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McNamara's Cephalometric Analysis for Iraqi Population in Mosul City

(Normal values of McNamara analysis in Mosul city)

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Aims: The aims of this study are to establish normal values of Cl. I skeletal relationship and to assess (Cl. II & Cl. III skeletal relationships), in addition to the airway patency assessment based on McNamara's analysis in Mosul city for adult group of both genders.

Materials and Methods: This study was carried out on lateral cephalometric radiographs of total subjects (128) aged between (18-25) years old, Cl. I type (29 male and 26 female), Cl. II type (22 male and 19 female) and Cl. III type (17 male and 15 female), Steiner analysis (SNA, SNB and ANB angles) was used to differentiate subjects of Cl. I from those of Cl. II and Cl. III skeletal relationships. All lateral cephalometric radiographs were taken by (Kodak imagining 9000 C) machine, thirteen variables (angular and linear) of McNamara's analysis were analyzed digitally using (Kodak imagining software 9000 C).

Results and conclusions: The results of this study showed significant statistical differences among three skeletal patterns. In Cl. I skeletal pattern, there was no significant difference in the position of maxilla in relation to cranial base between males and females, males had significantly longer mandible and larger facial axis angle, no significant differences found in midfacial length, lower anterior facial height, and mandibular plane angle in both genders, also no significant differences found between anterioposterior position of upper and lower incisors in both genderes.

Key Words: McNamara's analysis, Cephalometric analysis , Digital radiography and analysis.

Introduction

One of the recent additions on cephalometric analysis is the McNamara analysis, this specific innovative analysis was introduced because a need had arisen for a method of analysis that is sensitive not only to the position of teeth within a given bone, but also to the relationship of jaw elements and cranial base structures one to another [1,2]. During the past years, clinical orthodontics has seen advent numerous orthognathic surgery procedures which allow three-dimensional repositioning of almost every bony structure in the facial region and of which presents new possibilities in the treatment of skeletal discrepancies [2]. This analysis is suitable not only for conventional orthodontic patients, but also for patients with skeletal discrepancies who are candidates for dentofacial orthopedics and orthognathic surgery [1,2]. McNamara analysis method is derived, in part, from the principles of the analyses of Ricketts and of Harvold , although other aspects, such as the construction of the nasion perpendicular and the point A vertical, are presumed to be original [2].

The advantages of using McNamara's analysis are summarized below:

1. This method depends primarily upon linear measurements rather than angles, so treatment planning (particularly for the orthognathic surgery) is made easier.
2. This method of analysis is more sensitive to vertical changes than is an analysis which relies on the ANB angle (Steiner analysis). The use of the ANB angle can be misleading, since it tends to be insensitive to the vertical component of jaw discrepancies.
3. This analytical procedure provides guidelines with respect to normally occurring growth increments.
4. The principles of this analysis are easily explained to non specialists.

This study aimed to:

1. Establishment of normal values of McNamara's cephalometric analysis for Cl. I skeletal relationship of Mosul city population.

2. Evaluation and comparison of Cl. I, Cl. II and Cl. III skeletal relations according to McNamara's analysis.
3. Estimation of gender differences between males and females in variables measured.
4. Assessment of airway patency depending on lateral cephalometric radiographs.

Materials and Methods

Total samples of (128 subjects) were selected from lateral cephalometric radiographs of patients age between (18-25 years), and divided as follows:

Cl. I skeletal pattern group : 55 subjects (29 males and 26 females).
Cl. II skeletal pattern group : 41 subjects (22 males and 19 females).
Cl. III skeletal pattern group : 32 subjects (17 males and 15 females).

According to Steiner analysis (ANB angle), the samples were classified into three saggital skeletal classes as follows [3,4]:

Cl. I : ANB = 0° – 4°.
Cl. II : ANB > 4°.
Cl. III : ANB < 0°.

