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A Comparative Study of Photographic and Cephalometric Measurements in Adult Female Bengalee Population

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Abstract: *In clinical Orthodontic practice, Radiography and photography are being used with equal reliability. In contrast to radiograph, photograph has no radiation hazard and it is less expensive. Simultaneously there is a paradigm shift in contemporary orthodontics, which emphasis more on soft tissue aesthetics rather than depending entirely on radiograph. Therefore the key question is whether photograph can be a substitute for conventional cephalogram partially if not totally in pre, interim and post treatment diagnostic and prognostic analysis. Therefore, to meet the mentioned objectives, a co relational, observational and analytical study has been performed in Guru Nanak Institute of Dental Sciences & Research, to compare the relationship between Photographic and Cephalometric measurements in adult female Bengalese population.*

Sample size was 30, with 18 – 25 years of age. Samples had been selected as random sample reported to the outpatient department having orthodontic problem of normal skeletal relationship. The study was a cross sectional study as per the set inclusion and exclusion criteria.

The significant findings of this study were:

- *On comparing the cephalometric and analogous photographic variables for the entire sample, positive and significant correlations had been found for all the variables studied ($r > 0$, $p < 0.05$).*
- *Highest correlation were found for Frankfort Mandibular plane (FMA vs TrOr'Go'Me') angle, SN-MP (SN-MP vs TrN'Go'Me') angle, Gonial (Ar-Go-Me vs TrGo'Me') angle, and Facial (FNP vs TrOr'N'Pog') angle.*
- *The reliability of using photographs is established, indicating that the facial landmarks can be located consistently on a photograph*
- *The photographic method was found to be a repeatable, reproducible, low cost and non invasive diagnostic alternative provided that a standardized protocol is followed.*

So, it can be concluded that, there is a significant and positive correlation exist between cephalometric and lateral photographic analysis. So, basis on certain parameter, lateral facial profile photographs can be used in pre, interim and post treatment diagnostic and prognostic analysis.

Key Words: *photographic, cephalometric measurements, adult female, bengalee population*

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I. Introduction

In orthodontics, accurate diagnosis is the most important for successful treatment outcome[1]. Diagnosis involves development of comprehensive data base of patient's information. The data is derived from case history, clinical examination and other diagnostic tools mainly such as study model, radiographs and photographs in general[2].

Physical appearance is significant feature of the face and self-esteem is strongly influenced by facial appearance[3]. So evaluation of patient's soft tissue profile becomes one of the most important components of orthodontic diagnosis and treatment planning. It has been established that the primary goal of orthodontic treatment is to attain and preserve optimal facial attractiveness[3]. Any orthodontic treatment that ignores facial soft tissue parameter, is prone to failure, as harmonious relationship are desired among the facial, skeletal, dental and soft tissue.[4]

Today, diagnosis and treatment planning place great emphasis on evaluation of the soft tissue and their role in esthetics, whereas the cephalogram has been shown to have questionable validities and reliability in the evaluation of soft tissue. Graber stated that, the photographs assumes even greater importance than cephalograms, he considered photographs as an essential diagnostic tool[1]. From lateral view, facial height, facial

depth, mandibular angle and the position of the upper and lower lips are the main factors that characterize facial pattern.[5-7]

Although cephalometrics is the essential for characterizing skeletal and dental craniofacial morphology, in clinical practice, it might not be practical for long epidemiological studies[8]. Cephalometry is an expensive and technique sensitive procedure. In developing countries like India, not everyone can afford the expensive apparatus, and the radiation exposure is also hazardous for the patient. International Commission of Radiological Protection (ICRP) recommended that, the maximum dose limit should be 1mSv annually for the public[9].

Lateral facial photography is a reproducible, low cost and low technique sensitive procedure to evaluate the craniofacial morphology. Lateral facial photography requires 90 degree from the side[2] in natural head position and can readily be used to assess the measurements of different overlying soft tissue parameters.
Continued relationship between facial overlying soft tissue structure and skeletal structure has been found through lateral radiograph analysis. For example Liliane et al showed that photographic method has proven to be an alternative to cephalogram[7]. Xingzhong Zhang showed the reliability of the photographic technique was excellent[8]. However comparison involving cephalometric and photographic measurements has seldom been performed on Bengalese population, who are the ethnic community of West Bengal, the eastern Indo-Aryan people, who are descended from Austro-Asiatic and Dravidian people and closely related to the others from adjoining region[10]. As cephalometric analysis constitutes the Gold Standard for diagnosing craniofacial morphology in clinical practice, the possibility of predicting cephalometric values through lateral photographs may be relevant as a noninvasive diagnostic tool[6]. The study focused on the investigation of the relationship between cephalometric measurements obtained from cephalometric radiographs and analogous measurements from standardized facial photographs on adult Bengalese female population.

