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University of Baghdad
College of Dentistry

The accuracy of soft tissue analysis on the cephalometric radiograph

A Project Submitted to the

College of Dentistry, University of Baghdad, Department of Orthodontics in Partial Fulfillment for the Bachelor of Dental Surgery

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Certification of the Supervisor

I certify that this project entitled "**The accuracy of soft tissue analysis on the cephalometric radiograph**" was prepared by **Yousif mahdi majeed** under my Supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry

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Dedication

To the one who always was there

to the guardian that loved me unconditionally

to the shield that always guards me

to the sword that always

To the hero I've had yet never deserved

to the soul that still beats within my heart ... My father

may your soul rest in peace and I hope you're proud of me ... You wanted me to be here and here I am fulfilling your wish

Acknowledgment

First and foremost, praises and thanks to **Allah** Almighty for helping me fulfill my dream, for his blessings throughout my work to complete it successfully.

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subject	Abbreviations
DPT	Dental panoramic tomograph
LI	labrale inferius
NHP	natural head position
POG	Pogonion
SD	Standard deviation
SPSS	Statistical Package for Social Sciences
STCA	Soft tissue cephalometric analysis
TVL	true vertical line
USA	United States
T	T- test
BT	B point and true vertical line
UE	Upper lip- Eline
LE	Lower lip- E line
UT	Upper line- true vertical line
LT	Lower lip- true vertical line
US	Upper lip- S line
LS	Lower lip- S line
PogT	Pogonion -true vertical line
STD	Standard deviation
Sig.	Signification
DF	Degree of freedom
NS	Non-significant
HS	High- significant
Ceph	Cephalometric
photo	Photograph

Introduction

Over the last decades, facial attractiveness has gained much relevance in orthodontic diagnosis and treatment plan decision making. Soft-tissue cephalometric analysis is considered a reliable diagnostic method not only for orthognathic surgeons but also for orthodontists because **(Durão *et al.*, 2013):**

(1) It provides information about sagittal and vertical craniofacial pattern and facial harmony.

(2) It includes a deepened assessment of soft-tissue profile characteristics.

Both skeletal and soft-tissue cephalometric analyses are performed on lateral cephalograms **(Cordasco *et al.*, 2013).** Many parameters of the soft-tissue cephalometric analysis can also be assessed on the patients' profile photograph. Thus, a photograph-based cephalometric analysis could be helpful for orthodontic treatment planning in those cases where the cephalometric radiograph is not specifically indicated **(Nucera *et al.*, 2017).**

Thus**, <u>the null hypothesis is;</u>** there is no difference in soft tissue analysis whether taken on profile photograph or lateral cephalometric radiograph.

Aims of the study

Aim:

To investigate if there is a difference in soft tissue analysis whether taken on profile photograph or lateral cephalometric radiograph.

Objective:

Performing the soft tissue analysis on lateral photographs and then lateral cephalometric radiograph.

Chapter one
Review of literature

1.1 Diagnosis in orthodontics

It must be comprehensive and not focused on only a single aspect of what in many instances can be a complex situation. Orthodontic diagnosis requires a broad overview of the patient's situation and must take into consideration both objective and subjective findings. It is important not to characterize the dental occlusion while overlooking a jaw discrepancy, developmental syndrome, systemic disease, periodontal problem, psychosocial problem, or the cultural milieu in which the patient is living **(Proffit *et al.*, 2019).**

Graber *et al* (2017) stated that the decision-making in orthodontics requires the establishment of a prioritized problem list before considering treatment options. In this method, the prioritized problem list becomes the diagnosis.

The elements of the data base are **(Graber *et al*., 2017)**:

1. Questionnaire and interview data
2. Clinical examination
3. Data from diagnostic records

1- Questionnaire and Interview

The goals of the interview process are to establish the patient's chief concern (major reason for seeking consultation and treatment) and to obtain further information about three major areas: (1) medical and dental history; (2) physical growth status; and (3) motivation, expectations **(Proffit *et al.*, 2019).**

2- Clinical Examination

There are two goals of the orthodontic clinical examination: **(Proffit *et al*., 2019).**

(1) To evaluate and document oral health, jaw function, facial proportions, and smile characteristics.

(2) To decide which diagnostic records are required?

3- Diagnostic records: (Mitchell and Littlewoo, 2019)

A. Study models

B. Photographs

C. Radiographs

A. Study models

Should show all the erupted teeth and be extended into the buccal sulcus (see **Fig1.1**). Traditionally, they are poured in dental stone and are typically produced from alginate impressions. They should be mounted in occlusion **(Proffit *et al.*, 2019).**

