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cranial base and its relation with jaws rotation in adult(CBCT scan study)

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□ ABSTRACT □

Facial structures, as well as their functions and correlations, have been extensively studied to expand the knowledge of craniofacial growth and development and to optimize growth predictions and proper indications of orthodontic and surgical treatments. The cranial base forms the boundaries of the craniofacial complex . The nasomaxillary complex is related to the anterior cranial base, whereas the mandible is related to its posterior portion. Therefore, the shape of the cranial base is an important factor in establishing the position of the maxilla and mandible. **Aim**: to investigate the relationship of cranial base with jaws rotation in adult orthodontically non-treated subjects using Cone-Beam Computed Tomography (CBCT) scan. **Materials and methods**: 27 Caucasian adult patients with no prior orthodontics treatment were selected (16 males, 11 females) .Cephalometric measurements determining type of jaw rotation were performed according to Björk's analysis. Pearson's Correlation Coefficient was calculated to investigate the relationship between the CBCT cranial base measurements and Cephalometric measurements determining type of jaw rotation . **Results**: This study reveal vary correlation between CBCT measurements of cranial base's dimensions and jaws rotation. **Conclusions**: There is no relationship between the cranial base morphology and Jaws rotation in adult orthodontically non-treated subjects.

Key Words: cranial base, jaw rotation ,CBCT.

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قاعدة القحف وعلاقتها باتجاه دوران الفكين لدى البالغين
(دراسة بواسطة التصوير الطبقي المحوري المخروطي)

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□ ملخّص □

درست البنى الوجهية و علاقتها مع البنى المجاورة بشكل كبير بهدف الحصول على معلومات واسعة عن عملية النمو والتطور التي تحدث في منطقة المركب القحفي الوجهي بحيث يمكننا من التنبؤ باتجاه النمو والتداخلات العلاجية الجراحية والتقويمية التي يمكن إجراؤها عند الحاجة .هذا ينتمي المركب الأنفي الفكي العلوي إلى قاعدة القحف الأمامية في حين يرتبط الفك السفلي مع الجزء الخلفي من قاعدة القحف ، لذلك تعتبر دراسة قاعدة القحف والتغيرات الشكلية التي تصيبها عاملا هاما في تحديد موقع كل من الفكين العلوي والسفلي.

هدف البحث : تحري وجود علاقة بين قاعدة القحف وبين ودوران الفكين لدى مرضى بالغين غير معالجين تقويميا باستخدام التصوير الطبقي المحوري المخروطي.

مواد وطرق البحث : اعتمادا على نتائج الدراسة الشعاعية ،بلغ عدد أفراد العينة 27 بالغاً (16 ذكور،11 أنثى) ممن لم يخضعوا لمعالجة تقويمية سابقة حيث تم انتقاؤهم من مرضى كانوا تلقائياً بصدد إجراء تصوير طبقي محوري مخروطي لأسباب لا تتعلق بمشاكل تقويمية ، تم إجراء دراسة سيفالومترية لتحديد اتجاه دوران الفكين وفق تحليل بيورك ، ومن ثم تحليل معامل ارتباط بيرسون لدراسة العلاقة بين قياسات قاعدة القحف المجراة على صور الطبقي المحوري المخروطي مع القياسات السيفالومترية المحددة لاتجاه دوران الفكين.

النتائج : أظهرت الدراسة وجود تنوع في الارتباط بين قياسات قاعدة القحف المجراة على صور الطبقي المحوري المخروطي مع القياسات الخاصة بنموذج دوران الفكين وفق تحليل بيورك.

الخلاصة : لم يلاحظ وجود علاقة بين مورفولوجيا قاعدة القحف مع نموذج دوران الفكين لدى المرضى البالغين الغير خاضعين لمعالجة تقويمية.

الكلمات المفتاحية : قاعدة القحف ، دوران الفكين ، تصوير طبقي محوري مخروطي.

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Introduction:

The cranial base plays a major role in the skull integration and function, which it can be considered as the oldest part of the vertebrate skull according to its phylogentic history (de Beer,1937)[1].

The cranial base connects the skull with the vertebral column and with the mandible, and in this role it is able to influence ontogenetic and interspecific patterns of variation in craniofacial morphology.[2]

Enlow and Hans proposed that differences in craniofacial morphology among living populations may be due to variation in the orientation of the cranial base and the facial cranium as a whole.[3]

Growth at the spheno-occipital synchondrosis increases the length of the cranial base, and as the maxillary complex lies beneath the anterior cranial fossa and the mandible articulates with the skull at the temporomandibular joint, which lies beneath the middle cranial fossa, the cranial base plays an important part in determining how the mandible and maxilla relate to each other.[4]

A computerized system for short-range facial growth prediction and treatment simulation, based on longitudinal observations of individual growth rate and growth direction over one or more years, has recently been developed by Bjorn-Jorgensen. ” Since this prediction further is based on skeletal age and includes the actual growth rotations of both mandible and maxilla, the method seems promising[5].