Criteria of samples selection include: all the subjects and their parents were Iraqi in origin, born and lived in Mosul city, no history of orthodontic treatment, no TMJ problems, no history of oral habits, no facial asymmetry and full permanent dentition. Cases of open bite, cross bite and Cl. II division 2 malocclusions were excluded, all radiographs were taken in natural head posture while subjects close their teeth in centric occlusion and lips were in relaxed position [1] [5]. The lateral cephalometric radiographs were taken from patients attended to (ECHO specialized dental center) in Mosul city by using digital radiographic machine of high technology (Kodak imagining 9000 C), while cephalometric analysis performed by using computer program (Kodak imagining software 9000 C) specific for cephalometric analysis.

The landmarks and reference lines for McNamara analysis as follows[2], Fig.(1):

A- Maxilla to Cranial Base:

1. NA-P perpendicular (nasion perpendicular to point A): A vertical line is constructed perpendicular to the Frankfort horizontal and extended inferiorly from the nasion. The perpendicular distance is measured from point A to the nasion perpendicular.

2. SNA : The angle between the SN and NA lines.

B- Mandible to Maxilla:

1. Co-Gn (effective mandibular length): A line is measured from the condylion to the anatomic gnathion.
2. Co-A (effective midface length): A line is measured from the condylion to point A.
3. MMD (maxillomandibular differences): Effective mandibular length minus effective midface length.
4. ANS-Me (lower anterior face height): A line is measured from the anterior nasal spine to the menton.
5. MD-P (mandibular plane angle): The angle between the anatomic Frankfort plane and the mandibular plane, gonion-menton.
6. FA-A (facial axis angle): A line is constructed from the basion to the nasion (NBa). A second line (the facial axis) is constructed from the posterosuperior aspect of the pterygomaxillary fissure (PTM) to the constructed gnathion (the intersection of the facial plane and the mandibular plane). The facial axis angle is the angle between the NBa and the facial axis.

C- Mandible to Cranial Base:

1. Pg-N (pogonion to nasion perpendicular): The perpendicular distance is measured from the pogonion to the nasion perpendicular.

D- Dentition:

1. Ui-A (upper incisor to point A): Point A perpendicular is constructed parallel to the nasion perpendicular through point A. The perpendicular distance is measured from the most anterior surface of the upper incisor to the point A perpendicular, Fig.(2).
2. Li-APg (lower incisor to A-Pg line): The distance is measured form the facial surface of the lower incisor to the A-pogonion line.

E- Air way Analysis:

1. Upper pharynx (U-PHA): The upper pharyngeal width is measured from a point on the posterior outline of the soft palate to the closest point on the posterior pharyngeal wall.
2. Lower pharynx (L-PHA): Lower pharyngeal width is measured from the intersection of the posterior border of the tongue and the inferior border of the mandible to the closest point on the posterior pharyngeal wall.