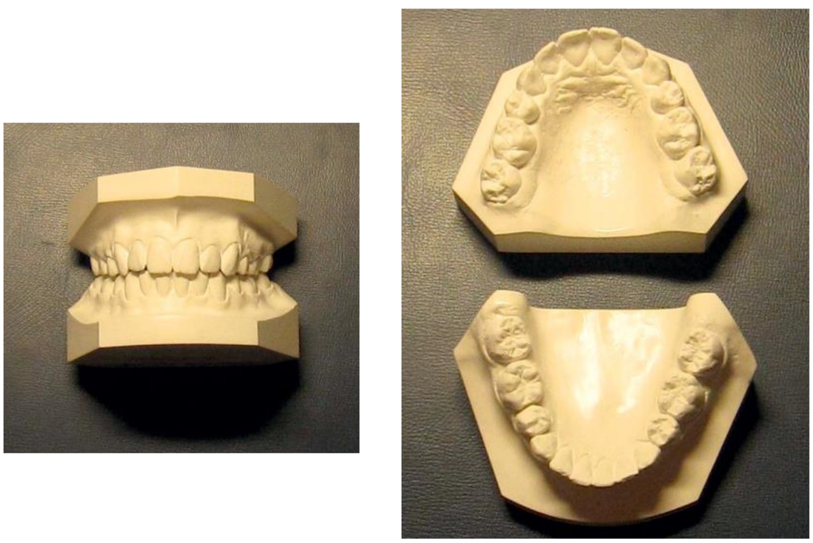

Figure 1.1: Study models

B. Photographs

Photographs are an essential part of clinical documentation. Current 'best practice' is a full set of extra- and intraoral photographs, both at the start and completion of a course of orthodontic treatment and, ideally, some mid treatment photographs showing key-stages in treatment**(Sandler and Murray, 2001).**

Figures 1.2 and 1.3 illustrate the requirements of the American Board of Orthodontics for oriented facial and intraoral photographs **(American Board of Orthodontics, 2016).**

Facial patterns play an important role in diagnosis and treatment planning, especially in serial extraction. From a practical standpoint, the photographs allow the orthodontist to better identify the patient**(Seixas and Câmara, 2021)**. The prime objective of diagnosis and treatment in relation to the face should be the creation of harmony and balance: a favorable, proportionate relationship between the teeth, skeletal pattern, and soft tissue matrix, including the profile. Similar to cephalometric radiographs, facial patterns are invaluable for the following:

1. Evaluation and documentation of craniofacial (and dental) relationships and proportions before treatment

2. Assessment of soft tissue profile and muscle balance

3. Proportional facial analysis and evaluation of symmetry

4. Total space analysis in tandem with occlusal curve analysis

5. Monitoring of treatment progress

6. These photographs and their pretreatment and post treatment evaluation allow for long-term improvement in treatment planning.

Figure 1.2 American Board of Orthodontics requirements for facial photographs. (American Board of Orthodontics, 2016).

Figure 1.3 American Board of Orthodontics requirements for intraoral photographs. (American Board of Orthodontics, 2016).

C. Radiographs

Any radiograph carries a low but identifiable risk, so each radiograph must be clinically justified. A radiograph is only prescribed after a full clinical examination to ensure that information cannot be supplementary by a less invasive method**(Graber *et al*., 2017)**. A radiograph may provide additional information on**(Mitchell and Littlewoo, 2019)**:

• Presence or absence of teeth

• Stage of development of permanent dentition

• Presence of ectopic or supernumerary teeth

• Presence of dental disease

• Relationship of the teeth to the skeletal dental bases, and their relationship to the cranial base root morphology of teeth, including root length and any existing root resorption.

-Radiographs commonly used in orthodontic assessment: (Proffit *et al.*, 2019).

• Dental panoramic tomograph (DPT)

• Cephalometric radiograph

• Upper standard occlusal radiograph

• Periapical radiographs

• Bitewing radiographs

*In this section we will focus Cephalometric radiograph.

1.2 Cephalometric radiograph

1.2.1 Types of Cephalometric radiographs:

There are following two types of cephalometric radiographs: **(Phulari, 2013).**

1. Frontal cephalometric radiograph: This provides an antero-posterior view of the skull **(**see **Fig. 1.4).**

2. Lateral cephalometric radiograph: provides a lateral view of the skull **(**see **Fig. 1.4).** It is taken with the head in a standardized reproducible position at a specified distance from the source of the x-ray**(Devereux *et al.*, 2011)**.

Since the introduction of lateral cephalometric radiography in 1931 by Broadbent in the USA and by Hofrath in Germany, this radiograph and its related analyses have become a standard tool in orthodontic assessment and treatment planning **(AlBarakati,*et al*., 2012).**

