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Comparison of photographic soft tissue analysis with conventional cephalographic soft tissue analysis using a computer based application

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Abstract

Background: Photographs have been widely used for the identification of an esthetic ideal. More recently, exposure to radiation and protection from radiation has helped us rediscover photography. The study was conducted to compare the values obtained from the cephalometric soft tissue analysis and photographic soft tissue analysis. The aims of this study was to develop an effortless and rapid method for the quantification of the soft-tissue profile by a lateral photograph and to collect data.

Methods: lateral profile photograph and lateral cephalograph of 10 patients undergoing orthodontic correction were collected and profile angle, nasofacial angle, nasofrontal angle, nasolabial angle, nasomental angle, mentocervical angle, maxillary sulcus contour, mandibular sulcus contour, upper lip projection, lower lip projection were measured using a computer based application named Image J® on both, cephalograph and photograph, for each patient and the difference of each was tabulated.

Results: The result showed that the p value was more than 0.05 for all the angles except upper lip projection, indicating that the difference obtained in the readings were not statistically significant. However, the p value obtained for upper lip projection was less than 0.05 suggestive of a difference

Conclusion: The study will serve as the reference study for further studies conducted for the soft tissue analysis for the orthodontic treatment plan. Photographs may be used for epidemiological work, screening, initial consultations and cases where irradiation needs to be avoided.

Keywords: Cephalometry, photographs, software, lateral profile, analysis

Introduction

The determination of facial aesthetics has always been done by pretreatment soft tissue analysis in the field of dentistry, especially in orthodontics, thereby offering an important medium for clinicians. Various cephalometric analyses have been proposed and applied on the lateral skull radiograph for the classical, quantitative assessments of soft-tissue profiles.[1]

Facial photography has been utilized only as passive record maintenance since the introduction of radiographic analyses, and other subsequent cephalometric assessments, in the last few years. Lateral photographs only had a subjective role, as the objective assessment was conducted on cephalometric radiographs. The most general use of photographs has been for identification of an aesthetic ideal.[2] Lately, the harmful effect of radiography and concerns regarding radioprotection has brought up the rediscovery of photography. The application of this method was first done by using linear and angular measurements from profile photographs on the soft-tissue profile of children who were born with a congenital disorder, unilateral cleft lip and palate.[1]

Newer advanced techniques of photography has enabled capturing facial profiles with very little distortion. Lateral photographs have assisted in various studies in respect to the soft tissues from adolescence to adulthood.[3] For the measurement of (assessing), the influence of different malocclusion classes, and the orthodontic treatment on facial esthetics, analyses of soft tissue profiles on quantitative photography were used in adults. The literature on profile analysis in children includes very little data.[1]

The evaluation of facial profile is more difficult in children than adults as they have an underlying dynamic skeletal growth taking place, which makes it a primary area of importance, especially at the early mixed dentition period. Clinically, it might be too early for the orthodontic treatment, but soft tissue analysis and quantification at an early age could be considered useful from a prognostic and diagnostic point of view.[4]

This study has a double- edged aim: to develop an effortless and rapid method for the quantification of the soft-tissue profile by a lateral photograph and to analyse data of patients with flush terminal plane molar relation by the use of software application (Image J2®) and compare the soft tissue analyses traced on, both, cephalograph and photograph.

Materials and methods

The comparative study was conducted at the Department of Pediatric and Preventive Dentistry, Krishnadevaraya College of Dental Sciences, Bengaluru. 10 Patients of 13–18 years of age undergoing orthodontic correction were selected for the study. Lateral profile photograph and lateral cephalograph of those 10 patients were collected and then the collected data was uploaded on the server. The profile angle, nasofacial angle, nasofrontal angle, nasolabial angle, nasomental angle, mentocervical angle, maxillary sulcus contour, mandibular sulcus contour,

upper lip projection, lower lip projection were measured by tracing lines and angles using a computer based application named Image J® on both, cephalograph and photograph, for each patient and the difference of each was tabulated. The exclusion criteria included, patients with mixed dentition, patients with any carious lesion, patients with maxillofacial trauma or pathology or any developmental defects.

