

Comparative assessment of cephalometric with its analogous photographic variables

ABSTRACT

Objective: The purpose of this study was to evaluate the accuracy of photographic measurements and compare it with its analogous cephalometric variables.

Materials and Methods: Lateral cephalograms and standardized facial profile photographs were obtained from a sample of 120 subjects (92 females, 28 males; age 12–22 years with mean age of 17.5 years). A total of 4 linear and 7 angular measurements along with 3 ratios analogous to one another were measured on both. Descriptive statistics for all measurements were computed. Pearson's correlation coefficients were computed between analogous measurements, and regression analysis was done for each variable measured on the photograph to accurately predict the cephalometric variable.

Results: The reliability of the standardized photographic technique was satisfactory. Most photographic measurements showed highly significant correlations ($P < 0.001$) with cephalometric variables. Among all measurements used, the A'N'B' angle was the most effective in explaining the variability of its analogous cephalometric ($r^2 = 0.35$). The Frankfort-mandibular plane angle' angle showed best results for vertical assessment ($r^2 = 0.81$) along with anterior face height (AFH) and lower anterior facial height ($r^2 = 0.859$) and ratio lower posterior facial height/AFH ($r^2 = 0.702$).

Conclusions: Although we cannot rule out lateral cephalogram as the primary record in orthodontics, photographic assessment can always be used through proper standardization, as an alternative diagnostic aid, and also for large-scale epidemiological purposes and places with unavailability of cephalostat.

Keywords: Diagnostic aid, lateral cephalograms, standardized facial profile photographs

INTRODUCTION

The analysis of hard- and soft-tissue landmarks of the face has always been the prime concern for the orthodontic treatment planning and management. It dates back to the end of the 19th century where the measurements of skull and faces were done using anthropometry.

Anthropometry lost its core value owing to its limitation to soft tissue and insignificant correlation to the underlying hard tissue. Roentgenographic cephalometry was developed by Broadbent and Hofrath in 1931,^[1] which has proven a boon to analyze dental, skeletal, and soft-tissue arena of craniofacial structures. Cephalometry thus presented itself as a reliable tool for craniofacial imaging. Traditional cephalometrics

include analysis of sagittal, vertical, and transverse skeletal and dental relationships along with the soft-tissue profile.^[2] However, no one can ignore the radiation hazard of radiography, owing to its innumerable stochastic effects^[3] and subjection to the availability of a radiation source and a

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Received: 04 December 2020, **Revised:** 19 February 2021, **Accepted:** 05 May 2021, **Published:** 20 April 2022

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How to cite this article: Gupta S, Tandon P, Singh GP, Shastri D. Comparative assessment of cephalometric with its analogous photographic variables. Natl J Maxillofac Surg 2022;13:99-107.

Access this article online	
Website: www.njms.in	Quick Response Code 
DOI: 10.4103/njms.NJMS_267_20	

head holder to make technique accurate. It is also not feasible to be used for large-scale epidemiological purposes and for primarily diagnosing a heritable trait in a family.^[4] Thus, there stands the need for a simple, low-cost technique for assessing the craniofacial morphology. This has brought into light noninvasive, inexpensive, and effective use of photographs through standardization to be used as a powerful method of quantitatively analyzing the craniofacial structures. Since soft-tissue thickness varies, the relationship between the soft tissue and hard tissue may not be always linear. However, many researchers have concluded that relationship exists between specific soft-tissue and skeletal variables and soft-tissue profile of an individual can be used to estimate the skeletal pattern.^[5-8] According to Graber photographs considered as an essential diagnostic aid and it had only secondary and subjective role.^[9] But if Photographs taken with proper standardization than it can be used effectively to analyze craniofacial disorders, establish treatment planning and evaluate orthodontic and orthognathic outcome. They also study changes in facial morphology and dimensions as a result of growth as well as treatment subjectively by comparing the obtained pretreatment and posttreatment photographs.^[10]

Studies have been done to compare radiographs and photographs, but better standardization is required such that photographs could be used as a significant clinical diagnostic tool to relevantly predict their analogous radiographic values. Further studies may provide in future a more relevant, efficient, noninvasive, and inexpensive way to diagnose and plan the treatment by effective standardized use of photographs.^[2,4,10,11]

This study focused on investigating the relationship between craniofacial measurements obtained from cephalometric radiographs and analogous photographic measurements by means of regression analysis.