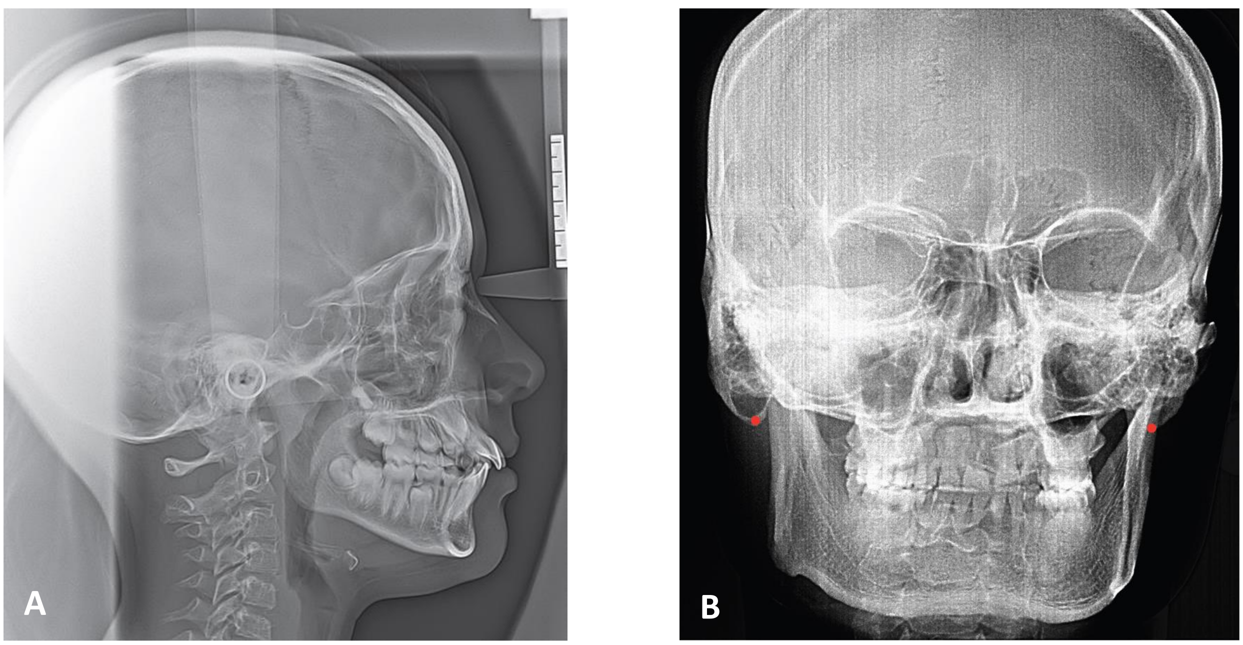

Figure 1.4: Cephalometric radiograph **A-** Lateral **B-** Frontal **(Phulari, 2013).**

As the radiation is cumulative, health care professionals must limit diagnostic radiation exposure to an absolute minimum and all exposures should be justifiable in terms of management of the patient **(Wall *et al.*, 2006).**

1.2.2 Indications of lateral cephalometric radiographs:

The United Kingdom for clinical orthodontics gives the following indications for use of a lateral cephalometric radiograph **(Devereux *et al.*, 2011).**

1. A skeletal discrepancy when functional or fixed appliances are to be used for labiolingual movement of incisors.
2. Patients with skeletal discrepancies in a teaching environment.
3. as a serial radiographs for assessing growth and planning joint orthodontic-orthognathic surgery patients.

1.2.3 Uses of cephalometric analysis: (Phulari, 2013)

Lateral cephalogram commonly is used for cephalometric analysis, as it used for:

1- Diagnostic purpose to assess whether malocclusion dental or skeletal in origin.

2- Enables clinician to know accurately the extent to which patient deviates from described norms.

3- Monitoring the changes occurring due to growth or treatment or their combination. In other words, precise evaluation of patient's response to treatment is made possible.

4- Prediction the changes that should occur in future for patient after orthodontic treatment.

1.2.4 Classification of cephalometric landmarks/points (see **Fig. 1.5**)

Phulari (2013) classify the landmarks according to the structures involved; therefore, the classification as follows:

1. Hard tissue cephalometric landmarks.
2. Soft tissue cephalometric landmarks.

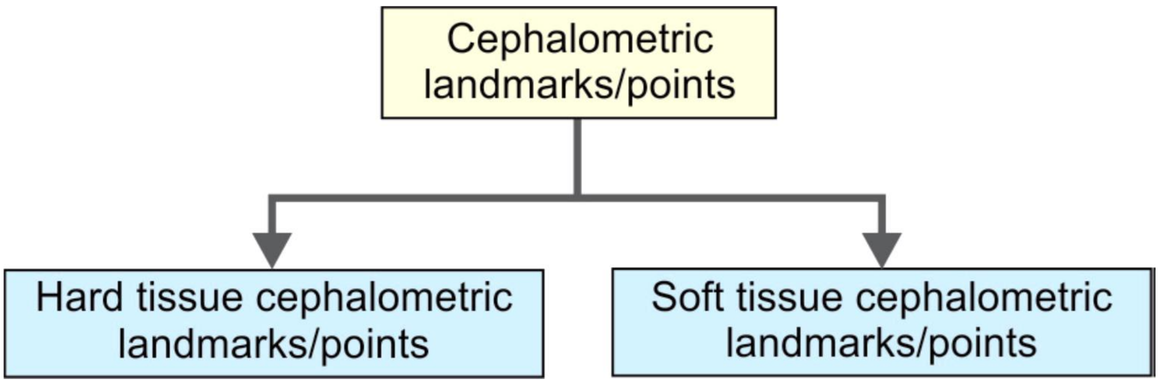

Figure 1.5: Cephalometric landmarks/points **(Phulari, 2013)**

1.2.4.1 Hard tissue cephalometric landmarks

These landmarks represent the actual hard tissue structures of the skull, such as nasal bone, ethmoidal bone, frontal bone, maxillary bone, mandible and hyoid, etc. **(Phulari, 2013)**

Examples of hard tissue cephalometric landmarks (see **Fig. 1.6):**

1- **A point (A):** the point of deepest concavity on the anterior profile of the maxilla. It is also called the subspinale and is taken to represent the anterior limit of the maxilla

2- **B point (B):** the point of deepest concavity on the anterior surface of the mandibular symphysis. B point is also sited on alveolar bone and can alter with tooth movement and growth.

3- **Gonion (Go):** the most posterior inferior point on the angle of the mandible.

4- **Menton (Me):** the most inferior point on the mandibular symphysis.