Based on previous study effect size calculated was 1.4 with α error probability of 0.05 and with 80 % power sample size calculated was 10 per group

Photographic Set up

Photographic set up consisted of a Nikon DSLR Camera with 18 to 55 mm macro lens having a primary flash. A tripod stand was set according to the height of the patient and used as a leveling unit to maintain the correct horizontal positioning of the optical lens. The standard set for lateral right profile photograph was patients without spectacles, with ears clearly visible and hair tucked back from forehead, neck and ears, lips at rest with maximum intercuspation, and natural head position (NHP) . As per the definition by Lundström, the normal head posture is the mean position of the head when the individual is standing in a relaxed position with the visual axis horizontal.

Cephalograph setup:

The digital extraoral radiograph of lateral skull were recorded with Orthophos XG, with software Side XS. The parameters for exposure were 73 kvP, 15 mA, and 9.4 seconds.

Computerized Assessment

The analysis of digital radiographic and photographic records were done using ImageJ, a Java image processing program available in public domain license for private usage; it is inspired by NIH Image for the Macintosh. It runs, either as an online browser application and also distributed as binary downloadable for Windows Operating System with Java1.4 or later virtual machine (JVM). The photograph and the cephalograph of each patient was uploaded and the below mentioned measurements were recorded. The measurements were automatically displayed on the system after the landmarks and lines were traced on the image.

Following measurements were recorded for the photograph and cephalograph[3]:

- Profile angle : Gla′-Sn-Pg′ soft tissue glabella-subnasale-soft tissue pogonion (Fig. 1) (Fig. 2).
- Nasolabial angle : C-Sn-ULA columella-subnasale-upper lip anterior (Fig. 3) (Fig. 4).
- Nasofrontal angle : the line drawn from nasion to Glabella that will intersect a line drawn a tangent to the nasal dorsum (Fig. 5) (Fig. 6).
- Nasofacial angle : vertical line tangent to the forehead at the glabella and the tangent to the chin at the pogonion so that a line drawn along the nasal dorsum intersects it (Fig. 7) (Fig. 8).
- Nasomental angle : line drawn through the nasal dorsum intersecting a line drawn from nasal tip to soft tissue chin at pogonion (Fig. 9) (Fig. 10).
- Mentocervical angle : a vertical line tangent to the forehead passing at glabella and second line intersecting tangent to the chin at pogonion (Fig. 11) (Fig. 12).
- Maxillary sulcus contour (Fig. 13) (Fig. 14).
- Mandibular sulcus contour (Fig. 15) (Fig. 16).
- Upper lip and lower lip projection (fig 17) (fig 18)

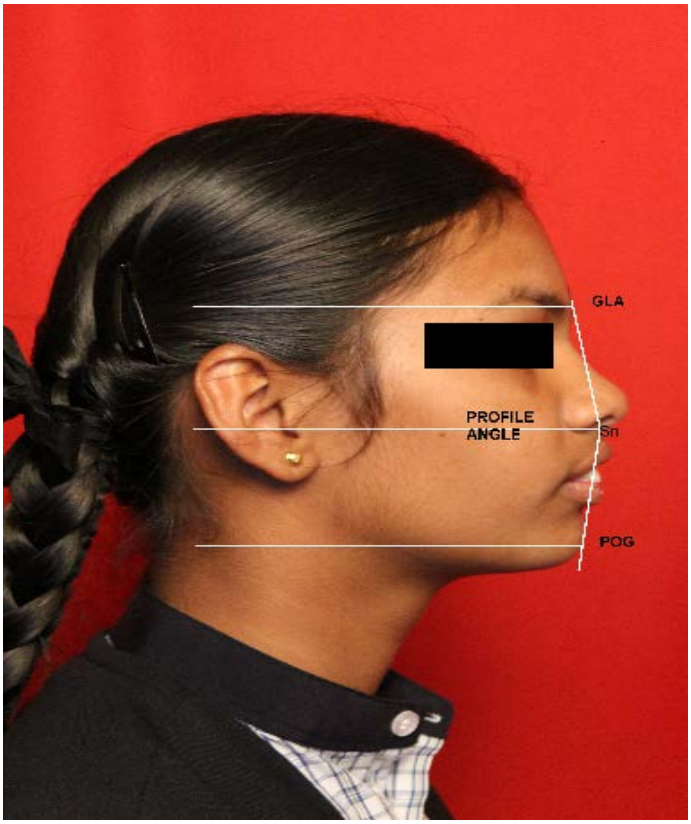

Figure 1 : Profile angle (Photographic analysis)

