

Photogrammetric analysis of facial soft tissue profile of Iraqi adults sample with Class II div.1 and Class III malocclusion: (A comparative study)

Salam R. Abd-Alwhab, B.D.S. ⁽¹⁾

Dhiaa J. Nasir, B.D.S., M.Sc. ⁽²⁾

ABSTRACT

Background: The purposes of this study were to determine the photogrammetric soft tissue facial profile measurements for Iraqi adults sample with class II div.1 and class III malocclusion using standardized photographic techniques and to verify the existence of possible gender differences.

Materials & methods: Seventy five Iraqi adult subjects, 50 class II div.1 malocclusion (24 males and 26 females), 25 class III malocclusion (14 males and 11 females), with an age range from 18-25 years.

Each individual was subjected to clinical examination and digital standardized right side photographic records were taken in the natural head position. The photographs were analyzed using AutoCAD program 2007 to measure the distances and angles used in the Soft Tissue Photogrammetric Analysis. Descriptive statistics was obtained for (29) measured variables for both genders and independent- samples t-test was performed to evaluate the genders difference.

Results & conclusions: The results indicated that: males had greater facial heights and lengths as well as greater prominences of facial dimensions in class II div.1 and class III malocclusion. The mean values of all angular variables were higher in females than males in the class II div.1 exceptin the following angular measurements: vertical nasal angle, angle of the nasal dorsum, cervicomental angle and angle of the lower facial third, with larger male dimensions in all linear measurements of the nasal, lips, chin area and facial analysis except upper facial third. Independent t-test showed statistically significant gender differences in the vertical nasal angle, nasal angle, nasofrontal angle; angle of the nasal dorsum; nasolabial angle, cervicomental angle, lower facial third, facial depth subnasal depth, nasal prominence, length of upper lip, length of lower lip of pogonion and height of chin, while in the class III malocclusion The mean values of all angular variables were higher in males than females except in the following: nasofrontal angle, nasal angle, nasolabial angle, mentolabial angle and angle of the middle facial third with larger male dimensions in all linear measurements of the facial, lips, chin area and nose analysis except the height of nasal tip, nasofrontal angle, nasal angle, nasolabial angle, angle of total convexity, lower facial third, upper lip, upper lip, prominence of lower lip, prominence of chin and height of chin. Independent t-test showed statistically significant gender differences.

Key words: photogrammetric analysis, soft tissue, class II div.1 or class III malocclusion. (J Bagh Coll Dentistry 2013; 25(4):134-144).

INTRODUCTION

Orthodontics has generally led the way in quantitative analysis of the soft tissue facial architecture, developing norms and longitudinal data, important equally to maxillofacial surgeons, plastic surgeons and to clinicians in prosthetic dentistry. Apart from the continuing attention received from clinical medicine, the face is now attracting serious study from diverse professions and is even becoming "big business" ^[1].

The faces were classified into straight, convex, and concave. This can be done with the patient either sitting upright or standing, but not reclining in a dental chair, and looking at the horizontal or a distant object, With the head in this position, note the relationship between two lines, one dropped from the bridge of the nose to the base of the upper lip, and a second one extending from that point downward to the chin. These line segments should form a nearly straight line. An angle between them indicates either profile convexity (upper jaw prominent relative to chin) or profile

(1)M.Sc. Student. Department of Orthodontics, College of Dentistry, Baghdad University.

(2)Assistant Professor. Department of Orthodontics, College of Dentistry, Baghdad University.

concavity (upper jaw behind chin). A convex profile therefore indicates a skeletal Class II jaw relationship, whereas a concave profile indicates a skeletal Class III jaws relationship ^[2]. Photogrammetry has existed within the profession of civil engineering, photogrammetry is a discipline devoted almost entirely for solving the problems of making accurate three-dimensional measurements from a pair of two-dimensional projected images ^[3].

Photographic analyses are inexpensive, yet do not expose the patient to potentially harmful radiation, and could provide better evaluation of the harmonic relationship among external craniofacial structures ^[4].

Facial photography is considered as a guide to the position of the teeth, and establishing of dimensions of two jaws relationship in three dimensions of vertical, antero-posterior and mediolateral ^[5].

However, the lack of morphologic balance among different skeletal components can be masked by compensatory soft tissue contribution ^[6]. Other advantages of camera imaging can be used to assess the symmetry of the face, profile

and facial types, serves as a record of the patient and to assess the progress of a case by comparing the preoperative and postoperative photographs [7].

The photographic analysis advantages are economic, safe because patient kept from radiation [8], but not considered as a specific diagnostic parameter but to evaluate facial appearance [9].

MATERIALS AND METHODS

Sample

The sample of this study was Iraqi adult people collected from orthodontic department, college of dentistry, University of Baghdad, 50 class II div.1 malocclusion (24 males and 26 females), 25 class III malocclusion (14 males and 11 females), with an age range from 18-25 years [10].

The sample was selected according to the following criteria:

1. Skeletal relation: Skeletal class II and class III relationship determined clinically by two fingers method [11].
2. Dental relation:
 - a) For Class II subjects: Class II div 1 malocclusion with overjet more than 4mm with bilateral class II buccal segment (molar or canine) [11,14].
 - b) For Class III subjects: Class III malocclusion with reverse overjet with bilateral class III buccal segment (molar or canine) [12].
3. Presence of full permanent dentition regardless the third molars.
4. No history of previous orthodontic treatment or orthognathic surgery.
5. No history of facial trauma or craniofacial disorder, such as cleft lips and palate.

