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Interrelation between Cranial Base and Facial Heights of Two Age Groups (Cross–sectional Study Using Digital Cephalometric Radiograph)

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الخلاصة

الهدف من الدراسة: تهدف الدراسة إلى اكتشاف العلاقة المتبادلة بين قاعدة الجمجمة و ارتفاعات الوجه آخذين بنظر الاعتبار الاختلافات العمرية والجنسية. **المواد وطرائق البحث**: جرت الدراسة على الأشعة الرأسية لثلاثة وستون شخصا مقسمين إلى مجموعتين عمريتين: المجموعة الأولى وتتضمن٣٦ شخصا تتراوح أعمارهم بين (١٠–١٥) عاما والمجموعة الثانية وتتضمن ٢٧ شخصا تتراوح أعمارهم بين (١٦–٢٥) عاما، كلتا المجموعتين تتسم بأنها ذات إطباق ضرسي من النوع الأول وباكتمال جميع الأسنان الدائمية. الأشعة الجانبيه للرأس تؤخذ من حاسوب جهاز الأشعة الرقمية (Planmeca dimaxis version 3). عدد القياسات الخطية المقيمة تسعة (ثلاثة منها لقاعدة الجمجمة وستة لارتفاعات الوجه) مع نسبة واحدة لارتفاعات (الوجه الخلفي إلى الأمامي). **النتائج**: أظهرت النتائج وجود زيادة معنوية في معدل قياسات المجموعة الثانية لكل من قاعدة الجمجمة وارتفاعات الوجه، وكذلك ضمن كل مجموعة معدل قياسات الذكور اظهر زيادة معنوية مقارنة بمثيلاتها الأنثوية. أما نسبة ارتفاعات الوجه الخلفي إلى الأمامي كانت ضمن المعدلات الطبيعية ولكلتا الفئتين العمريتين، فضلا عن وجود ارتباط ايجابي معنوي لمعظم قياسات قاعدة الجمجمة مع قياسات ارتفاعات الوجه. **الاستنتاجات**: علاقة ايجابية متبادلة وجدت بين النمو الحاصل في قاعدة الجمجمة و النمو الحاصل في التراكيب المعنية لطول الوجه.

ABSTRACT

Aims: The aim of this study is to detect the interrelation between the cranial base and the facial heights involving age and sex differences. **Materials and Methods:** The study was carried out on cephalometric of 63 subjects divided into two age groups: The first group including 36 subjects of 10–15 years and the second group including 27 subjects of 16–25 years, both groups of normal Cl.I molar occlusion with full set of permanent teeth. Lateral cephalometric radiograph were selected from computer of digital radiography system (Planmeca dimaxis version 3). Nine linear measurements three for cranial base and six for facial heights with one ratio posterior to anterior facial height were evaluated. **Results:** There were a significant increase in means of group 2 for each cranial base and facial heights measurements, also within each age group means for male samples showed a significant increase in comparison with those of females. Posterior to anterior facial heights ratios were involved in normal range for both age groups. In addition a significant positive correlation were found between most of cranial base measurements with those of facial heights. **Conclusions:** Positive interrelation may be existed between growth of cranial base and growth of facial heights structures.

Key words: Cranial base, Facial heights, Digital cephalometric.

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INTRODUCTION

The cranial base floor is the foundation on which the human face develops and the dimension of the middle cranial fossa influences the relationship between nasomaxillary complex and mandible(1). Growth and development of the cranial base and the face are intimately related to each other, and has therefore been a focus of interest to many researchers(2). Orthodontic treatment itself may have some effects upon the growth of the face. A basic knowledge of the process of facial growth is essential for the clinical practice of orthodontist. Mandibular growth occurs as a result of periosteal activity and the alveolar processes develop vertically to keep pace with the eruption of teeth. and it is elongated by the growth of condylar cartilage, where its growth is expressed as a downward and forward displacement along with the anterior and posterior remodeling[3,4].

The main growth sites in the base of the skull, sphenoccipital, intersphenoidal and sphenoethmoidal synchondrosis. The sphenoccipital synchondrosis does not close until approximately 20 years of age, so it is apparently regarded as the principal contributor to the elongation of the cranial base[5]. The growth of nasomaxillary complex, was including sutural growth, apposition and resorption, cartilaginous growth of nasal septum, functional matrix and effect of periosteal and endosteal surfaces[6].