Figure 3 :Nasolabial angle (Photographic analysis)

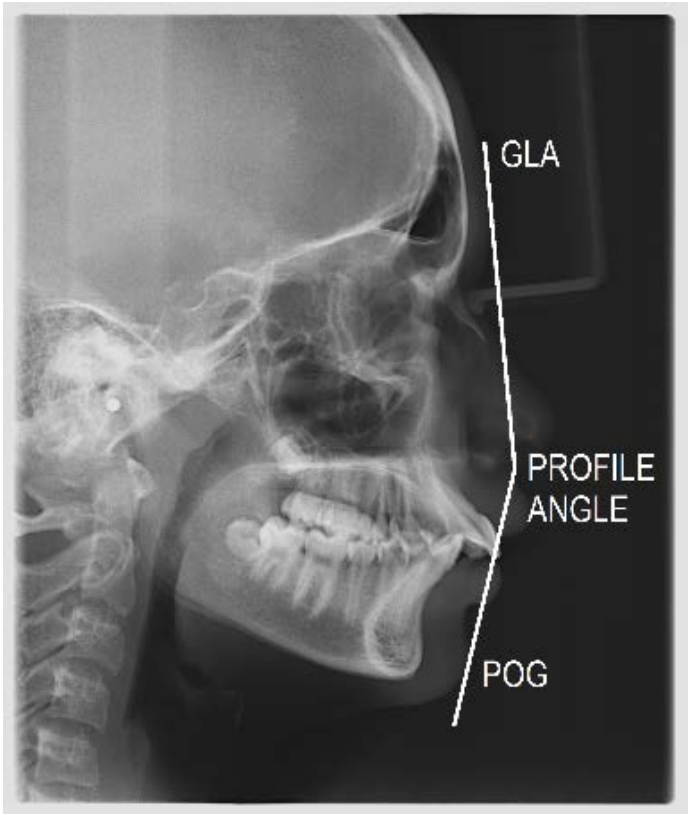

Figure 2 : Profile angle (cephalometric analysis)

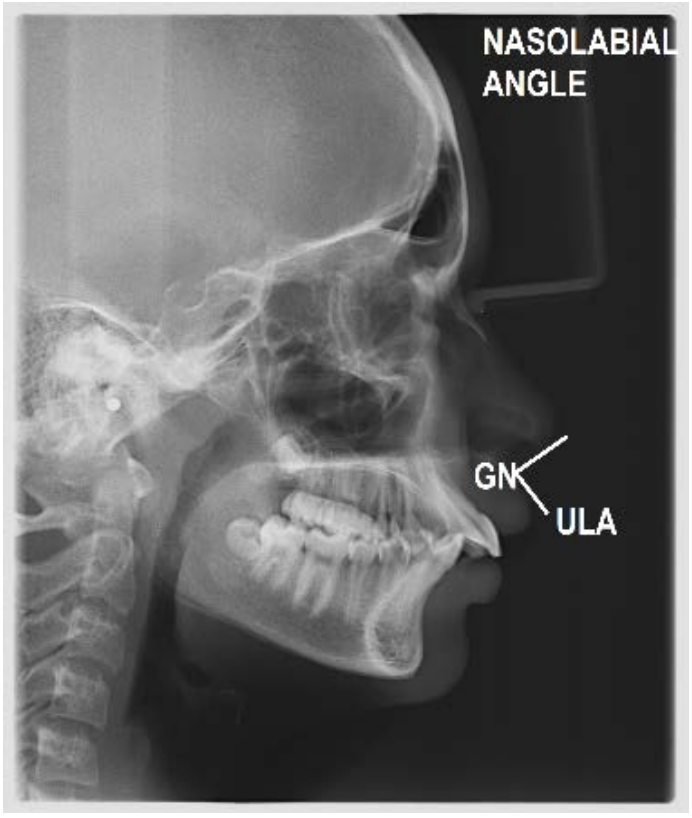

Figure 4 : Nasolabial angle (cephalometric analysis)