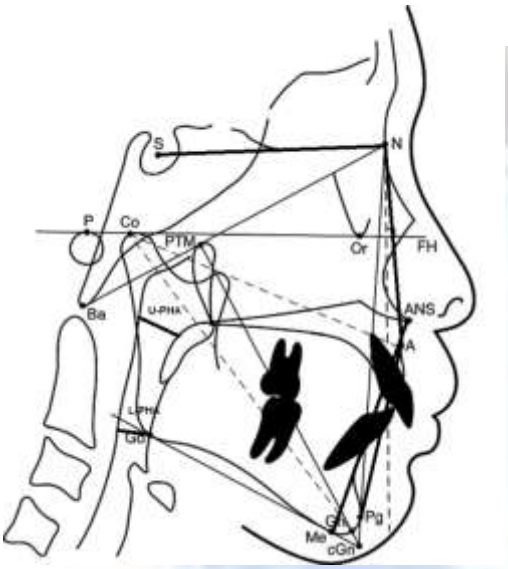

Fig.(1): Landmarks and Reference Lines of McNamara's Analysis

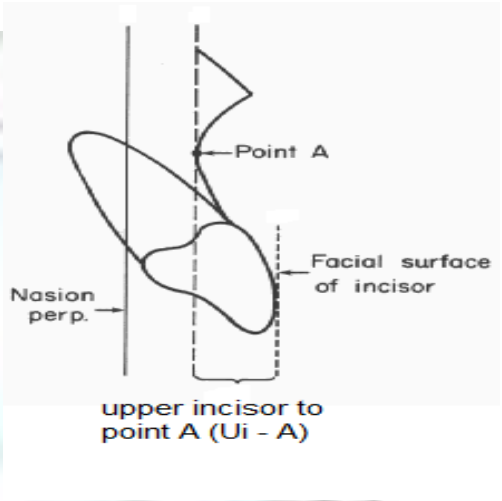

Fig.(2): Analysis of Upper Incisor to Point A

Results

Descriptive statistics of all variables of (Cl. I, Cl. II and Cl. III) skeletal pattern groups were shown in Tables (1,2 and 3 respectively).

Table (1): Descriptive Statistics For All Variables Of Cl. I Skeletal Relation Group

Variables	Sex	No.	Min.	Max.	Mean	SD
NA-P*	Male	29	- 2.05	- 3.15	- 2.5750	.41563
	Female	26	- 1.95	- 3.10	- 2.6750	.39843
SNA**	Male	29	81.80	84.50	83.0833	.90646
	Female	26	79.20	85.00	82.0000	1.96265
Co-Gn*	Male	29	105.80	117.20	111.532	3.66151
	Female	26	99.60	107.70	105.102	2.85937
Co-A*	Male	29	79.60	87.30	84.4167	2.56703
	Female	26	78.80	86.60	82.0167	3.26583
	Male	29	20.30	32.40	27.2800	4.34345

MMD*	Female	26	19.40	27.60	22.7500	3.58204
ANS-Me*	Male	29	59.40	68.30	63.6000	2.87193
	Female	26	58.70	64.20	61.4333	2.15654
MDP**	Male	29	29.10	34.10	31.5167	1.70460
	Female	26	27.10	35.20	30.7333	2.98775
FAA**	Male	29	.20	1.60	.9167	.53072
	Female	26	.12	.62	.3033	.17131
Pg-N*	Male	29	- 1.30	- 3.20	- 2.1667	.83106
	Female	26	- 2.70	- 6.60	- 4.1833	1.33179
Ui-A*	Male	29	3.90	6.90	5.4833	1.12324
	Female	26	3.60	6.70	5.1000	1.02372
Li-APg*	Male	29	2.70	4.90	3.6000	.72388
	Female	26	2.90	4.70	3.7833	.61779
U-PHA*	Male	29	9.50	14.50	12.1500	1.74900
	Female	26	10.30	12.80	11.5333	.84774
L-PHA*	Male	29	6.50	11.80	9.1667	1.70255
	Female	26	10.80	14.20	12.8333	1.11654

* Means measured in millimeters.

** Means measured in degree.

Table(2): Descriptive Statistics For All Variables Of Cl. II Skeletal Relation Group

Variables	Sex	No.	Min.	Max.	Mean	SD
NA-P*	Male	22	1.55	2.90	2.2333	.49766
	Female	19	2.10	3.30	2.7333	.39328
SNA**	Male	22	84.70	92.20	88.1500	2.46556
	Female	19	84.50	89.20	87.3000	2.00200
Co-Gn*	Male	22	103.70	112.50	107.402	2.85096
	Female	19	97.60	106.70	102.302	3.25515
Co-A*	Male	22	85.70	94.50	89.9833	3.11475
	Female	19	84.40	91.80	88.8	2.536
MMD*	Male	22	17.70	22.30	20.4167	1.53547
	Female	19	13.90	18.20	16.6667	1.56034
ANS-Me*	Male	22	62	66.7	64.283	1.80933
	Female	19	58.80	67.10	63.6333	2.96153
MDP**	Male	22	30.70	37.20	33.9833	2.15074
	Female	19	29.80	38.20	34.5917	3.49806
	Male	22	-.70	-.15	-.3767	.19356