Instruments and Equipment:

1. Sterilizer (Memmert, Germany).
2. Millimeter graded vernier (Dentaurum, Germany).
3. Measuring tape, used to measure the distance between subject and camera lens.
4. Dental mouth mirrors and kidney dish
5. Gloves for clinical examination.
6. Sharpened Pencil.
7. Professional digital camera (Canon EOS Rebel T3i, 18 Mega pixels, DSLR Camera, Japan).
8. Memory flashes (Transcend, 16 GB, Japan).
9. Analyzing equipment:
 - a. Pentium IV portable computer (FUJITSU).
 - b. Analyzing software (AutoCAD 2007).
10. Plump line with (0.5 kg) weight hung.
11. Mirror held on stand.

12. A blue background panel, 0.95 m width and 1.10 m length.
13. Connection cable between camera and primary flash.
14. Macro lens 100 mm, canon Japan. A 100 mm focal lens was selected in order to maintain the natural proportions [13].
15. A height adjustable tripod, used for fixing the camera in position.
16. Scale fixed by movable stand.
17. Primary flash and secondary flash respectively.

Methods

Each individual was seated on a dental chair and asked information about name, age, origin, history of facial trauma and previous orthodontic treatment. Then the subject was clinically examined (extra-orally and intra-orally).

Clinical Examination

1. Assessment of the anteroposterior skeletal relationships.
2. Assessment of the dental relationship.
3. Measurement of the Overjet.
4. Measurement of the Overbite.

Photographic set-up

The photographic set-up consisted of a tripod that held a digital camera, optical axis of the lens (Macro lens 100 mm) and a primary flash. The tripod controlled the stability and the correct height of the camera according to the subject's body height and ensured the correct horizontal position of the optical axis of the lens. A 100 mm focal lens was selected in order to maintain the natural proportions. A primary flash was attached to the tripod by a lateral arm, at a distance of 27 cm from the optical axis of the camera and 75 degrees from the upper right angle.

Another element of the set-up was a secondary flash, the secondary flash placed behind the subject. Its function was to light the background and eliminate undesirable shadows from the contours of the facial profile. A slave cell allowed synchronization with the main flash [14].

Photographic Records

The camera was used in its manual position; the shutter speed was 1/125 per second, and the opening of the aperture f/2.8. The subject was positioned on a line marked on the floor, and a vertical scale divided into millimeters was placed behind the subject, in front of the scale a plumb line; suspending a 0.5 kg weight was held by a thick black thread that indicated the True Vertical (TV) plane, on the photographs and 120 cm

in front of the subject and on the opposite side of the scale outside the frame there was a vertical mirror, the center of the camera lens was kept at approximately 110 cm away from the subject, this distance was standardized to obtain sharp image [15]. In order to take the records for right side of subject in NHP, the subjects were asked to walk a few steps, stand at rest facing the mirror, in front of the scale and look into their eyes in the mirror, and place their arms at their side. The lips should also be relaxed, adopting the position as they normally show during the day, before starting the recording procedure, the patients were instructed to remove the eye glasses and the operator ensured that the patient's forehead, neck, and ears were clearly visible during the recording [14] (fig.1).



Figure 1: Standardized right side profile in NHP

Photogrammetric analysis

The pictures after recording were imported to the AutoCAD program, and appeared in the master sheet, on which the points and planes were determined, and then the linear and angular soft tissue landmarks were marked and photogrammetric analysis was carried out. The expected magnification in the linear measurements was corrected by using a scale for each picture with appropriate equation (fig 2).

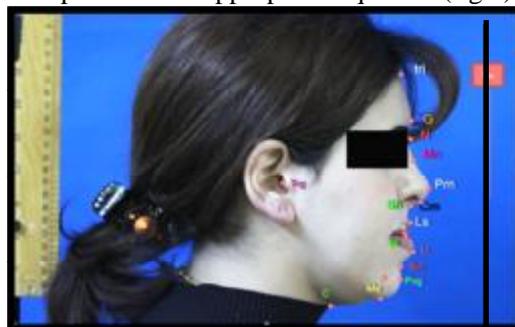


Figure 2: Photogrammetric analyses by AutoCAD program

Soft tissue landmarks

A) Facial landmarks: According to Fernandez Riveiro, [15] (fig.3).

1. Point **N'** (Nasion soft tissue): The point of

deepest concavity of the soft tissue contour of the root of the nose.

2. Point **Sn (subnasale)**: The point where the lower border of the nose meets the outer contour of the upper lip
3. Point **cm (Columella)**: The most anterior point on the columella of the nose.
4. Point **Pog'** (soft tissue pogonion): The most prominent point on the soft tissue contour of the chin.
5. Point **Li (labiale inferior)**: the point that indicates the mucocutaneous limit of the lower lip
6. Point **Ls (labiale superior)**: the point that indicates the mucocutaneous limit of the upper lip
7. Point **Me'** (Menton soft tissue): the most inferior point of the inferior edge of the chin.
8. Point **C (cervical)**: The intersection of lines tangent to neck and throat.
9. Point **tri (trichion)**: the sagittal midpoint of the forehead that borders the hairline.
10. Point **Mn (mid nasal)**: A pronounced convexity of the dorsal profile of the nose
11. Point **Trg (tragus)**: The most posterior point of the auricular tragus.
12. Point **Sm (supramentale)**: The point of greatest concavity in the midline of the lower lip between labraleinferius and menton.
13. Point **Stomion superior (Sts)**, the most inferior point of the upper lip.
14. Point **Stomion inferior (Sti)**, the most superior point of the lower lip.
15. Point **Prn** (Pronasale or Nasal tip): The most prominent point of the tip of the nose.
16. Point **G'** (glabella): The most anterior point of the middle line of the forehead



Figure 3: Landmarks used in this investigation. G', glabella; N', nasion; Mn', mid nasal; Prn, pronasal; Cm, columella; Sn, subnasal; Ls, labial superior; Li, labial inferior; Sm, supramentale; Pog' , pogonion; Me', menton; C', cervical; Trg, tragus; Stomion superior (Sts), Stomion inferior (Sti).

