25.221***	8.241**	1.984
LPDH (mm)	40.637***	4.674*	2.382
UPDH/UADH	3.257	1.263	4.442*
LPDH/LADH	1.785	27.695***	2.137
SOFT TISSUE			
Sn-Stm_s (mm)	6.904**	0.226	4.033*
Stm_s-UI (mm)	0.516	2.283	0.014

* $p < .05$, ** $p < .01$, *** $p < .001$

The anteroposterior relationship of maxilla and mandible was described by the ANB angle and the Wits appraisal. There was no significant difference in the ANB angle by sex and by type of occlusion. Furthermore, there was no apparent interaction effect between sex and type of occlusion as well. Interestingly, there was significant difference in the Wits appraisal by type of occlusion ($p<.001$), but no apparent difference by sex. The Wits appraisal was significantly lesser in the open bite group than in the normal group. The Wits appraisal indicated that the mandible was in a more anterior position to the maxilla in the open bite group than that in the normal group. However, there was no significant interaction effect between sex and type of occlusion, which implied that the difference in the Wits appraisal by type of occlusion was the same for both sexes.

Vertical relationship

There was no significant difference in the palatal plane angle (SN-PP), as the vertical position of maxilla, by sex and by type of occlusion. In addition, there was no significant interaction effect as well.

For the vertical relationship of mandible, the differences in the means of Y-axis angle (NSGn) and the gonial angle (Ar-GoGn) were clearly evident between the two types of occlusion ($p<.001$) , irrespective of sex. The NSGn and Ar-GoGn angles were larger in the open bite group than in the normal group. Whereas, there were significant effects of sex ($p<.05$) and type of occlusion ($p<.001$) on the mandibular plane angle (SN-GoGn). The SN-GoGn angle was obviously greater in the open bite group than in the normal group. The difference in the ramus height (Ar-Go) was significant for the normal and open bite groups ($p<.001$) and for either sex ($p<.001$). The ramus height was significantly longer in the normal group than in the open bite group.

Furthermore, there were no significant interaction effects between sex and type of occlusion on the NSGn angle, Ar-GoGn angle, SN-GoGn angle and the ramus height, which implied that the differences in these variables by type of occlusion were the same for both the males and the females.

The vertical relationship of maxilla and mandible, as demonstrated by the palatomandibular plane angle (PP-GoGn), had significant difference by type of occlusion ($p<.001$) but no obvious difference by sex. In addition, there was no significant interaction effect between sex and type of occlusion on the PP-GoGn angle, which implied that the difference in the PP-GoGn angle by type of occlusion was the same for both sexes. The PP-GoGn angle was considerably greater in the open bite group than in the normal group.

Facial height and vertical facial proportion

There were significant differences in the total anterior facial height (TAFH), the lower anterior facial height (LAFH), the total posterior facial height (TPFH) and the lower posterior facial height (LPFH) by sex ($p<.001$) and type of occlusion ($p<.001$), but no significant interaction effects. Thus, the effects of type of occlusion on those facial heights were similar in the males and females. The TAFH and LAFH were significantly greater in the open bite group than in the normal group. On the contrary, the TPFH and the LPFH were apparently lesser in the open bite group than in the normal group.

There were significant differences in the upper anterior facial height (UAFH) and the upper posterior facial height (UPFH) by sex ($p<.001$), but no obvious differences by type of occlusion. Furthermore, there were no significant interaction effects, which implied that the differences in the UAFH and the UPFH by sex were the same for the normal group and the open bite group.

There was significant effect by type of occlusion on the UAFH/LAFH ratio ($p<.001$), but no significant effect by sex and no significant interaction effect between sex and type of occlusion. The difference in the UAFH/LAFH ratio was clearly evident between the normal and open bite groups, irrespective of sex. The UAFH/LAFH ratio was apparently lesser in the open bite group than in the normal group.

There was significant difference in the UPFH/LPFH ratio by sex ($p<.01$) and by type of occlusion ($p<.001$), but no significant interaction effect between sex and type of occlusion. Similarly, there was obvious difference in the

TPFH/TAFH ratio by sex ($p<.001$) and by type of occlusion ($p<.001$), but no significant interaction effect between sex and type of occlusion. These results implied that the effects of type of occlusion on the UPFH/LPFH ratio and the TPFH/TAFH ratio were the same for both sexes. The UPFH/LPFH ratio was significantly greater in the open bite group than in the normal group, while the TPFH/TAFH ratio was apparently greater in the normal group than in the open bite group.

1.2. Dental pattern

Dental relationship

There were significant differences in the inclination of maxillary incisor in relation to NA line (UI-NA) and that in relation to SN line (UI-SN), the inclination of mandibular incisor in relation to NB line (LI-NB) and that in relation to Go-Gn line (LI- GoGn), the interincisal angle (UI-LI), and the overbite by type of occlusion (all significances at $p<.001$; with the exception of LI-GoGn angle which was significance at $p<.01$) , but no obvious differences by sex. Furthermore, there were no significant interaction effects, which implied that the differences in all dental variables by type of occlusion were the same for both sexes. The UI-NA angle, UI-SN angle and LI-NB angle were considerably greater in the open bite group than in the normal group. While the LI-GoGn angle and the UI-LI angle were apparently smaller in the open bite group than in the normal group. The present data showed that the mean of overbite was 2.26 millimeters for the normal subjects and the mean of open bite was -2.87 millimeters for the open bite subjects.

Dentoalveolar height

There were significant differences in the upper anterior dentoalveolar height (UADH) and lower anterior dentoalveolar height (LADH) by sex ($p<.01$), but no significant differences by type of occlusion. In addition, there were no significant interaction effects between sex and type of occlusion, which meaned that the differences in the UADH and LADH by sex were the same for both the normal and open bite groups.