FAA**	Female	19	-.82	-.32	-.60	.16959
Pg-N*	Male	22	- 5.10	- 10.30	- 7.3667	1.70372
	Female	19	- 6.10	- 11.40	- 8.6667	1.80960
Ui-A*	Male	22	7.00	10.10	8.4667	1.25167
	Female	19	5.30	9.30	7.6333	1.49622
Li-APg*	Male	22	1.40	3.90	2.8000	.83427
	Female	19	2.10	3.70	2.7833	.61128
U-PHA*	Male	22	10.80	16.30	13.3667	1.81181
	Female	19	10.80	15.40	13.2167	1.47975
L-PHA*	Male	22	7.80	11.40	9.8000	1.31149
	Female	19	6.40	10.20	8.4167	1.23194

* Means measured in millimeters.

** Means measured in degree.

Table(3): Descriptive Statistics For All Variables Of Cl. III Skeletal Relation Group

Variables	Sex	No.	Min.	Max.	Mean	SD
NA-P*	Male	17	- 3.3	- 2.0	- 2.5167	.44460
	Female	15	- 3.5	-2.1	- 2.8333	.58878
SNA**	Male	17	80.70	84.20	82.5500	1.24860
	Female	15	79.70	83.30	81.7667	1.20277
Co-Gn*	Male	17	113.40	124.80	118.782	3.77169
	Female	15	112.70	123.60	116.652	3.79724
Co-A*	Male	17	79.70	89.40	84.8667	3.15320
	Female	15	80.70	86.20	83.4667	1.99767
MMD*	Male	17	30.10	38.60	33.7500	2.89189
	Female	15	29.80	37.40	33.1833	2.55376
ANS-Me*	Male	17	57.40	63.30	60.5500	2.37466
	Female	15	52.90	61.20	56.3667	3.01507
MDP**	Male	17	25.80	33.80	31.0667	2.87518
	Female	15	24.60	33.30	29.9833	2.98625
FAA**	Male	17	.85	2.2	1.44	.50835
	Female	15	1.4	3.1	2.033	.60882
Pg-N*	Male	17	1.30	3.80	2.2500	.84794
	Female	15	1.70	4.30	2.5833	.90866
Ui-A*	Male	17	.80	3.20	2.2167	.81097
	Female	15	1.40	3.30	2.2167	.62423
	Male	17	3.2	5.7	4.666	.843

Li-APg*	Female	15	3.2	5.1	4.516	.6997
U-PHA*	Male	17	10.60	14.10	12.4167	1.16175
	Female	15	8.70	13.70	11.5650	1.80204
L-PHA*	Male	17	13.80	17.20	15.6000	1.10995
	Female	15	11.70	16.60	14.2833	1.80601

* Means measured in millimeters.

** Means measured in degree.

A-Relationship of Maxilla to Cranial Base:

Analysis of variance (ANOVA) showed significant differences at ($p \leq 0.001$) among variables (NA-P and SNA) measured in Cl. I, Cl. II and Cl. III groups in both males and females, as in Table (4), while Table (5) shows duncan's multiple range test of maxilla relation to cranial base.

Table (4): Analysis of Variance of Maxilla Relation to Cranial Base Among Cl. I, Cl. II and Cl. III groups of Both Genders

		Sum of Squares	df	Mean Square	F	Sig.
NA-P	Between Groups	211.905	5	42.381	198.946	.000
	Within Groups	6.391	122	.213		
	Total	218.296	127			
SNA	Between Groups	239.536	5	47.907	16.179	.000
	Within Groups	88.832	122	2.961		
	Total	328.367	127			

Table (5): Duncan's Multiple Range Test of Maxilla Relation to Cranial Base Among Cl. I, Cl. II and Cl. III Groups of Both Genders

Variables	Group	Number	Mean ± SE	Duncan's gp***
NA-P*	Cl. III F	15	-2.8333 ± 0.2404	A
	Cl. I F	26	-2.675 ± 0.1627	A
	Cl. I M	29	-2.575 ± 0.1697	A
	Cl. III M	17	-2.5167 ± 0.1815	A
	Cl. II M	22	2.2333 ± 0.2032	B
	Cl. II F	19	2.7333 ± 0.1606	B
SNA**	Cl. III F	15	81.7667 ± 0.491	A
	Cl. I F	26	82.000 ± 0.8012	A
	Cl. III M	17	82.5500 ± 0.5097	A
	Cl. I M	29	83.0833 ± 0.3701	A
	Cl. II F	19	87.300 ± 0.8173	B
	Cl. II M	22	88.1500 ± 1.006	B

* Means measured in millimeters.

