Original Research

Comparison of angular and linear measurements of soft tissue profile between cephalograms and photograph in subjects with class I and class II malocclusion in North Indian population- A comparative study

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ABSTRACT

Aim: The aim of the present study was to compare angular and linear measurements of soft tissue profile between cephalograms and photograph in subjects with Class I and Class II malocclusion. **Materials and Methods:** Samples consist of digital lateral cephalograms and profile photograph of 100 subjects (50 Class I and 50 Class II, 25 males and 25 females in each group) between age ranges of 18 to 35 years (mean age 22^{+}/- 2.32). All records were taken in natural head position, centric occlusion and lips in relaxed position. Intra-class correlation coefficients (ICCs) were calculated from repeated photographic measurements to evaluate method reliability. Seven angular and fourteen linear parameters were measured for soft tissue analysis on both lateral cephalogram and photographs. Student's t-test was done for making adequate comparison. **Results:** The reliability of the photographic technique was found satisfactory and no statistical difference in angular as well as linear parameters was found for soft tissue profile on both photographs & cephalograms respectively. **Conclusion:** Photographs can be used as an alternative for cephalograms in epidemiologically large-scale studies, where there is a need for cost effective, non-invasive techniques.

Keywords:-*Cephalogram, malocclusion, photographs, soft tissue profile.*

In the era of digitalisation, digital photographs instead of lateral cephalograms in day to day Orthodontic practice, is gaining popularity in the recent years. Previously photographs were used only as an adjunct to cephalograms in anthropometric research and orthodontics clinical practice. However, with upcoming recent advances in technology and standardization in photographic techniques, they can be used as adjunct to radiographs and for maintaining clinical records. Standardized cephalograms have a strong arm in diagnosis and treatment planning of orthodontic cases [1-3]. With the advent of new cephalometric analysis for comparison between normal and abnormal skeletal patterns, the diagnosis and treatment planning for orthodontic patients has become easier. Consistent skeletal and overlying facial soft tissue relationships was obtained from radiographic analysis [4-6]. But a few studies comparing the measurements on cephalograms and photographs are done till date with conflicting results have been documented in literature [7, 8]. Since cephalometric analysis continues to be the goldstandard for diagnosing craniofacial morphology in

dental and orthodontic clinical practice, a non-invasive diagnostic tool for predicting cephalometric values through photographs, especially in epidemiological research purposes and where radiographic setup may not be possible, photographs can be a valuable aid.

The validity of any measurement obtained from cephalometric radiographs is dependent on the reliability of the landmarks identified. This concept emphasizes the importance of reliable landmarks for cephalometric facial analysis and should be considered for angular and linear soft tissue measurements on facial photographs. The reliability of skeletal landmarks on lateral cephalometric radiographs has been well documented [9]. However; there is limited evidence about the reliability of facial soft tissue landmarks on photographs. Therefore better evidence about the reliability of photogrammetric soft tissue landmarks is needed before a reliable facial analysis can be constructed [10, 11].

In previous studies facial profile has been compared between photographic and cephalometric measurements, to assess the diagnostic accuracy of photograph as an alternative low cost, low radiation method for assessing soft tissue profile of the patients [12, 13]. Another study compared only angular photogrammetric measurements of soft tissue profile of north Indian males and females using Nemoceph NX software. The advantage of various cephalometric softwares like Dolphin, Nemoceph, Vistadent, Quick Ceph, Dr Ceph and FACA Dare is that they provide rapid, precise and customized method of measurements and allow simulating and predicting multiple treatment options. In the present study we have taken more number of linear and angular parameters than the previous studies to cover the full assessment of soft tissue facial profile. Aim of the present study was to compare various parameters between lateral cephalogram and photograph in Class I and Class II malocclusion.

MATERIAL AND METHODS

The patients were selected for the study by simple random sampling who had come to the Department of Orthodontics for the orthodontic treatment. The initial orthodontic records consisted of lateral cephalograms which were required for the study. Participants selected for the study were explained the details of the study and an informed written consent was obtained from parents or their legal guardians. The study outline and design followed the principles mentioned in the Declaration of Helsinki. Lateral cephalograms and standardized profile photographs were obtained from 150 subjects.