Björk and Skieller were first who describe upper and lower jaws rotations during human growth and development. They described the rotation in terms of either a forward or a backward direction. Forward rotation occurs when there is more vertical facial growth posteriorly than anteriorly. For backward rotation this pattern is reversed, relatively greater vertical growth occurring anteriorly compared to posteriorly. This vertical rotation of the maxillary complex is generally less than that seen in the mandible due to the contribution of middle cranial fossa growth [6,7,8].

The mandibular growth rotation is composed of a complex system of movements. In a recent report by Bjork and Skieller,the bony mandibular corpus and its soft-tissue covering, the matrix, have been considered as independent tissue systems capable of independent rotation. Both forward and backward rotation was divided into three components: total rotation, referring to the rotation of the mandibular corpus (implant line or reference line) relative to the anterior cranial base; matrix rotation, referring to the rotation of the soft-tissue matrix of the mandible (tangential line to lower mandibular border) relative to the anterior cranial base; and intramatrix rotation, referring to the rotation of the mandibular corpus within its soft-tissue matrix (or the difference between reference lines), expressing the amount of remodeling at the lower border of the mandible. Analyzed from longitudinal samples, the total rotation, which is the sum of matrix and intramatrix rotation, generally showed a steady increase with age, forward or backward, dependent on the case. On the contrary, the matrix rotation displayed a pendulum movement, forward or backward, in the same person during development. The intramatrix rotation, like the total rotation, increased steadily during growth, but with fluctuations counteracting the pendulum movements of the matrix.[6,7,8]

However, there is some evidence proposes that changes in the ratios of the cranial base can effect facial shape. This kind of interaction is predicted to be particularly important, and exclusive to humans, in which the upper face lies almost completely under the anterior cranial fossa [9,10,11,12,13].

In addition, because of the difficulties in surgical accessing to the cranial base, anatomical complexity, missing damaging in cranial base in many fossil and inability to observe it without using a special technology morphology (reviewed in Spoor et al., 2000) [14] ,a new analysis and techniques of imaging which quantitatively compare three-dimensional differences in form gave us more possibilities for studying growth and variation in complex regions such as the cranial. Finally, more information about the relationships between cranial base morphology and development of other parts of skull may help us to understand and resolve a number of important phylogenetic and behavioral issues throughout primate evolution [15,16,17,18].

Study Objectives:

The aim of this study is to investigate the relationship of cranial base with jaws rotation in adult orthodontically non-treated subjects using CBCT scan.

MATERIALS AND METHODS

-Subjects:

Sample's subjects were selected from adult patients who, any way, had to have a CBCT scan for non-neurological disorders purpose, but not especially for this study.

Criteria for selecting the subjects:

1) no supernumerary tooth / supplementary tooth / missing tooth / impacted tooth.
2) No history of trauma to the dento-facial structures.
4) Subjects must have fully erupted permanent dentition up to second molar tooth.
5) Exclusion criteria also were subjects with open bite, deep bite, closed bite.
6) Exclusion criteria also were subjects with congenital anomalies/ evident signs of neurological impairment and/or syndromes and/or craniofacial malformation.

fifty Caucasian adult subjects (28 males, 22 females) with no prior orthodontics treatment (16 to 27 years of age) mean age of 20.02 years: females average age was 20.15 years; males average age was 21.84 years) and they were submitted to select Normal type of lower jaw rotation (according to Björk) adult subjects; gender of subjects was randomly selected.

Sample* estimation*:

To determine the minimum sample size to be statistically significant, a pilot study was realized on 27 subjects (who were selected according to the criteria of selecting this study`s sample). It has been found that descriptive statistics results follow the normal distribution; therefore, determining the minimum sample size to be statistically significant was according to the following formula:

$$n = \frac{Z^2 . \sigma^2}{(e)^2}$$

(N): is the sample size ;.(z): is the value corresponding to a confidence level, estimated at 95% (Z = 2.58) at Confidence level of 99 % (i.e. significance level is 0.019), (σ): highest Standard Deviation value within the all the variables, (σ 9.72)

(e): Margin of error (maximum acceptable error in mean estimate) (e=5)

Thus:

$$n = \frac{(2.58)^2 (9.72)^2}{5^2} \approx 25.15$$

According to this pilot study, we determined that to get an exact estimate about the mean of patients' results, and the error in his estimate doesn't exceed 5 of the mean, with a significance level of 99% requires a sample size (n) of 26 patients as minimum, whereas the size of the sample in this study was n= 27.

- *CBCT study:*

CBCT scans were obtained in centric occlusion (maximum dental intercuspation); data were obtained using a 3D cone-beam volume scanner (SCANORA® 3D FOVs.). Used settings were as following: Standard scan mode with an imaging volume of 40 cmx13 cm, Scan speed of 9 s, Slice thickness 0.3 mm, 120 kV, 47mA.