5- **Nasion (N):** the most anterior point on the frontonasal suture. If it is difficult to locate the nasion, the point of deepest concavity at the intersection of the frontal and nasal bones can be used instead.

6- **Orbitale (Or):** the most inferior anterior point on the margin of the orbit.

7- **Pogonion (Pog):** the most anterior point on the mandibular symphysis.

9- **Porion (Po):** the uppermost outermost point on the bony external auditory meatus. This landmark can be obscured by the ear posts of the cephalostat, and some advocate tracing these instead. This is not recommended, however, as they do not approximate to the position of the external auditory meatus.

10- **Sella (S):** the midpoint of the sella turcica.

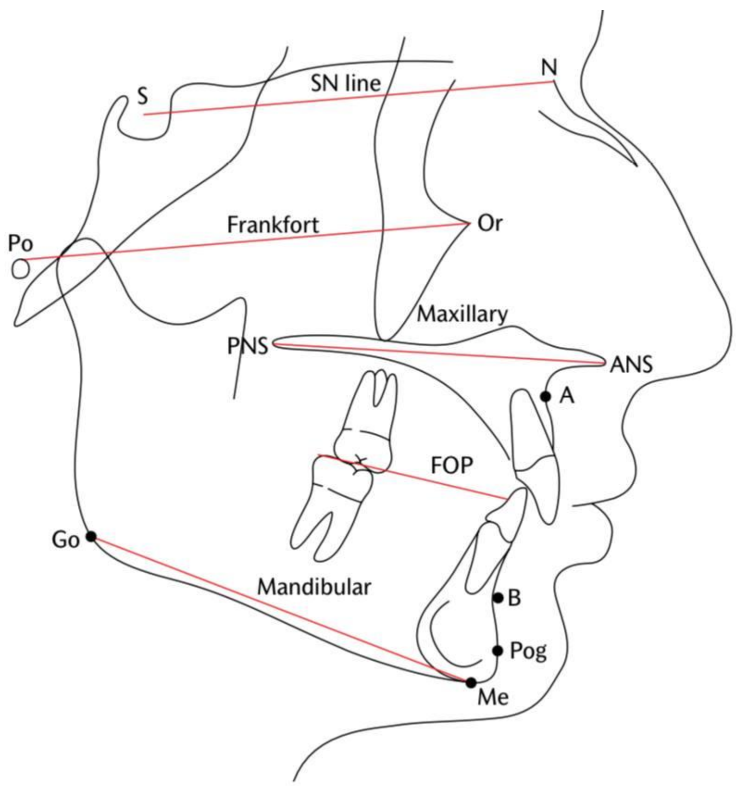

Figure 1.6: Commonly used points and reference lines **(Mitchell & Littlewood, 2019)**

1.2.4.2 Soft tissue cephalometric landmarks (Phulari, 2013) (Fig. 1.7):

Cephalometric landmarks/points located on soft tissues are categorized as soft tissue cephalometric landmarks/points.

-Soft tissues:

- Forehead
- Nose
- Lips
- Chin.

Examples of soft tissues cephalometric landmarks:

- Soft tissue nasion
- Subnasale
- Subspinale
- Stomion
- Soft tissue pogonion
- Soft tissue gnathion.

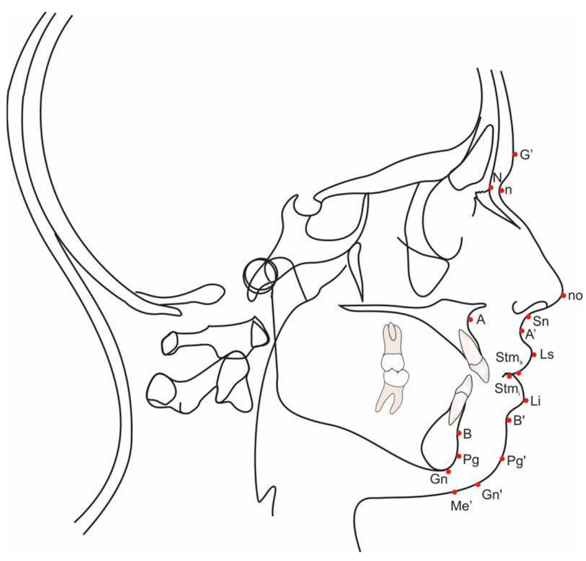

Figure 1.7: Cephalometric landmarks of the soft tissue of the face**. (Kharbanda, 2019).**

1.3 Soft tissue analysis (see Fig. 1.8)

Careful analysis of the soft tissues is important, particularly if changes to incisor position are planned and in diagnosis and planning prior to orthognathic surgery, some of the more commonly used analyses include **(Mitchell and Littlewood, 2019):**

1- **The Holdaway line:** a line from the soft tissue chin to the upper lip. In a well-proportioned face, this line, if extended, should bisect the nose.

2- **Rickett's E-plane**: a line joining the soft tissue chin and the tip of the nose. In a balanced face, the lower lip should lie 2 mm (± 2 mm) anterior to this line with the upper lip positioned a little further.

3- **The facial plane:** a line between soft tissue nasion and soft tissue chin. In a well-balanced face, the Frankfort plane should bisect the facial plane at an angle of about 86° (indicated by *) and point A should lie on it.