II. Aims And Objectives

a) To investigate the relationship between craniofacial measurements obtained from cephalometric radiographs and measurements from profile photograph.
b) To compare and correlate craniofacial measurements taken from cephalometric radiographs with measurements from standardized facial photographs.
c) To search for an inexpensive, ready to use tool that can be used as a substitution of cephalogram in pre, interim and post treatment diagnostic and prognostic analysis.

III. Material And Method

This cross sectional study 30 untreated normal Bengalese subjects were selected from the outpatient the department of Orthodontics & Dentofacial Orthopedics, Guru Nanak Institute of Dental Sciences & Research, Kolkata – 700114.

Inclusion Criteria-
Angle class I molar relationship
Age range between 18 – 25 (adult Bengalese females)
Lateral cephalogram should be of good quality. All the cephalometris landmarks should be visible and there should be good contrast with soft tissue.
Photographs also should be of good quality. Lateral facial photographs requires 90 degree from the side. All the landmarks soft tissue landmarks should be visible and there should be good contrast with proper exposure. There should not be any scratch mark.
Cephalometry and photography should be in 1:1 proportionate ratio with the face Cephalogram and photographs should be taken under standard protocol using valid tools.

Exclusion Criteria- No obvious facial asymmetry
No previous orthodontic treatment done
No facial surgery
No scar marks on face
Female over 28 year of age are excluded, as in older female, age changes are obviously visible, which give an impact on soft tissue.

Hard tissue point & their definition used in this comparative study:

A. Porion – The Porion is the most superior point of the outline of external auditory meatus. The term ‘ machine porion’ refers to the most superior point of the image of the ear rod in the cephalostat.
B. Orbitale – The lowest point of the inferior margin of orbit

C. Sella – The point representing the geometric centre of the pituitary fossa (sella turcuca) in the mid sagittal plane.
D. Nasion – The intersection of the internasal and frontonasal suture in the mid sagittal plane
E. Point A – The point at the deepest midline concavity on the maxillary alveolus between anterior nasal spine and prosthion
F. Point B – The point at the deepest midline concavity on the mandibular alveolus between infradentale and pogonion
G. Pogonion – The most anterior point on the contour of the bony mandibular symphysis in the mid sagittal plane.
H. Menton – The most inferior point of the bony mandibular symphysis in the mid sagittal plane.
I. Gonion – The most inferior posterior point on the contour of the angle of the mandible. It may be constructed as the point of intersection of the posterior ramal plane and mandibular plane, extending the bisector through the curvature of the gonial region of the mandible.
J. Articulare – It is constructed at the point of intersection of the image of the posterior border of the mandibular ramus and the inferior border of the basilar part of the occipital bone.

Soft tissue point and their definition used in this comparative study:
A. Tragion – A point in the depth of the notch just above the tragus of the ear.
B. Orbitale – It is a point on soft tissue on most inferior portion of the orbital floor below the centre of eye found by palpation.
C. Nasion – It is usually the point of deepest concavity of the soft tissue contour of the root of the nose overlying the area of the frontonasal suture.
D. Point A – The point of greatest concavity of the facial contour of the upper lip between subnasale and labrale superius in the mid sagittal plane.
E. Point B – It is the point of greatest concavity of the facial contour of the lower lip between labrale inferius and soft tissue pogonion.
F. Pogonion – It is the most prominent or anterior point on the soft tissue chin in the mid sagittal plane.
G. Menton – It is the lowest point on the soft tissue over mandible in the mid sagittal plane.
H. Gonion – It is the most lateral point on the soft tissue contour of each mandibular angle located at the same level on the hard tissue gonion found by palpation.

Statistical Analysis:

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS 24.0. and GraphPad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. Paired t-tests were a form of blocking and had greater power than unpaired tests. Correlation was calculated by Pearson correlation analysis. The Pearson product-moment correlation coefficient was a measure of the linear dependence between two variables X and Y. Linear Regression Analysis was performed by with 95% confidence interval. Explicit expressions that can be used to carry out various t-tests are given below. In each case, the formula for a test statistic that either exactly follows or closely approximates a t-distribution under the null hypothesis is given. Also, the appropriate degrees of freedom are given in each case. Each of these statistics can be used to carry out either a one-tailed test or a two-tailed test. p-value ≤ 0.05 was considered for statistically significant.