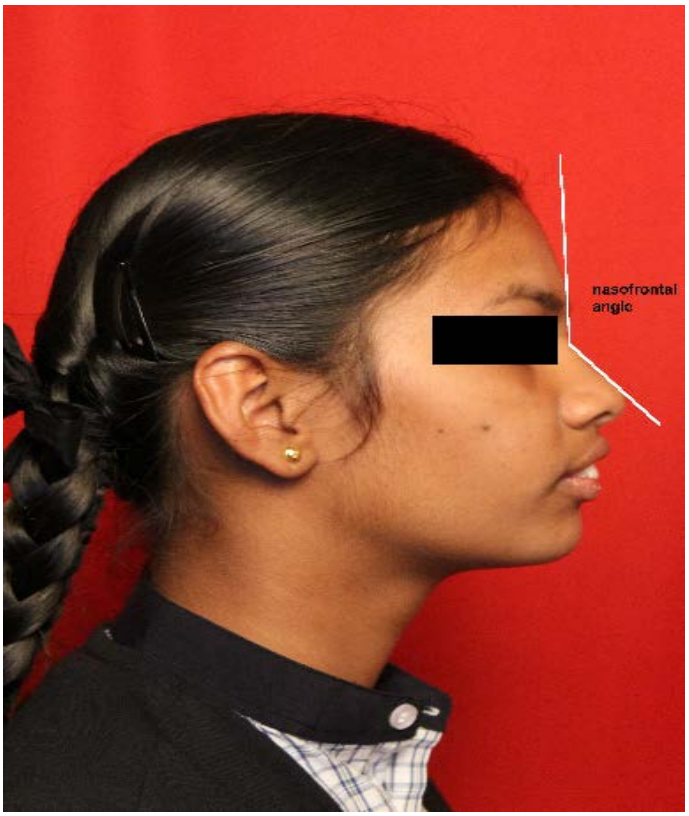

Figure 5 : Nasofrontal angle (Photographic analysis)

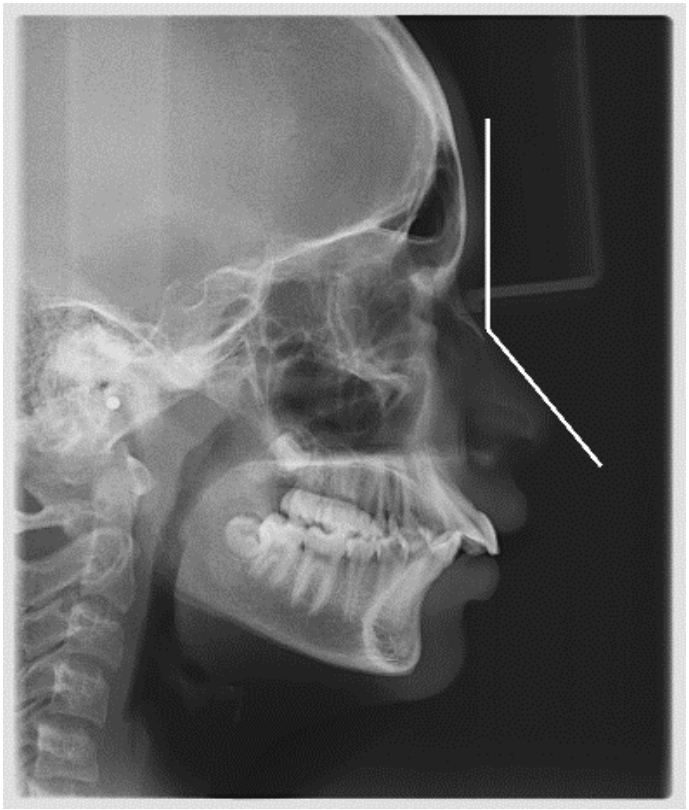

Figure 6 : Nasofrontal angle (cephalometric analysis)