Patients with Class I skeletal base (ANB 0-2 degrees), Class II skeletal base (ANB 2-4 degrees), presence of complete maxillary anterior segment, no history of orthodontic treatment and no history of craniofacial trauma and absence of congenital anomalies or malformations were included in the study. Patients with any anomalies were excluded from the study.

After inclusion criteria of the study was used 100 subjects were selected for the study, (50 Class I and 50 Class II, 25 males and 25 females in each group of Indo-Aryan Indian race) between age ranges of 18 to 35 years (mean age - 22+- 2.32).Study was carried out as a cross sectional study over a period of 2 months from June 2018 till August 2018 in Lucknow Uttar Pradesh.
They were further divided into skeletal Class I and Class II base with the help of cephalometric readings (ANB angle according to Steneir's analysis).

- Group Ia (Right Profile Photograph) Of Class I malocclusion
- Group Ib (Lateral Cephalogram) Of Class I malocclusion
- Group IIa (Right Profile Photograph) Of Class II malocclusion
- Group IIb (Lateral Cephalogram) Of Class II malocclusion

Standardized profile photographs of the right side were taken in the natural head position (NHP), and maximum intercuspation with lips at rest was followed throughout the study procedure (Figure 1). A80 X 30 cm mirror was hung on a tripod, which can be adjusted according to patients height and allowed for vertical adjustments, were used to obtain photographs in NHP. Patients were asked to stand a step behind a line drawn 120 cm from the mirror with feet slightly apart and arms relaxed. Patients were made relaxed by asking them to tilt their head up and down with decreasing amplitude and take a step forward looking straight ahead into the reflection of their eyes in the mirror, with this the patient was bought in the desired Ortho position (Figure 2).To record the NHP angle, a protractor was placed on the tip of the nose and the soft tissue pogonion, and a plumb line [14-16]. Digital Single-Lens Reflex Camera (EOS 1300D, Canon, Tokyo, Japan) mounted with Canon EF 100 mm f/2.8 Prime Macro Lens

Ultrasonic (Canon, Tokyo, Japan). A Ring flash (Canon, Tokyo, Japan) was used throughout the duration of study for all photographs. The Camera was mounted on tripod for stabilization and adjusted to the subject's height.

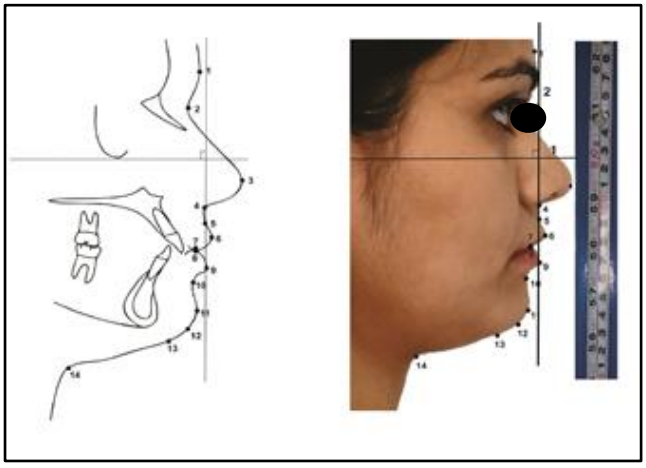

Figure 1 - Landmarks: 1.Glabella (G'), 2.Soft tissue Nasion (N'), 3.Pronasal (P), 4.Subnasal (Sn), 5.Superior Labial Sulcus (SLS), 6.Labralesuperoris (Ls), 7.StomiumSuperioris (stm s), 8.Stomiuminferioris (stmi), 9.Labraleinferiorus (Li), 10.Inferior Labial Sulcus (ILS), 11.Soft tissue Pogonion (Pog'), 12.Soft tissue Gnathion (Gn'), 13.Soft tissue Menton (Me'), 14.Cervical point (C), 15.Frankfort Horizontal Plane (FH), 16.True Vertical Line (TVL).