The significant differences in the upper posterior dentoalveolar height (UPDH) and lower posterior dentoalveolar height (LPDH) were observed by sex ($p<.001$) and by type of occlusion ($p<.01$ and $p<.05$, respectively). However, there were no significant interaction effects between sex and type of occlusion in the UPDH and LPDH. Thus, the effects of type of occlusion on the UPDH and LPDH were similar in the males and the females. The UPDH was significantly greater in the open bite group than in the normal group. The LPDH was significantly lesser in the open bite group than in the normal group.

There was no significant difference in the UPDH/UADH ratio by sex and by type of occlusion. However, there was significant interaction effect between sex and type of occlusion on the UPDH/UADH ratio ($p<.05$). While, there was marked difference in the LPDH/LADH ratio by type of occlusion ($p<.001$), but no significant difference by sex. In addition, there was no significant interaction effect which implied that the difference in the LPDH/LADH ratio by type of occlusion was the same for both sexes. The LPDH/LADH ratio was apparently lesser in the open bite group than in the normal group.

I.3. Soft tissue pattern

There was significant difference in the upper lip length ($Sn\text{-}Stm_S$) by sex ($p<.01$) but no obvious difference by type of occlusion. However, there was significant interaction effect between sex and type of occlusion on the upper lip length ($p<.05$) which meaned that the difference in the upper lip length by sex was the same for both the normal and open bite groups. For the maxillary incisor exposure (Stm_S-UI), there was no significant effect by sex and type of occlusion, and interaction effect.

In summary, the cephalometric measurements which showed the differences between the males and females were the NSBa angle, SN-GoGn angle, ramus height, TAFH, UAFH, LAFH, TPFH, UPFH, LPFH, UAFH/LAFH ratio, TPFH/TAFH ratio, UADH, LADH, UPDH, LPDH, and $Sn\text{-}Stm_S$. While the cephalometric measurements which showed the differences between the normal and open bite groups were the SNB angle, Wits value, SN-GoGn angle, PP-GoGn angle, Ar-GoGn angle, NSGn angle, ramus height, TAFH, LAFH, UAFH/LAFH ratio, TPFH, LPFH, UPFH/LPFH ratio, and TPFH/TAFH, UI-NA angle, LI-NB angle, UI-SN angle, LI-GoGn angle, UI-LI angle, overbite, UPDH, LPDH, and LPDH/LADH ratio. These results indicated that both sexes and types of occlusion had the effects to the skeletodental cephalometric measurements.

From the two-way analysis of variance (Table 3), there were significant interaction effects between sex and type of occlusion on the UPDH/UADH ratio and the upper lip length ($Sn\text{-}Stm_S$) ($p<.05$). The results of Scheffe test of the UPDH/UADH ratio and the upper lip length with a significant level of .05, which compared the mean differences among four groups : Normal males (NM), Normal females (NF), Open bite males (OM), and Open bite females (OF) were shown on Table 4 and Table 5 respectively.

There was no significant difference at the 5% level of significance for the UPDH/UADH ratio. However, there was significant difference of upper lip length ($Sn\text{-}Stm_S$) between the normal males and the normal females ($p<.05$) with the mean difference of 1.929 millimeters (Table 5). The upper lip length in the normal males was longer than in the normal females, but no sex difference for the upper lip length was found in the open bite group.

Table 4 Multiple comparisons for means of UPDH/UADH ratio in two types of occlusion of both sexes by Scheffe test (NM=normal males, NF=normal females, OM=open bite males, OF=open bite females)

Group $\bar{X}$	NM 0.887	OF 0.878	NF 0.89	OM 0.926
NM 0.887				
OF 0.878	0.009			
NF 0.89	0.003	0.012		
OM 0.926	0.039	0.048	0.036	

* p < .05, ** p < .01, *** p < .001

Table 5 Multiple comparisons for means of Sn-Stm_s (mm) in two types of occlusion of both sexes by Scheffe test (NM=normal males, NF=normal females, OM=open bite males, OF=open bite females)

Group $\bar{X}$	NF 24.3 mm.	OF 25.333 mm.	OM 25.59 mm.	NM 26.229 mm.
NF 24.3 mm.				
OF 25.333 mm.	1.033			
OM 25.59 mm.	1.29	0.157		
NM 26.229 mm.	1.929*	0.896	0.639	

* p < .05, ** p < .01, *** p < .001

Part II. Comparisons of the cephalometric measurements between the normal males and females, and between the open bite males and females. (Table 6 and 7)

II.1. Skeletal pattern

Anteroposterior relationship

The NSBa angle was significantly smaller in the normal males than in the normal females ($p<.05$), but was not significantly different between the open bite males and the open bite females.

The anteroposterior position of the maxilla in relation to anterior cranial base (SNA) was not clearly different in both sexes of the normal group and of the open bite group. The anteroposterior position of the mandible in relation to anterior cranial base (SNB) was not significantly different in both sexes of the normal group and the open bite group.

For the anteroposterior relationships of maxilla and mandible of the normal and open bite groups, the ANB angle and the Wits appraisal were not significantly different in both sexes.

Vertical relationship

The SN-PP angle, as described by the vertical relationship of maxilla , was significantly smaller in the normal males than in the normal females ($p<.05$), however, this angle was not obviously different in either sex of the open bite group.

For the vertical relationships of mandible, the Ar-GoGn angle, the NSGn angle, the Sn-GoGn angle and the PP-GoGn angle were not apparently different in both sexes of the normal group and the open bite group; with the exception of that in the normal group, the SN-GoGn angle was significantly smaller in the males than in the females ($p<.05$). The ramus height (Ar-Go) was significantly longer in the males than in the females ($p<.001$), for either the normal and open bite groups.