-CBCT Cranial base measurements *:(Fig .1)*

CBCT points for evaluating the symmetry between hemibase of skull:

(C) crista galli [19,20] .

(S) sella turcica [19,20]

(X) xiphoid of the lesser wing of the sphenoid [19,20] .

(M) the internal acoustic meatus [19,20] .

(O) opisthion [19,20] .

−CBCT cranial base measurements :

−*Anterior cranial fossa (left side) :* anterior cranial base fossa(left side) was evaluated by using the angle between crista galli(C) – sella turcica (S) – xiphoid of the lesser wing of the sphenoid(X) angle (CSXL). Angle was read in degrees [19,20]

−.*Anterior cranial fossa (right side)* : anterior cranial base fossa(right side) was evaluated by using the angle between crista galli(C) – sella turcica (S) – xiphoid of the lesser wing of the sphenoid(X) angle (CSXR Angle was read in degrees [19,20] .

−*middle cranial fossa* (left side): middle cranial fossa(Left side) was evaluated by using angle between the xiphoid of the lesser wing of the sphenoid (X) – sella Turcica (S) –internal acoustic meatus(M) angle (XSML) . Angle was read in degrees [19,20] .

−*middle cranial fossa* (right side): middle cranial fossa (right side) was evaluated by using angle between the xiphoid of the lesser wing of the sphenoid (X) – sella Turcica (S) –internal acoustic meatus(M) angle (XSMR) . Angle was read in degrees [19,20] .

−*posterior cranial fossa (left side)* : posterior cranial fossa (left side) was evaluated by using the angle between the internal acoustic meatus (M) – sella Turcica (S) – opisthion(O) angle (MSOL) . Angle was read in degrees [19,20] .

posterior cranial fossa (right side) : posterior cranial fossa (right side) was evaluated by using the angle between the internal acoustic meatus (M) – sella Turcica (S) – opisthion(O) angle (MSOR) . Angle was read in degrees [19,20]

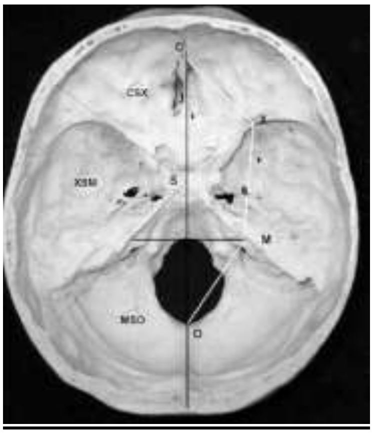

Figure 1 CBCT cranial base measurements

-lateral cephalometric analysis : (Fig.2)

U Oz Measurements from in vivo CBCT-generated cephalograms from Maxilim software were found to be similar to conventional images.[21]

Kumar [22] concluded that measurements from in vivo CBCT synthesized cephalograms are similar to those based on conventional radiographic images.

Chang-Seo Park [23] found that there were significant differences in one linear and three angular measurements between the conventional lateral and CBCT synthesized cephalometric radiographs.

In this study, lateral cephalometric analysis was performed by Kumar [22] method using the CBCT scans, which were obtained in centric occlusion.

All digital cephalometric measurements were performed by one and the same author (angles measurements in degrees).) digitally using the CBCT software. Linear CBCT digital measurements accurate to the nearest 0.01 mm. whereas angular measurements were accurate to the nearest 0.01 degrees.

Cephalometric evaluating Jaws Rotation was performed according to Björk and Skieller [6,7,8,24,25,26,27].

Planes and lines that have been used in this investigation according to Björk and Skieller [6 ,7 , 8 , 24 , 25 , 26 ,27].were formed by the following facial components:

-Nasion-Sella line (NSL): the plane of the anterior cranial base, it is a line drawn from nasion (N) to Sella (S).which it is the center of sella turcica

-Nasal Line (NL): it is the Palatal plane, a line drawn from the apex of the anterior nasal spine (ANS) to the apex of the posterior nasal spine (PNS).

-S-Ar: A line drawn from the center of sella turcica (S) to articular (Ar) (Ar is the point. of intersection of the dorsal contour of the articular processes of the mandibular condyle and the temporal bone).

-Ar-Go: A line drawn from articular (Ar) to Gonion (Go) (Go is the point of intersection between lines tangent, to the base and ramus of the mandible.

-ML: It is the Mandibular plane , formed by a line joining Gonion (Go) and Menton (Me) (Me is the lowest point of the outer border of the Mandibular symphysis).

Cephalometrics liner measurements:

that have been used in this investigation according to Björk and Skieller [6 ,7 , 8 , 24 , 25 , 26 ,27].

N-Me: Anterior facial height: A linear distance from Nasion to Menton.

S–Go: Posterior facial height: A linear distance from Sella to Gonion constructed.