B) Facial planes and lines: According to **Fernandez Riveiro**^[15] (fig.4).

1. **True Vertical Line (TVL):** The line was placed through soft tissue nasion and was perpendicular to the true horizontal line.
2. **True horizontal line (THL):** The line was placed through soft tissue tragus and was perpendicular to the true vertical line.
3. **G'- Sn line:** The line between points glabella and subnasale
4. **Sn-columella line:** The line between points subnasale and the most anterior point on the columella of the nose.
5. **Sn- Ls line:** The line between points subnasale and the median point in the upper margin of the upper membranous lip.
6. **Sn- pog' line:** The line between points subnasale and soft tissue pogonion
7. **G'-N' line:** The line between points glabella and soft tissue nasion.
8. **N'-Prn line:** The line between points soft tissue nasion and the tip of the nose.
9. **N'-Mn line:** The line between points soft tissue nasion and mid nasal.
10. **Li-Sm line:** The line between point labiale inferior and supramentale.
11. **Sm-Pog' line:** The line between points supramentale and soft tissue pogonion.
12. **C-Me' line:** The line between points cervical and soft tissue menton.
13. **G'-Pog'line:** The line between points glabella and soft tissue pogonion.
14. **N'-Trag line:** The line between points soft tissue nasion and tragus.
15. **Trag-Sn line:** The line between points tragus and subnasale.
16. **Trag-Me' line:** The line between points tragus and soft tissue menton.
17. **Sn-Sm line (Canut's line):** The line between points subnasale and supramentale.
18. **G'-Prn line:** The line between points glabella and tip of the nose.
19. **Prn-Pog' line:** The line between points tip of the nose and soft tissue pogonion.
20. **N'-Pog' line:** The line between points soft tissue nasion and soft tissue pogonion.
21. **Mn-Prn line:** The line between points mid nasal and the tip of the nose.

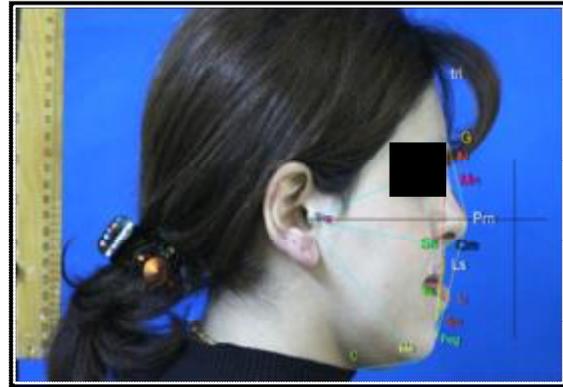


Figure 4: Facial planes and lines used in the study

Facial Measurements

A) Angular Measurements: According to **Fernandez Riveiro**^[14] (fig.5) and (fig.6).

1. G'-N'-Prn-: Nasofrontal angle.
2. Cm-Sn/N'-Prn: Nasal angle.
3. N'-Prn/TV (N): Vertical nasal angle.
4. N'-Mn-Prn: Angle of the nasal dorsum.
5. Cm-Sn-Ls: Nasolabial angle.
6. Li-Sm-Pog': Mentolabial angle.
7. C-Me'/G'-Pog': Cervicomental angle.
8. N'-Trg-Sn: Angle of the middle facial third.
9. Sn-Trg-Me': Angle of the lower facial third.
10. Sn-Sm/TH: Angle of the head position.
11. G'-Sn-Pog': Angle of the facial convexity.
12. G'-Prn-Pog': Angle of the total facial convexity.

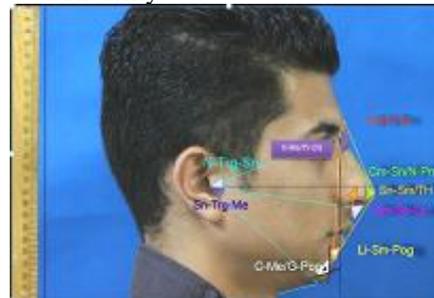


Figure 5: Angular measurements of the analysis



Figure 6: Angular parameters of the facial convexity. A) Angle of facial convexity. B) Angle of total facial convexity.

B) Linear Measurements: According to **Fernandez Riveiro**^[15].

The reference lines were: (fig.7).

1) TV through N. 2) TH through Trg.

1) Vertical Linear Measurements (parallel to TV line): (fig.8).

1. Upper facial third, **Tri-G'**.
2. Middle facial third, **G'-Sn**.
3. Lower facial third, **Sn-Me'**.
4. Nasal length, **N'-Sn**.
5. Length of upper lip, **Sn-Sts**.
6. Length of lower lip, **Sti-Sm**.
7. Height of chin, **Sm-Me'**.
8. Height of nasal tip, **Sn-Prn**.



