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The relationship of the temporomandibular joint disc thickness with facial growth according to Jarabak in adult male subjects (cephalometric and MRI study).

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□ ABSTRACT □

Mandible articulates with the cranium via the TMJ. All the components of the TMJ, including the TMJ disc, seem to be associated with altered characteristics of the craniofacial complex and its growth. However, the exact role of the TMJ disc thickness during the process of the facial growth is not clear yet.

Aim: The aim of this study is to investigate the association between the TMJ disc thickness and the facial growth determined according to Jarabak in adult male subjects with no clinical or MRI symptoms of Temporomandibular Joint Disorders.

Materials and methods: 20 males from 19 to 25 years of age, were selected as volunteers from pretreatment patients undergoing orthodontic evaluation at the Department of Orthodontics and Dentofacial Orthopedics at Tishreen University with no clinical or MRI symptoms of TMDs. Studying cephalometric growth was performed according to Jarabak. MRI study was performed of both TMJ for calculating disk thickness. *Pearson's Correlation Coefficient* was calculated to investigate the relationship between the TMJ disc thickness's measurements (left &right) and cephalometric measurements determined according to Jarabak's analysis for estimating facial growth.

Results: There was significant relationship between the measurements of TMJ disc thickness (left &right) and the cephalometric measurements determined according to Jarabak for estimating facial growth in adult male subjects with no clinical or MRIsymptoms of TMDs. Conclusions : There was no relationship between the measurements of TMJ disc thickness (both sides) with the cephalometric measurements determined according to Jarabak for estimating facial growth in adult male subjects with no clinical or MRIsymptoms of TMDs.

Key Words: Facial growth cephalometric evaluating by Jarabak ,TMJ disc thickness,male subjects with no clinical or MRI symptoms of TMDs.

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علاقة ثخانة قرص المفصل الفكي الصدغي مع النمو الوجهي حسب جاراباك لدى الأفراد الذكور البالغين (دراسة سيفالومترية وبالرنين المغناطيسي).

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□ ملخّص □

يتم فصل الفك السفلي مع الجمجمة بواسطة المفصل الفكي الصدغي، حيث ترتبط جميع مكونات المفصل الفكي الصدغي بما في ذلك القرص المفصلي مع الخصائص المتنوعة للمركب القحفي الوجهي ومع نموه، إلا إنه من غير الواضح بعد الدور الدقيق الذي تلعبه سماكة قرص المفصل الفكي الصدغي حلال علمية نمو الوجهي.

هدف البحث: دراسة العلاقة بين ثخانة قرص المفصل الفكي الصدغي مع النمو الوجهي الذي تم تحديده حسب جاراباك وذلك لدى أفراد من الذكور البالغين ممن ليس لديهم أعراض سريرية لإضطرابات المفصل الفكي الصدغي ولا على صور الرنين المغناطيسي.

مواد وطرق البحث: 20متطوع ذكر ممن لم يخضعوا لمعالجة تقويمية سابقة تم انتقاؤهم من المراجعين بهدف المعالجة التقويمية في قسم تقويم الأسنان والفكين بكلية طب الأسنان بجامعة تشرين تراوحت أعمارهم بين 19 و 25 سنة، المتطوعون المذكورون بدون أعراض سريرية لإضطرابات المفصل الفكي الصدغي ولا على صور الرنين المغناطيسي، لاحقاً تم إجراء دراسة سيفالومترية للنمو الوجهي وفق جاراباك، بالإضافة إلى دراسة صور المرنان للمفصل الفكي الصدغي بهدف قياس سماكة القرص المفصلي، تم إجراء تحليل معامل ارتباط بيرسون ما بين ثخانة قرص المفصل الفكي الصدغي (الأيمن والأيسر) مع القياسات السيفالومترية المحددة للنمو الوجهي حسب جاراباك.

النتائج: لم نجد إرتباطاً ذو دلالة إحصائية مابين ثخانة قرص المفصل الفكي الصدغي (الأيمن والأيسر) مع القياسات السيفالومترية المحددة للنمو الوجهي حسب جاراباك لدى أفراد من الذكور البالغين ممن ليس لديهم أعراض سريرية لإضطرابات المفصل الفكي الصدغي ولا على صور الرنين المغناطيسي.

الخلاصة: لا يوجد إرتباط ما بين مابين ثخانة قرص المفصل الفكي الصدغي (في كلا الجهتين) مع القياسات السيفالومترية المحددة للنمو الوجهي حسب جاراباك لدى أفراد من الذكور البالغين ممن ليس لديهم أعراض سريرية لإضطرابات المفصل الفكي الصدغي ولا على صور الرنين المغناطيسي.