Table 6 The comparisons of the cephalometric measurements between the normal Northern Thai males and females

Variables	Normal males		Normal females		t-value
	$\overline{X}$	SD	$\overline{X}$	SD	
SKELETAL					
NSBa (deg)	129.77	4.721	132.43	5.008	-2.28*
SNA (deg)	83.914	2.743	83.271	3.409	0.87
SNB (deg)	82.514	3.001	81.957	3.02	0.77
ANB (deg)	1.4	1.454	1.371	1.597	0.08
WITS (mm)	-3.1	2.452	-3.6	2.496	0.85
SN-PP (deg)	8.429	2.367	9.986	3.512	-2.18*
SN-GoGn (deg)	27.614	4.257	30.157	4.379	-2.46*
PP-GoGn (deg)	19.186	4.306	20.171	4.72	-0.91
Ar-GoGn (deg)	118.63	4.935	120.86	4.809	-1.91
NSGn (deg)	67.329	2.546	68.429	3.826	-1.42
Ar-Go (mm)	55.371	3.647	50.771	4.172	4.91***
TAFH (mm)	133.06	4.648	124.69	4.703	7.49***
UAFH (mm)	59.3	3.225	56.229	2.384	4.53***
LAFH (mm)	73.771	3.6	68.457	4.095	5.77***
UAFH/LAFH	0.806	0.061	0.824	0.061	-1.26
TPFH (mm)	92.571	4.453	83.129	4.481	8.84***
UPFH (mm)	48.643	2.369	44.8	2.474	6.64***
LPFH (mm)	43.929	4.632	38.329	4.116	5.35***
UPFH/LPFH	1.122	0.152	1.184	0.162	-1.66
TPFH/TAFH	0.696	0.037	0.667	0.036	3.36***
DENTAL					
UI-NA (deg)	23.929	5.021	24.571	5.344	-0.52
LI-NB (deg)	30.829	3.682	31.4	5.586	-0.51
UI-SN (deg)	107.86	5.42	107.77	5.414	0.07
LI-GoGn (deg)	100.91	4.135	99.3	7.421	1.12
UI-LI (deg)	123.9	6.049	119.3	20.948	1.25
Overbite (mm)	2.329	0.97	2.186	1.044	0.59
UADH (mm)	31.329	2.233	29.671	2.651	2.83**
LADH (mm)	45.757	7.653	43.629	2.715	1.55
UPDH (mm)	27.7	1.824	26.314	1.831	3.17**
LPDH (mm)	39.629	2.167	35.857	2.191	7.24***
UPDH/UADH	0.887	0.064	0.89	0.062	-0.25
LPDH/LADH	0.842	0.038	0.822	0.033	2.32*
SOFT TISSUE					
$Sn\text{-}Stm_S$ (mm)	26.229	1.832	24.3	1.933	4.28***
$Stm_S\text{-}UI$ (mm)	1.886	1.255	2.171	1.043	-1.04

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 7 The comparisons of the cephalometric measurements between the open bite Northern Thai males and females

Variables		Open bite males		Open bite females		t - value
		X̄	SD	X̄	SD	
SKELETAL						
NSBa	(deg)	128.82	5.654	130.99	5.756	-1.47
SNA	(deg)	82.455	4.163	82.667	3.022	-0.24
SNB	(deg)	81.023	4.025	80.458	4.476	0.5
ANB	(deg)	1.432	3.61	2.208	3.438	-0.86
WITS	(mm)	-5.909	6.879	-6.438	4.546	0.38
SN-PP	(deg)	8.205	2.75	8.573	3.377	-0.45
SN-GoGn	(deg)	38.227	6.143	39.427	5.586	-0.81
PP-GoGn	(deg)	30.023	5.211	30.854	5.956	-0.56
Ar-GoGn	(deg)	129.95	6.828	128.76	4.933	0.83
NSGn	(deg)	71.545	3.677	71.969	4.599	-0.38
Ar-Go	(mm)	51.341	5.313	46.677	4.377	3.87***
TAFH	(mm)	137.09	7.243	127.58	5.825	5.86***
UAFH	(mm)	58.5	3.433	55.323	3.031	3.9***
LAFH	(mm)	78.591	5.136	72.26	4.907	4.94***
UAFH/LAFH		0.746	0.05	0.769	0.068	-1.4
TPFH	(mm)	86.045	7.116	77.656	4.86	5.76***
UPFH	(mm)	48.591	3.611	45.417	2.868	3.96***
LPFH	(mm)	37.477	5.337	32.24	4.403	4.32***
UPFH/LPFH		1.32	0.199	1.437	0.235	-2.03*
TPFH/TAFH		0.628	0.049	0.609	0.037	1.78
DENTAL						
UI-NA	(deg)	33.273	6.451	31.667	7.144	0.9
LI-NB	(deg)	34.886	8.795	36.24	8.429	-0.62
UI-SN	(deg)	115.64	7.838	114.14	7.965	0.74
LI-GoGn	(deg)	96.068	10.602	96.771	8.865	-0.29
UI-LI	(deg)	110.5	12.903	110.2	11.483	0.1
Open bite	(mm)	-3.364	2.065	-2.646	1.624	1.57
UADH	(mm)	31.795	2.983	30.75	3.312	1.26
LADH	(mm)	47.659	3.688	44.698	3.266	3.38***
UPDH	(mm)	29.341	2.616	26.875	2.429	3.85***
LPDH	(mm)	37.864	3.223	35.563	3.124	2.83**
UPDH/UADH		0.926	0.083	0.878	0.073	2.45*
LPDH/LADH		0.795	0.041	0.795	0.041	-0.08
SOFT TISSUE						
$Sn-Stm_s$	(mm)	25.591	2.603	25.333	2.84	0.36
Stm_s-UI	(mm)	1.409	2.649	1.615	2.43	-0.32

* p < .05, ** P < .01, *** p < .001

Facial height and vertical facial proportion

The TAFH, UAFH, LAFH, TPFH, UPFH and LPFH were significantly greater in the males than in the females for both the normal and open bite groups ($p < .001$).

The UAFH/LAFH ratio was not significantly different between the males and the females in both the normal and open bite groups. The UPFH/LPFH ratio in the open bite group was apparently higher in the females than in the males ($p < .05$), but in case of the normal group, it was not significantly different in either sex. While the TPFH/TAFH ratio in the normal group was obviously higher in the males than in the females ($p < .001$), but in case of the open bite group, it was not significantly different in either sex.