The orientation of circumferencial system was that sutural growth will result in the downward and forward movement of facial complex when compared with base of skull[7]. Lateral cephalogram are used to study anteroposterior and vertical relations[8].

These can be either conventional or digital computed radiography system (CR) where the latter unlike the conventional one in which a filmless imaging system breaking it into electronic pieces presenting and storing the image using a computer[9].

The lateral digital cephalogram's advantages include: superior gray scale resolution, reduced patient exposure to x–rays, increased speed of image viewing, lower equipment and film costs, also increased time efficiency, improved patient education, easy storage, registration and retrieval of cephalometric values and tracings while the main disadvantage were the initial set–up cost of the digital system too much expensive[10].

Hence, the aim of this study is to detect the interrelation between the cranial base and the facial heights involving age and gender differences.

MATERIALS AND METHODS

A total of 5567 Iraqi patient attended from various regions of Mosul city were taking different digital radiographs. The study was carried out on the cephalometric radiographs of 63 subjects who were selected from computer of digital radiography system (Planmeca dimaxis version 3) including two age groups: the first age group–G1– (10–15) years included 36 subjects; 16 males and 20 females. This group characterized by adolescent growth spurt for both genders[4] and the second age group–G2– (16–25) years included 27 subjects; 15 males and 12 females, while the latter group was considered as the extension of adult age group for both genders also. The inclusive criteria of selection for each subject were: Class I molars and canines relations; Competent lips (rest position); no orthodontic treatment; full set of permanent dentition in both jaws excluding third molars; normal over jet and over bite about 2–4mm and normal arrangement of dentition with no apparent dental or skeletal discrepancy; and finally no massive proximal caries or fractured anterior teeth.

The identifications of cephalometric points and corresponding lines of this study were made directly on computer of CR system for each subject, then linear measurements were made via special program (Dimaxis Planmeca Pro) which were supplied in this computer.

These lines including: Sella–nasion (SN) Represents the anteroposterior extent of the anterior cranial base [11]. Sella–basion (SBa) or posterior cranial base which is a plane joining between sella and nasion point[12]. Basion– nasion (BaN) or the depth of the cranial base, this distance measured between basion and nasion points [13]. Total anterior facial height–TA (N–Me) which is the vertical distance from nasion to menton[14].Upper–anterior facial height–UA (N–ANS) which is the vertical distance from nasion to anterior nasal spine [15]. lower anterior facial height LA (ANS–Me) which is the vertical distance from anterior nasal spine to menton[16]. Total posterior facial height–TP (S–Go) which is the vertical distance from center of sella torcica to gonion[16]. Upper posterior facial height–UP(S–PNS) the length of the perpendicular line from posterior nasal spine on to the SN[17]. lower posterior facial height–LP (PNS–Go) which is the perpendicular line from the point gonion to the palatal plane[16]. All these linear measurements are illustrated in Figure (1).