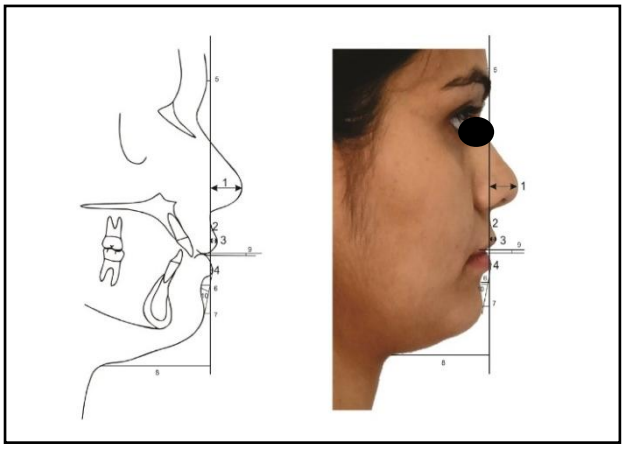

Figure 2 - Angular Measurements: 1. Upper lip Angle, 2. Naso Frontal Angle, 3. Naso Mental Angle, 4. Naso Facial Angle, 5. Mento Cervical Angle

To avoid facial deformations and maintain natural proportions, 100 mm Macro Lens was used. The camera image settings were used on manual setting for maximum image quality suitable with the given the lighting condition. The true vertical (VER) was obtained using a 15-cm vertical scale and was adapted in a plumb line. The scale was positioned in the mid sagittal plane, which allowed for recording the photographs at life size (1:1). (Figure 3)

Digital lateral cephalogram were shot with a NewTom (Verona, Italy). The exposure parameters were kept standard at 70 kV, 10 mA, and 0.5 seconds for all the lateral cephalogram. 1:1 scale (life size) was kept so that there were no magnification errors. Lateral Cephalograms were taken in an NHP (mirror position) with maximum intercuspation and lip sat rest. The digital photographic and lateral cephalograms were analysed with Radiocef 2.0 (Radio Memory Ltda, Belo Horizonte, MG, Brazil) software for Windows. 21 soft tissue parameters were measured in all of which 14 were linear and 7 were angular measurements. The software automatically calculated all the measurements, when all the desired points were marked. A single operator in blind study design performed all the computerized analysis of facial morphology through radiographs and photographs.

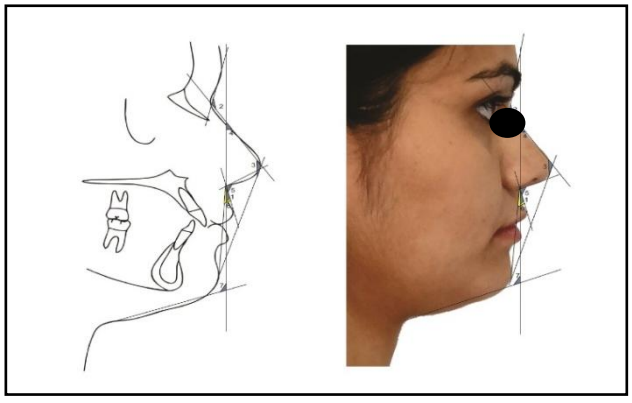

Figure 3 - Linear Measurements: 1.Nasal projection, 2.Soft tissue point A to TVL, 3.Upper Lip Anterior to TVL, 4. Lower Lip Anterior, 5.Glabella to TVL, 6.Soft tissue point B to TVL, 7.Soft tissue Pogonion to TVL, 8.Throat Length, 9.Interlabial Gap, 10. Inferior Labial Sulcus, 11. Upper lip Length, 12. Lower Lip Length, 13. Lower 1/3 Facial height, 14.Total Facial Height.