Soft tissue cephalometric analysis (STCA) relies on natural head posture, and the vertical and horizontal positions of soft tissue landmarks identified on cephalograms or photographs are recorded relative to the patient0s head position **(Ploder *et al*., 2019).** To define a reference plane, the natural head position (NHP) is frequently used and is defined as the head position when the visual axis of a standing patient is exactly horizontal **(Dvortsin *et al*., 2011)**. A line perpendicular to the horizontal in NHP, the true vertical line (TVL), is used as a reference for the measurements of soft and hard tissue landmarks identified on cephalograms or photographs.

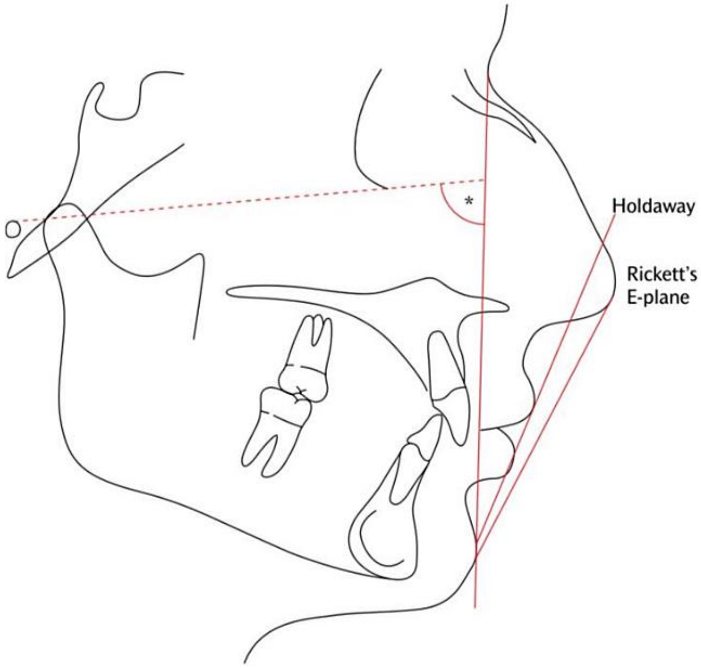

Figure 1.8: Commonly used soft tissue analyses **(Mitchell and Littlewood, 2019)**

Chapter Two
Materials and Methods

2.1 Materials

2.1.1 The Sample

The sample of this study consisted of patients seeking orthodontic treatment from private clinics. The sample was all of Iraqi origin with an age range between 5-35 years.

For every subject in the sample, a true lateral cephalogram and lateral photographs were taken. Out of subjects included, only subjects (males and females) met the inclusion criteria. Since some subjects were excluded because of unclear photographs and/or cephalograms to identify the required landmarks with certainly.

2.1.2 Criteria for Sample Selection

1- Any type of skeletal and dental relationship.

2- Absence of gross asymmetry of the face and the jaws.

3- No previous orthopedic treatment for the head or facial surgical treatment.

4- The males must be without mustaches or beard.

The Materials, Instruments and Equipment (see **Fig. 2.1):**

- A white background panel.
- Digital camera (Nickon 5200).
- Ruler
- Pencil
- Eraser

- Protractor

All the cephalograms were taken at Yusur dental clinics, using digital x-ray unit system machine operated by Myray software.

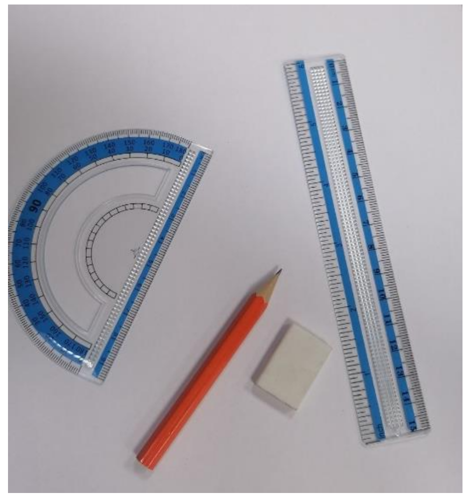

Fig 2.1: materials, Instruments and Equipment used

2.2 The Method:

2.2.1 Personal Information:

Detailed history was taken from each individual; the history included informations about name, age, medical and dental history, history of facial trauma and previous orthopedic or surgical treatment.

2.2.2 Clinical Examination:

While the individual was seated on a regular chair, the operator examined him/her by using two finger method to determine the type of malocclusion.

Individuals were also examined for any facial asymmetry, so to be sure that they fulfilled the inclusion criteria mentioned previously.

2.2.3 Record Taking:

For each patient a lateral head photograph was taken in standing position in natural head position and a true lateral cephalogram was taken in standing position with the aid of a cephalostat.

- Free standing position:

The photographs were taken while the subject is standing in NHP.

2.2.4 Radiographic Protocol:

After taking the photographs, the lateral cephalometric image was taken for each subject with teeth lightly together and lips relaxed. The radiography was made under rigidly standardized conditions. The unit was adjusted according to the height of the patient who was in a standing position. The patient's head was positioned so that the x-ray beam was perpendicular to the patient's sagittal plane. The head was fixed with ear posts and faced the nasal positioner. The patient was instructed not to move during the radiographic exposure.

2.2.5 Analysis of the Records:

All lateral head photographs and cephalometric radiographs were printed on papers to prepare it for the analysis process.

The analysis process done manually to calculate the angular and linear measurements.