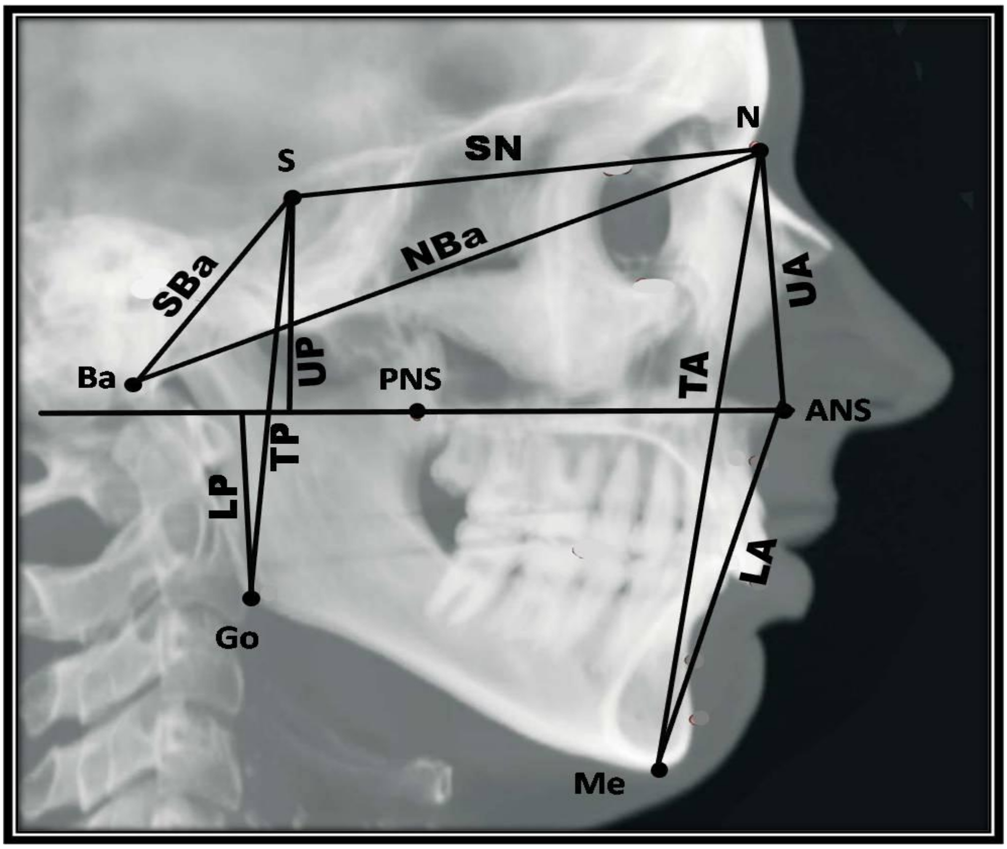

Figure (1): Linear measurements of cranial base and facial heights; SN: anterior cranial base; SBa: posterior cranial base; NBa: depth of cranial base; TA: (N–Me); total anterior facial height; UA: (N–ANS), upper anterior facial height; LA: (ANS–Me); lower anterior facial height; TP: (S–Go), total posterior facial height; UP: (S–PNS); upper posterior facial height; LP: (PNS–Go); lower posterior facial height.

Statistical Package for the Social Science (SPSS) program was used to analyze the data to obtain descriptive analysis (minimum, maximum, mean and standard deviation) of total samples and their male and females subdivisions and for both age groups. The ratio of posterior to anterior facial heights (TP/TA) which is the ratio of total posterior facial heights (SGo)×100 /total anterior facial heights (N–Me)[18]. Comparison between two samples within each age group or between them were determined using Students *t*–test at 0.05 level of significance and Pearson's correlation coefficient analysis to explore the correlation between cranial base and facial height measurements.

RESULTS

The descriptive analysis of total, male and female samples of both groups were shown in Table (1) for cranial base measurements SN, SBa and NBa respectively, in Table (2) of total, male and female samples for anterior facial heights measurements TA, UA, LA respectively and in Table (3) of total, male and female samples for posterior facial heights measurements TP, UP and LP respectively.

The results of t–test showed significant increase of mean for cranial base and anterior and posterior facial heights measurements of G2 with corresponding type and gender of G1as in Tables (1,2,3) respectively, as the mean of SN in G2 was significantly increase in comparison with SN in G1. In addition comparisons within each age group regarding genders showed significant increase of means for male samples of each cranial base and anterior and posterior facial heights measurements in comparison with those of females as in Tables (1,2,3) respectively, as mean of male UP was significantly increased in comparison with female UP of same age group.

Table (1): Means and standard deviations for anterior, posterior and depth of cranial base of the total, male and female samples.