The linear and angular measurements were repeated after an interval of one month on 30 subjects (15 males and 15 females) who were randomly selected. The Data was assembled and collected to perform statistical analysis using the Statistical Package for the Social Sciences, version 21 (SPSS Inc, Chicago, Ill). Each photographic and cephalometric variable was given Descriptive statistics. Independent sample t-test was employed for evaluating the sexual dimorphism. To compare cephalometric and photogrammetric measurements in

Class I and Class II malocclusion students t test was applied. To ensure the repeatability and reproducibility of the method, Intra class correlation coefficients (ICCs) were estimated from repeated photographic measurements. Levels of $P < 0.05$ were considered to be statistically significant.

RESULTS

Tables 1 and 2 denote the Means, standard deviations and ranges for all cephalometric and photographic measurements. A high intra-class co-relation was seen among the two values. Statistically no significant gender differences were found for cephalometric and photographic measurements and in general, no statistical significant difference between all the linear and angular parameters in Class I and Class II malocclusion groups was noted when compared between photographs and lateral cephalograms.

DISCUSSION

The reliability of hard and soft tissue landmarks on lateral cephalometric radiographs has been well documented in literature, however; there is limited evidence about the reliability of facial soft tissue landmarks on photographs**.**

As said now a days it is believed that malocclusion should be treated from an aesthetic point of view depending on the patient's face, and not alter the face in light of teeth when it is in harmony. Thus, the assessment of soft tissue is of utmost importance in diagnosis and treatment planning in orthodontics. Considering this we tried to compare angular and linear measurements of soft tissue profile between cephalogram and photograph in Class I and Class II malocclusions. As shown in the Table 2 the difference between mean value of all angular parameters between photograph and cephalogram of Class I and Class II malocclusion patients was statistically non-significant and were similar to the results obtained by Munish Reddy et al [17]. Facial convexity angle, Nasofrontal angle, Nasofacialangle, Nasomental angle and Cervicomental angle were the parameters which were same in both the studies. However, no other studies have been done to compare parameters between cephalogram and photograph hence no other comparison could be made.

Table: 1 - Comparison of angular parameters

Parameters	Class I						Class II					
	Comparison of group Ia with Ib for angular parameters						Comparison of group IIa with IIb for angular parameters					
	Group Ia		Group Ib				Group IIa		Group IIb			
	Mean	SD	Mean	SD	'p'	IP	Mean	SD	Mean	SD	'p'	IP
Facial convexity Angle	14.91	4.87	16.05	5.24	0.542	NS	16.44	4.49	18.30	4.34	0.259	NS
Neck&lower 3rd Angle	108.29	8.31	108	10.20	0.419	NS	111.75	9.26	111.96	6.27	0.942	NS
Upper Lip Angle	17.39	8.33	18.69	8.57	0.676	NS	16.48	6.38	16.57	6.20	0.968	NS
Naso labial Angle	100.90	12.12	94.1	11.06	0.118	NS	103.44	12.83	103.64	11.43	0.964	NS
Naso frontal Angle	118.57	48.75	115.1	48.46	0.848	NS	133.81	10.64	129.88	12.45	0.360	NS
Naso facial Angle	33.97	3.78	35.73	4.83	0.277	NS	32.56	4.54	35.27	4.46	0.110	NS
Nasomental Angle	127.70	5.87	125.3	7.12	0.318	NS	129.41	5.12	125.31	5.19	0.370	NS
Mentocervical Angle	100.26	8.41	99.2	9.40	0.750	NS	102.56	9.46	101.49	6.89	0.725	NS

To diagnose skeletal morphology and craniofacial imaging in routine orthodontic practice, cephalometric analysis is one of the gold standards. However, the photographic assessment is gaining interest as diagnostic tool for epidemiologic studies as it does not expose the patient to harmful X-ray radiations and is cost-effective too [1].