Figure 7: The reference lines used in this study.

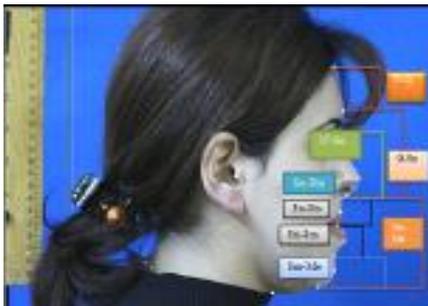


Figure 8: Vertical measurements (parallel to TV line).

2) Horizontal linear measurements (parallel to TH line): (fig.9).

1. Facial depth, **Trg-Sn**
2. Nasal prominence, **Prn /TV (N')**
3. Subnasal depth, **Sn /TV (N')**
4. Mentolabial depth, **Sm /TV (N')**
5. Prominence of upper lip, **Ls /TV (N')**
6. Prominence of lower lip, **Li /TV (N')**
7. Prominence of chin, **Pog /TV (N')**

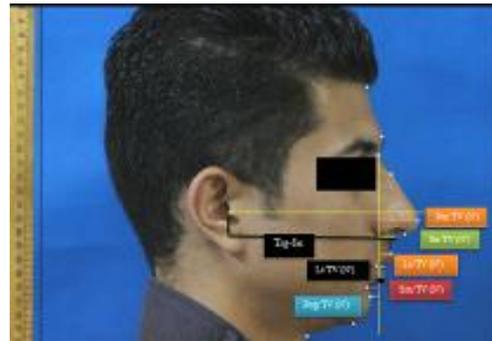


Figure 9: Horizontal measurements (parallel to TH line).

3) Canut's linear measurements (perpendicular to Sn-Sm line): (fig.10).

1. Canut's nasal prominence.
2. Canut's prominence of pogonion.



Figure 10: Measurements related to Sn-Sm line.

RESULTS

1. Photogrammetric Analysis of Angular Measurements in Degree (°)

Descriptive statistics and gender differences of angular measurements for CLII division 1:

The mean values for the measured angular measurements were:

1. Higher in males than females for: vertical nasal angle; angle of the nasal dorsum; cervicomental angle and angle of the lower facial third.
2. Higher in females than males for: nasofrontal angle; nasal angle; nasolabial angle; mentolabial angle; angle of the head; angle of the middle facial third; angle of facial convexity and angle of total facial convexity.

Independent *t*-test was done to find the gender differences regarding the measured angles as following: (table. 1).

A significant difference between genders regarding vertical nasal angle, nasal angle nasofrontal angle; angle of the nasal dorsum; nasolabial angle and cervicomental angle.

Table 1: Descriptive statistics and gender differences of Angular measurements for CL II division 1 (in degree °)

Variables	Male (N=24)		Female (N=26)		Gender Difference (d.f.=48)	
	Mean	S.D.	Mean	S.D.	t-test	p-value
G-n/prn	141.54	4.95	145.15	3.86	-2.89	0.006 **
Cm-Sn/N-prn	73.67	4.26	82.04	5.77	-5.79	0.000 ***
N'-prn/TV(N)	32.88	3.53	30.46	3.33	2.49	0.016 *
N-Mn/prn	173.63	4.64	168.77	6.56	3	0.004 **
Cm-Sn-LS	94.71	9.41	102.42	5.99	-3.49	0.001 ***
Li-Sm-pog	116.33	11.42	122.12	14.51	-1.56	0.126 (NS)
C-me/G'-pog	104.96	6.34	98.42	8.93	2.96	0.005 **
N'-trg/Sn	29.58	2.24	30.69	2.26	-1.74	0.088 (NS)
Sn-trg-Me	38.08	3.35	36.77	3.12	1.44	0.157 (NS)
Sn-Sm/TH	73.54	5.55	74.77	4.6	-0.85	0.397 (NS)
G'-Sn-pog	158.29	3.64	159.15	3.84	-0.81	0.42 (NS)
G-Prn-pog	133.96	4.75	135.5	4.9	-1.13	0.265 (NS)

Descriptive statistics and gender differences of angular measurements for CLIII

The mean values for the following angular measurement variables were as the following: (table.2)

- 1- Higher in females than males for nasofrontal angle; nasal angle; nasolabial angle; mentolabial angle and angle of the middle facial third.
- 2- Higher in males than females for vertical nasal angle; angle of the nasal

dorsum; cervicomental angle; angle of the lower facial third; angle of the head and angle of facial convexity; angle of total convexity.

Independent *t*-test was done to find the gender differences regarding the measured angles and as following:

A significant difference between genders in measured variables in: nasofrontal angle, nasal angle, nasolabial angle and angle of total convexity.