MATERIALS AND METHODS

The present study was conducted on 120 subjects divided into 28 male and 92 female patients of age range from 12 years to 22 years (mean age of 17.5 years). Profile facial photographs and lateral cephalometric radiographs were taken for the measurement of various analogous angular and linear parameters and ratios. Lateral cephalograms were already required as part of initial orthodontic records. Parents or legal guardians were informed about the study procedure and written consent was obtained. An approval was obtained from the Institutional Ethics Committee before starting the study (Ref. code 84th ECM II B– Thesis/P23).

The inclusion criteria were (1) subjects of Indian origin, (2) mean age of 17.5 years with age range of 12–22 years, (3) no previous orthodontic/orthopedic or surgical treatment, (4) all six maxillary anterior teeth present, (5) no craniofacial trauma, and (6) no facial asymmetry present.

Photographic method

Standardized right profile photographs were taken in the natural head position (NHP), with maximum intercuspation and lips at rest as were the specifications for taking the lateral cephalogram. The photographs were taken using Nikon DSLR D7100 (f/4 aperture, focal length 100 mm at zero exposure without flash). The subject was seated on the stool at a distance of 15 inches against a clear white background^[12] compared with the midsagittal plane and the distance from the camera was 60 inches to the midsagittal plane.^[13] The NHP (which is a standardized and reproducible position, of the head in an upright posture, the eyes focused on a point in the distance at the eye level, which implies that the visual axis is horizontal) was clinically achieved by asking the subjects to tilt their head up and down with a decreasing amplitude until relaxed and then look at the eye level into a mirror hung on the wall in front of the subject. To avoid interference while achieving NHP, a protractor, modified with a wire pendulum, was placed on the tip of the nose and the soft-tissue pogonion to check if the same angle between the wire and the baseline of the protractor was achieved during both records.^[10] [Figure 1].

The anatomic landmarks were palpated and marked with an adhesive micropore tape. The menton point was identified with an adhesive Styrofoam bead to allow better visibility for the camera.^[10] The occlusal plane was marked on the face of the subject with a string incorporated in plaster of Paris held against the subject's cheek at the level of held fox plane and



Figure 1: Natural head position by modified protractor on the tip of the nose and the soft-tissue pogonion

was then pressed against the skin [Figure 2]. Right-angled millimeter scale was placed while taking photographs to achieve measurements in life size (1:1) [Figure 3]. The angular and linear measurements were taken on photographs using ImageJ software version 1.52a (free software) (Url-<https://imagej.nih.gov/ij/download.html>). Scale is set in the software using the ruler for obtaining the linear measurements in the photograph.

The identification of the preestablished landmarks was done by the same rater. For analyzing the reproducibility, 20 samples were randomly selected and the landmarks were identified twice in 2 days' interval, which were found to be accurately repeatable.

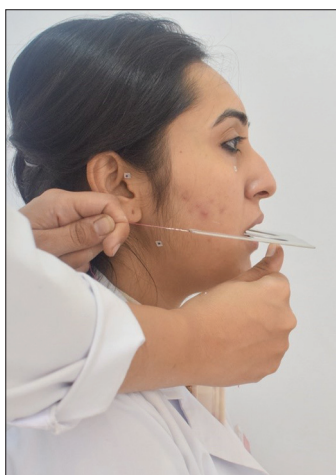


Figure 2: Marking the occlusal plane by plaster of Paris using fox plane as a reference