II.2. Dental pattern

Dental relationship

The inclination of maxillary and mandibular incisors related to their bases (UI-NA, UI-SN, LI-NB, LI-GoGn) for the normal and open bite groups were not significantly different in either sex. The interincisal angle (UI-LI) and the overbite were also not obviously different in either sex for both the normal and open bite groups.

Dentoalveolar height

The UADH in the normal group was significantly greater in the males than in the females ($p < .01$), but in case of the open bite group, it was not obviously different between sexes. Conversely, the LADH in the open bite group was apparently greater in the males and in the females ($p < .001$), but in the normal group there was no significant difference in either sex.

The UPDH and the LPDH for both the normal and open bite groups were significantly greater in the males than in the females.

In the open bite group, the UPDH/UADH ratio was significantly lesser in the females than in the males ($p < .05$), however, there was no obvious difference between sexes in the normal group. While the LPDH/LADH ratio in the normal group was considerably higher in the males than in the females ($p<.05$), but in case of the open bite group, it was similar in both sexes.

II.3. Soft tissue pattern

The upper lip length ($Sn\text{-}Stm_S$) was significantly greater in the males than in the females ($p<.001$) for the normal group, but no significant difference was revealed in either sex for the open bite group. The maxillary incisor exposure ($Stm_S\text{-}UI$) did not show any significant differences in either sex for both the normal and open bite groups.

Part III. Comparison of the cephalometric measurements among the skeletal Class I, Class II and Class III in the open bite group

The comparisons of the skeletal, dental and soft tissue patterns of the skeletal Class I, Class II and Class III in the open bite group by one-way analysis of variance (one-way ANOVA) were presented in Table 8. If the F-value was significant, the Scheffe test would be done to identify which of several possible differences between means of cephalometric measurements was significant (Table 8). In this study, the ANB angle corresponded with the Wits value in the differentiation among skeletal Class I, Class II and Class III with anterior open bite. The SNB angle was significantly lesser in the Class II open bite group than in the Class I and Class III open bite groups. The SN-GoGN and PP-GoGn angles were the same for the Class I and Class III open bite groups, but they were apparently greater in the Class II open bite group than in the Class III open bite group. The NSGn angle was significantly greater in the Class II open bite group than in the Class I and Class III open bite groups. The ramus height (Ar-Go) was significantly shorter in the Class II open bite group than in the Class III open bite group.

For the anterior facial heights and the posterior facial heights, there were no significant differences among three groups of the open bite.

The UI-NA and UI-SN angle were almost the same in the skeletal Class I, Class II and Class III open bite groups. The LI-NB angle and the LI-GoGn angle were significantly greater in the Class II and Class I open bite groups than in the Class III open bite group. The interincisal angle (UI-LI) was similar to the Class II and the Class I open bite groups, but it was significantly lesser in the Class II and Class I open bite groups than in the Class III open bite group. The anterior open bite was not significantly different among skeletal Class I, Class II and Class III open bite groups.

The UADH, LADH and LPDH were significantly greater in the Class II open bite group than in the Class III open bite group, while the UPDH/UADH ratio was significantly lesser in the Class II open bite group than in the Class III open bite group. However, the UPDH was not significantly different among skeletal Class I, Class II and Class III in open bite group.

The upper lip length was similar for the Class I open bite and the Class III open bite groups, but it was significantly longer in the Class II open bite group than in the Class I and Class III open bite groups.

Table 8 Means , standard deviations, one-way ANOVA and Scheffe test of skeletal Class I , Class II and Class III in the open bite group

Variables		Class I (n=17)	Class II (n=34)	Class III (n=19)	F value	Scheffe test		
		$\bar{X}_i \pm SD$	$\bar{X}_{ii} \pm SD$	$\bar{X}_{iii} \pm SD$		$\bar{X}_i - \bar{X}_{ii}$	$\bar{X}_i - \bar{X}_{iii}$	$\bar{X}_{ii} - \bar{X}_{iii}$
SKELETAL								
NSBa	(deg)	132.21±6.40	129.74±5.82	129.63±4.98	1.22			
SNA	(deg)	82.59±3.91	82.85±2.95	82.16±3.77	0.25			
SNB	(deg)	81.21±3.37	78.02±2.73	84.82±3.99	26.74***	**	**	**
ANB	(deg)	1.38±0.86	4.84±1.29	-2.66±2.09	159.28***	**	**	**
WITS	(mm)	-6.71±2.82	-2.78±3.90	-12.13±3.87	39.88***	**	**	**
SN-PP	(deg)	8.68±3.54	8.84±3.05	7.58±3.06	1.01			
SN-GoGn	(deg)	37.65±6.55	41.40±4.55	36.10±5.40	6.81**			**
PP-GoGn	(deg)	28.97±6.25	32.56±4.97	28.53±5.52	4.33*			*
Ar-GoGn	(deg)	128.38±5.37	128.16±5.36	131.55±5.68	2.57			
NSGn	(deg)	71.32±3.44	74.31±2.95	67.87±4.03	22.27***	*	*	**
Ar-Go	(mm)	48.94±5.60	46.60±4.84	50.18±4.56	3.46*			*
TAFH	(mm)	129.24±7.10	130.93±7.55	131.13±8.60	0.34			
UAFH	(mm)	56.03±3.17	56.74±3.32	55.84±4.05	0.48			
LAFH	(mm)	73.21±5.91	74.19±5.49	75.29±6.22	0.58			
UAFH/LAFH		0.77±0.07	0.77±0.06	0.74±0.07	0.93			
TPFH	(mm)	80.44±7.69	79.22±6.34	82.08±6.92	1.07			
UPFH	(mm)	45.85±2.47	46.56±3.43	46.66±4.22	0.30			
LPFH	(mm)	34.59±6.68	32.68±4.64	35.42±4.69	1.89			
UPFH/LPFH		1.38±0.29	1.45±0.20	1.34±0.20	1.62			
TPFH/TAFH		0.62±0.05	0.60±0.03	0.63±0.04	2.15			
DENTAL								
UI-NA	(deg)	33.76±7.07	30.02±6.35	34.60±6.94	3.51			
LI-NB	(deg)	36.74±8.50	39.46±6.54	28.47±7.21	14.24***		**	**
UI-SN	(deg)	116.26±7.91	112.68±6.68	116.58±9.38	2.04			
LI-GoGn	(deg)	98.12±9.77	100.53±7.20	88.03±6.92	16.01***		**	**
UI-LI	(deg)	108.35±12.7	105.96±7.98	119.79±11.9	11.12***		**	**
Openbite	(mm)	2.35±1.28	3.18±1.93	2.79±1.89	1.23			
UADH	(mm)	30.50±3.58	32.24±2.74	29.53±3.05	5.22**			*
LADH	(mm)	45.32±4.05	46.66±3.05	44.05±3.83	3.42*			*
UPDH	(mm)	27.62±2.35	27.88±2.86	27.26±2.88	0.31			
LPDH	(mm)	35.82±3.41	37.46±3.07	34.60±2.94	5.33**			*
UPDH/UADH		0.91±0.06	0.87±0.08	0.93±0.08	4.39*			*
LPDH/LADH		0.80±0.04	0.80±0.05	0.79±0.04	0.93			
SOFT								
Sn-Stm_s	(mm)	24.74±2.66	26.60±2.68	23.89±2.0	7.90***	*		**
Stm_s-UI	(mm)	2.00±2.02	1.48±2.58	1.26±2.74	0.41			