** Means measured in degree.

***Different letters mean significant difference at $p \leq 0.05$.

B- Relationship Of Mandible To Maxilla:

Analysis of variance (ANOVA) showed significant differences (at $p \leq 0.001$) among variables (Co-Gn, Co-A, MMD, ANS-Me, MDP and FAA) measured in Cl. I, Cl. II and Cl. III groups in both males and females, as in Table (6), while Table (7) shows duncan's multiple range test of mandible relation to maxilla.

Table (6): Analysis of Variance of Mandible Relation to Maxilla in Cl. I, Cl. II and Cl. III Groups of Both Genders

		Sum of Squares	df	Mean Square	F	Sig.
Co-Gn	Between Groups	1279.562	5	255.912	22.269	.ooo
	Within Groups	344.757	122	11.492		
	Total	1624.319	127			
Co-A	Between Groups	292.696	5	58.539	7.422	.000
	Within Groups	236.632	122	7.888		
	Total	529.328	127			
MMD	Between Groups	1449.075	5	289.815	33.848	.000
	Within Groups	256.868	122	8.562		
	Total	1705.943	127			
ANS-Me	Between Groups	263.046	5	52.609	7.956	.000
	Within Groups	198.363	122	6.612		
	Total	416.409	127			
MDP	Between Groups	100.674	5	20.135	2.624	.000
	Within Groups	230.194	122	7.674		
	Total	330.867	127			
FAA	Between Groups	32.056	5	6.411	38.226	.000
	Within Groups	5.032	122	.168		
	Total	37.088	127			

Table (7): Duncan's Multiple Range Test of Mandible Relation to Maxilla in Cl. I, Cl. II and Cl. III Groups of Both Genders

variables	Group	Number	Mean ± SE	Duncan gp***
Co-Gn*	Cl. II F	19	102.3 ± 1.3289	A
	Cl. I F	26	105.1 ± 1.167	AB
	Cl. II M	22	107.4 ± 1.163	B
	Cl. I M	29	111.53 ± 1.494	C
	Cl. III F	15	116.65 ± 1.55	D
	Cl. III M	17	118.78 ± 1.539	D
	Cl. I F	26	82.01 ± 1.333	A

Co-A*	Cl. III F	15	83.46 ± 0.815	A
	Cl. I M	29	84.41 ± 1.048	A
	Cl. III M	17	84.86 ± 1.287	A
	Cl. II F	19	88.8 ± 1.0357	B
	Cl. II M	22	89.98 ± 1.271	B
MMD*	Cl. II F	19	16.6667 ± 0.637	A
	Cl. II M	22	20.416 ± 0.626	B
	Cl. I F	26	22.75 ± 1.462	B
	Cl. I M	29	27.28 ± 1.773	C
	Cl. III F	15	33.183 ± 1.042	D
	Cl. III M	17	33.75 ± 1.18	D
ANS-Me	Cl. III F	15	56.366 ± 1.23	A
	Cl. IIIM	17	60.55 ± 0.969	B
	Cl. I F	26	61.433 ± 0.88	BC
	Cl. I M	29	63.6 ± 1.172	BC
	Cl. II F	19	63.63 ± 1.209	BC
	Cl. II M	22	64.283 ± 0.738	C
MDP**	Cl. III F	15	29.98 ± 1.219	A
	Cl. I F	26	30.73 ± 1.219	AB
	Cl. III M	17	31.066 ± 1.173	ABC
	Cl. I M	29	31.516 ± 0.695	ABC
	Cl. II M	22	33.816 ± 0.878	BC
	Cl. II F	19	34.59 ± 1.428	C
FAA**	Cl. II F	19	-0.60 ± 0.0692	A
	Cl. II M	22	-0.37 ± 0.079	A
	Cl. I F	26	0.303 ± 0.069	B
	Cl. I M	29	0.916 ± 0.216	C
	Cl. III M	17	1.44 ± 0.207	D
	Cl. III F	15	2.033 ± 0.248	E