Figure 3: Patient seated for right profile photograph

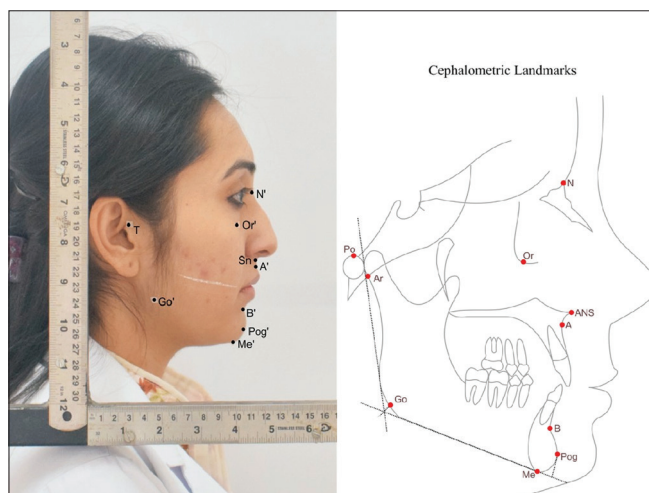


Figure 4: Landmarks used in profile photograph and lateral cephalograms (1) N' (soft-tissue nasion) (2) Or' (soft-tissue orbitale) (3) T (tragion) (4) Sn Point (subnasale) (5) A' (soft-tissue Point A) (6) B' (soft-tissue Point B) (7) Goæ (soft-tissue gonion) (8) Pog' (soft-tissue pogonion) (9) Me' (soft-tissue menton) landmarks used in lateral cephalogram (1) N (nasion) (2) Or (orbitale) (3) Po (porion) (4) Ar (articulare) (5) ANS (Anterior nasal spine) (6) A (subspinale) (7) Go (gonion) (constructed) (8) B (supramentale) (9) Pog (pogonion) (10) Me (menton)

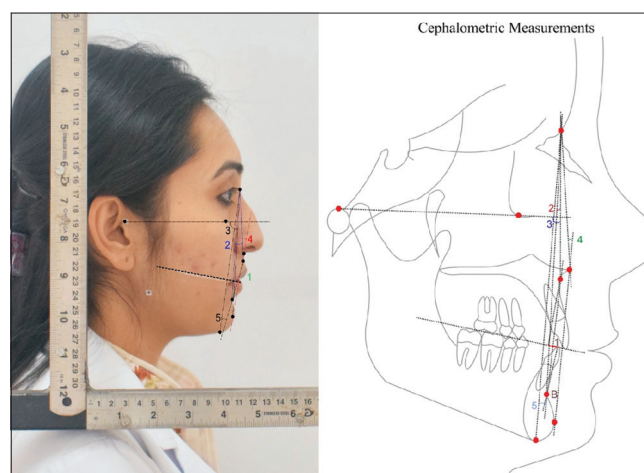


Figure 5: Sagittal measurements in profile photograph and lateral cephalogram (1) Wits' appraisal I2. A' N' B' 3. family nurse practitioners' (Soft-tissue facial angles) (4) N'.Sn.Pog' (5) N'Me'/A'B' (soft-tissue A-B plane angle) Lateral cephalogram: (1) Wits appraisal (2) ANB angle (3) family nurse practitioners' (facial angle) (4) N.ANS.Pog angle (5) NMe/AB (AB plane angle)

Table 1: Mean±standard deviation of variables of standardized facial profile photographs in overall and also in male and female

Variables	Mean±SD			Gender difference	
	Overall	Males	Females	Mean	Significant
Sagittal measurements					
Linear (mm)					
Wits' appraisal	3.43±2.03	3.9±1.95	3.28±2.04	0.62	NS
Angular (degree)					
A'N'B'	9.84±2.57	10.7±2.32	9.58±2.6	1.12	NS
FNP'	91.36±3.76	90.79±4.42	91.53±3.55	-0.74	NS
N'.Sn.Pog'	21.92±5.49	23.68±4.86	21.38±5.58	2.3	NS
N'Me'/A'B'	-8.5±3.96	-9.32±3.57	-8.25±4.06	-1.07	NS
Vertical measurements					
Linear (mm)					
AFH' (N'-Me')	110.57±6.4	113.53±7.58	109.67±5.74	3.86	NS
LAFH' (Sn-Me')	64.27±5.44	66.32±6.68	63.64±4.87	2.68	NS
PFH' (Tr-Go')	40.73±6.23	39.93±6.23	40.96±6.25	-1.03	NS
Angular (degree)					
Tr.Go'.Me' (Gonial angle)	128.1±8.07	129.07±6.92	127.8±8.4	1.27	NS
FMA'	33.14±9.68	34.51±11.27	32.72±9.16	1.79	NS
OPA'	17.44±5.83	19.7±5.26	16.45±5.84	3.25	NS
Ratios					
LAFH'/AFH'	0.58±0.04	0.59±0.03	0.58±0.04	0.01	NS
PFH'/AFH'	0.37±0.04	0.37±0.04	0.37±0.05	0	NS
PFH'/LAFH'	0.7±0.18	0.66±0.21	0.71±0.17	-0.05	NS