* $p < .05$, ** $p < .01$, *** $p < .001$

Part IV. Correlation analyses between the dentofacial measurements for both the normal and the open bite groups

The 27 cephalometric variables of the normal and open bite groups were selected and divided into 4 groups : vertical skeletal relationship, facial height, dental, and dentoalveolar height. Each group of normal and open bite groups are correlated in 10 matrices as shown in Table 9 and Table 10 with the correlation coefficient of 1% significant level.

IV.1. Correlations for the dentofacial measurements of the normal group

Table 9 shows the correlation for the 27 selected variables of the normal subjects (combination of both sexes), with the correlation coefficients which were of 1% significant level.

Matrix I shows the correlations between the vertical skeletal variables. The SN-PP angle was positively correlated with the SN-GoGn angle and the NSGn angle, but was negatively correlated with the PP-GoGn angle. The SN-GoGn angle was positively correlated with the Ar-GoGn angle, the NSGn angle and the PP-GoGn angle, but was negatively correlated with the ramus height (Ar-Go). The Ar-GoGn angle was also negatively correlated with the ramus height (Ar-Go), but was positively correlated with the PP-GoGn angle. The PP-GoGn angle was positively correlated with the NSGn angle, but was negatively correlated with the ramus height (Ar-Go).

The correlations between the vertical skeletal variables and the facial height variables are displayed in Matrix II. The SN-PP angle was positively correlated with the UAFH, the UAFH/LAFH ratio, but was negatively correlated with the LAFH, the TPFH and the UPFH.

The SN-GoGn angle and the Ar-GoGn angle as well as the NSGn angle were positively correlated with the UPFH/LPFH ratio, but were negatively correlated with the TPFH and LPFH , and the TPFH/TAFH ratio. The PP-GoGn angle was positively correlated with the LAFH and the UPFH/LPFH ratio, but was negatively correlated with the UAFH/LAFH ratio, TPFH, LPFH and the TPFH/TAFH

Table 9 Correlations between 27 dentofacial measurements in the normal subjects (both sexes combined). All represented correlation coefficients were based on the 1% significant level.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Vertical skeletal			I																								
1. SN-PP																											
2. SN-GoGn	0.331																										
3. Ar-GoGn		0.764																									
4. NSGn	0.325	0.609																									
5. PP-GoGn	-0.353	0.786	0.646	0.382																							
6. Ar-Go		-0.572	-0.454		-0.522																						
Facial height			II								V																
7. TAFH						0.418																					
8. UAFH	0.333						0.693																				
9. LAFH	-0.446				0.390	0.399	0.868																				
10. UAFH/LAFH	0.637				-0.354			0.516	-0.706																		
11. TPFH	-0.334	-0.619	-0.522	-0.313	-0.386	0.813	0.634	0.366	0.600																		
12. UPFH	-0.502						0.768	0.624	0.604		0.621																
13. LPFH		-0.730	-0.557	-0.365	-0.642	0.855	0.338		0.393		0.884																
14. UPFH/LPFH		0.652	0.436	0.322	0.760	-0.663					-0.521	0.336	-0.863														
15. TPFH/TAFH		-0.946	-0.694	-0.532	-0.734	0.695					0.756		0.856	-0.733													
Dental			III								VI							VIII									
16. UI-NA																											
17. LI-NB																											
18. UI-SN		-0.456		-0.445									0.319		0.417	0.822											
19. LI-GoGn		-0.377	-0.404		-0.330									-0.316	0.392		0.718										
20. UI-LI																	-0.324		-0.354								
21. Overbite																	-0.300										
Dental Height			IV								VII							IX						X			
22. UADH					0.584		0.573		0.725	-0.806		0.405				-0.302		-0.330									
23. LADH																											
24. UPDH						0.540	0.575		0.648	-0.451	0.549		0.529	-0.391								0.687					
25. LPDH						0.540	0.775	0.357	0.796	-0.441	0.721	0.523	0.693									0.401		0.372			
26. UPDH/UADH		-0.397	-0.327		-0.676	0.435							0.422	-0.512	0.386	0.376		0.424				-0.594					
27. LPDH/LADH		-0.471	-0.499		-0.597	0.397					0.437		0.500	-0.530	0.539				0.470						0.444		

angle was positively correlated with the LAFH and the UPFH/LPFH ratio, but was negatively correlated with the UAFH/LAFH ratio, TPFH, LPFH and the TPFH/TAFH ratio. The ramus height (Ar-Go) was positively correlated with the TAFH and LAFH, the TPFH and LPFH, and the TPFH/TAFH ratio, but was negatively correlated with the UPFH/LPFH ratio.