	Variables**	No.	Min.	Max.	SE	Mean± SD	t–value	p–value
Anterior Cranial Base	SNt1	36	62.34	70.23	.3239	66.18±1.94	3.58	<0.01*
	SNt2	27	64.72	68.93	.2460	66.86±1.28		
	SNm1	16	65.04	68.27	..20721	66.67±1.09	3.39	<0.01*
	SNf1	20	62.34	67.27	.3818	65.15±1.71		
	SNm2	15	66.10	68.93	.2672	67.55±1.03	3.21	<0.01*
	SNf2	12	64.72	67.93	.2917	65.99±1.01		
	Variables	No.				Mean ± SD	t–value	p–value
	SNm1	16				66.67±1.09	2.49	<0.05*
	SNm2	15				67.55±1.03		
	SNf1	20				65.15±1.71	2.58	<0.05*
	SNf2	12				65.99±1.01		
Posterior Cranial Base	Variables	No.	Min.	Max.	SE	Mean ± SD	t–value	p–value
	SBat1	36	41.06	46.82	.2575	44.15±1.54	4.53	<0.001*
	SBat2	27	42.25	46.83	.2344	45.40±1.22		
	SBam1	16	44.11	46.82	.2181	45.26±.87	4.17	<0.01*
	SBaf1	20	41.06	45.99	.3130	43.28±1.40		
	SBam2	15	45.00	46.83	.1728	45.40±1.22	3.50	<0.01*
	SBaf2	12	42.25	46.55	.3759	44.65±1.31		
	Variables	No.				Mean ± SD	t–value	p–value
	SBam1	16				45.26±.87	2.22	<0.05*
	SBam2	15				45.40±1.22		
	SBaf1	20				43.28±1.40	2.21	<0.05*
	SBaf2	12				44.65±1.31		
Depth of Cranial Base	Variables	No.	Min.	Max.	SE	Mean ± SD	t–value	p–value
	NBat1	36	96.00	102.32	.2633	100.01±1.058	4.18	<0.01*
	NBat2	27	98.82	103.04	.2521	100.99±1.31		
	NBam1	16	100.01	102.32	.1572	100.94±.63	4.95	<0.01*
	NBaf1	20	96.00	101.40	.3847	99.26±1.72		
	NBam2	15	100.00	103.04	.2996	101.61±1.16	2.76	<0.05*
	NBaf2	12	98.82	102.13	.3084	100.21±1.07		
	Variables	No.				Mean ± SD	t–value	p–value
	NBam1	16				100.94±.63	2.28	<0.05*
	NBam2	15				101.61±1.16		
	NBaf1	20				99.26±1.72	2.73	<0.05*
	NBaf2	12				100.21±1.07		

*significant difference**; **** Measurement of mean in millimeter unit for all types of variables; SD: standard deviation; SE: standard Error of means. SN: anterior cranial base; SBa: posterior cranial base; and NBa: depth of cranial base; t1 and t2: total sample (both male and female data) of first and second age group respectively; m1and m2: male data of first and second age group respectively; f1 and f2: female data of first and second age group respectively.

Table (2): Means and Standard deviations for Anterior facial heights of the total, male and female samples.

	Variables**	No.	Min.	Max.	SE	Mean** ± SD	*t*–value	*p*–value
Total Anterior Facial Height	TAt1	36	102.38	108.33	.3216	105.45±1.93	21.10	<0.01*
	TAt2	27	110.00	115.84	.3163	112.93±1.64		
	TAm1	16	105.29	108.33	.2829	106.89±1.13	6.97	<0.01*
	TAf1	20	102.38	106.91	.3630	104.27±1.62		
	TAm2	15	110.00	115.84	.4072	113.75±1.58	2.93	<0.05*
	TAf2	12	110.71	113.82	.3151	111.91±1.09		
	Variables	**No.**				**Mean ± SD**	***t*–value**	***p*–value**
	TAm1	16				106.89±1.13	12.62	<0.01*
	TAm2	15				113.75±1.58		
	TAf1	20				104.27±1.62	15.05	<0.01*
	TAf2	12				111.92±1.09		
Upper Anterior Facial Height	**Variables**	**No.**	**Min.**	**Max.**	**SE**	**Mean ± SD**	***t*–value**	***p*–value**
	UAt1	36	45.00	49.84	.2686	47.34±1.161	4.52	<0.01*
	UAt2	27	46.00	50.50	.2667	48.89±1. 39		
	UAm1	16	46.13	49.84	.3102	48.27±1.24	5.54	<0.01*
	UAf1	20	45.00	49.28	.3372	46.60±1.51		
	UAm2	15	46.00	50.50	.3419	49.49±1.32	2.48	<0.05*
	UAf2	12	46.34	49.82	.3158	48.13±1.09		
	Variables	**No.**				**Mean ± SD**	***t*–value**	***p*–value**
	UAm1	16				48.27±1.24	4.25	<0.01*
	UAm2	15				49.49±1.32		
	UAf1	20				46.60±1.51	3.55	<0.01*
	UAf2	12				48.13±1.10		
Lower Anterior Facial Height	**Variables**	**No.**	**Min.**	**Max.**	**SE**	**Mean ± SD**	***t*–value**	***p*–value**
	LAt1	36	57.16	63.78	.2799	60.32±1.68	16.14	<0.01*
	LAt2	27	63.10	69.47	.3526	66.72±1.83		
	LAm1	16	60.42	63.78	.1959	61.51±.78	5.00	<0.01*
	LAf1	20	57.16	61.49	.3592	59.37±1.61		
	LAm2	15	65.00	69.44	.3722	67.47±1.44	2.34	<0.05*
	LAf2	12	63.10	69.47	.5448	65.79±1.89		
	Variables	**No.**				**Mean ± SD**	***t*–value**	***p*–value**
	LAm1	16				61.51±.78	15.03	<0.01*
	LAm2	15				67.47±1.44		
	LAf1	20				59.37±1.61	12.16	<0.01*
	LAf2	12				65.79±1.89		