الكلمات المفتاحية: ميلان المنحدر المفصلي،الميلان الأنسي الوحشي لمحاور القواطع، إطباق صنف أول هيكلي، مرضى تقويم بدون أعراض سريرية وشعاعية لإضطرابات المفصل الفكي الصدغي.

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Introduction

Amount and direction of the facial growth patterns significantly affect on the orthodontic plan of treatment and on the sequence of its steps, it can also greatly influence the therapeutic result.[1-7], it has been demonstrated that the face grows in a downward and forward direction via posterior growth and anterior displacement [8-15].and that the jaws have its own growth rotation [3-5, 16], through the use of tantalum pins in longitudinal radiographic studies, Björk and Skiellerwere able to demonstrate that the forward and downward displacement of the jaws also had a component of rotation owing to the pattern of surface remodeling.Such rotations were described as either forward or backward with sub-types for both [4, 5, 13, 17, 18]. Lavergne and Gasson found that the rotation of the mandible during growth is not only dependant on mandibular intrinsic factors, but also is strongly related to the intensity of growth of both jaws [19]. Based on Bjork's rotational growth researches, Jarabakmake more researches and suggested his own facial growth analysis where he use Height Ratio (FHR) of Jarabak (Jarabak quotient) asmain indicator to predict the type of facial growth [20].Based on the valuation of (FHR)Jarabakfound that growth could be divided into 3 main patterns and mentioned the high association between the varieties of the growth pattern with the meaning of the Downs's Y-axis[2120-23]:

−*NeutralGrowthPattern* (Normal).63%≤ FHR ≤ 59%.

−*Hyperdivergent GrowthPattern* (*Clockwise*): FHR <59%.

−*Hypodivergent GrowthPattern* (*Counterclockwise*). FHR >63%.

Jarabak mentioned the high association between the variety of the growth patterns and the meaning of the Downs's Y-axis [20].

Furthermore,Jarabakused Sumangle(SA)for evaluating facial growth rotation,Sumangle (SA) based on the summation of three facial angles: Saddle angle (N-S-AR) +Articular angle (S-AR-GO) + Gonial angle (AR-GO-ME). Should be noted that the term sumangle (SA) according to Björk was not used byBjörk in his original works, it has been attributed in the literature to Jarabak [2424].

Jarabakfound that according to (SA) the facial growth rotation could be divided into 3 main patterns [20]:

−*NeutralGrowthPattern*. SA=±396 6 degrees.

−*Posterior Growth Rotation* (*Hyperdivergence*)SA>402.degrees.

−*Anterior Growth Rotation* (*Hypordivergence*) SA < 390 degrees.

As Implant and histological studies have established that growth in mandibular length occurs primarily at the condyle [13, 14, 25], several studies evaluated the association between TMJ morphology and facial growth or craniofacial characteristics [13, 14, 2626-28], and because the mandible articulates with the cranium via the TMJ, all the component of the TMJ, including the TMJ disc status, seems to be associated with altered craniofacial characteristics [2929], Burke has correlated increased superior joint spaces to patients exhibiting a horizontal (counterclockwise) facial pattern [3030].Björkmentioned the effects of bilateral condylar hypoplasia on facial development in adolescents [3131];TMJ disc abnormality was associated with reduced forward growth of the maxillary and mandibular bodies and with reduced downward growth of the mandibular ramus [2929]. To our knowledge, no previous study has evaluated the association between the TMJ disc thickness and facial growth in adult male subjects with no clinical or MRI symptoms of Temporomandibular Joint Disorders.

Study Objectives

The aim of this research is to investigate the association between the TMJ disc thickness and the facial growth determined according to Jarabakin adult male subjects with no clinical or MRIsymptomsof Temporomandibular Joint Disorders.

MATERIALS AND METHODS

-*Subjects.*

To perform MRI study sample`s subjects (male only) were selected as volunteers from pretreatment patients undergoing orthodontic evaluation at the Department of Orthodontics and Dentofacial Orthopedics at Tishreen University.

The criteria for selecting the subjects were taken as follows:

1) No history of previous orthodontic treatment.

2) No history of trauma to the TMJ and dento-facial structures.

3)Each subject must have fully erupted permanent dentition up to second molar tooth.

4)No supernumerary tooth / supplementary tooth / missing tooth / impacted tooth.