Table: 2 -Measurement of Linear parameters

Parameters	Class I						Class II					
	Group Ia		Group Ib				Group IIa		Group IIb			
	Mean	SD	Mean	SD	'p'	IP	Mean	SD	Mean	SD	'p'	IP
Inferior Labial Sulcus	-3.41	1.88	-5.25	2.31	0.224	NS	-5.18	2.08	-5.91	2.24	0.366	NS
Inter labial Gap	2.37	1.60	3.49	2.36	0.137	NS	3.26	2.99	3.85	2.60	0.568	NS
Upper lip Length	18.36	2.87	18.60	2.29	0.802	NS	19.09	2.55	18.92	2.55	0.855	NS
Lower Lip Length	40.91	4.78	39.37	4.72	0.384	NS	40.38	5.38	39.65	4.85	0.699	NS
Lower 1/3 height	61.49	5.50	61.4	5.31	0.975	NS	62.01	6.96	61.62	6.16	0.870	NS
total facial height	109.67	6.61	108.19	6.67	0.548	NS	110.77	8.99	108.7	8.04	0.511	NS
Glabella to TVL	-5.82	5.26	-6.63	5.09	0.7	NS	-8.71	4.54	-9.70	3.95	0.5	NS
Nasal Projection To TVL	11.63	4.61	10.51	4.11	0.49	NS	10.26	7.96	12.01	2.59	0.42	NS
Soft Tissue A Point to TVL	0.35	1.10	0.03	0.96	0.404	NS	0.27	0.68	0.11	1.03	0.619	NS
Upper Lip Anterior to TVL	3.09	2.35	3.57	2.22	0.570	NS	3.26	1.35	3.47	1.56	0.708	NS
Lower Lip Anterior to TVL	1.73	3.13	1.71	2.87	0.955	NS	-0.44	1.82	-0.47	1.48	0.967	NS
Soft Tissue B Point To TVL	-5.31	3.90	-6.35	4.02	0.478	NS	-8.68	3.85	-8.94	3.43	0.848	NS
Soft Tissue Pogonion to TVL	-5.45	4.24	-5.83	4.58	0.818	NS	-6.95	3.76	-6.44	3.12	0.686	NS
Throat Length	53.57	5.46	55.02	5.64	0.481	NS	53.15	9.64	52.93	5.82	0.940	NS

The linear and angular measurements obtained from the photographs were found to be useful for characterizing facial morphology and can be reliably measured and traced (as well as lateral cephalograms) which corroborates with previous studies[18-21]. The findings from the study suggests that photography can prove to be a feasible and practical alternative where traditional radiographs are considered too invasive or practically impossible [12, 20]. Some short comings of photographic technique in the form of distortion were seen during the course of study was because of the distance between the lens and the subject which shows the objects near the camera appear larger than those farther from it [21]. This is important when attempting to compare structures in different planes of space. The procedure was standardized by employing a single operator for taking pictures and performing computerized analysis. The results showed that both methods reproducibility was also satisfactory.

With the different skeletal facial patterns, both cephalometric and photographic measurements had no significant gender differences, confirming similar

distribution into male and female subgroups. Different authors reported sexual dimorphism with labial, nasal, and chin areas when evaluating photographs. Male faces on an average, shows greater heights and lengths as well as greater prominences of these areas [23]. The values were found to be similar in proportions for both male and female subjects, even though male subjects showed greater absolute measurements. The age group selected for current study (18–35 years) elected because, as adults there will be minimal amount of hard and soft tissue growth which may lead to changes in the linear measurement values. Staudt and Kiliaridis [8] observed that several soft tissue measurements gave a reliable description of the underlying sagittal jaw relationship. Though cephalometric remains the method of choice for evaluation of dento-skeletal and soft tissue structure of patients, it can be summarized from the results of this study that photographs might be used as an alternative for large-scale epidemiologic studies, especially when there is a need for a low-cost, non-invasive method that can be used in diverse clinical and field settings.

The basic limitations with the photographs are that the assessment of hard tissue structures is not possible but photographs can be used as a valuable diagnostic tool for soft tissue assessment. Hence, to validate the findings of our study, further research is needed in future, comparing large number of subjects in different Classes of malocclusion and in different races of population. The norms for photographs should be determined in future studies as well.

CONCLUSION

Photographs may be used as an alternative for evaluation of soft tissue structure of patients in epidemiologically large-scale studies, where there is a need for cost effective, non-invasive techniques.

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