*Significant difference**;** **Measurement of mean in millimeter unit for all types of variables; SD: standard deviation; SE: standard Error of means. TA: total anterior facial height; UA: upper anterior facial height; LA: Lower anterior facial height; t1 and t2: total sample (both male and female data) of first and second age group respectively; m1and m2: male data of first and second age group respectively; f1 and f2: female data of first and second age group respectively.

Table (3): Means and Standard deviations for Posterior facial heights of the total, male and female samples.

	Variables**	No.	Min.	Max.	SE	Mean ± SD	t–value	p–value
Total Posterior Facial Height	TPt1	36	63.94	69.89	.3308	67.44±1.98	13.72	<0.01*
	TPt2	27	70.39	74.33	.2588	72.63±1.34		
	TPm1	16	66.56	69.89	.2216	68.86±.89	5.38	<0.01*
	TPf1	20	63.94	69.83	.4248	66.31±1.90		
	TPm2	15	71.00	74.15	.2775	73.16±1.07	2.34	<0.05*
	TPf2	12	70.39	74.33	.4005	71.96±1.39		
	Variables	**No.**				**Mean ± SD**	**t–value**	***p*–value**
	TPm1	16				68.86±.89	13.47	<0.01*
	TPm2	15				73.16±1.07		
	TPf1	20				66.31±1.90	11.74	<0.01*
	TPf2	12				71.96±1.39		
Upper Posterior Facial Height	**Variables**	**No.**	**Min.**	**Max.**	**SE**	**Mean ± SD**	**t–value**	***p*–value**
	UPt1	36	37.64	43.73	.2593	41.50±1.56	6.17	<0.01*
	UPt2	27	41.45	46.34	.2787	43.55±1.45		
	UPm1	16	41.43	43.73	.1826	42.34±.73	4.98	<0.01*
	UPf1	20	37.64	43.69	.3845	40.82±1.72		
	UPm2	15	42.00	46.34	.3740	44.13±1.45	2.24	<0.05*
	UPf2	12	41.45	45.02	.3211	42.82±1.11		
	Variables	**No.**				**Mean ± SD**	**t–value**	***p*–value**
	UPm1	16				42.34±.73	3.58	<0.05*
	UPm2	15				44.13±1.45		
	UPf1	20				40.82±1.72	5.01	<0.01*
	UPf2	12				42.82±1.11		
Lower Posterior Facial Height	**Variables**	**No.**	**Min.**	**Max.**	**SE**	**Mean ± SD**	**t–value**	***p*–value**
	LPt1	36	33.25	38.92	.2688	36.89±1.61	6.24	<0.01*
	LPt2	27	37.25	43.00	.3046	39.54±1.58		
	LPm1	16	35.89	38.87	.2191	37.79±.88	3.50	<0.01*
	LPf1	20	33.25	38.92	.3850	36.17±1.72		
	LPm2	15	37.25	43.00	.4290	40.11±1.66	2.25	<0.05*
	LPf2	12	37.35	41.18	.3427	38.83±1.19		
	Variables	**No.**				**Mean ± SD**	**t–value**	***p*–value**
	LPm1	16				37.79±.88	5.18	<0.001*
	LPm2	15				40.11±1.66		
	LPf1	20				36.17±1.72	4.93	<0.001*
	LPf2	12				38.83±1.19		

*Significant difference**; **** Measurement of mean in millimeter unit for all types of variables; SD: standard deviation; SE: standard Error of means; TP: total posterior facial height; UP: upper posterior facial height; LP: Lower posterior facial height; t1 and t2: total sample (both male and female data) of first and second age group respectively; m1and m2: male data of first and second age group respectively; f1 and f2: female data of first and second age group respectively.