Matrix III shows the correlations between the vertical skeletal variables and the dental variables. The SN-GoGn angle was negatively correlated with the UI-SN angle and the LI-GoGn angle. The Ar-GoGn angle and the PP-GoGn angle were negatively correlated with the LI-GoGn angle. There was a negative correlation between the NSGn angle and the UI-SN angle.

Matrix IV shows the correlations between the vertical skeletal variables and the dentoalveolar height variables. The SN-GoGn angle, the Ar-GoGn angle and the PP-GoGn angle were negatively correlated with the UPDH/UADH ratio and the LPDH/LADH ratio. Furthermore, the PP-GoGn angle was positively correlated with the UADH. The ramus height (Ar-Go) was positively correlated with the UPDH and LPDH, the UPDH/UADH ratio, and the LPDH/LADH ratio.

The correlations between the facial height variables are shown in Matrix V. The TAFH was positively correlated with the UAFH and LAFH, the TPFH, UPFH, and LPFH. The UAFH was positively correlated with the UAFH/LAFH ratio, the TPFH, and the UPFH. While the LAFH was negatively correlated with the UAFH/LAFH ratio, but was positively correlated with the TPFH, UPFH and LPFH. The TPFH was positively correlated with the UPFH, LPFH, and the TPFH/TAFH ratio, but was negatively correlated with the UPFH/LPFH ratio. The UPFH was positively correlated with the UPFH/LPFH ratio. While the LPFH was negatively correlated with the UPFH/LPFH ratio, but was positively correlated with the TPFH/TAFH ratio. There was a negative correlation between the UPFH/LPFH ratio and the TPFH/TAFH ratio.

Matrix VI shows the correlations between the facial height variables and the dental variables. The LPFH was positively correlated with the UI-SN angle. The UPFH/LPFH ratio was negatively correlated with the LI-GoGn angle. While the TPFH/TAFH ratio was positively correlated with the UI-SN angle and the LI-GoGn angle.

The correlations between the facial height variables and the dentoalveolar height variables are shown in Matrix VII. The TAFH and LAFH were positively correlated with the UADH, UPDH and LPDH. While the UAFH had the only significant positive correlation with the LPDH. The UAFH/LAFH ratio was negatively correlated with the UADH, UPDH and LPDH. The TPFH was positively correlated with the UPDH, LPDH, and the LPDH/LADH ratio. The UPFH was positively correlated with the UADH and LPDH. The LPFH was positively correlated with the UPDH, LPDH, the UPDH/UADH ratio, and the LPDH/LADH ratio. The UPFH/LPFH ratio was negatively correlated with the UPDH, the UPDH/UADH ratio, and the LPDH/LADH ratio. The TPFH/TAFH ratio was positively correlated with the the UPDH/UADH ratio and the LPDH/LADH ratio.

Matrix VIII shows the correlations of the dental variables. There was highly positive correlations between the UI-NA angle and the UI-SN angle. The LI-NB angle was positively correlated with the LI-GoGn angle, but was negatively correlated with the interincisal angle (UI-LI) and the overbite. The LI-GoGn angle was also negatively correlated with the UI-LI angle.

Matrix IX shows the correlations between the dental variables and the dentoalveolar height variables. The UI-NA angle and UI-SN angle were negatively correlated with the UADH, but were positively correlated with the UPDH/UADH ratio. The LI-GoGn angle was positively correlated with the LPDH/LADH ratio.

The correlations of the dentoalveolar height variables are presented in Matrix X. The UADH was positively correlated with the UPDH and LPDH, but was negatively correlated with the UPDH/UADH ratio. The UPDH was positively correlated with the LPDH, while the LPDH was positively correlated with the LPDH/LADH ratio.

In the normal occlusion, the overbite was positively correlated with the LI-NB angle (r = -0.300). The SN-GoGn angle had highly negative correlation with the TPFH/TAFH ratio (r = -0.946), moderately positive correlation with the PP-GoGn angle (r = 0.766) and the Ar-GoGn angle (r = 0.764), and moderately negative correlation with the LPFH (r = -0.730). The PP-GoGn angle had moderately positive correlation with the UPFH/LPFH ratio (r = 0.750), and moderately negative correlation with the TPFH/TAFH ratio (r = -0.734). The SN-PP angle was moderately positively correlated with the UAFH/LAFH ratio (r = 0.637). The TAFH had highly positive correlation with the LAFH (r = 0.868), and moderately positive correlations with the UPFH (r = 0.768) and the LPDH (r = 0.775). The LAFH showed moderately negative correlation with the UAFH/LAFH ratio (r = -0.706), moderately positive correlations with the UADH (r = 0.725), the UPDH (r = 0.648) and the LPDH (r = 0.796). The TPFH was highly positively correlated with the LPFH (r = 0.884). All of these correlation coefficients were significant at 1% level.

IV.2. Correlations for the dentofacial measurements of the open bite group

Table 10 shows the correlation matrices for the 27 selected variables of the open bite subjects (combination of both sexes), with the correlation coefficients which were of 1% significant level.

Matrix I shows the correlations between the vertical skeletal variables. The SN-PP angle was positively correlated with the NSGn angle. The SN-GoGn angle was positively correlated with the Ar-GoGn angle, the NSGn angle and the PP-GoGn angle, but was negatively correlated with the ramus height (Ar-Go). The NSGn angle was also positively correlated with the PP-GoGn angle, but was negatively correlated with the ramus height (Ar-Go). There was a negative correlation between the PP-GoGn angle and the ramus height (Ar-Go).