Table 2: Descriptive statistics and gender differences of Angular measurements for CLIII (in degree)

Variables	Male (N=14)		Female (N=11)		Gender Difference (d.f.=23)	
	Mean	S.D.	Mean	S.D.	t-test	p-value
G-n/prn	141.5	6.28	147.09	6.07	-2.24	0.035 *
cm-Sn/N-prn	78.07	6.57	83.36	5.1	-2.2	0.038 *
N'-prn/TV(N)	29.57	4.69	28.09	2.81	0.92	0.365 (NS)
N-Mn/prn	172.29	5.48	171.91	5.39	0.17	0.865 (NS)
Cm-Sn-LS	96.07	6.29	105.45	11.09	-2.67	0.014*
Li-Sm-pog	144.29	9.75	144.64	5.2	-0.11	0.915 (NS)
C-Me/G'-pog	98.64	3.93	97.45	6.44	0.57	0.574 (NS)
N'-trg/Sn	30.43	2.53	30.73	1.27	-0.36	0.725 (NS)
Sn-trg-Me	37.57	3.63	35	2.28	2.05	0.052 (NS)
Sn-Sm/TH	86.07	3	84	5.37	1.23	0.233 (NS)
G'-Sn-pog	174.64	4.31	172.64	3.96	1.2	0.243 (NS)
G-Prn-pog	146.43	4.29	141.45	5.22	2.62	0.015 **

2) Photogrammetric Analysis of Linear Measurements (in mm).**Descriptive statistics and gender differences of facial dimensions****Descriptive statistics and gender differences of facial dimensions for CL II division 1**

The mean values for the linear measurement variables are as the following: (table.3)

- 1- Higher in males than females for middle facial third **G'-Sn**, lower facial third **Sn-Me** and facial depth **Trg-Sn**.
- 2- Higher in females than males for upper facial third **Tri-G'**.

Independent *t*-test was done to find the gender differences regarding the measured dimensions and as following: **a-** A very highly significant

difference regarding lower facial third Sn-me and facial depth Trg-Sn.

Table 3: Descriptive statistics and gender differences of facial dimensions analysis for CLII div 1 (in mm)

Variables	Descriptive Statistics						Gender Difference (d.f.=48)	
	Total (N=50)		Male (N=24)		Female (N=26)		t-test	p-value
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Tri-G'	47.49	5.39	47.41	4.9	47.57	5.9	-0.1	0.919 (NS)
G'-Sn	65.91	4.07	66.51	4.26	65.35	3.89	1.01	0.319 (NS)
Sn-me	68.69	6.35	72.15	5.11	65.49	5.74	4.32	0.000 ***
Trg-Sn	104.53	6.92	108.31	6.12	101.03	5.75	4.34	0.000 ***

Descriptive statistics and gender differences of facial dimensions for CLIII: (table.4)

In general, the mean values of all measured variables were higher in males than females.

Independent t-test showed a highly significant difference regarding lower facial third Sn-me.

Table 4: Descriptive statistics and gender differences of facial dimensions analysis for CLIII (in mm)

Variables	Descriptive Statistics						Gender Difference (d.f.=23)	
	Total (N=25)		Male (N=14)		Female (N=11)		t-test	p-value
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Tri-G'	48.26	5.14	48.31	5.86	48.19	4.33	0.06	0.953 (NS)
G'-Sn	66.47	5.27	67.79	5.73	64.8	4.3	1.44	0.164 (NS)
Sn-me	71.04	5.31	74.57	3.74	66.55	3.15	5.69	0.000 ***
Trg-Sn	101.57	7.03	103.55	7.96	99.06	4.89	1.64	0.116 (NS)

Descriptive statistics and gender differences of nose analysis: Descriptive statistics and gender differences of nose analysis for CLII division 1: (table.5)

In general, the mean values of all measured variables are higher in males than females.

Independent t-test was showed a significant difference regarding subnasal depth Sn /TV (N) and nasal prominence Prn /TV (N).

Table 5: Descriptive statistics and gender differences of nose analysis for CLII div. 1 (in mm).

Variables	Descriptive Statistics						Gender Difference (d.f.=23)	
	Total (N=25)		Male (N=14)		Female (N=11)		t-test	p-value
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Tri-G'	48.26	5.14	48.31	5.86	48.19	4.33	0.06	0.953 (NS)
G'-Sn	66.47	5.27	67.79	5.73	64.8	4.3	1.44	0.164 (NS)
Sn-me	71.04	5.31	74.57	3.74	66.55	3.15	5.69	0.000 ***
Trg-Sn	101.57	7.03	103.55	7.96	99.06	4.89	1.64	0.116 (NS)

Descriptive statistics and gender differences of nose analysis for CLIII:

The mean values for the following linear measurement variables are as the following: all

measured variables higher in males except Sn-Prn (table.6), there is non-significant genders difference for all measured variables.

Table 6: Descriptive statistics and gender differences of nose analysis for CLIII (in mm)

Variables	Male (N=14)		Female (N=11)		Gender Difference (d.f.=23)	
	Mean	S.D.	Mean	S.D.	t-test	p-value
N'-Sn	54.53	2.71	52.77	3.43	1.44	0.164(NS)
Prn/Sn-Sm	14.65	1.59	14.19	1.28	0.78	0.45(NS)
Prn/Tv(n)	22.79	3.82	21.91	1.86	0.7	0.493(NS)
Sn-Prn	12.53	1.79	12.87	1.52	-0.51	0.618(NS)
Sn/Tv	7.3	3.87	5.95	2.74	0.98	0.339(NS)

Descriptive statistics and gender differences of the lips analysis:

Descriptive statistics and gender differences of the lips analysis for CLII division 1: (table.7)

The mean values of all measured variables were higher in males than females. Independent *t*-test was showed a highly significant difference regarding length of upper lip **Sn-Sts** and length of lower lip **Sti-Sm**.