5)Exclusion criteria were subjects with congenital anomalies/ syndromes and dental abrasion, premature occlusal contact points, functional mandibular deviations, posterior crossbites, and dentoskeletal asymmetries.

6)Exclusion criteria also were clinical symptoms of TMDs: TMJ sounds (clicking or crepitation), bruxism, range and deviation of mouth opening, tenderness to palpation of the joint and the masticatory muscles, deflection of the mandible during mouth opening or closing, and joint or muscle pain during mouth opening and protrusive or lateral mandibular movements.

7)Subjects who were diagnosed with any MRI symptoms of temporomandibular joint disorders were excluded.

Sample estimation

To determine the minimum sample size to be statistically significant, a pilot study was realized on 20 subject (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 99% (Z = 2.58) (i.e. significance level is 0.019), (σ): highest Standard Deviation value within the all the variables (σ= 8.19)

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

Thus:

$$n = \frac{(2.58)^2(8.19)^2}{5^2} \approx 17.8$$

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 does not exceed 5 of the mean, with a significance level of 99% requires a sample size (n) of 17.8 patients as minimum.

The size of this study's sample was 20males from 19 to 25 years of age, (mean age of 23.4 years).

-MRI study:

For evaluating the TMJ status for purpose of excluding patients with TMDs symptoms, and calculating disk thickness, techniques such as plain film radiography and computed tomography (CT) are limited becausethey involve exposing subjects to ionizing radiation and can only depict hard tissues, in our study we used Magnetic Resonance Imaging (MRI) because it's capable of producing an accurate portrayal of soft tissues (including the TMJ disc) within and around the joint without using radiation [**خطأ! وسيطة رمز تبديل غير معروفة.**32-34], therefore, MRI was chosen for our study.

In the closed-mouth,MRI axial scout images of TMJ were obtained first to direct the bilateral parasagittal MRI scans perpendicular to the long axis of the condylar axis.The bilateral parasagittal high-resolution MRI scans were made on both TMJsof all 20subjects, In each sequence 16 slices were acquired (8 parasagittal slices for each side.)using a General Electric 2010 HDX (1.5 tesla)Magnetic Resonance Imaging System in the closed-mouthusing a bilateral 3-inch TMJ surface coil receivers. MRI images were obtained in T1 using FSE PD-w sequences (TR 1500, TE 10 , FA 90°) with 2-mm parasagittal slices (2mm - 0.2 mm gap), Left and right TMJ were scanned separately, the total scanning time was approximately 40 minutes per subject.MRI serial sections were carefully investigated to evaluate the TMJ status with propose of excluding patients with TMDssymptoms (including disc displacement), disc thickness was measured on central section. The *maximal* thickness of the anterior and posterior bands and the *minimal* thickness ofthe intermediate zone were digitally measured(in mm)by one of the authors on the MRI digital images according to Wang [35] method (Fig 1)using the computer-assisted analysis of the MRI unit, digital measurements accurate to the nearest 0.01 mm.

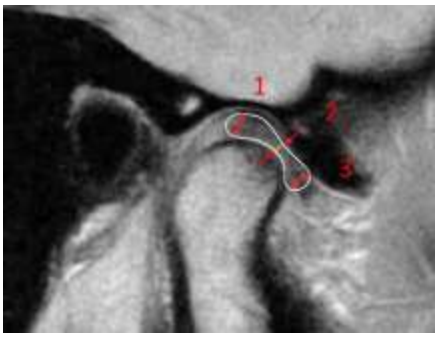

Figure 1measured thickness of posterior band of TMJ disc (1), measured thickness of intermediate zone of TMJ disc (2), measured thickness of anterior band of TMJ disc (3).

-lateral cephalometric analysis:

All lateral cephalometric radiographs were obtained in centric occlusion with the head in the natural head position and lips in the rest position lateral cephalograms has been scanned into JPEG digital format at 300 dpi and an 8-bit greyscale using scanner with 1600 dpi imaging 40 800 pixels per line and 48-bit color depth, and displayed on 15-inch LCD screen Notebook with resolution of 1366 X 768, high-pixel resolution with pixel pitch of 0.297 mm, a contrast ratio of 450:1, and a brightness of 250 cd/m 2, with 32-bit color. The digital tracing of the lateral cephalogramwas done using Dolphin Imaging Software Version 11 (Dolphin Imaging). All digital cephalometric measurements were performed by one of the authors (angles measurements in degrees, liner measurements in mm).