* Means measured in mms. ** Means measured in degree. ***Different letters mean significant difference at $p \leq 0.05$.

C- Relationship of Mandible to Cranial Base:

Analysis of variance (ANOVA) showed significant differences (at $p \leq 0.001$) in variable (Pg-N) measured in Cl. I, Cl. II and Cl. III groups in both males and females, as in Table(8), while Table (9) shows duncan's multiple range test of mandible relation to cranial base.

Table (8): Analysis of Variance of Mandible Relation to Cranial Base in Cl. I, Cl. II and Cl. III groups of Both Genders

		Sum of Squares	df	Mean Square	F	Sig.
Pg-N	Between Groups	671.856	5	134.371	79.148	.000
	Within Groups	50.932	122	1.698		
	Total	722.787	127			

Table (9): Duncan's Multiple Range Test of Mandible Relation to Cranial Base in Cl. I, Cl. II and Cl. III groups of Both Genders

variables	Group	Number	Mean ± SE	Duncan gp**
Pg-N*	Cl. II F	19	-8.66 ± 0.738	A
	Cl. II M	22	-7.36 ± 0.695	A
	Cl. I F	26	-4.18 ± 0.543	B
	Cl. I M	29	-2.16 ± 0.339	C
	Cl. III M	17	2.25 ± 0.346	D
	Cl. III F	15	2.58 ± 0.371	D

* Means measured in millimeters.
**Different letters mean significant difference at $p \leq 0.05$.

D- Analysis of Dentition :

Analysis of variance showed significant differences (at $p \leq 0.001$) between variables (Ui-A, Li-APg) measured in Cl. I, Cl. II and Cl. III groups in both males and females, as in Table (10), while Table (11) shows duncan's multiple range test of analysis of dentition.

Table (10): Analysis of Variance of Dentition Analysis in Cl. I, Cl. II and Cl. III Groups of Both Genders

		Sum of Squares	df	Mean Square	F	Sig.
Ui-A	Between Groups	206.891	5	41.378	34.663	.000
	Within Groups	35.812	122	1.194		
	Total	242.703	127			
Li-A Pg	Between Groups	19.609	5	3.922	7.410	.000
	Within Groups	15.878	122	.529		
	Total	35.488	127			

Table (11): Duncan's Multiple Range Test of Analysis of Dentition in Cl. I, Cl. II and Cl. III Subjects of Both Genders

Variables	Group	Number	Mean ± SE	Duncan gp**
Ui-A*	Cl. III M	17	2.216 ± 0.331	A
	Cl. III F	15	2.216 ± 0.254	A
	Cl. I F	26	5.1 ± 0.417	B
	Cl. I M	29	5.48 ± 0.458	B
	Cl. II F	19	7.63 ± 0.61	C
	Cl. II M	22	8.46 ± 0.511	C
Li- A Pg*	Cl. II F	19	2.78 ± 0.249	A
	Cl. II M	22	2.8 ± 0.34	A
	Cl. I M	29	3.6 ± 0.295	AB
	Cl. I F	26	3.78 ± 0.252	BC
	Cl. III F	15	4.51 ±0.285	C
	Cl. III M	17	4.66 ± 0.344	C

* Means measured in millimeters.
**Different letters mean significant difference at $p \leq 0.05$.

E- Airway Analysis (Airway Patency) :

Analysis of variance (ANOVA) showed no significant differences (at $p \leq 0.001$) in variable (U-PHA) and significant differences (at $p \leq 0.001$) in variable (L-PHA) measured in Cl. I, Cl. II and Cl. III groups in both males and females, as in Table(12), while Table (13) shows duncan's multiple range test of airway analysis.