SD: Standard deviation, NS: Non significant. *Just significant, **Moderately significant, ***P<0.001 Highly significant, NS: Nonsignificant

Table 2: Mean±standard deviation of variables of lateral cephalograms in overall and also in male and female subjects

Variables	Mean±SD			Gender different	
	Overall	Males	Females	Mean different	Significant
Sagittal measurements					
Linear (mm)					
Wits appraisal	2.77±2.68	2.88±2.49	2.74±2.75	0.14	NS
Angular (degree)					
ANB	4.39±3.14	4.07±2.89	4.48±3.22	-0.41	NS
FNP	84.14±5.91	81.96±6.89	84.81±5.44	-2.85	NS
N.ANS.Pog	19.26±6.64	19.57±5.09	19.16±7.07	0.41	NS
NMe/AB	-5.33±3.3	-5.39±2.27	-5.31±3.57	-0.08	NS
Vertical measurements					
Linear (mm)					
AFH (N-Me)	106.48±6.63	109.68±7.76	105.49±5.95	4.19	NS
LAFH (ANS-Me)	59.69±5.95	61.79±7.33	59.04±5.34	2.75	NS
LPFH (Ar-Go)	40.14±5.11	41.92±6.32	39.62±4.61	2.3	NS
Angular (degree)					
Ar.Go.Me (Gonial angle)	127.28±7.67	126.93±7.65	127.38±7.71	-0.45	NS
FMA	30.09±7.45	31.32±8.76	29.71±7.01	1.61	NS
OPA	10.77±4.15	12.91±4.36	10.11±3.88	2.8	NS
Ratios					
LAFH/AFH	0.55±0.04	0.56±0.04	0.55±0.04	0.01	NS
LPFH/AFH	0.37±0.05	0.38±0.05	0.37±0.05	0.01	NS
LPFH/LAFH	0.68±0.1	0.69±0.1	0.68±0.1	0.01	NS

SD: Standard deviation, NS: Nonsignificant. *Just significant, **Moderately significant, ***P<0.001 Highly significant, NS: Nonsignificant

Statistical analysis

All the statistical analyses were performed using SPSS Inc. Released 2007. SPSS for Windows, Version 16.0. Chicago, SPSS Inc. windows software. Mean and standard

deviation (SD) were calculated for each photographic and cephalometric variable. Comparisons between groups were assessed by using independent *t*-test. Cephalometric measurements were compared with

Table 3: Comparison between standardized facial profile photographs and lateral cephalograms in overall subjects (using paired t-test)

Overall	Mean±SD	Different	P
Sagittal measurements			
Linear (mm)			
Wits' appraisal	3.43±2.03	0.65	0.003**
Wits appraisal	2.77±2.68		
Angular (degree)			
A'N'B'	9.84±2.57	5.45	<0.001***
ANB	4.39±3.14		
FNP'	91.36±3.76	7.21	<0.001***
FNP	84.14±5.91		
N'.Sn.Pog'	21.92±5.49	2.66	<0.001***
N.ANS.Pog	19.26±6.64		
N'Me'/A'B'	-8.50±3.96	-3.17	<0.001***
NMe/AB	-5.33±3.30		
Vertical measurements			
Linear (mm)			
AFH' (N'-Me')	110.57±6.40	4.10	<0.001***
AFH (N-Me)	106.48±6.63		
LAFH' (Sn-Me')	64.27±5.44	4.58	<0.001***
LAFH (ANSMe)	59.69±5.95		
PFH' (Tr-Go')	40.73±6.23	0.59	0.351 (NS)
LPFH (Ar-Go)	40.14±5.11		
Angular			
Tr.Go'.Me'	128.10±8.07	0.82	0.176 (NS)
Ar.Go.Me	127.28±7.67		
FMA'	33.14±9.68	3.47	<0.001***
FMA	30.09±7.45		
OPA'	17.44±5.83	6.67	<0.001***
OPA	10.77±4.15		
Ratios			
LAFH'/AFH'	0.58±0.04	0.03	<0.001***
LAFH/AFH	0.55±0.04		
PFH'/AFH'	0.37±0.04	0.00	0.073 (NS)
LPFH/AFH	0.37±0.05		
PFH'/LAFH'	0.70±0.18	0.02	0.272 (NS)
LPFH/LAFH	0.68±0.01		

*Just significant, **Moderately significant, *** $P < 0.001$ Highly significant, NS: Nonsignificant. SD: Standard deviation, NS: Nonsignificant

analogous photographic measurements to assess Pearson correlation coefficients. Linear regression analyses were made between cephalometric (dependent variable to be estimated) and photographic (independent variable) measurements.