IV. Result And Analysis

Table: Distribution of mean ANB vs. A'N'B' Group, Ar Go Me vs. TrGo'Me', FMA vs. TrOr'Go'Me', FNP vs. TrOr'N'Pog', NA Pog vs. N'A'Pog', SNA vs.TrN'A', SNB vs. TrN'B' and SNMP vs. TrN'Go'Me'

		Number	Mean	SD	Minimum	Maximum	Median	p-value
ANBvs. A'N'B'Group	Cephalometry	30	3.6000	1.5669	1.0000	6.0000	4.0000	<0.0001
	Photography	30	7.8000	2.2190	3.0000	13.0000	8.0000	
Ar Go Me vs.TrGo'Me'	Cephalometry	30	128.6000	4.7822	120.0000	139.0000	127.5000	0.0938
	Photography	30	130.7000	4.7645	119.0000	142.0000	131.0000	
FMA vs. TrOr'Go'Me'	Cephalometry	30	25.4000	4.3991	18.0000	32.0000	25.0000	0.2475
	Photography	30	24.1333	3.9891	18.0000	35.0000	23.5000	
FNP vs. TrOr'N'Pog'	Cephalometry	30	87.5000	3.6079	82.0000	97.0000	87.0000	0.6155
	Photography	30	86.9667	4.5218	80.0000	103.0000	86.5000	
NA Pog vs.	Cephalometry	30	6.7000	3.8430	1.0000	13.0000	7.5000	<0.0001

N'A'Pog'	Photography	30	18.5333	4.5161	9.0000	26.0000	19.0000	
SNAvs.TrN'A'	Cephalometry	30	84.1000	2.3686	79.0000	88.0000	85.0000	0.3379
	Photography	30	84.7667	2.9441	79.0000	93.0000	85.0000	
SNB vs.TrN'B'	Cephalometry	30	80.5000	2.3686	76.0000	86.0000	80.0000	<0.0001
	Photography	30	76.9333	2.9441	71.0000	83.0000	77.0000	
SNMP vs.TrN'Go'Me'	Cephalometry	30	31.4667	4.2729	24.0000	40.0000	31.5000	0.0961
	Photography	30	33.2667	3.9648	24.0000	42.0000	33.5000	

Table: Association of Linear Regression Analysis between Cephalometric and Photographic Measurements

	F	Intercept Coefficient	df	Level of Significance (p-value)	Slope Coefficient	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
SNA and TrN'A'	.106	-.966	58	.338	0.667	.690	-2.048	.714
		-.966	55.457	.338	0.667	.690	-2.049	.716
SNB and TrN'B'	2.067	4.974	58	<0.0001	3.567	.717	2.131	5.002
		4.974	55.221	<0.0001	3.567	.717	2.130	5.004
ANB and A'N'B'	1.334	-8.468	58	<0.0001	4.200	.496	-5.193	-3.207
		-8.468	52.161	<0.0001	4.200	.496	-5.195	-3.205
SNMP and TrN'Go'Me'	.180	-1.691	58	.096	1.800	1.064	-3.930	.330
		-1.691	57.678	.096	1.800	1.064	-3.931	.331
FMA and TrOr'Go'Me'	1.183	1.168	58	.247	1.267	1.084	-.904	3.437
		1.168	57.454	.248	1.267	1.084	-.904	3.437
FNP and TrOr'N'Pog'	.387	.505	58	.615	.533	1.056	-1.581	2.647
		.505	55.275	.616	.533	1.056	-1.583	2.650
NA Pog and N'A'Pog'	.062	-10.930	58	<0.0001	11.833	1.083	-14.001	-9.666
		-10.930	56.552	<0.0001	11.833	1.083	-14.002	-9.665
Ar Go Me and TrGo'Me'	.082	-1.704	58	.094	2.100	1.232	-4.567	.367
		-1.704	57.999	.094	2.100	1.232	-4.567	.367