Index I: This index is an expression of the proportion between the posterior and the anterior facial height. It represented Mandibular inclination. Index I calculated as following :

$$Index.I = \frac{S - Go}{N - Me} = 63.6 \pm 6.4$$

Cephalometrics angular measurements: that have been used in this investigation according to Björk and Skieller [6 ,7 , 8 , 24 , 25 , 26 ,27].

Saddle angle –S- (NSAr): an angle between anterior and posterior cranial base

Articular angle-Ar- (SArGo): an angle between posterior cranial base and ramus height. Björk called (Articular angle): the angle at the temporomandibular joint

Gonial angle –GO- (ArGoMe): an angle between lines tangent, to the base and ramus of the mandible.

Sum angles according to Björk (Björk ∑): sum of angles Saddle angle (S), Articular angle (Ar), and Gonial angle (Go).

Upper Gonial angle –Go1- (NGoAr) an angle Nasion point (N) , Gonion point (Go) and Articular point (Ar).

Lower Gonial angle – Go2- (NGoMe): an angle between Gonion constructed-Nasion line and is the Mandibular plane (ML).

NL-NSL: an angle between theanterior cranial base and Nasal Line (in some literatures Nasal Line it is Palatal plane).

ML-NSL: an angle between the anterior cranial base and ML

NL-ML: an angle between NL plane and ML Plane.

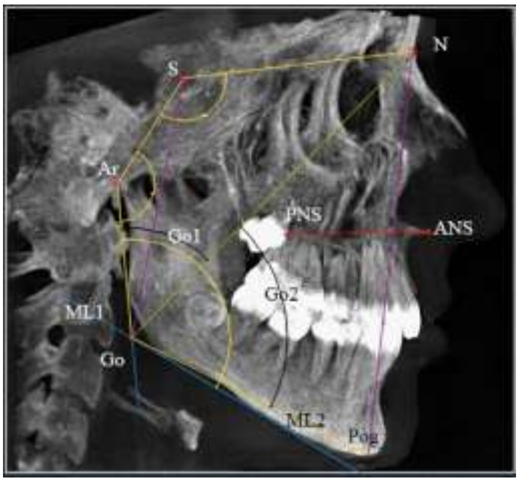

Figure 2 Cephalometrics points and measurements that have been used in this investigation according to Bjork & skieller analysis

Error of method:

All the CBCT measurements in this study are only angular measurements, all of it were repeated twice with a minimum interval of one month by the same investigator, the initial measurements and the repeated measurements were compared by using a paired t-test to check any systematic error. Random errors were also checked using the Dahlberg formula. The t-test at the 0.5 level did not show any significance. The random error for the measurements varied between 0.33 and 0.42.

Statistical method:

Using Microsoft Excel of Microsoft office 2013, Pearson's Correlation Coefficient was calculated to investigate the strength of the linear association of all of the CBCT measurements of cranial base with all cephalometrics measurements that have been used in this investigation with purpose of determining jaws rotation (according to Björk and Skieller)

RESULTS:

Descriptive statistics for cephalometric measurements estimated Jaws Rotation according to Björk and Skieller (regardless of gender, male, female) are shown in (Table1,Table2) .

Table 1: Descriptive statistics for cephalometric measurements estimated Jaws Rotation according to Björk and Skieller (regardless of gender, male, female)part 1.

Gender	*Descriptive statistics*	*NSL\ML*	*NSL\Nl*	*ML\NL*	*S-Go/N-Me*	*NGoMe*
♂&♀	Mean	31.50	8.04	23.45	67.08	71.87
	Standard Error	1.22	0.68	1.03	0.99	1.05
	Standard Deviation	6.36	3.54	5.33	5.16	5.47
	Sample Variance	40.49	12.56	28.42	26.64	29.97
	Count	27.00	27.00	27.00	27.00	27.00
♂	Mean	30.25	7.83	22.42	67.73	70.78
	Standard Error	1.68	1.11	1.33	1.43	1.22
	Standard Deviation	6.72	4.43	5.30	5.71	4.88
	Sample Variance	45.17	19.66	28.11	32.61	23.78
	Count	16.00	16.00	16.00	16.00	16.00
♀	Mean	33.31	8.36	24.95	66.15	73.46
	Standard Error	1.69	0.52	1.58	1.30	1.85
	Standard Deviation	5.60	1.73	5.25	4.33	6.13
	Sample Variance	31.41	2.98	27.53	18.72	37.59
	Count	11.00	11.00	11.00	11.00	11.00

Table 2: Descriptive statistics for cephalometric measurements estimated Jaws Rotation according to Björk and skieller(regardless of gender, male, female) part 2.