2.2.5.1 Photographic and Cephalometric Analysis:

2.2.5.1.1 The Landmarks (see Fig. 2.2):

Following landmarks were pointed on the photographs and cephalometric radiographs:

Subnasale: is the point at which the nasal septum between the nostrils merges with the upper cutaneous tip in the midsagittal plane.

Point B: Soft tissue point B or soft tissue submentale is the point of greatest concavity in the midline of the lip between labrale inferius (Li) and soft tissue pogonion (Pog' or Pogs).

Pogonion: Soft tissue pogonion is the most prominent or anterior point on the soft tissue chin in the midsagittal plane.

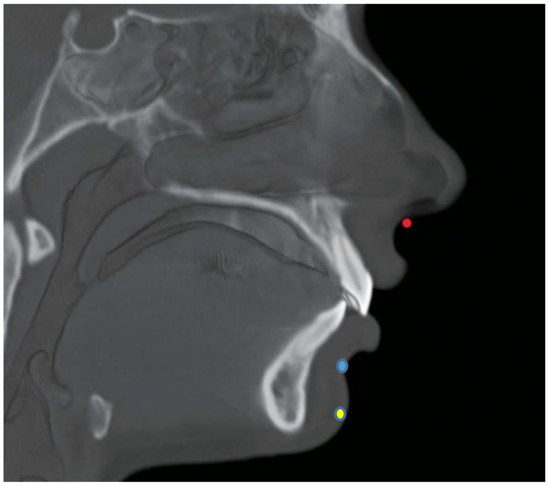

Figure 2.2: The Landmarks Red point: subnasale, Blue point: soft tissue point B, yellow point: Soft tissue pogonion **(Phulari, 2013).**

2.2.5.1.2 The lines (Kharbanda, 2019):

Rickett's E line: a line joining the soft tissue chin and the tip of the nose **(**see **Fig. 2.3)**. In a balanced face, the lower lip should lie 2 mm (± 2 mm) anterior to this line with the upper lip positioned a little further.

Fig 2.3: E line; A- with upper lip, B- with lower lip

Steiner's S line: is drawn from the pog to the midpoint of the S-shaped curve between the Sn and nasal tip **(**see **Fig. 2.4).** Normally, the upper and lower lips touch the S line. The lips lying behind this line are too retrusive, while those lying ahead are protrusive.

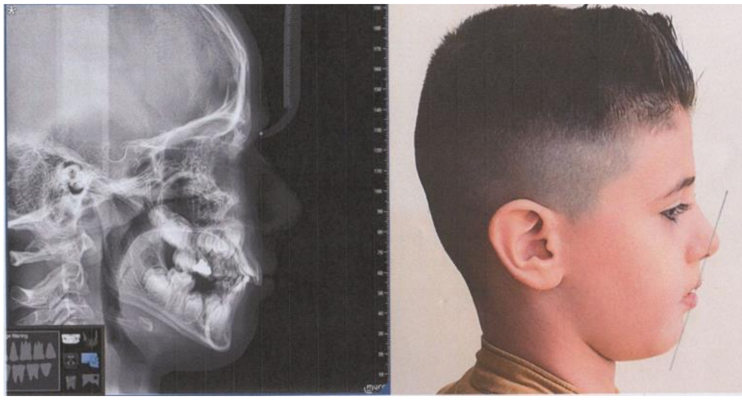

Fig 2.4: S line; A- with the upper lip, B- with the lower lip

True Vertical Line (TVL): it is a line passing through the Sn and perpendicular to the natural horizontal head position **(**see **Fig. 2.5)**. TVL projections are anteroposterior measurements of soft tissue and represent the dentoskeletal position plus the soft tissue thickness overlying hard tissue landmarks. The horizontal distance for each landmark, measured perpendicular to the TVL.

Ideally, the value is between 1.5 to 5 for the upper lip, and between -1.5 and 3.3 for the lower lip.

Point B -True Vertical Line (TVL): The horizontal distance between the point of greatest concavity in the midline of the lower lip between labrale inferius and menton and TVL. Ideally, it is -8.7_-5.5mm for the male and -6.8_-3.8mm for the female.

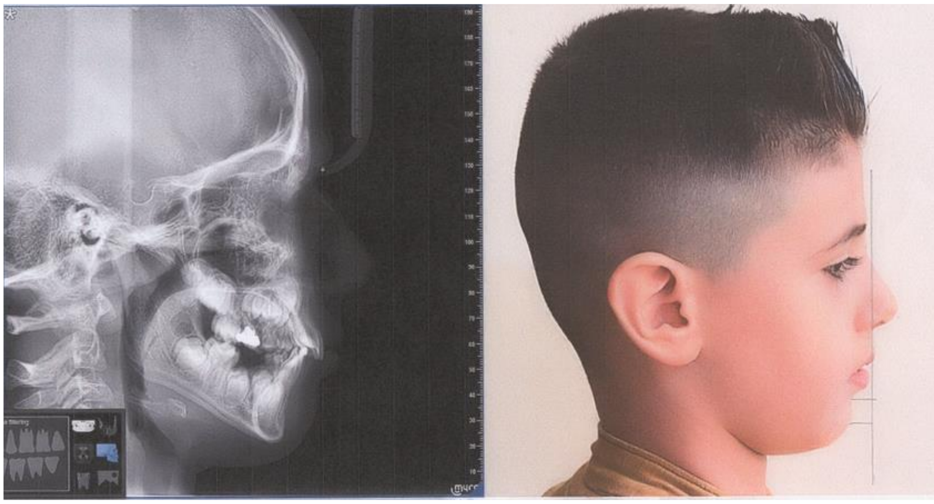

Fig. 2.5: TVL; A- with upper lip, B- with lower lip, C- with point B E-with pog.