We found that mean level of Photography was higher than Cephalometry. Difference of mean ANB vs. A'N'B' in two groups was statistically significant (p<0.0001). We found that mean level of Photographywas higher than Cephalometry. Difference of mean Ar Go Me vs. TrGo'Me' in two groups was not statistically significant (p=0.0938). It was found that mean level of Cephalometry was higher than Photography. Difference of mean FMA vs. TrOr'Go'Me' in two groups was not statistically significant (p=0.2475).We found that mean level of Cephalometry was higher than Photography. Difference of mean FNP vs. TrOr'N'Pog' in two groups was not statistically significant (p=0.6155). It was found that mean level of Photography was higher than Cephalometry. Difference of mean NA Pog vs. N'A'Pog' in two groups was statistically significant (p<0.0001).We found that mean level of Photography was higher than Cephalometry. Difference of mean SNA vs. TrN'A' in two groups was not statistically significant (p=0.3379). T Statistic = 0.9663. It was found that mean level of Cephalometry was higher than Photography. Difference of mean SNB vs. TrN'B' in two groups was statistically significant (p<0.0001).We found that mean level of Photography was higher than Cephalometry. Difference of mean SNMP vs. TrN'Go'Me' in two groups was not statistically significant (p=0.0961). T Statistic = 1.6914. Positive correlation was found between SNA vs. TrN'A' and that was statistically significant.

Positive correlation was found between SNB vs. TrN'B'and that was statistically significant.Positive correlation was found between ANB vs. A'N'B'and that was statistically significant.Positive correlation was found between SNMP vs. TrN'Go'Me'and that was statistically significant.Positive correlation was found between FMA vs. TrOr'Go'Me'and that was statistically significant.Positive correlation was found between FNP vs. TrOr'N'Pog'and that was statistically significant.Positive correlation was found between NA Pog vs. N'A'Pog'and that was statistically significant.Positive correlation was found between Ar Go Mevs. TrGo'Me'and that was statistically significant.

V. Discussion

If we consider the sample size of similar type of studies done by some others, Xingzhong Zhang et al[8]. had taken 326 samples in their study, Liliane de Carvalho et al[6]. had taken 123 subjects in their study, Dolly P Patel et al[7] had taken 60 samples in their study, Saibel Farishta, Zinnie Nanda[11] had taken 80 samples in their study.

Cephalometric analysis is rewarded currently as a gold standard for skeletal craniofacial morphology in orthodontic clinical practice. But contemporary orthodontics have led the way in the emergence of the paradigm shift, placing greater emphasis on soft tissue structure and assessment of the soft tissue changes that occur with each dentoskeletal change and with age thus allowing for greater accuracy in treatment planning[5]. For many

years photographs are being used for documentation in orthodontic practice, but they are usually analyzed from a qualitative point of view only. Quantitative evaluations are seldom performed, probably because of the lack of carefully standardized technique, both in taking the picture and in their evaluation[6]. A standardized photography protocol[12] includes accurate establishment of landmarks. Considering that, most photographic measurements of superficial landmarks were performed based on anatomic points achieved by palpation. Other landmarks obtained from lateral photographs used in this current study are at the midline which is located in the same plane of space. Because the subject does not move, it is easier to take measurements, there are no skin pressure related errors, and the period of interaction with the subject is potentially shorter. Moreover, measurements can be performed repeatedly and data stored permanently, which makes longitudinal follow-up study feasible.

In this current study, these hard tissue angles and their corresponding soft tissue angles were being analyzed to draw inference. In this present study, cephalogram was traced manually, and angular measurements had been drawn directly on photographic paper. If we look some other study, Sandeep Pogulwar et al.[5] analyzed both digital photographic and radiographic records with Dolphin imaging software. Xingzong Zhang et al[8] traced manually on tracing paper, Liliane de Carvalho et al[6]. analyzed both digital photographic and radiographic records with Radiocef 2.0 software, Atalia Wasserstein et al[4]. traced both cephalographs and photographs manually.

In this present study, Strong and highly significant correlation was found in Correlation between FMA and TrOrGo'Me', where the Pearson Correlation Coefficient value is 0.911. If we compare it with other's same type of study, the Correlation value was o.32 in the study of Dolly P Patel et al[7], 0.42 in the study of Sandeep Pogulwar et al[5], and 0.93 in the study of Bittner and Pancherz. Due to strong significant correlation of the Mandibular plane angle, photographs can be used reliably to judge the facial growth pattern.

Strong and highly significant Correlation was found in Correlation between SNMP and TrN'Go'Me', where the Correlation Coefficient value is 0.866. If we compare it with other's same type of study, the Corelation Coefficient value was 0.33 in the study of Warda Arif Khan et al[2], and 0.27 in the study of Dolly P Patel et al[7].