Table 7: Descriptive statistics and gender differences of the lip analysis for CLII div. 1(in mm)

Variables	Descriptive Statistics						Gender Difference (d.f.=48)	
	Total (N=50)		Male (N=24)		Female (N=26)		t-test	p-value
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Sn-Sts	22.6	3.48	24.07	3.16	21.25	3.25	3.1	0.003 **
Sti-Sm	17.06	2.33	18.14	2.16	16.07	2.06	3.47	0.001 **
Ls / Tv	13.33	3.58	14.33	3.64	12.42	3.33	1.94	0.059(NS)
Li / Tv	7.8	4.88	7.82	5.26	7.77	4.6	0.03	0.974(NS)

Descriptive statistics and gender differences of the lip analysis for CLIII: (table.8).

In general, all males show larger mean values than females. Independent *t*-test was showed a

significant difference regarding upper lip **Ls / TV**, upper lip **Sn-Sts** and prominence of lower lip **Li / TV**.

Table 8: Descriptive statistics and gender differences of the lip analysis for CLIII

Variables	Descriptive Statistics						Gender Difference (d.f.=23)	
	Total (N=25)		Male (N=14)		Female (N=11)		t-test	p-value
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Sn-Sts	21.99	2.44	23.35	2.03	20.26	1.74	4.01	0.001 ***
Sti-Sm	20.13	2.21	20.52	2.01	19.63	2.45	1	0.328 (NS)
Ls / Tv	8.67	3.8	10.23	3.56	6.69	3.23	2.57	0.017 *
Li / Tv	9.9	4.82	11.71	4.38	7.59	4.5	2.31	0.03 *

Descriptive statistics and gender differences of the chin area:

Descriptive statistics and gender differences of the chin area for CLII div.1:(table.9).

The mean values of all measured variables are higher in males than females. Independent *t*-test showed a significant difference regarding Canut's prominence of pogonion **Pog/Sn-Sm** and height of chin **Sm-Me**.

Table 9: Descriptive statistics and gender differences of the chin area for CLII div.1 (in mm)

Variables	Male (N=24)		Female (N=26)		Gender Difference (d.f.=48)	
	Mean	S.D.	Mean	S.D.	t-test	p-value
Sm-Me	28.04	2.6	25.94	2.48	2.92	0.005 **
Sm / Tv	-0.60 [#]	4.71	-0.99 [#]	4.61	0.3	0.767 (NS)
Pog /Tv	1.31	5.66	-0.09 [#]	4.97	0.93	0.355 (NS)
Pog/Sn-Sm	4.67	2.34	3.26	1.91	2.35	0.023 *

the negative sign will indicate backward position in relation to TV

Descriptive statistics and gender differences of the chin area for CLIII:(table10).

The mean values of all measured variables are higher in males than females. Independent *t*-test

showed a significant difference regarding prominence of chin **Pog /TV (N)** and height of chin **Sm-Me**.

Table 10: Descriptive statistics and gender differences of the chin area for CLIII (in mm)

Variables	Descriptive Statistics						Gender Difference (d.f.=23)	
	Total (N=25)		Male (N=14)		Female (N=11)		t-test	p-value
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Sm-Me	28.77	3.56	30.72	2.77	26.27	2.88	3.92	0.001 **
Sm / Tv	5.2	4.25	6.22	4.67	3.91	3.43	1.37	0.183 (NS)
Pog /Tv	5.56	5.39	8.29	5.71	2.09	1.92	3.43	0.002 **
Pog/Sn-Sm	2.57	2.33	2.88	2.85	2.17	1.47	0.75	0.46 (NS)

DISCUSSION

An improvement in soft tissue facial esthetics in orthodontics is one of the most important goals of treatment. As a consequence, many studies have been performed to understand the different characteristics of soft tissue; these include the different architecture of soft tissue in different individuals, soft tissue profile for populations, the response of the soft tissue to orthodontic treatment, and the inter-relationship of the nose, chin, and lips in achieving harmonious soft tissue profiles.

It is important to mention that, this study is considered as the first and only photogrammetric research in Iraq that dealt with Class II and III patterns and there were even very little information all over the world regarding them, so the comparisons mostly were done depending on previous studies that were done in normal occlusion, the purpose of this research to establish average parameters that define the soft tissue facial profile of Class II div.1 and Class III of Iraqi orthodontic patients and compared them with other previous researches.

Two-dimensional photogrammetry has been used for evaluating the soft tissues in orthodontic treatment. The method was shown to be sufficiently reproducible since it was simple to achieve in a conventional setting, without the need for special equipment^[16].

Gender differences for class II div. 1:

Photogrammetric Analysis of Angular measurements (°).

- 1. The nasofrontal angle (G – N – Prn):** This angle showed statistically highly significant gender differences; with wider angle in females than males. This may indicate a more flattening of females forehead than males, this came to be in agreement with **Fernandez Riveiro**^[14]; **Aljanaby**^[17]; **Malkoç et al**,^[13], and in contrast to the findings of **Epker**^[18].
- 2. The nasal angle (Cm – Sn/N – Prn):** showed statistically very highly significant gender differences, the mean value was larger in females than males. This came in agreement with **Fernandez Riveiro**^[17] and disagreed with **Aljanaby**^[17] and **Malkoç et al**,^[13].
- 3. Vertical nasal (N- Prn/TV) angle:** demonstrated significant gender difference, it was wider in males than in females, this came in agreement with **Fernández-Riveiro et al**,^[14]; **Malkoç et al**,^[13] and **Aljanaby**^[17].
- 4. Nasal dorsum (N – Mn – Prn) angle:** Showed statistically significant gender difference with wider angles in males than in females, this came in agreement with

Fernández-Riveiro et al,^[14]; **Aljanaby**^[17] and **Malkoç et al**,^[13].