gender	*Descriptive statistics*	*NSAr*	*SArGo*	*ArGoMe*	Björk ∑	*NGoAr*
♂&♀	Mean	125.48	144.00	122.56	392.03	50.69
	Standard Error	0.92	1.61	1.67	1.24	1.15
	Standard Deviation	4.77	8.39	8.70	6.42	5.99
	Sample Variance	22.76	70.38	75.71	41.19	35.88
	Count	27.00	27.00	27.00	27.00	27.00
♂	Mean	126.04	144.34	120.73	391.10	49.96
	Standard Error	0.77	1.92	2.08	1.76	1.47
	Standard Deviation	3.07	7.66	8.32	7.02	5.87
	Sample Variance	9.42	58.75	69.22	49.30	34.50
	Count	16.00	16.00	16.00	16.00	16.00
♀	Mean	124.66	143.50	125.21	393.37	51.75
	Standard Error	2.00	2.93	2.70	1.65	1.89

	Standard Deviation	6.62	9.72	8.94	5.46	6.28
	Sample Variance	43.81	94.41	79.98	29.80	39.44
	Count	11.00	11.00	11.00	11.00	11.00

Descriptive statistics for CBCT of Atlas's dimensions (regardless of gender, male, female) are shown in (Table 3).

Table 3:Descriptive statistics for CBCT of cranial base dimensions (regardless of gender, male, female).

gender	*Descriptive statistics*	*CSXL*	*XL-S-ML*	*CSXR*	*XR-S-MR*	*ML-S-O1*	*MR-S-O2*
♂&♀	Mean	61.37	79.59	61.96	80.26	39.05	48.89
	Standard Error	0.98	1.28	0.98	1.30	0.86	11.16
	Standard Deviation	5.07	6.68	5.08	6.78	4.48	57.97
	Sample Variance	25.67	44.58	25.76	45.94	20.11	3360.97
	Count	27.00	27.00	27.00	27.00	27.00	27.00
♂	Mean	61.09	80.73	61.59	81.14	38.18	56.03
	Standard Error	1.29	1.73	1.30	1.60	0.86	18.82
	Standard Deviation	5.17	6.91	5.21	6.39	3.45	75.27
	Sample Variance	26.69	47.74	27.10	40.89	11.93	5665.58
	Count	16.00	16.00	16.00	16.00	16.00	16.00
♀	Mean	61.77	77.92	62.51	78.99	40.31	38.50
	Standard Error	1.55	1.89	1.53	2.24	1.69	1.91
	Standard Deviation	5.14	6.26	5.08	7.42	5.61	6.32
	Sample Variance	26.40	39.15	25.77	55.08	31.42	39.98
	Count	11.00	11.00	11.00	11.00	11.00	11.00

Pearson's Correlation test was performed to test the relationship between the CBCT measurements of cranial base's dimensions with all cephalometrics measurements that have been used in this investigation with purpose of determining jaws rotation according to Björk and Skieller (regardless of gender). Results of this test are presented in (Table4) .

Table4 : Pearson's Correlation test between CBCT measurements of Cranial base's dimensions and the cephalometric measurements determining jaws rotation (according to Björk and Skieller) within all subjects of the sample (regardless of gender).

♂&♀	*CSXL*	*XL-S-ML*	*CSXR*	*XR-S-MR*	*ML-S-O1*	*MR-S-O2*
NSL\ML	0.13▲	-0.24▼	0.26▲	-0.39▼	0.21▲	-0.07▼
NSL\Nl	0.31▲	-0.50▼▼	0.34▲	-0.33▼	0.39▲	-0.16▼
ML\NL	-0.05▼	0.05▲	0.08▲	-0.25▼	-0.01▼	0.02▲
S-Go/N-Me	-0.17▼	0.29▲	-0.40▼	0.45▲	-0.24▼	-0.04▼
NSAr	0.14▲	-0.01▼	0.29▲	-0.24▼	-0.15▼	0.07▲
SArGo	-0.39▼	0.12▲	-0.37▼	0.23▲	0.27▲	0.28▲

ArGoMe	0.18▲	-0.20▼	0.24▲	-0.30▼	0.09▲	0.11▲
Björk ∑	-0.16▼	-0.12▼	0.05▲	-0.29▼	0.36▲	0.57▲▲
NGoAr	0.35▲	-0.15▼	0.31▲	-0.26▼	-0.17▼	-0.21▼
NGoMe	0.02▲	-0.16▼	0.17▲	-0.36▼	0.22▲	-0.07▼

Where:

▲: Positive **weak** strength of correlation, ▲▲: Positive **Moderate** strength of correlation. ▼: Negative **weak** strength of correlation, ▼▼: Negative **Moderate** strength of correlation.

Within all sample's subjects, Pearson's Correlation test showed weak strength (with different direction) of correlation between CBCT measurements of cranial base's dimensions and the cephalometric measurements determining jaws rotation (according to Björk and Skieller). Exclusion was a moderate, negative correlation showed by: left middle cranial base(with NL-NSL) while it was moderate positive correlation between : right posterior cranial base (with Björk ∑).