As the facial growth can be evaluated on the lateral cephalogramsusing Height Ratio (FHR) and sumangle (SA) according to Jarabak [20],the Height Ratio (FHR) of Jarabak, Saddle angle (N-S-AR), Articular angle (S-AR-GO), Gonial angle (AR-GO-ME), Upper Gonialangle (AR-GO-ME), Lower Gonialangle (N-GO-ME) and Jarabaksumangle (SA),weredetermined and calculated on the lateral cephalograms of the sample's subjects according to Jarabak's analysis [20- 23].

−Error of method:

Allcephalometricand MRI measurements were repeated twice with a minimum interval of one month by one of the authors, the initial measurements and the repeated measurements were compared by using a paired t-test to check any systematic error. The t-test at the 05 level did not show any statistical significance.

Statistical method:

Using Microsoft Excel of Microsoft office 2013, t-test was used to assess statistical significance between right and left measurements of TMJ disc thickness. Statistical significance was determined at the 5% levels of confidence. P-values smaller than .05 were considered statistically significant.No difference was found between the right and left measurements of TMJ disc thickness (Tab 1).

Table 1 P value of t-test between the left and right measurements of TMJ disc thickness

		α
P value of t-test between the left and right thickness of posterior band.	0.8	0.05
P value of t-test between the left and right thickness of intermediate zone.	0.57	0.05
P value of t-test between the left and right thickness of anterior band.	0.69	0.05

Using Microsoft Excel of Microsoft office 2013,Pearson's Correlation Coefficientwas calculatedto investigate:

1. The strength of a linear association (dependence) ofthe thickness of posterior band of the left and right TMJ discwith Height Ratio (FHR) of Jarabak, Saddle angle (N-S-AR), Articular angle (S-AR-GO), Gonial angle (AR-GO-ME), Upper Gonial angle (AR-GO-ME), Lower Gonial angle (N-GO-ME) and Jarabaksumangle (SA).
2. The strength of a linear association (dependence) of the thickness of intermediate zone of the left and right TMJ discwith Height Ratio (FHR) of Jarabak, Saddle angle (N-S-AR), Articular angle (S-AR-GO), Gonial angle (AR-GO-ME), Upper Gonial angle (AR-GO-ME), Lower Gonial angle (N-GO-ME) and Jarabaksumangle (SA).
3. The strength of a linear association (dependence) ofthe thickness of anterior band of the left and right TMJ discwith Height Ratio (FHR) of Jarabak, Saddle angle (N-S-AR), Articular angle (S-AR-GO), Gonial angle (AR-GO-ME), Upper Gonial angle (AR-GO-ME), Lower Gonial angle (N-GO-ME) and Jarabaksumangle (SA).

RESULTS

Descriptive statistics for left TMJ disc thickness's three measurements are presented in Table 2.

Table 2 Descriptive statistics for left TMJ disc thickness (in mm).

	thickness of left posterior band	thickness of left intermediate zone	thickness of left anterior band
Mean	2.50	1.21	2.42
Standard Deviation	0.53	0.32	0.58
Sample Variance	0.28	0.10	0.34
Count	20	20	20

Descriptive statistics for right TMJ disc thickness's three measurements are presented in Table 3.

Table 3 Descriptive statistics for right TMJ disc thickness (in mm).

	thickness of right posterior band	thickness of right intermediate zone	thickness of right anterior band
Mean	2.55	1.27	2.49
Standard Deviation	0.63	0.35	0.57
Sample Variance	0.39	0.12	0.32
Count	20	20	20

Descriptive statistics for cephalometric measurements determined according to Jarabak [20] for estimating facial growth of the sample's subjects are shown in Table 4.

Table 4 Descriptive statistics for cephalometric measurements estimated facial growth according to Jarabak.

	Mean	Standard Deviation	Sample Variance	Count
FHR	63.18	7.25	52.59	20
N-S-AR	124.72	7.60	57.83	20
S-AR-GO	145.14	7.03	49.36	20
AR-GO-ME	125.48	7.96	63.39	20
Upper Gonial angle	51.79	4.66	21.75	20
Lower Gonial angle	73.69	5.00	25.02	20
(SA).	395.34	8.19	67.11	20

Pearson's Correlation test was performed to test the relationship between the TMJ disc thickness's three measurements (left &right sides) with Height Ratio (FHR) of Jarabak, Saddle angle (N-S-AR), Articular angle (S-AR-GO), Gonial angle (AR-GO-ME), Upper Gonial angle (AR-GO-ME), Lower Gonial angle (N-GO-ME) and Jarabaksumangle (SA). Results of this test are presented in Table 5.