The correlations between the vertical skeletal variables and the facial height variables are displayed in Matrix II. The SN-PP angle was positively correlated with the UAFH and the UAFH/LAFH ratio, but was negatively correlated with the LAFH, TPFH, UPFH, and the TPFH/TAFH ratio. While the SN-GoGn angle was negatively correlated with the TPFH, LPFH, and TPFH/TAFH ratio, but was positively correlated with the UPFH/LPFH ratio. The gonial angle (Ar-GoGn) was negatively correlated with the TPFH/TAFH ratio. The Y-axis angle (NSGn) was positively correlated with the UAFH and UPFH/LPFH ratio, but was negatively correlated with the LPFH and TPFH/TAFH ratio. The ramus height (Ar-Go) was positively correlated with the TAFH, LAFH, TPFH, UPFH, LPFH, and the TPFH/TAFH ratio, but was only negatively correlated with the UPFH/LPFH ratio. The PP-GoGn angle was positively correlated with the LAFH and the UPFH/LPFH ratio, but was negatively correlated with the UAFH/LAFH ratio, TPFH, LPFH, and TPFH/TAFH ratio.

Table 10 Correlations between 27 dentofacial measurements in the open bite subjects (both sexes combined). All represented correlation coefficients were based on the 1% significant level.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Vertical skeletal			I																								
1. SN-PP																											
2. SN-GoGn																											
3. Ar-GoGn		0.417																									
4. NSGn	0.337	0.797																									
5. PP-GoGn		0.846	0.427	0.616																							
6. Ar-Go		-0.538		-0.305	-0.485																						
Facial height			II								V																
7. TAFH						0.428																					
8. UAFH	0.368			0.338			0.703																				
9. LAFH	-0.340				0.401	0.407	0.905	0.340																			
10. UAFH/LAFH	0.606				-0.390		-0.335	0.425	-0.702																		
11. TPFH	-0.325	-0.539			-0.362	0.819	0.617	0.423	0.566																		
12. UPFH	-0.457					0.326	0.733	0.646	0.587		0.656																
13. LPFH		-0.685		-0.401	-0.620	0.852	0.323		0.357		0.873																
14. UPFH/LPFH		0.663		0.434	0.718	-0.673					-0.544		-0.876														
15. TPFH/TAFH	-0.337	-0.904	-0.387	-0.614	-0.723	0.659					0.718		0.812	-0.709													
Dental			III								VI							VIII									
16. UI-NA		-0.351		-0.363																							
17. LI-NB				0.321																							
18. UI-SN		-0.461		-0.525											0.400	0.901											
19. LI-GoGn			-0.533														0.674										
20. UI-LI																-0.416	-0.845	-0.527	-0.782								
21. Open bite		0.347			0.422																						
Dental height			IV								VII								IX					X			
22. UADH		0.371		0.503	0.536		0.632		0.713	-0.529	0.314	0.430				-0.314		-0.335									
23. LADH		0.371		0.444	0.336		0.692	0.446	0.640			0.371					0.534		0.362	-0.401		0.571					
24. UPDH						0.465	0.711	0.339	0.742	-0.461	0.581	0.410	0.491									0.641	0.492				
25. LPDH				0.383			0.572	0.376	0.535		0.352					-0.330	0.541		0.490	-0.304		0.577	0.808	0.399			
26. UPDH/UADH		-0.420		-0.342	-0.520	0.337							0.398	-0.401	0.340	0.476						-0.478		0.363			
27. LPDH/LADH			-0.396													-0.362		-0.315							0.496		

The correlations between the vertical skeletal variables and the dental variables are shown in Matrix III. The SN-GoGn angle was negatively correlated with the UI-NA angle and UI-SN angle. The Ar-GoGn angle had a negative correlation with the LI-GoGn angle. The NSGn angle was negatively correlated with the UI-NA angle and UI-SN angle, but was positively correlated with the LI-NB angle. The open bite had significantly positive correlations ($p<.01$) with the SN-GoGn angle ($r = 0.347$) and the PP-GoGn angle ($r = 0.422$).

Matrix IV shows the correlations between the vertical skeletal variables and the dentoalveolar height variables. The SN-GoGn angle was positively correlated with the UADH and LADH, but was negatively correlated with the UPDH/UADH ratio. The gonial angle (Ar-GoGn) had only a negative correlation with the LPDH/LADH ratio. The NSGn angle was positively correlated with the UADH, LADH and LPDH, but was negatively correlated with the UPDH/UADH ratio. The PP-GoGn angle was positively correlated with the UADH and the LADH, but was negatively correlated with the UPDH/UADH ratio. The ramus height (Ar-Go) had positive correlations with the UPDH and the UPDH/UADH ratio.

Matrix V shows the correlations between the facial height variables. The TAFH was positively correlated with the UAFH, LAFH, TPFH, UPFH and LPFH, but was negatively correlated with the UAFH/LAFH ratio. The UAFH was positively correlated with the LAFH, UAFH/LAFH ratio, TPFH and UPFH. While the LAFH was negatively correlated with the UAFH/LAFH ratio, but was positively correlated with the TPFH, UPFH and LPFH. The TPFH was positively correlated with the UPFH, LPFH and TPFH/TAFH ratio, but was negatively correlated with the UPFH/LPFH ratio. The LPFH was positively correlated with the TPFH/TAFH ratio, but was negatively correlated with the UPFH/LPFH ratio. While the UPFH/LPFH ratio was negatively correlated with the TPFH/TAFH ratio.

Matrix VI shows the correlations between the facial height variables and the dental variables. There was a positive correlation between the TPFH/TAFH ratio and the UI-SN angle.

The correlations between the facial height variables and the dentoalveolar height variables are shown in Matrix VII. The TAFH and LAFH were positively correlated with the UADH, LADH, UPDH and LPDH. The UAFH was positively correlated with the LADH, UPDH and LPDH. The UAFH/LAFH ratio was negatively correlated with the UADH and UPDH. The TPFH was positively correlated with the UADH, UPDH and LPDH. The UPFH was positively correlated with the UADH, LADH, and UPDH. While the LPFH was positively correlated with the UPDH and UPDH/UADH ratio. In addition, the UPDH/UADH ratio was positively correlated with the TPFH/TAFH ratio, but was negatively correlated with the UPFH/LPFH ratio.