Pog- True Vertical Line (TVL): The horizontal distance between the most prominent point on the soft tissue contour of the chin and TVL. Ideally, the value -5.3_-1.7mm for the male and -4.5_-0.7 for the female.

2.2.5.1.3 The angles:

The nasolabial angle: it measures the inclination of the columella in relation to the upper lip **(**see **Fig. 2.6)**. The angle should be in the range of 90 to 120 degrees.The morphology of the nasolabial angle is a function of several anatomic features. Procumbency of the maxilla tends to produce an acute nasolabial angle, and maxillary retrusion tends to produce an obtuse nasolabial angle, but the angle is very much affected by nasal form itself. **(Graber, 2017).**

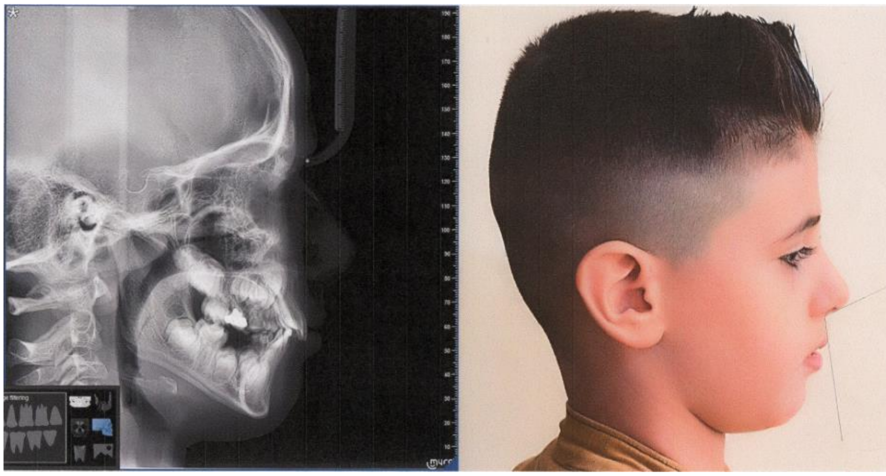

Fig. 2.6: The nasolabial angle

Statistical analysis

All the data of the sample were subjected to computerized statistical analysis using SPSS (Statistical Package for Social Sciences) computer program (version 23). The statistical analysis included:

1- Descriptive Statistics: including

- Mean and Standard deviation (SD).
- Minimum, maximum values.
- Statistical tables.

2- Inferential Statistics: including

- Paired t-test for the comparison between photographs and lateral cephalometric radiograph.

Chapter Three

Results

3.1 Assessing Nasolabial angle:

Nasolabial angle was the only angle selected in two occasions; from the profile photograph and from lateral cephalometric radiograph.

3.1.1 Descriptive data:

Table 3.1 shows that the mean values of Nasolabial angle in the two conditions had almost a same values.

Relatively high standard deviation values were noted in the two situations. but, the SD value was higher in cephalometric radiograph than that of the profile photograph, this high standard deviation value reflect wide variability among subjects of present sample.

The minimum, maximum values were of comparable values in the two situations.

Table 3.1: Descriptive statistics of Nasolabial angle (in degrees) for the total sample (N=23).

Angle	Condition	N	Minimum	Maximum	Mean	Std. Deviation
Nasolabial angle	Ceph	23	70	117	95.17	14.553
	Photo	23	72	123	95.20	11.717

3.1.2 Comparison between the angle in the radiograph and photograph:

When comparing mean values of nasolabial angle between cephalograph and photograph; paired samples t-taste was used. The test showed a non-significant difference; as the mean value in cephalograph was (95.17°) and in photograph was (95.20°).

Table 3.2: Comparison between nasolabial angle (in degrees) in cephalometric radiograph and photograph

Condition	Mean	Std. Deviation	t	df	Sig.
Ceph - Photo	-0.0217	11.8977	-0.009	22	0.993(NS)

3.2 Assessing soft tissue lines

The planes selected for this study are the Rickett's E line, Steiner's S line, True vertical line (TVL).

The relation of the lips the three lines, relation of point B to the TVL, and the relation of the Pog to the TVL were assessed in this study.

3.2.1 Descriptive data:

Table 3.3 shows that there were a big differences in mean values of the soft tissue lines in both conditions (radiograph and photograph). In addition to that, there were a differences in the minimum values of the two conditions. Relatively high standard deviation values were noted in the two situations, this high standard deviation value reflect wide variability among subjects of present sample.

Only the maximum values were of comparable values in the two situations.

Table 3.3: Descriptive statistics of soft tissue lines (in millimeters) for the total sample (N=23).