Table 5 Pearson's Correlation between the TMJ disc thickness's measurements (left &right) and cephalometric measurements determined according to Jarabak's analysis for estimating facial growth.

	thickness of posterior band (left)	thickness of posterior band (right)	thickness of intermediate zone (left)	thickness of intermediate zone (right)	thickness of anterior band (left)	thickness of anterior band (right)
FHR	0.23 ▲	0.48 ▲	-0.28 ▼	0.29 ▲	0.03 ▲	0.38 ▲
N-S-AR	0.04 ▲	0.19 ▲	0.08 ▲	-0.28 ▼	0.21 ▲	-0.11 ▼
S-AR-GO	-0.04 ▼	-0.03 ▼	-0.03 ▼	0.19 ▲	-0.25 ▼	0.34 ▲
AR-GO-ME	-0.26 ▼	-0.37 ▼	0.13 ▲	0.18 ▲	-0.03 ▼	-0.07 ▼
Upper Gonial angle	-0.16 ▼	-0.30 ▼	0.08 ▲	0.13 ▲	0.01 ▲	0.06 ▲
Lower Gonial angle	-0.27 ▼	-0.41 ▼	0.13 ▲	-0.19 ▼	-0.05 ▼	-0.19 ▼
(SA).	-0.26 ▼	-0.40 ▼	0.18 ▲	-0.29 ▼	-0.05 ▼	-0.30 ▼

▲: Positive **weak** correlation, ▼: Negative **weak** correlation.

Pearson's Correlation ravel that the strength of the correlation of each side of the measurements of TMJ disc thickness with the cephalometric measurements statically were always weak.

DISCUSSION

Several studies evaluated the association between TMJ disorders, and occlusal features [3636. 3737]or craniofacial characteristics [38]،Flores-Mir and Nebbestudied temporomandibular joint disc status and craniofacial growth، but his study sample included subjects with TMDs[29].

Other researches were interested in studying the TMJ disc thickness but in TMD patients precisely[35], Kurita performed Histologic comparison of the temporomandibular joint disk between patient with and without TMD [3939], Sun studied the effect off nonbalanced occlusion on the thickness of the temporomandibular joint disc in rats [40], all these researches mentioned that TMJ disc thickness and status can be affected by TMDsand malocclusion.

However, results of such researches cannot be compared with those of results of our study.

There was no statically difference between the left and right TMJ disc thickness (Tab 1) this was somehow corresponded the results previously reported by Chu [4141]. Anyway, the strength of the correlation of the right and left side of the measurements of TMJ disc thickness with the cephalometric measurements (determined according to Jarabak for estimating facial growth) were not the same (Tab 5). However this difference was statically unimportant, because the strength of the correlation of each side of the measurements of TMJ disc thickness with the cephalometric measurements statically were always weak (Tab 5). Weak strength mean there is no relationshipbetween the measurements of TMJ disc thickness (both sides) with the cephalometric measurements determined according to Jarabak for estimating facial growth in adult male subjects with no clinical or MRI symptoms of Temporomandibular Joint Disorders.

Comparing of the kind of the correlation of the right and left side of the measurements of TMJ disc thickness of both posterior band, and anterior band with the

cephalometric measurements showed that left and right thickness have the same kind (direction) of correlation with each cephalometric measurements (determined according to Jarabak for estimating facial growth) but with deferent correlation strength which was always weak (Tab 5).

Correlation's strength of left and right thickness of intermediate zone with the cephalometric measurements were always weak, it had the same kind (direction) only with AR-GO-ME and Upper Gonial angle.

CONCLUSION

1- No statically difference between left and right TMJ disc thickness in adult male subjects with no clinical or MRI symptoms of Temporomandibular Joint Disorders.

2- In adult male subjects with no clinical or MRI symptoms of Temporomandibular Joint Disorders, the strength of the correlation of the right and left side of the measurements of TMJ disc thickness with the cephalometric measurements (determined according to Jarabak for estimating facial growth) werenot the same and always weak.

3- No relationship between the measurements of TMJ disc thickness (both sides) with the cephalometric measurements determined according to Jarabak for estimating facial growth in adult male subjects with no clinical or MRI symptoms of TMDs.

However, the relationship between the measurements of TMJ disc thickness, remains variable, and is deserving of further study with big samples of both genders using MRI as a safe and accurate technique for this porous.

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