RESULTS

Means, SDs, and gender differences for all cephalometric and photographic measurements were obtained [Tables 1 and 2]. No significant gender differences were found. On comparing [Table 3] the analogous photographic and cephalometric variables, statistically significant differences were found for almost all variables

except lower posterior facial height (LPFH), gonial angle, LPFH/anterior face height (AFH), and LPFH/lower anterior facial height (LAFH).

Highly significant correlations ($P < 0.001$) were found for most sagittal and vertical diagnostic variables [Table 4]. Coefficients ranged from weak to strong. Given the entire sample, the highest coefficients were found between AFH' versus AFH and LAFH' versus LAFH ($r = 0.927$), followed by Frankfort-mandibular plane angle (FMA) versus FMA' ($r = 0.902$). The lowest coefficients were obtained for PFH' versus LPFH ($r = 0.309$).

Linear regression analysis done for each variable was evaluated [Table 5]. The photographic variables that best explain the variability of analogous cephalometric variables are A'N'B' angle ($r^2 = 0.35$) and FMA' angle ($r^2 = 0.81$) along with AFH and LAFH ($r^2 = 0.859$) and ratio LPFH/AFH ($r^2 = 0.702$).

DISCUSSION

Craniofacial morphology which encompasses both hard and soft tissues have been an important field of discussion and investigation since ages and its understanding is of utmost importance, especially in the field of orthodontics, as the facial appearance and esthetics are prime concerns along with perfect occlusion. Anthropometry was used since the 19th century but fails to sustain, as measurements are affected by pressure on the soft tissue from the fingers or measuring instruments. Interaction time with the patient increases requiring patient to remain stable for a long time, making him uncomfortable and results inaccurate.^[10,11,15] Chairside measurements are tedious and unrealistic during first-time consultations^[4] and cannot be repeated in future in case of error and doubt. Cephalometric analysis constitutes the current gold standard for analyzing and estimating skeletal craniofacial morphology. Its accessibility is still difficult in many parts, especially in a developing country like India, due to heavy and expensive inventory which it requires. Even at lower doses, there remains a risk of a long-term stochastic effects such as cancer, with children and adolescents being more susceptible.^[16] On the ground of noninvasiveness and low cost, photograph is the sphere of interest and thus more efforts have been made to effectively use photographs for quantitatively estimating the craniofacial morphology. The standardized photographic technique has numerous advantages as the subject does not feel uncomfortable and there are no skin pressure-related errors. It is easier to take measurements and the time needed with the patient is also lesser. It is easier for the clinician to explain the photographs to the patient rather than a cephalogram, thus aiding in

Table 4: Correlation between standardized facial profile photographs and lateral cephalograms in overall subjects (using Karl Pearson's correlation)

Measurement Parameters		Overall	
Photographic	Cephalometric	Correlation	P
Sagittal measurements			
Linear			
Wits appraisal'	Wits appraisal	0.530	<0.001***
Angular			
A'N'B'	ANB	0.593	<0.001***
FNP'	FNP	0.374	<0.001***
N'.Sn.Pog'	N.ANS.Pog	0.507	<0.001***
N'Me'/A'B'	N Me/AB	0.330	<0.001***
Vertical measurements			
Linear			
AFH' (N'-Me')	AFH (N-Me)	0.927	<0.001***
LAFH' (Sn-Me')	LAFH (ANS-Me)	0.927	<0.001***
PFH' (Tr-Go)	LPFH (Ar-Go)	0.309	0.001***
Angular			
Tr.Go.Me	Ar.Go.Me	0.65	<0.001***
FMA	FMA	0.902	<0.001***
OPA	OPA	0.65	<0.001***
Ratio			
LAFH'/AFH'	LAFH/AFH	0.596	<0.001***
LPFH'/AFH'	LPFH/AFH	0.838	<0.001***
PFH'/LAFH'	LPFH/LAFH	0.366	<0.001***