The findings of the ratios of total posterior facial heights to the total anterior facial heights of the total, male and female samples were within the normal range. There were no significant differences of these ratios between age groups as in Table (4). The findings of Pearson's correlation coefficient analysis showed a significant positive correlation of total SN of G1with total SN of G2 and with anterior and posterior of upper, lower and total facial heights measurements of G1. While total SN of G2 showed a significant positive correlation with LA, UP, LP and TP of G1 and with UA, TA and TP of G2. While Male SN of G1 showed a significant negative correlation with LP of G2. On the other side, female SN of G1showed a significant positive correlation with (anterior and posterior) of (upper, lower and total) facial heights measurements of G1. Female SN of G2 showed a significant positive correlation with female UP of G1 only as in Table (5).

Table (4): the ratio of total posterior facial heights to total anterior facial heights of the total, male and female samples.

Variables*	**Mean ± SD**	***t*–value**	***p*–value**
TPt1/TAt1	63.97±1.56	1.38	> 0.05**
TPt2/TAt2	64.32±1.34		
TPm1/TAm1	64.42±0.88	1.19	> 0.05**
TPf1/TAf1	63.61±1.89		
TPm2/Tam2	64.34±1.43	1.14	> 0.05**
TPf2/TAf2	64.30±1.28		

*Variables mean were measured in millimeter unit; **Not significant; SD: standard deviation; TP: total posterior facial height; TA: total anterior facial height; t1 and t2: total sample (both male and female data) of first and second age group respectively; m1and m2: male data of first and second age group respectively; f1 and f2: female data of first and second age group respectively.

Table (5): Correlation Coefficient for Anterior Cranial Base versus Facial Heights

Correlation regarding total Measurements													
	UA1	**LA1**	**TA1**	**UP1**	**LP1**	**TP1**	**SNt2**	**UA2**	**LA2**	**TA2**	**UP2**	**LP2**	**TP2**
SNt1	.604**	.777**	.729**	.627**	.716**	.668**	.484*	.165	.148	.19 7	.127	.042	.195
SNt2	.290	.422*	.289	.413*	.479*	.462*		.389*	.322	.404*	.263	.051	.459*
Correlation regarding male group													
	UAm1	**LAm1**	**TAm1**	**UPm1**	**LPm1**	**TPm1**	**SNm2**	**UAm2**	**LAm2**	**TAm2**	**UPm2**	**LPm2**	**TPm2**
SNm1	.422	.046	.474	.317	-.341	.256	.055	.169	-.254	-.044	-.015	-.536*	-.013
SNm2	.405	.180	.062	.381	-.080	-.441		.430	-.129	.256	-.117	-.206	-.005
Correlation regarding Female group													
	UAf1	**LAf1**	**TAf1**	**UPf1**	**LPf1**	**TPf1**	**SNf2**	**UAf2**	**LAf2**	**TAf2**	**UPf2**	**LPf2**	**TPf2**
SNf1	.532*	.854**	.632**	.519*	.734**	.684**	.556	-.206	.442	-.143	.312	-.219	.369
SNf2	.275	.387	.422	.822**	.467	.373		-.364	.340	-.234	.115	-.433	.524

*Correlation is significant at the $p \le 0.05$; ** Correlation is significant at the $p \le 0.01$; SN: anterior cranial base; t1 and t2: total sample (both male and female data) of first and second age group respectively; m1and m2: male data of first and second age group respectively; f1 and f2: female data of first and second age group respectively.

On the other side the findings of Table (6) showed significant positive correlation of total SBa of G1with LA, TA and LP of G1, while total SBa of G2 showed a significant positive correlation with LA of G1 only and TA and UP of G2. The male SBa of G1 and G2 showed a non significant different positive and negative correlation with facial heights measurements. While, the female SBa of G1showed a significant negative correlation with female LA of G2 only.

Table (6): Correlation Coefficient for Posterior Cranial Base versus Facial Heights.