Strong and highly significant Correlation was found in Correlation between ArGoMe and TrGo'Me', where the correlation value is 0.816. If we compare it with other's same type of study, the Correlation Coefficient value was 0.79 in the study of Liliane de Carvalho et al[6].

Strong and highly significant Correlation was found in Correlation the between FNP and TrOrN'Pog', where the correlation value is 0.804. If we compare it with other's same type of study, the Correlation Coefficient value was 0.971 in the study of Sandeep Pogulwar et al[5], and 0.61 in the study of Liliane de Carvalho et al[6].

Moderately positive but highly significant correlation was found in the correlation between SNA and TrN'A', where the correlation value is 0.661. If we compare it with other's same type of study, the Correlation coefficient value was 0.463 in the study of Dolly P Patel et al[7], 0.434 in the study of Xingzhong Zhang et al[8] and o.367 in the study of Warda Arif Khan et al[2].

Moderately positive but highly significant correlation was found in the correlation between SNB and TrN'B' where the Correlation coefficient value is 0.606. If we compare it other's same type of study, the Correlation coefficient value was 0.390 in the study of Warda Arif Khan et al[2], 0.460 in the study of of Xingzhong Zhang et al[8], and 0.546 in the study of Dolly P Patel et al[7].

Weakly positive but significant Correlation was found in the correlation between NAPog'and N'A'Pog', where the Correlation coefficient value was 0.512.

Weakly positive significant Correlation was found in the correlation between ANB and A'N'B', where the Correlation coefficient value is 0.472. If we compare it with other's same type of sytdy, the Correlation Coefficient value was 0.930 in the study of Sandeep Pogulwar et al[5], 0.283 in the study of Dolly P Patel et al[7], and 0.82 in the study of Lilliane de Carvalho[6].

Barnett DP in his article[13] concluded that the point A an B on the facial skeleton is closely correlated with the position of the corresponding points on the integumental soft tissue. He also stated that the relative projection of the soft tissue A and B gives an accurate indication of relative projection of hard tissue A and B as does the angle ANB.

Linear regression analysis showed that the photographic variable that best explained the variability of its analogous cephalometric measurements in the current study was the A'N'B' angle, where r^{14} value is o.68. This means that at least 68% of the variance of the cephalometric assessment can be explained by such photographic measurements given the total sample. If we consider other study, it is supported by the study of Liliane de Carvalho[6] where the value is same.

Interestingly, some other significant findings have come out from the present study, which has got some relevance on adult Bengalese female population on Steiner's analysis. Within standard deviation 2.3, the mean SNA value of adult Bengalese female population is 84.1, within standard deviation 2.3, the mean SNB value of adult Bengalese female population is 80.5, and within standard deviation 1.5, the mean ANB value is 3.6. If we

consider other study in respect of other parts of India, in a study done by Kanappan on south Indian people (n=100), the SNA value was 82.6, SNB was 79.9 and ANB was 2.7. In a study done by John KK, on Keralites (n=50), the SNA value was 84.14, SNB was 81.85, and ANB was 2.27. In a study done by Bora & Baruah[15] on Assamese people (n=70), the SNA value was 84.5, SNB was 81.41 and ANB was 3.01. In a study done by Patel HM on Gujarathi people (n=30), the SNA value was 81.26, SNB was 78.25 and ANB was 3.01. In another study done by O.P.Kharbanda[16] on North Indian people (n=45), the SNA value was 82.6, SNB was 79.21, and ANB was 3.27. If we consider International findings, in a study, done by Ruth et al[17]. on Israelis (n=40), SNA was 81.63,SNB was 78.2 and ANB was 3.43. In a study done by Park et al[18]. on Korean people (n=80), SNA was 81.15, SNB was 78.7 and ANB was 2.5. In a study done by Gracia[19] on Mexican Americans (n=59), SNA was 83.6, SNB was 80.8, and ANB was 2.8. In a study done by Miura Fujio[20] et al on Japanese (n=90), SNA was 81.3, SNB was 76.8, ANB was 4.5.In another study done by Drummond[21] on Negroes (n=40), SNA was 84.7, SNB was 79.2, and ANB was 5.5.

VI. Conclusion

In primary outcome, the reliability of the photographic method was established, while comparing standardized facial photography with cephalometric radiography as a method of characterizing craniofacial morphology in diagnosing and treatment planning of orthodontic problem.

In secondary outcome, some parameters showing sagittal relationship of jaw, that is angle SNA, SNB and ANB value has come out in adult Bengalee female population which can be compared with the population group of other parts of India and world of different ethnic group.

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