*Just significant, **Moderately significant, ***P<0.001 highly significant. HS: Highly significant

patient education and motivation. In addition, measurements can be made recurrently as well as the data can be stored permanently, thus allowing feasibility of long follow-up longitudinal studies. Furthermore, they make an excellent diagnostic tool for large-scale epidemiological studies as they are cost-effective and noninvasive. Profitt however has evolved a shift of paradigm from hard tissue to soft tissue. Thus, the soft-tissue evaluation and assessment is of utmost importance during the treatment outcome estimation, treatment progress assessment, and treatment planning.^[17]

Through proper standardization of the photograph, certain shortcomings with the photographic technique have been easily overcome in the study. First, the magnification factor varies in photographs which are negated in the study by placing a right-angled millimeter scale against the profile of the photograph. Furthermore, angular variables and ratios were used more often, which partially invalidate the difficulty of magnification. Second, similar head inclination during both the procedures were ensured by the use of a modified protractor to obtain the same angle between the center line and wire passing through its center point with a weight attached to give it stability under gravity, as failing to do same will change the location of landmarks and therefore severely affect the measurements. The occlusal plane of

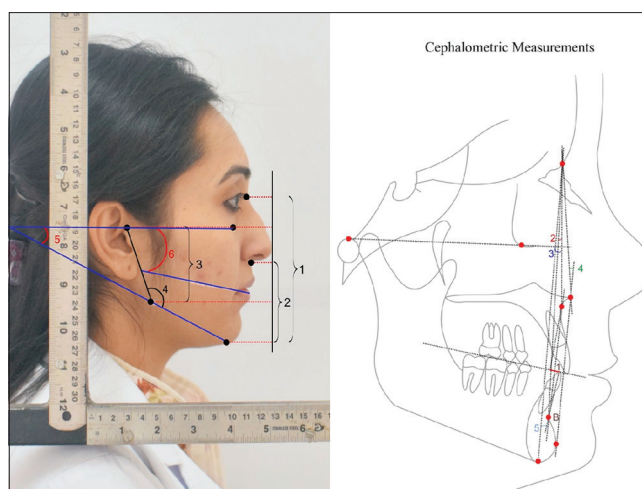


Figure 6: Vertical measurements in profile photograph and lateral cephalogram (1) Anterior facial height' (2) Lower anterior facial height' (3) Posterior facial height' (4) Tr.Go'.Me' (Soft-tissue gonial angle) (5) Frankfort-mandibular plane angle' (Soft-tissue Frankfort to mandibular plane angle) (6) Occlusal plane angle' (soft-tissue Frankfort to occlusal plane angle) Lateral cephalogram: (1) Anterior facial height (2) Lower anterior facial height (3) Lower Posterior facial height (4) Ar.Go.Me (Gonial angle) 5. Frankfort-mandibular plane angle (6) Occlusal plane angle

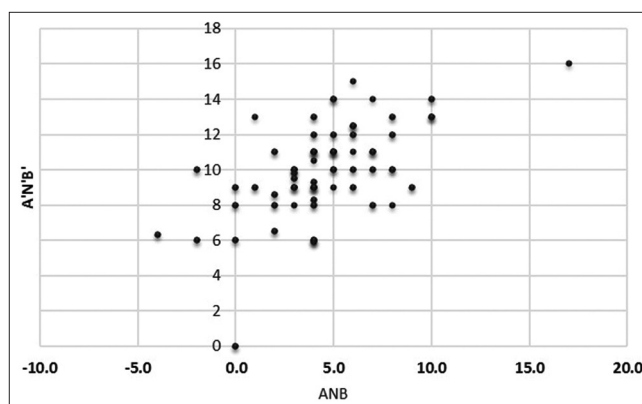


Figure 7: Scatter plot illustrating linear regression plot between cephalometric and photographic measurement ANB versus A'N'B'

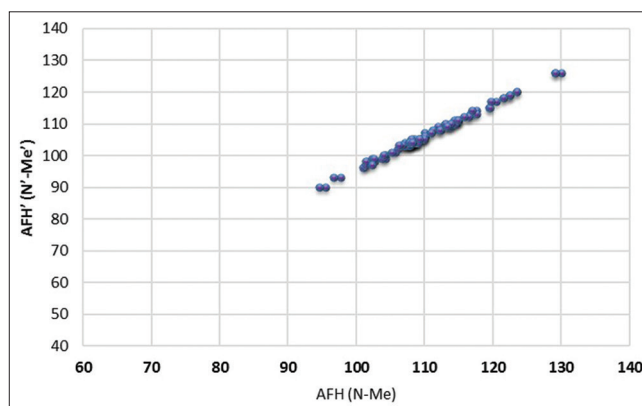


Figure 8: Scatter plot illustrating linear regression plot between cephalometric and photographic measurement anterior face height versus anterior face height'