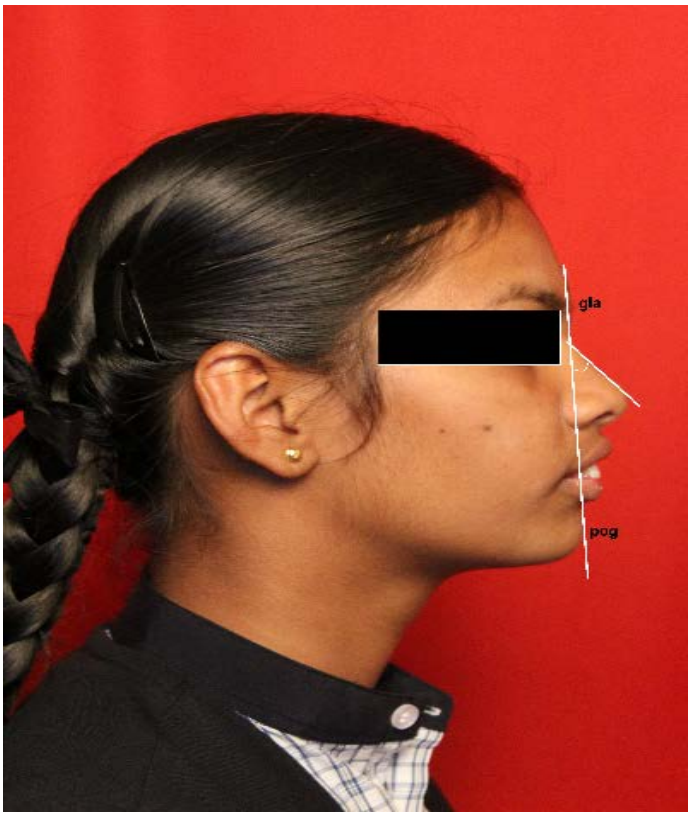

Figure 7 : Nasofacial angle (Photographic analysis)

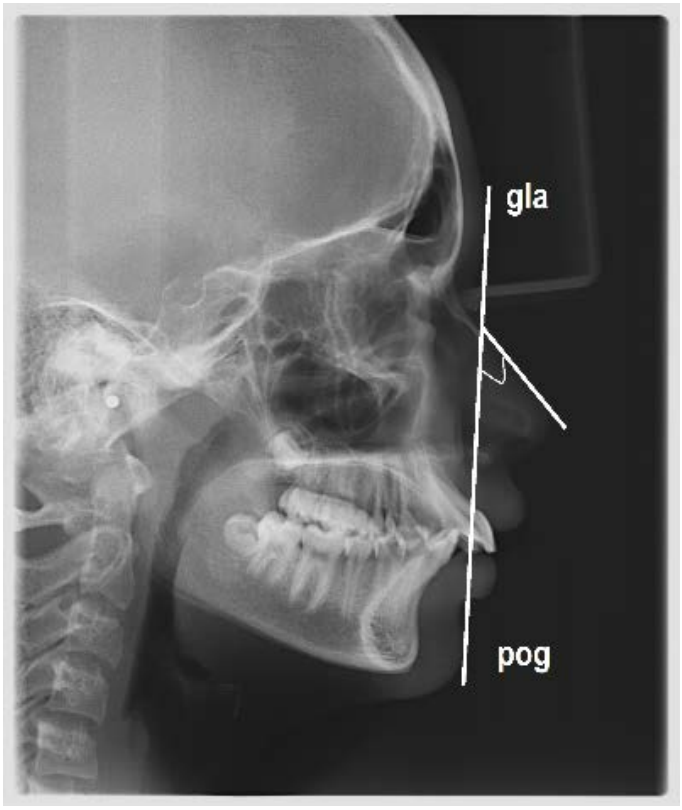

Figure 8 : Nasofacial angle (cephalometric analysis)