Correlation regarding total Measurements													
	UA1	**LA1**	**TA1**	**UP1**	**LP1**	**TP1**	**SNt2**	**UA2**	**LA2**	**TA2**	**UP2**	**LP2**	**TP2**
SBat1	.308	.335*	.525**	.282	.341*	.287	.064	-.055	-.143	.041	-.027	-.282	.063
SBat2	.263	.430*	.278	.199	.357	.274	□	.181	.368	.403*	.559**	.304	.333
Correlation regarding male group													
	UAm1	**LAm1**	**TAm1**	**UPm1**	**LPm1**	**TPm1**	**SNm2**	**UAm2**	**LAm2**	**TAm2**	**UPm2**	**LPm2**	**TPm2**
SBam1	-.085	.032	-.098	-.074	-.045	-.265	-.447	.216	.145	.170	-.101	.271	0.92
SBam2	.020	.196	-.198	-.397	-.164	.486	□	-.108	.167	-.001	.413	-.241	.204
Correlation regarding Female group													
	UAf1	**LAf1**	**TAf1**	**UPf1**	**LPf1**	**TPf1**	**SNf2**	**UAf2**	**LAf2**	**TAf2**	**UPf2**	**LPf2**	**TPf2**
SBaf1	-.026	-.175	.233	-.052	.039	-.234	.290	-.037	-.587*	-.275	.246	-.280	-.234
SBaf2	.411	.479	.546	.171	.425	.230	□	-.217	.232	.299	.436	.366	.054

*Correlation is significant at the $p \leq 0.05$; **Correlation is significant at the $p \leq 0.01$; SBa: posterior cranial base; t1 and t2: total sample (both male and female data) of first and second age group respectively; m1and m2: male data of first and second age group respectively; f1 and f2: female data of first and second age group respectively.

Lastly, the findings of Table (7) showed a significant positive correlation of total NBa of G1with all total anterior and posterior facial heights measurements of G1 and just LA of G2.

While total NBa of G2 showed a significant positive correlation with all total anterior and posterior facial heights measurements of G2.The male NBa of G1 showed a significant positive correlation with just male LP of G1. Finally female NBa of G1 showed a significant positive correlation with female UA, LA, TA, LP and TP of G1.

Table (7): Correlation Coefficient for Depth of Cranial Base versus Facial Heights

Correlation regarding total Measurements													
	UA1	**LA1**	**TA1**	**UP1**	**LP1**	**TP1**	**SNt2**	**UA2**	**LA2**	**TA2**	**UP2**	**LP2**	**TP2**
NBat1	.580**	.816**	.710**	.580**	.544**	.664**	.360	.265	.385*	.347	.357	.252	.351
NBat2	.193	.225	.234	.150	.317	.379	□	.381*	.588**	.609**	.501**	.412*	.553**
Correlation regarding male group													
	UAm1	**LAm1**	**TAm1**	**UPm1**	**LPm1**	**TPm1**	**SNm2**	**UAm2**	**LAm2**	**TAm2**	**UPm2**	**LPm2**	**TPm2**
NBam1	.235	.207	.229	.390	–.583*	.133	.284	.036	–.064	.337	–.229	–.185	–.100
NBam2	.120	.206	–.277	.044	–.053	–.018	□	.496	.411	.506	.478	.130	.374
Correlation regarding Female group													
	UAf1	**LAf1**	**TAf1**	**UPf1**	**LPf1**	**TPf1**	**SNf2**	**UAf2**	**LAf2**	**TAf2**	**UPf2**	**LPf2**	**TPf2**
NBaf1	.487*	.805**	.642**	.435	.520*	.543*	–.107	–.230	.273	–.041	.283	–.222	.091
NBaf2	.016	.004	–.021	.141	.104	.092	□	–.419	.564	.309	.088	.478	.461

*Correlation is significant at the $p \leq 0.05$; ** Correlation is significant at the $p \leq 0.01$ NBa: depth of cranial base; t1 and t2: total sample (both male and female data) of first and second age group respectively; m1andm2: male data of first and second age group respectively; f1 and f2: female data of first and second age group respectively.

DISCUSSION

The findings indicated that samples means of cranial base SN, SBa, NBa and facial heights linear measurements TA, UA, LA, TP, UP and LP of total, male and female types were significantly increase with age. These were agreed with study of Swennen[14] who found that cranial base–related landmarks such as Sella and Nasion are not absolutely fixed and can be changed during growth. Rakosi[18] determined the mean annual growth rate from age 1to 18 years, he showed about 3/4 mm of annual increase for S–N and various growth rates for different craniofacial measurements. Moldez[19] showed clinically the developmental processes, especially from puberty to adulthood, are major considerations in orthopedic, orthodontic, and orthognathic surgical planning.