Table (12): Analysis of Variance of Airway Analysis in Cl. I, Cl. II and Cl. III Groups of Both Genders

		Sum of Squares	df	Mean Square	F	Sig.
U-PHA	Between Groups	18.652	5	3.730	1.616	.186
	Within Groups	69.235	122	2.308		
	Total	87.887	127			
L-PHA	Between Groups	263.847	5	52.769	26.659	.000
	Within Groups	59.383	122	1.979		
	Total	323.230	127			

Table (13): Duncan's Multiple Range Test Of Airway Analysis in Cl. I, Cl. II and Cl. III Groups of Both Genders

Variables	Group	Number	Mean ± SE	Duncan gp**
U-PHA*	Cl. I F	26	11.53 ± 0.346	A
	Cl. III F	15	11.56 ± 0.735	A
	Cl. I M	29	12.15 ± 0.714	A
	Cl. III M	17	12.41 ± 0.474	A
	Cl. II F	19	13.21 ± 0.604	A

	Cl. II M	22	13.36 ± 0.739	A
L-PHA*	Cl. II F	19	8.41 ± 0.502	A
	Cl. I M	29	9.16 ± 0.695	A
	Cl. II M	22	9.8 ± 0.535	A
	Cl. I F	26	12.83 ± 0.455	B
	Cl. III F	15	14.28 ± 0.737	BC
	Cl. III M	17	15.6 ± 0.453	C

* Means measured in millimeters.
**Different letters mean significant difference at $p \leq 0.05$.

Discussion

This study aims to establish normal values of McNamara analysis of Mosul city population for both males and females of different skeletal relationships.

A-Relationship Of Maxilla To Cranial Base:

The results showed no significant differences in position of maxilla in relation to N perpendicular (NA-P distance) between males and females in Cl. I group, this agree with Nahidh [6] who studied McNamara cephalometric analysis among students in Baghdad city. In the other hand, significant differences present among Cl. II group and remaining groups, possibly due to anterior position of point (A) in prognathic maxilla present in Cl. II group.In case of angular position of maxilla relative to sella – nasion plane (SNA angle), no significant differences found between males and females in Cl. I group, this result disagree with Nahidh study [6]. While Cl. II group had largest mean which significantly differs from other groups due to anterior position of point A. The results also showed no significant differences in (SNA) angle means among Cl. I and Cl. III groups (males and females), this agree with Mohammed [7].

B- Relationship Of Mandible To Maxilla:

The results showed effective mandibular length (Co-Gn) had its largest mean in Cl. III group with no significant differences between males and females, this result may attributed to long mandible present in Cl. III than Cl. I and Cl. II skeletal patterns. Effective midfacial length (Co-A) had its largest mean in Cl. II group with no significant differences between males and females, this large midfacial length lead to maxillary prognathisim and Cl. II malocclusion. Also no significant differences found between males and females in Cl. I group, this result disagree with Nahidh [6] who found males had significantly greater midfacial length than females. Maxillomandibular difference had its significantly greatest mean in Cl. III group, while smallest mean present in Cl. II females subjects, this may be due to anterior rotation of mandibular growth pattern present in Cl. III subjects. Lower anterior facial height (ANS–Me) showed its statistically greatest values in males of Cl. II group, this agree with McNamara[2] who mentioned that if lower anterior facial height is increased, the mandible will appear to be more retrognathic and if this height decreased the mandible will appear to be more prognathic, the same can be conclude from work of Tagawa et al [8] who studied orthopedic correction of Cl. III malocclusion, he found that anterior and posterior vertical dimensions of the face increased significantly after treatment. The results showed Cl. III group had smallest lower facial height. No significant differences found between males and females in Cl. I group.