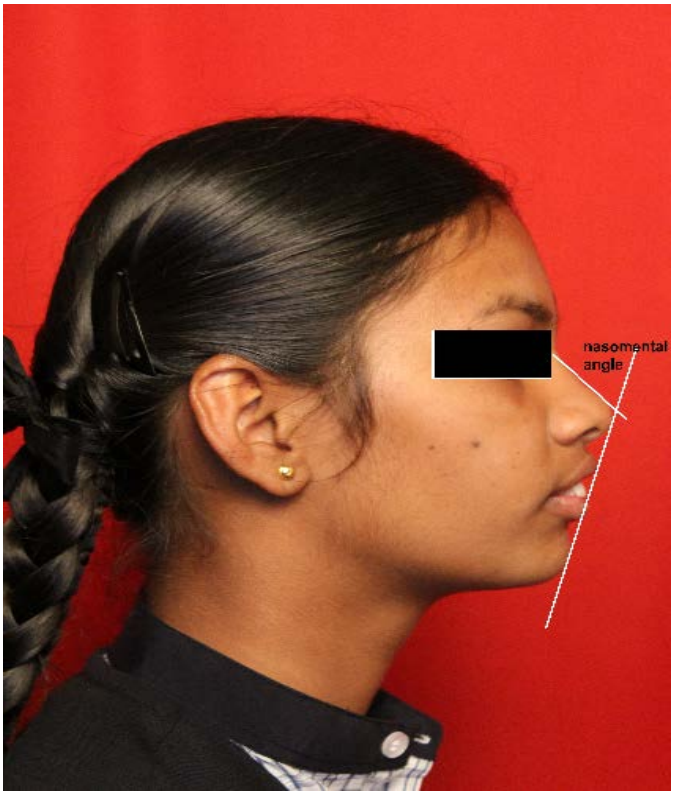

Figure 9: Nasomental angle (Photographic analysis)

Figure 11 : Mentocervical angle (Photographic analysis)

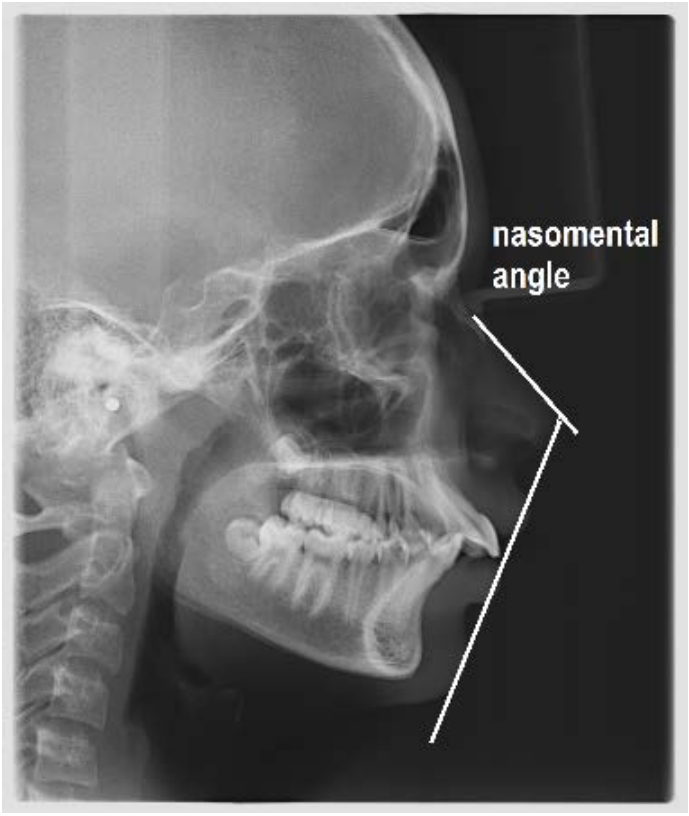

Figure 10: Nasomental angle (cephalometric analysis)