Results of Pearson's Correlation test of the relationship between the CBCT measurements of cranial base's dimensions with all cephalometrics measurements that have been used in this investigation with purpose of determining jaws rotation according to Björk and Skieller within male subjects of the sample are presented in Table 5.

Table 5: Pearson's Correlation test between CBCT measurements of Cranial base's dimensions and the cephalometric measurements determining jaws rotation (according to Björk and Skieller) within male subjects of the sample.

♂	*CSXL*	*XL-S-ML*	*CSXR*	*XR-S-MR*	*ML-S-O1*	*MR-S-O2*
NSL\ML	-0.06▼	-0.20▼	0.14▲	-0.47▼	0.49▲	-0.03▼
NSL\Nl	0.38▲	-0.60▼▼	0.41▲	-0.36▼	0.62▲▲	-0.17▼
ML\NL	-0.40▼	0.25▲	-0.16▼	-0.30▼	0.10▲	0.09▲
S-Go/N-Me	0.00	0.33▲	-0.35▼	0.61▲▲	-0.66▼▼	-0.08▼
NSAr	0.08▲	-0.24▼	0.29▲	-0.60▼▼	0.36▲	0.12▲
SArGo	-0.43▼	0.41▲	-0.23▼	0.42▲	-0.19▼	0.37▲
ArGoMe	0.35▲	-0.44▼	0.29▲	-0.51▼▼	0.34▲	0.22▲
Björk ∑	-0.01▼	-0.17▼	0.22▲	-0.41▼	0.36▲	0.72▲▲
NGoAr	0.41▲	-0.41▼	0.18▲	-0.40▼	0.19▲	-0.24▼
NGoMe	-0.34▼	0.12▲	-0.01▼	-0.27▼	0.27▲	-0.06▼

Where:

▲: Positive **weak** strength of correlation, ▲▲: Positive **Moderate** strength of correlation.

▼: Negative **weak** strength of correlation, ▼▼: Negative **Moderate** strength of correlation.

Within male sample's subjects, Pearson's Correlation test showed weak strength (with different direction) of correlation between CBCT measurements of cranial base's dimensions and the cephalometric measurements determining jaws rotation (according to Björk and Skieller). Exclusion was a moderate, positive correlation showed by all of: right middle cranial base (S-Go\N-Me), left posterior cranial base(with NL-NSL) and right posterior cranial base (with Björk ∑) , While a moderate negative correlation showed by all of : left middle cranial base(with NL-NSL) , right middle cranial base (with NSAr and ArGoMe) and left posterior cranial base (with S-Go\N-Me).

Results of Pearson's Correlation test of the relationship between the CBCT measurements of cranial base's dimensions with all cephalometrics measurements that have been used in this investigation with purpose of determining jaws rotation according to Björk and Skieller within female subjects of the sample are presented in Table 6.

Table 6: Pearson's Correlation test between CBCT measurements of Cranial base's dimensions and the cephalometric measurements determining jaws rotation (according to Björk and Skieller) within female subjects of the sample.

♀	*CSXL*	*XL-S-ML*	*CSXR*	*XR-S-MR*	*ML-S-O1*	*MR-S-O2*
NSL\ML	0.44▲	-0.19▼	0.45▲	-0.22▼	-0.18▼	-0.10▼
NSL\Nl	0.09▲	-0.20▼	0.18▲	-0.35▼	0.14▲	0.26▲
ML\NL	0.43▲	-0.14▼	0.42▲	-0.12▼	-0.24▼	-0.20▼
S-Go/N-Me	-0.47▼	0.11▲	-0.49▼	0.17▲	0.31▲	0.19▲
NSAr	0.21▲	0.11▲	0.36▲	-0.09▼	-0.32▼	-0.18▼
SArGo	-0.35▼	-0.29▼	-0.55▼▼	0.02▲	0.64▲▲	0.42▲
ArGoMe	-0.09▼	0.29▲	0.13▲	0.02▲	-0.25▼	-0.13▼
Björk ∑	-0.50▼▼	0.10▲	-0.33▼	-0.04▼	0.35▲	0.32▲
NGoAr	0.24▲	0.32▲	0.48▲	-0.04▼	-0.58▼▼	-0.33▼
NGoMe	0.41▲	-0.42▼	0.35▲	-0.41▼	0.10▲	0.20▲

Where:

▲: Positive **weak** strength of correlation, ▲▲: Positive **Moderate** strength of correlation.

▼: Negative **weak** strength of correlation, ▼▼: Negative **Moderate** strength of correlation.

Cephalometric measurements determining jaws rotation in female subjects showed weak correlation in different direction with CBCT measurements of cranial base's dimensions, Exclusion was a moderate negative correlation showed by all of Left anterior cranial base (with Björk ∑),right anterior cranial base (with SArGo) and left posterior cranial base (with NGoAr) , while a moderate positive correlation was showed between : left posterior cranial base (with SArGo) **.**

DISCUSSION:

Analyzing the samples showed that the ratio of females samples larger than males, it was obvious that all subjects are young, this may be due to the fact that the Syrian society is considered youthful with higher females ratio compared with males ,also it"s noticeable that young people especially females more demanding for orthodontic treatment than males.