Profitt[20] showed an increase in facial height and concomitant eruption of teeth continue throughout life, but the decline to adult level often does not occur until the early twenties in boys, somewhat earlier in girls. In addition within each age group, the means of male samples of these craniofacial measurements showed significant increases in comparison with those of females, these gender variations probably occur, because males grow at faster rates and over a longer period of time than females, this agreed with Henneberke[2] who found size differences between boys and girls were largely established before 7 years of age and increased after 10.5 years of age, this is especially for the distances S–N and N–Ba and length of the distance S–Ba increases slowly, but constantly, until early adulthood 17 years for both boys and girls. Marshall's[21] study on adolescent girls and Bishara's[22] longitudinal study between 5–25 years of age agreed with these gender variations. Also, the same findings were shown in studies of SN by Johannsdottir[23], Bishara[24], Wood worth[25], Afifi[26], Gasgoos[27] and Paulsson[28], also Sossa's study[29] on SN and SBa. Contrary to this Kerr[17] showed no significant differences in normal class I for NBa. But for N–ANS and S–PNS the results agreed with studies of Biggerstaff[30]. Study on Greek and American Caucasians by Argyropoulos[31] also agreed for N–ANS and S–PNS. Finally for N–ANS the findings agreed with Flyn's[32] study on American Black and White samples, Park's[33] study on Koreans and Bascifti[34].

The findings of the ratio of total posterior facial heights to total anterior facial heights of the total, male and female samples were within normal mean value and their comparisons showed no significant differences within or between age groups. The results agreed with the study of Rakosi[18] who reported that the mean value for posterior to anterior facial height is 62–65%. Issacson[35] reported that the changes related to the facial growth are also the result of differences in the anterior and posterior facial heights development.

The total SN of G1gave rise significant positive correlation with the total SN of G2. This accepted by Mitchel[3] and Sejrsen[36] as the sphenoccipital synchondrosis of cranial base does not close until approximately 20 years of age. So, it apparently the principal contributor of the elongation of the cranial base and as suture position anterior to TMJ, but posterior to anterior cranial fossa, so it influences significantly the overall facial skeletal pattern. In addition total SN of G1 showed a significant positive correlation with facial heights measurements TA, UA, LA, TP, UP and LP of G1. This approved by the study of Henneberke[2] where Growth of the anterior part of the cranial base is still necessary after the brain has virtually ceased to grow, at 7 to 8 years, to allow for facial growth. The greatest amount of which is still to come. Also the study of Afifi[26] showed that the SN significantly and positively influence UA and Kasai's[37] studied the variation in anterior cranial base was associated with the difference in anterior facial height and lower anterior facial height. Male SN of G1 showed a significant negative correlation with male LP of G2, while female SN of G2 showed a significant positive correlation with female UP of G1 only. This disagrees with Afifi's[26] study who showed SN significant and negative influence UP. The total SBa of G1gave rise significant positive correlation with LA, TA and LP of G1, while total SBa of G2 showed a significant positive correlation with LA of G1 and TA and UP of G2. On the other side female SBa of G1showed a significant negative correlation with female LA of G2 only. Hayashi[38] reported that this may be due to the anteroposterior position of the glenoid fossa in relation to the position of the maxilla. The length and inclination of the cranial base, which is related to Ba point, that might influence the position of the glenoid fossa. Therefore Andria[39] found an elongated cranial base would bring the glenoid fossa backward and place the mandible in retrusive position which make it rotate in downward and backward direction. The total NBa of G1gave rise to the significant positive correlation with facial heights measurements of G1 TA, UA, LA, TP, UP and LP and just LA of G2. While total NBa of G2 showed a significant positive correlation with TA, UA, LA, TP, UP and LP of G2 only. Such positive correlation may be attributed to the association between the elongation of cranial base length NBa and the underlying maxillary complex and the position of glenoid fossi that influences their articulating mandibular development[3].

CONCLUSIONS

It can be concluded from this study that proceeding from adolescent to adult age group showed a significant increase for means of all craniofacial linear measurement, whether cranial base of anterior, posterior and depth or facial heights of anterior and posterior and of upper, lower and total measurements. In addition, means of male samples of all these measurements gave rise to the significantly higher values than those of female one. The ratios of posterior to anterior facial heights for total, male and female were within normal range of both groups. There were a non significant differences between them. Finally, there was a significant positive correlation between means of anterior, posterior and depth of cranial base with means of most of upper, lower and total measurements of both anterior and posterior facial heights that may refer to positive interrelation between growth of cranial base and growth of facial heights structures.

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