Matrix VIII shows the correlations between the dental variables. The UI-NA angle was positively correlated with the UI-SN angle, but was negatively correlated with the interincisal angle (UI-LI). While the LI-NB angle was positively correlated with the LI-GoGn angle, but was negatively correlated with the interincisal angle (UI-LI). Furthermore, the interincisal angle (UI-LI) was negatively correlated with the UI-SN angle and the LI-GoGn angle.

Matrix IX shows the correlations between the dental variables and the dentoalveolar height variables. The UI-NA angle was positively correlated with the UPDH/UADH ratio, but was negatively correlated with the UADH, LPDH and the LPDH/LADH ratio. While the UI-SN angle was negatively correlated with the UADH and the LPDH/LADH ratio. The LI-NB angle and LI-GoGn angle were positively correlated with the LADH and LPDH. In contrast, the interincisal angle (UI-LI) was negatively correlated with the LADH and LPDH.

Matrix X shows the correlations between the dentoalveolar height variables. The UADH was positively correlated with the LADH, UPDH and LPDH, but was negatively correlated with the UPDH/UADH ratio. The LADH was positively correlated with the UPDH and LPDH. The UPDH was positively correlated with the LPDH and the UPDH/UADH ratio. While the LPDH was positively correlated with the LPDH/LADH ratio.

In the anterior open bite malocclusion, the anterior open bite was positively correlations with the SN-GoGn angle (r = 0.347) and the PP-GoGn angle (r = 0.422). The SN-GoGn angle had highly negative correlation with the TPFH/TAFH ratio (r = -0.904), highly positive correlation with the PP-GoGn angle (r = 0.846), and moderately positive correlation with the NSGn angle (r = 0.797). The PP-GoGn angle had moderately positive correlation with the UPFH/LPFH ratio (r = 0.718), and moderately negative correlation with the TPFH/TAFH ratio (r = -0.723). The SN-PP angle was moderately positively correlated with the UAFH/LAFH ratio (r = 0.606). The TAFH had highly positive correlation with the LAFH (r = 0.905), and moderately positive correlations with the UAFH (r = 0.708), the UPFH (r = 0.733) and the UPDH (r = 0.711). The LAFH showed moderately negative correlation with the UAFH/LAFH ratio (r = -0.702), and moderately positive correlations with the UADH (r = 0.713), the LADH (r = 0.640) and the UPDH (r = 0.742). The TPFH was highly positively correlated with the LPFH (r = 0.873). All of these correlation coefficients were significant at 1% level.

Part V. Stepwise multiple regression analysis for anterior open bite

When analyzing the variation of the anterior open bite, the following multiple regression was computed:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \dots\dots\dots + b_kX_k$$

where Y = dependent variable which was the anterior open bite (mm.)

X_1 to X_k = independent variables (predictor variables)

a = constant

b_1 to b_k = regression coefficients

The independent variables (X_1 to X_{26}), which might have influences on the anterior open bite, were the SN-PP, SN-GoGn, Ar-GoGn, NSGn, PP-GoGn, Ar-Go, TAFH, UAFH, LAFH, UAFH/LAFH, TPFH, UPFH, LPFH, UPFH/LPFH, TPFH/TAFH, UI-NA, LI-NB, UI-SN, LI-GoGn, UI-LI, UADH, LADH, UPDH, LPDH, UPDH/UADH and LPDH/LADH. These variables for the anterior open bite cases (combined sexes) were entered in the equation. The stepwise multiple linear regression analysis was presented in Table 11 which illustrated that the four predictor variables : PP-GoGn, UPDH/UADH ratio, LPDH/LADH ratio and UI-SN; had a significant independent contribution to the variations in the anterior open bite ($p<.001$).

Table 11 The predictor variables for the anterior open bite

Variables	b	SE (b)	Beta	t-value
PP-GoGn	.328546	.029956	1.047070	10.967***
UPDH/UADH	18.111749	2.114549	.797243	8.565***
LPDH/LADH	23.627974	3.517380	.576957	6.717***
UI-SN	.054678	.018848	.241150	2.901**
Constant	-48.423871	5.358193		-9.037***

* $p < .05$, ** $p < .01$, *** $p < .001$

$R = .81927$ $R^2 = .67120$ $F = 33.17199$ ***

where b = Regression coefficient

SE (b) = Standard error of regression coefficient

Beta = Standardized regression coefficient

R = Multiple correlation coefficient

R^2 = Coefficient of determination

The predictive equation for anterior open bite in the form of raw scores was :

$$\text{Anterior open bite} = -48.423871 + 0.328546\ \text{PP-GoGn} + 18.111749\ \text{UPDH/UADH} + 23.627974\ \text{LPDH/LADH} + .054676\ \text{UI-SN}$$

When the dependent variable (Y) and the four independent variables (X_1-X_4) were converted to standard scores; Z_Y , Zx_1 , Zx_2 , Zx_3 , Zx_4 ; each Z had a mean of 0 and standard deviation of 1.

Then the predictive equation for anterior open bite in the form of standard score was :

$$Z'_{\text{Anterior open bite}} = 1.047070\ Z_{\text{PP-GoGn}} + 0.797243\ Z_{\text{UPDH/UADH}} + 0.576957\ Z_{\text{LPDH/LADH}} + 0.241150\ Z_{\text{UI-SN}}$$

with the multiple correlation coefficient (R) = 0.81927,

and the coefficient of determination (R^2) = 0.67120

This meaned that sixty-seven percent of the variation in the anterior open bite was explained by the PP-GoGn angle, the UPDH/UADH ratio, the LPDH/LADH ratio and the UI-SN angle. The standardized regression coefficient (Beta) of each variable showed the degree of contribution to the anterior open bite. Therefore, the PP-GoGn angle was the most effective predictor to anterior open bite.