Mandibular plane angle (MD-P) showed its statistically greatest mean in Cl. II group (no significant differences between males and females), this may be due to short mandible lead to posterior rotation and more obtuse angle. Also results showed no significant differences between males and females subjects of Cl. I group. Facial axis angle (FA-A) had its statistically greatest degree in Cl. III females, while Cl. II males and females had statistically smallest degree (no significant differences between them). McNamara[2] mentioned that excessive vertical development is indicated by negative values (less than 90) while deficient vertical facial development is indicated by positive values (greater than 90), the angle measured is that formed by basion-PTM-gnathion and expected to have perpendicular relationship in a balanced face. In Cl. I group, males had statistically significant higher mean than females, this disagree with Nahidh[6] who found no significant differences present between males and females. In relationship of mandible to maxilla, three variables (Co-A, ANS-Me and MD-P) had no significant differences between males and females in Cl. I group, this agree with Wong et al [9] who studied

McNamara's cephalometric analysis in Chinese using three dimensional cone beam computerized tomography (CBCT) and found no significant differences between males and females for variables relating mandible to maxilla, the remaining three variables that had significant differences between males and females, males always had greater mean's value than females.

C- Relationship Of Mandible To Cranial Base:

Results showed Cl. III group had pogonion (Pg point) in front of nasion perpendicular in about 2 mm, a prognathic mandible with small mandibular plane angle lead to this forward pogonion position than normal Cl. I balanced face. While Cl. II group had negative reading (-7 to -8 mm) behind nasion perpendicular line, this result may caused by retrusive mandible and steep mandibular plane angle[(10)]. In Cl. I group, males had pogonion significantly anteriorly located in relation to nasion perpendicular than females.

D- Analysis Of Dentition:

Relation of upper incisors to the maxilla: results showed centrals of Cl. II group located more anteriorly in relation to vertical line drawn through point A (parallel to nasion perpendicular) than other groups, with no significant differences between males and females. This perhaps due to more anterior position of alveolar part of maxilla in relation to basal part present in Cl. II group, in the same time protruded centrals and flaring present usually in Cl. II skeletal pattern may be cause this results. In other hand, Cl. III group showed centrals positioned more posteriorly in relation to (A- perpendicular), this retruded centrals may occur due to anterior cross bite[(10)]. Relation of lower incisors to the mandible: results showed lower centrals in Cl. III group located more anteriorly than remaining groups in relation to the reference line (A- pogonion) with no significant differences between males and females, long protruded mandible and anterior reverse overjet may cause this proclination in lower incisors [(10)]. While Cl. II group (males and females) and Cl. I males showed posterior position of upper centrals in relation to (A-pogonion) line. In both variables of upper and lower incisors there were no significant differences in mean's value between males and females in Cl. I group.

E- Airway Analysis (Airway Patency) :

Results showed no significant differences among subjects of all groups in upper pharynx measurement, probably due to slight effect of maxilla and mandible on upper pharyngeal width, whoever more studies needed with a three dimensional representation since head film outline of the nasopharynx is a two dimensional representation of a three dimensional structure [(2)] . McNamara mentioned that 5 mm or less in the upper pharyngeal measurement is indicator of possible airway impairments, in this study majority of subjects had upper pharynx measurements located between (11-14) mm with no statistical differences between males and females. Lower pharynx measurements showed Cl. III males and females had widest lower pharyngeal width with no significant differences between them, while (Cl. II F, Cl. I M and Cl. II M) subjects had narrowest width. Cl. III group had long and / or anterior position mandible may lead to anterior tongue position and wide lower pharynx space, also anterior tongue position may happen due to habitual posture or enlargement of the tonsils. More accurate diagnosis about airway impairment can be made only by an otorhinolaryngologist during clinical examination.

Conclusions

- It would be preferable to use specific norms of McNamara analysis for Mosul city, results showed differences between this study and other studies in Iraq and world.
- In this study, majority of variables had no gender differences in Cl. I group, 8 variables out of 13 total variables measured had no significant differences between males and females.
- Three dimensional representation and clinical examination by otorhinolaryngologist are necessary for complete airway analysis.

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