This study reveal vary correlation between CBCT measurements of cranial base's dimensions and jaws rotation according to the gender.

In details:

<u>Left anterior cranial base:</u> (CSXL) showed within sample's subjects regardless of gender (tab 4) and in male subjects (tab5) weak negative correlation with jaws rotations. This mean, in adult subjects and male subjects the left anterior cranial base has no

significant relationship with jaws rotation. Whereas in female subjects it showed more positive correlation (but almost weak) with jaws rotation (tab 6), except of negative moderate correlation with Björk ∑ .This mean ,in female subjects the left anterior cranial base has no significant relationship with jaw rotation.

Nevertheless, this study revealed that within female sample's subjects the more size increasing of the left anterior cranial base angle, the less of Björk ∑ and vice versa. And this was in contrary with Alice Chin [28] who found that the cranial base appears to have a certain correlation with the jaw base relationship and this maybe because he used traditional cephalometric and his study was just in sagital plan beside it was applied in Chinese population, and Kerr WJ [29] who found that the cranial base shape and size play an important part in determining the length of the maxilla, the position of condyle, and subsequently prognathism of the mandible and this also because his study was in sagital plane.

We cannot compare directly the results of the relationship between the cranial base dimensions and the jaws rotation with the previous researches because, these studies were a cephalometric, which mean, the measurements of such anatomical parts in the axial plane were not possible.

Left middle cranial base: (XL-S-ML) showed within sample's subjects regardless of gender (tab 4) and in male subjects (tab 5) weak negative correlation with jaws rotations except of negative moderate correlation (with NSL\NL). This mean, in adult subjects and male subjects the left middle cranial base has no significant relationship with jaws rotation. Nevertheless, this study revealed that within sample's subjects regardless of gender (tab 4) and in male subjects (tab 5), the more size increasing of the left middle cranial base angle, the less of NSL\NL angle and vice versa. Whereas in female subjects it showed more negative correlation (but almost weak) with jaws rotation (tab 6).

And this was in contrary of Alice Chin[28] who found that The cranial base appears to have a certain correlation with the jaw base relationship and this maybe because he used traditional cephlometric and his study was just in sagital plan beside his study was applied in Chinese population, and Kerr WJ[29] who found that the cranial base shape and size play an important part in determining the length of the maxilla, the position of condyle, and subsequently prognathism of the mandible and this also because his study was in sagital plane.

We cannot compare directly the results of the relationship between the cranial base dimensions and the jaws rotation with the previous researches because, these studies were a cephalometric, which mean; the measurements of such anatomical parts in the axial plane were not possible.

Right anterior cranial base: (CSXR) showed within sample's subjects regardless of gender (tab 4) and in male subjects (tab5) weak positive correlation with jaws rotations. This mean, in adult subjects and male subjects the right anterior cranial base has no significant relationship with jaws rotation. Whereas in female subjects it showed more positive correlation (but almost weak) with jaws rotation (tab 6), except of negative moderate correlation with SArGo angle .

This mean, in female subjects the right anterior cranial base has no significant relationship with jaw rotation.

Nevertheless, this study revealed that within female sample's subjects the more size increasing of the right anterior cranial base angle the less of SArGo angle and vice versa.

And this was in contrary of Alice Chin[28] who found that the cranial base appears to have a certain correlation with the jaw base relationship and this maybe because he used traditional cephlometric and his study was just in sagital plan beside it was applied in Chinese population and Kerr WJ[29] who found that the cranial base shape and size play an important part in determining the length of the maxilla, the position of condyle, and subsequently prognathism of the mandible and this also because his study was in sagital plane.

We cannot compare directly the results of the relationship between the cranial base dimensions and the jaws rotation with the previous researches, because these studies were a cephalometric, which mean; the measurements of such anatomical parts in the axial plane were not possible.

Right Middle cranial base: (XR-S-MR) showed within sample's subjects regardless of gender (tab 4) and in female subjects (tab 6) weak negative correlation with jaws rotations. This mean; in adult subjects and female subjects the right middle cranial base has no significant relationship with jaws rotation. Whereas in male subjects it showed more negative correlation (but almost weak) with jaws rotation (tab 5), except of negative moderate correlation with NSAr angle and ArGoMe angle while a moderate positive correlation has been found with S-Go\N-Me.