- 5. The Cervicomental angle (C-Me/G- Pog):** was larger in males than in females and showed highly significant differences between genders, this came to be in agreement with the findings of **Aljanaby**^[17] and **Malkoç et al**,^[13] however this came to be in contrast with the findings of **Fernández-Riveiro et al**,^[14].
- 6. The Nasolabial Angle (Cm – Sn – Ls):** Was significantly higher in females which coincided with the findings of **Milosevic et al**,^[19] and **Malkoç et al**,^[13], while disagreed with **Fernández-Riveiro et al**,^[14] and **Aljanaby**^[17].

Photogrammetric Analysis of Linear Measurements (In mm.):

1. Facial Analysis:

A. Facial heights: The lower facial third (**Sn-Me**) was larger in males than females and showed statistically highly significant and this came to be in agreement **Fernández-Riveiro et al**,^[15]; **Aljanaby**^[17].

B. Facial depth: Facial depth (**Trg-Sn**) was also larger in males than females and showed very highly significant this came to be in agreement with **Fernández-Riveiro et al**,^[15]; **Aljanaby**,^[17].

2. Nose Analysis:

When statistically analyzing the nose, the following were observed:

A) Nasal prominence (Prn/TV): Was larger in males than females, showed highly significant difference between them, this came to be in agreement with **Fernández-Riveiro et al**,^[15]; **Aljanaby**^[17].

B) Subnasal depth (Sn/TV through N'): Was significantly larger in males than females, this may be due to a more anterior position of (**Sn**) point in males than in females, this came to be in agreement with **Fernández-Riveiro et al**,^[15]; **Aljanaby**^[17].

3. Lip Analysis:

The mean values of (**Sn-Sts** and **Sti-Sm**) were significantly larger in males than in females, this came to be in agreement with (**Fernández-Riveiro et al**,^[15]; **Aljanaby**^[17]).

Both the upper lip (**Ls-TV**) and the lower lip (**Li-TV**) through (**N'**) showed statistically gender difference, and came to be in contrast to **Fernández-Riveiro et al**,^[15]; **Aljanaby**^[17].

4. Chin Area Analysis:

All the measurements of the chin area showed greater length and greater prominence in males than in females. (**Sm-Me**) and (**Pog/Sn-Sm**) showed significant difference, this came to be in agreement with **Fernández-Riveiro et al**,^[15]; **Aljanaby**^[17].

**Gender differences for CL III samples:
Photogrammetric Analysis of Angular
measurements (°).**

- 1. The Nasofrontal angle (G – N – Prn):** Was significantly larger in females than males, this came to be in agreement with **Fernández-Riveiro et al,**^[14]; **Malkoç et al,**^[13]; **Aljanaby**^[17].
- 2. The nasal angle (Cm – Sn/N – Prn):** Was significantly larger in females than males, this came to be in agreement with **Fernández-Riveiro et al,**^[14]; **Milosevic et al,**^[19] and disagreed with **Malkoç et al**^[13]; **Aljanaby**^[17].
- 3. The Nasolabial Angle (Cm – Sn – Ls):** Was larger in females than males (more acute in males) showed statistically significant gender differences and agreed with finding of **Milosevic et al,**^[19]; **Malkoç et al,**^[13], while disagreed with **Fernández-Riveiro et al,**^[14]; **Aljanaby,**^[17].
- 4. Total Facial Convexity (G–Prn–Pog):** Angle of total facial convexity showed statistically significant this finding disagreed with **Fernández-Riveiro et al,**^[13]; **Milosevic et al,**^[19]; **Malkoç et al,**^[13]; **Aljanaby,**^[17].

**Photogrammetric Analysis of Linear
Measurements (In mm.)**

1. Facial Analysis:

A) Facial heights (upper facial third; **Tri-G**, middle facial third; **G-Sn**, lower facial third; **Sn-Me**): Larger in males than in females, the lower facial third (**Sn-Me**) was statistically very highly significant and this came to be in agreement with **Fernández-Riveiro et al,**^[15]; **Aljanaby,**^[17].

B) Facial depth (Trg-Sn): was larger in males than in females, showed non-significant difference between genders, this came in contrast to **Fernández-Riveiro et al,**^[15]; **Aljanaby,**^[17].

2. Nose Analysis:

Prn/Sn-Sm was larger in males than in females, showed statistically non-significant difference, this came to be in agreement with **Aljanaby,**^[17] while disagreed with **Fernández-Riveiro et al,**^[15].

3. Lips Analysis:

The length of upper lip (**Sn-Sts**) in males was larger than in females with a highly significant difference between genders, came to be in agreement with **Fernández-Riveiro et al,**^[15]; **Aljanaby,**^[17]. Both the upper lip (**Ls-TV**) and the lower lip (**Li-TV**) through (**N'**) were larger in males than in females, showed statistically significant difference, and this came to be in agreement with **Fernández-Riveiro et al,**^[15]; **Aljanaby,**^[17].

4. Chin Area Analysis:

All the measurements of the chin area showed greater length and greater prominence in males than in females, **Sm-Me** and **Pog /Tv** showed significant difference, this came to be in agreement with **Fernández-Riveiro et al,**^[15]; **Aljanaby,**^[17].