the subject was transferred on the subject's cheek so that profile photographs are taken in maximum intercuspation and lips closed as on the lateral cephalogram.^[4] Photographic measurements were higher than the cephalometric measurements because of the added soft-tissue thickness. The difference in mean was found to be highly significant for all analogous parameters except posterior facial height (PFH), gonial angle, PFH'/AFH', and PFH'/LAFH' for overall male and female. The correlation was found to be positive and highly significant for all analogous parameters except A-B plane angle' and ratio PFH'/LAFH' in males. Maximum correlation coefficient established for the parameters AFH and LAHF which is highly significant ($r = 0.927$, $P < 0.001$) and minimum correlation coefficient for the parameter PHF (Tr-Go and Ar-Go) ($r = 0.309$, $P = 0.001$).

Bittner and Pancherz^[18] found a moderately positive correlation between A'N'B' and ANB stating that points A and B are closely correlated (moderate correlation $r = +0.63$) with the position of the corresponding points on integumental soft tissue; thus; it partly reflects the maxillomandibular relationship. Barnett^[19] also concluded that the soft-tissue projection of point A and B gives an accurate indication of the relative position of hard tissue point A and B which it justifies the accuracy of A'N'B' [Figure 7].

The correlation between family nurse practitioners (FNP') and FNP (facial angle) was minimum among females as compared to other variables that could be because of the irregularity of soft-tissue thickness over the chin area.^[2,18]

N'.Sn. Pog'/N. ANS. Pog (angle of convexity) shows a highly significant difference as Sn point shows thicker soft-tissue integument over the subnasal hard tissue and grows much in thickness when compared to the increase in hard tissue over the nasion area.^[2,20] In addition, the prognathism of the

soft-tissue chin changes almost identically to the nasion area changes. Therefore, it can be established that soft-tissue changes of the chin are not much responsible for changes in the profile convexity as compared to the soft-tissue thickness over subnasal area.^[20]

A-B plane angle is calculated using N-Me plane as soft-tissue pogonion often shows higher variability,^[2,18] whereas the menton has less soft-tissue variations.^[2]

AFH and LAFH show a highly significant correlation ($r = 0.927$, $r^2 = 0.859$ for both) as the soft-tissue menton follows the hard tissue menton almost linearly [Figures 8 and 9].

The lower value of correlation for PFH may be due to the inaccuracy in determining the accurate position of gonion by palpation.

The FMA angle shows the highest correlation ($r = 0.902$) among all the angular measurements used in the study which is highly significant ($P < 0.001$) [Figure 10].

The correlation factor of LPFH/AFH was significantly higher ($P < 0.001$) for overall (0.838), male (0.786) and female (0.855). These findings were consistent with the results of study done by L Gomes *et al.*^[10]

From the results of our study, we can establish the fact that standardized facial profile photograph can empower the lateral cephalogram for soft-tissue and hard-tissue evaluation as they are inexpensive, noninvasive, and more convenient to use. It can be used as an alternative to lateral cephalogram, especially in establishing the preliminary diagnosis of the patients, and for large-scale assessment, especially in epidemiological purposes.

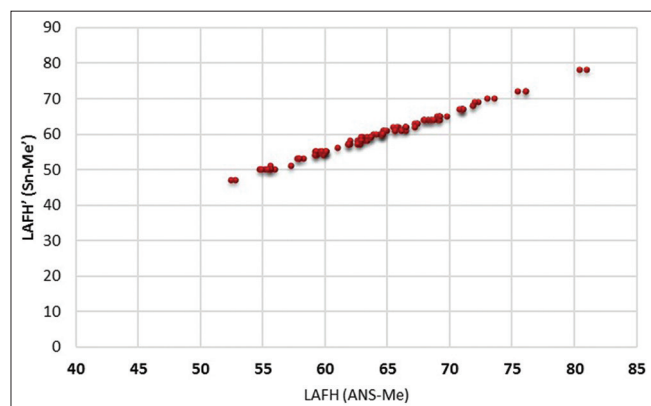


Figure 9: Scatter plot illustrating linear regression plot between cephalometric and photographic measurement lower anterior facial height versus lower anterior facial height'