This mean; in male subjects the right middle cranial base has no significant relationship with jaw rotation. Nevertheless, this study revealed that within male sample's subjects the more size increasing of the right middle cranial base angle the less of NSAr angle and ArGoMe angle and the more of S-Go\N-Me vice versa. And this was in contrary of Alice Chin[28] who found that the cranial base appears to have a certain correlation with the jaw base relationship and this maybe because he used traditional cephlometric and his study was just in sagital plan beside it was applied in Chinese population and Kerr WJ[29] who found that the cranial base shape and size play an important part in determining the length of the maxilla, the position of condyle, and subsequently prognathism of the mandible and this also because his study was in sagittal plane.

We cannot compare directly the results of the relationship between the cranial base dimensions and the jaws rotation with the previous researches because, these studies were a cephalometric, which mean, the measurements of such anatomical parts in the axial plane were not possible.

Left posterior cranial base: (ML-S-O1) showed within sample's subjects regardless of gender (tab 4) weak positive correlation with jaws rotations. This mean; in adult subjects the left posterior cranial base has no significant relationship with jaws rotation. Whereas in male subjects it showed more positive correlation (but almost weak) with jaws rotation (tab 5), except of positive moderate correlation with NSL\NL angle while a moderate negative correlation was been found with S-Go\N-Me.

This mean, in male subjects the left posterior cranial base has no significant relationship with jaw rotation.

Nevertheless, this study revealed that within male sample's subjects the more size increasing of the left posterior cranial base angle the less of S-Go\N-Me index and the more of NSL\NL vice versa. While more weak positive correlation was found with in female subjects except a moderate negative correlation was been found with NGoAr angle and moderate positive correlation with SArGo angle.

This mean that in female subjects the more size increasing of the left posterior cranial base the less of NGoAr and the more the SArGo angle. And this was in contrary of Alice Chin[28] who found that the cranial base appears to have a certain correlation with the jaw base relationship and this maybe because he used traditional cephlometric and his study was just in sagital plan beside it was applied in Chinese population and Kerr WJ[29] who found that the cranial base shape and size play an important part in determining the length of the maxilla, the position of condyle, and subsequently prognathism of the mandible and this also because his study was in sagital plane.

We cannot compare directly the results of the relationship between the cranial base dimensions and the jaws rotation with the previous researches because, these studies were a cephalometric, which mean; the measurements of such anatomical parts in the axial plane were not possible.

<u>Right posterior cranial base:</u> (MR-S-O2) showed within sample's subjects regardless of gender (tab 4) weak positive correlation with jaws rotations except of moderate positive correlation with Björk $\sum$.

This mean; in adult subjects the right posterior cranial base has no significant relationship with jaws rotation. Whereas in male subjects it showed more positive correlation (but almost weak) with jaws rotation (tab 5), except of positive moderate correlation with Björk $\sum$ angle. This mean; in male subjects the right posterior posterior cranial base has no significant relationship with jaw rotation.

Nevertheless, this study revealed that within male sample's subjects the more size increasing of the right posterior cranial base angle, the more of Björk $\sum$ angle.

While more weak positive correlation was found with in female subjects, this mean that in female subjects the right posterior cranial base has no significant relationship with jaws rotation. And this was in contrary of Alice Chin[28] who found that the cranial base appears to have a certain correlation with the jaw base relationship and this maybe because he used traditional cephlometric and his study was just in sagital plan beside it was applied in Chinese population and Kerr WJ[29] who found that the cranial base shape and size play an important part in determining the length of the maxilla, the position of condyle, and subsequently prognathism of the mandible and this also because his study was in sagital plane.

We cannot compare directly the results of the relationship between the cranial base dimensions and the jaws rotation with the previous researches, because these studies were a cephalometric, which mean; the measurements of such anatomical parts in the axial plane were not possible.

CONCLUSION:

1- This study reveal vary correlation between CBCT measurements of cranial base's dimensions and jaws rotation according to the gender. CBCT measurements of cranial base's dimensions in adult male subjects (comparing with adult Female subjects) had more strong correlation (but vary in strength and direction) with jaws rotations.

2- This study revealed that within female sample's subjects the more size increasing of the left anterior cranial base angle, the less of Björk $\sum$ and vice versa.

3- This study revealed that within sample's subjects regardless of gender (tab 4) and in male subjects (tab5) the more size increasing of the left middle cranial base angle, the less of NSL\NL angle and vice versa.

4- This study revealed that within female sample's subjects the more size increasing of the right anterior cranial base angle the less of SArGo angle and vice versa.

5- This study revealed that within male sample's subjects the more size increasing of the right middle cranial base angle the less of NSAr angle and ArGoMe angle and the more of S-Go\N-Me vice versa.

6- This study revealed that within male sample's subjects the more size increasing of the left posterior cranial base angle, the less of S-Go\N-Me index and the more of NSL\NL vice versa.

7- This study revealed that within female subjects the more size increasing of the left posterior cranial base, the less of NGoAr and the more the SArGo angle.

8- This study revealed that within male sample's subjects the more size increasing of the right posterior cranial base angle, the more of Björk $\sum$ angle.

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