**Comparison between CLII and CLI
Angular measurements:**

- 1. N-Prn/TV:** Was significantly larger in CLII than CLIII in both genders, this came to be in agreement with **Malkoç et al,**^[13].
- 2. Li-Sm/pog:** Was significantly smaller in CLII than CLIII in both genders which came to be in agreement with **Spalding,**^[20].
- 3. G-Sn/Pog, G-Prn/Pog and Sn-Sm/TH:** Were significantly larger in CLIII in both genders, came to be in agreement with **Proffit et al,**^[2].

Linear measurement:

- 1. Prn/Sn-Sm:** Was significantly larger in CLIII, came to be in agreement with **Proffit et al,**^[2].
- 2. Sn/TV:** Was significantly larger in CLII, came to be in agreement with **Kumar and Tamizharasi,**^[21].
- 3. Sti-Sm:** Was significantly larger in CLIII in both genders, came to be in agreement with **Ricketts et al,**^[22].
- 4. Ls-TV:** Was significantly larger in CLII in both genders **Proffit et al**^[2].
- 5. Sm-Tv:** Was significantly larger in CLIII than in CLII, came to be in agreement with **Powell and Humphrys**^[23].

REFERENCES

- Alcade RE, Jinno Ti, Orsini ME, Susakia, Sugiyarm, Matsumura T. Soft tissue cephalometric 1968 norms in Japanese adults. *Am J Dentofac Orthop*, 2000; 118: 84-9.
- Proffit WR, Fields HW, Sarver DM. Contemporary orthodontics. 4th ed. St. Louis: Mosby Elsevier; 2007.
- Baumrind S, Moffitt FH, Curry S. Three dimensional x-ray stereometry from paired coplanar images: A progress report. *Am J Orthod* 1983; 84(4): 292-312.
- Cox NH, Vander Linden FPGM. Facial harmony. *Am J Orthod* 1971; 60:175-83.
- Charles M, Heartwell JR, Arthur OR. Syllabus of complete dentures. 2nd ed. Lea and Febiger; 1975.
- Yogasawa F. Predicting soft tissue profile changes of concurrent with orthodontic treatment. *Angle Orthod* 1990; 60(3):199-206. (IVSL).
- Al-Mulla AA. Orthodontic the challenge. Iraq; 2009.
- Ferorrio VF, Sforza C, Miani A, Pizzini G. Craniofacial morphology by photographic evolution. *Am J Orthod* 1993; 104 (4): 327-36.
- Bishara SE. A textbook of Orthodontics. 1st ed. Philadelphia: W.B. Saunders Company; 2001.
- Kalha AS, Latif A, Govardhane SN. Soft tissue cephalometric norms in a South Indian ethnic population. *Am J Orthod Dentofac Orthop* 2008; 133(6): 876-81.

11. Foster TD. A textbook of orthodontics. 2nd ed. Oxford: Blackwell Scientific Publications; 1985.
12. Houston WJB. The analysis of errors in orthodontic measurements. *Am J Orthod* 1983; 83(5): 382-90.
13. Malkoc S, Demir A, Uysal T, Canbuldu N. Angular photogrammetric analysis of the soft tissue facial profile of Turkish adults. *Eur J Orthod* 2009; 31(2): 174-9. (IVSL).
14. Fernandez-Riveiro P, Smyth-Chamosa E, Suarez-Quintanilla D, Suarez-Cunqueiro M. Angular photogrammetric analysis of the soft tissue facial profile. *Eur J Orthod* 2003; 25(3): 393-9.
15. Fernandez Riveiro P, Quintanilla DS, Chamosa ES, Cunqueiro MF. Analysis of soft tissue facial profile *Am J Orthod Dentofac Orthop* 2002; 122(1): 59-66.
16. Muge A, Demet K, Ilken K. Reliability of reference distances used in photogrammetry. *Angle Orthod* 2010; 80 (4):670-7.
17. Aljanabi S. Photogrammetric Analysis of Facial Soft Tissue Profile of Iraqi Adults Sample with Class I normal occlusion. A master thesis, Department of Orthodontics, College of Dentistry, University of Baghdad, 2011.
18. Epker BN. Adjunctive esthetic surgery in the orthognathic surgery patient. In: McNamara JA, Carlson DS, Ferrara A, editors. *Esthetic and the treatment of facial form*. Vol 28. Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development; University of Michigan; 1992. p. 187-216.
19. Milosevic SA, Varga ML, Slaj M. Analysis of the soft tissue facial profile by means of angular measurements. *Eur J Orthod* 2008; 30(2) 135-40.
20. Spalding PM. Treatment of Class II malocclusion. [Cited by: Bishara SE. *A textbook of Orthodontics*. 1st ed. Philadelphia: W.B. Saunders Company; 2001. pp. 324- 375].
21. Kumar S, Tamizharasi. Reliability of Photographic Analysis in determining the malocclusion using different Facial profiles and Facial Types among college students in the age group of 19-24 years- A pilot study. *JIADS*. 2010; 1(3): 7-10.
22. Ricketts RM, Berch RW, Gugino CF, Hilgers JJ, Schulhof RJ. *Bioprogressive therapy*. Book 1. Rocky Mountain Orthodontics; 1980.
23. Powell N, Humphreys B. Proportion of esthetic face. New York: Thieme; 1984. p. 38.