Condition	Line	N	Minimum	Maximum	Mean	Std. Deviation
Ceph	UE	23	-5.00	2.00	-1.4565	1.95932
	LE	23	-4.00	2.00	-0.5870	1.65593
	UT	23	-1.50	3.00	1.0217	1.04966
	LT	23	-4.00	3.00	-0.0435	1.80852
	US	23	-4.50	4.00	0.4674	1.82206
	LS	23	-2.00	3.50	0.5000	1.65145
	BT	23	-11.00	0	-4.9565	2.67103
	PogT	23	-10.00	3.00	-4.1304	3.50071
Photo	UE	23	-3.00	1.50	-1.1304	1.09977
	LE	23	-3.00	1.00	-0.7174	1.14640
	UT	23	-0.50	1.50	0.4348	0.54988
	LT	23	-2.00	1.00	-0.6087	0.94094
	US	23	-1.50	2.50	0.1522	0.93158
	LS	23	-1.50	1.50	0.1739	0.94879
	BT	23	-6.00	-1.00	-3.3043	1.40405
	PogT	23	-6.00	0	-2.8261	1.93419

3.2.2 Comparison between soft tissue lines in radiograph and photograph

When comparing mean values of soft tissue lines between cephalograph and photograph; paired samples t-taste was used **(Table 3.4).** The test showed a non-significant difference between the cephalometric radiograph and photograph regarding the relation of the upper and lower lips with E-line and S-line (0.582 and 0.077 respectively), and a significant difference in the relation of point B to the TVL (0.020). Whereas, there was a high difference between the cephalometric radiograph and photograph concerning the relation of the lips to the TVL and the relation of the Pog to the TVL (0.004 and 0.001 respectively).

Table 3.4: Comparison between soft tissue lines (in millimeters) in cephalometric radiograph and photograph

Lines	Mean	Std. Deviation	t	df	Sig.
E- line	-0.0978	1.1955	-0.555	45	0.582 (NS)
TVL	0.5761	1.2994	3.007	45	0.004 (HS)
S-line	0.32065	1.20030	1.812	45	0.077 (NS)
B-TVL	-1.6522	2.0859	-3.799	22	0.001 (HS)
Pog-TVL	-1.3043	2.4943	-2.508	22	0.020 (S)

Chapter Four
Discussion

4.1 The study design

This study aimed to compare between the soft tissue analysis taken from profile photograph and from lateral cephalometric radiograph; as if the result is comparable, therefore, we can depend on the cephalometric radiograph for both hard tissue and soft tissue analysis.

The sample of this study was **23** patients (as many subjects were excluded because of unclear photographs and/or cephalometric radiographs to identify the required landmarks with certainly) seeking orthodontic treatment with a wide age range (5-35 years).

The analysis done manually, as it is more precise to locate the landmark manually than digitally.

4.2 Comparison between photographs and lateral cephalometric radiographs regarding the Nasolabial angle:

Comparing the mean values of nasolabial angle for subjects in the two conditions showed a statistically non-significant differences for the total sample **(Table 3.2),** as the mean values of the angle taken from the cephalometric radiograph was 95.17, while, the angle taken from the photograph was 95.20.

4.3 Comparison between photographs and lateral cephalometric radiographs regarding the Soft tissue line:

Table 3.4 shows that there were a statistically non-significant differences between the photographs and lateral cephalometric radiographs regarding the relation of the upper and lower lips with the E-line and the S-line, but, the difference were only regarding the relation of the lips, point B, and Pog with the TVL.

This may be attributed to the tipping of the head (more downward) of the patient during taking the radiograph relative to the position during taking the profile photographs, which could be associated with adaptation of subjects to the ear rods of the cephalostat, which is in agreement with **Leitao and Nanda (2000).** However, **Greenfield *et al*. (1989)** found that subjects extend their heads and necks higher with ear rods than that without ear rods.

In addition, previous results attributed the difference in head orientation to the following reasons:

- Possibility of abnormal position due to tenseness and excitement of the individual resulting in "unnatural" tilting of the head **(Down, 1956; Moorrees and Kean, 1958).**
- It appeared that some subjects tilted their head downward to accommodate the ear rods of the cephalostat **(Leitao and Nanda, 2000).**
- A change in head position is a completely random event and may be due to mood at the time, distraction, and/or misinterpretation of instructions **(Barbera, 2008).**

Furthermore, there were differences in the results of the previous studies; these differences between the previous studies may be attributed to:

- ❖ Differences in subject's ethnic background; this may have implications for the average craniofacial morphology of the different samples.

- The techniques used for head positioning in NHP differ between studies e.g. some operators used mirror guided head position while others used self-balanced head position; all techniques were correct but may lead to some changes.
- Differences in equipment like using digital radiographic machine or conventional radiographic machine with different film size and quality.
- Differences in the operator handling (technique used), experience and interpretation of landmarks (Although the same definitions for each landmark were used, it is likely that there were some operator differences in interpretation).

This study suggests a poor diagnostic concordance between soft tissue analysis on cephalographs and that on profile photographs rejecting the null hypothesis of this study. This results agreed with the results of **Nucera *et al*. (2017).**

Chapter Five
Conclusions and Suggestions

Conclusions

As there is a degree of head rotation during taking the cephalograph that affect the precision of soft tissue analysis on the lateral cephalometric radiograph; therefore, soft tissue analysis performed on profile photographs is the only reliable method to evaluate soft tissue profile compared to that performed on lateral cephalometric radiograph.

Suggestions

- Repeating the study with the adjustment of the head of the patient by the cephalostat to be sure that there is no rotation of the head during taking the radiograph.
- Repeating the study with asking the patient to slightly tilting his/her head during taking the profile photograph.

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