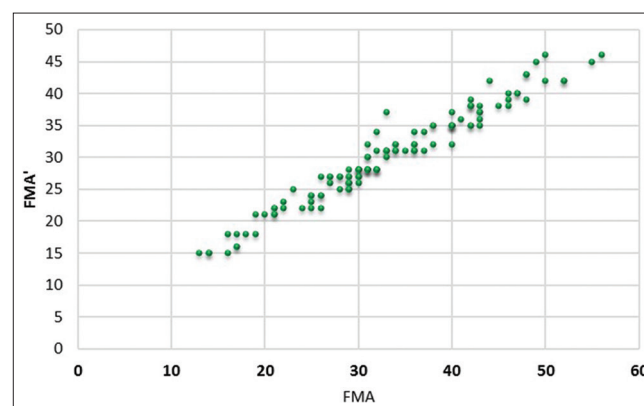


Figure 10: Scatter plot illustrating linear regression plot between cephalometric and photographic measurement Frankfort-mandibular plane angle versus Frankfort-mandibular plane angle

Table 5: Regression analysis for predicting lateral cephalometric measurements using standardized facial profile photographs

Measurement parameters		Linear predictor function ($y=a + bx$)				
Cephalometric (y)	Photographic (x)	Intercept	Slope	P	SE	R ²
Sagittal measurements						
Linear						
Wits	Wits'	0.38	0.7	<0.001***	0.103	0.281
Angular						
ANB	A'N'B'	-2.73	0.72	<0.001***	0.091	0.352
FNP	FNP'	30.52	0.59	<0.001***	0.135	0.140
N ANS Pog	N'.Sn.Pog'	5.81	0.61	<0.001***	0.096	0.257
NMe/A B	N'Me'/A'B'	-2.99	0.28	<0.001***	0.073	0.109
Vertical measurements						
Linear						
AFH (N-Me)	AFH' (N'-Me')	-7.73	1.03	<0.001***	0.008	0.859
LAFH (ANS-Me)	LAFH' (Sn-Me')	-10.36	1.09	<0.001***	0.008	0.859
LPFH (Ar-Go)	PFH' (Tr-Go')	29.82	0.253	<0.001***	0.073	0.095
Angular						
Ar.Go.Me	Tr.Go'.Me'	48.14	0.62	<0.001***	0.067	0.423
FMA	FMA'	5.17	0.75	<0.001***	0.015	0.814
OPA	OPA'	2.701	0.463	<0.001***	0.05	0.423
Ratio						
LAFH/AFH	LAFH'/AFH'	0.19	0.63	<0.001***	0.079	0.355
LPFH/AFH	PFH'/AFH'	0.03	0.94	<0.001***	0.057	0.702
LPFH/LAHF	PFH'/LAFH'	0.53	0.21	<0.001***	0.05	0.134

*Just significant, **Moderately significant, *** $P < 0.001$ HS. HS: Highly significant, SE: Standard error^[21]

The accuracy in assessment of cephalometric measurements from its analogous photographic measurement can be obtained from the linear regression equation we have formulated for each parameter since each parameter was found to be significantly correlated to its counterpart.

In the recent past, there has been a shift in paradigm from hard tissue to soft tissue; thus, the use of photographs can be a primary diagnostic aid since it well correlates the facial soft tissue.

In future, further studies and researches are needed so as to establish enhanced criteria for standardization and calibration so that photographic evaluation can reveal soft tissue as well as hard tissue.

CONCLUSIONS

1. Photographic measurements were higher than the cephalometric measurements and the correlation was found to be highly significant for all analogous parameters except A-B plane angle' and ratio PFH'/LAFH' in males
2. A'N'B' was the best to describe its cephalometric counterpart among facial angle', angle of convexity' and A-B plane angle', angular measurements in sagittal plane
3. AFH', LAFH', FMA, and ratio of PFH'/AFH' were the best to describe discrepancy in vertical plane

4. Although we cannot rule out lateral cephalogram as a primary record in orthodontics, photographic assessment can always be used through proper standardization, as an alternative diagnostic aid, and also for large-scale epidemiological purposes and places with unavailability of cephalostat.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the legal guardian has given his consent for images and other clinical information to be reported in the journal. The guardian understands that names and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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