Figure 12 : Mentocervical angle (cephalometric analysis)

Figure 13 : Maxillary sulcus contour (Photographic analysis)

Figure 15: Mandibular sulcus contour (Photographic analysis)

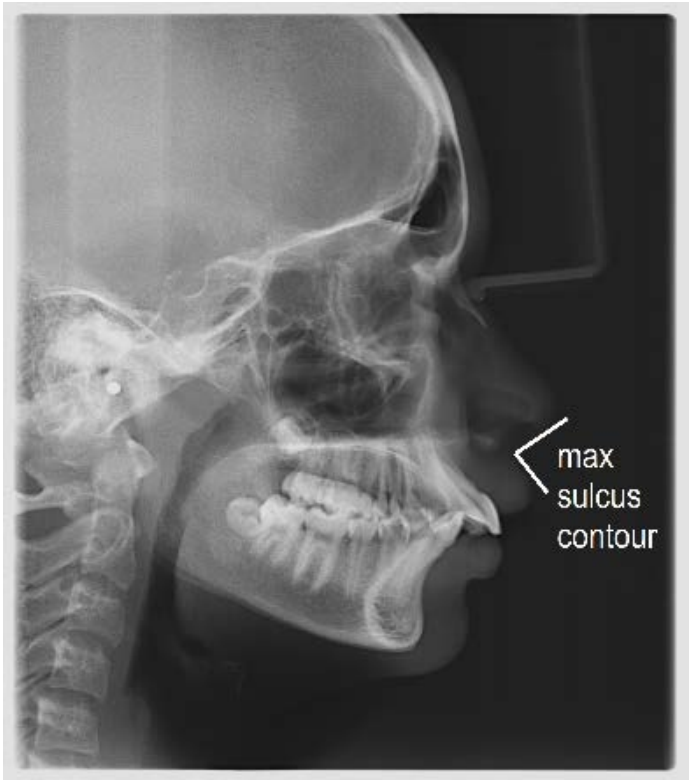

Figure 14 : Maxillary sulcus contour (cephalometric analysis)

Figure 16 : Mandibular sulcus contour (cephalometric analysis)

Figure 17: Upper lip and lower lip projection (Photographic analysis)

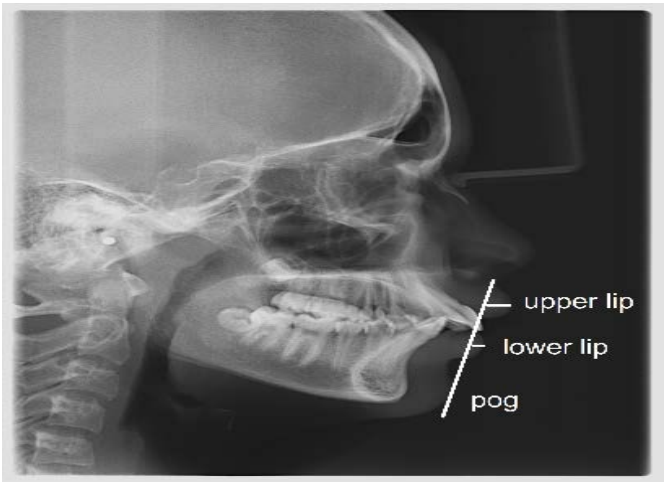

Figure 18 : Upper lip and lower lip projection (cephalometric analysis)

Results

The values of the angles and lines traced on the cephalograph and photograph using the Image J application. On the data collected descriptive statistical analysis including mean values for each photographic and cephalometric calculation with standard deviation derived with a narrow range of 95% confidence interval indicated higher accuracy of the study (Table 1). The Mann-Whitney U test was used to compare differences between two independent groups (photographic and cephalometric) with the dependent variable which is either ordinal or continuous, but not normally distributed (table 2). The result showed that the p value was more than 0.05 for profile angle, nasofacial angle, nasofrontal angle, nasolabial angle, nasomental angle, mentocervical angle, maxillary sulcus contour, mand sulcus contour, and lower lip projection indicating that the difference obtained in the readings were not statistically significant. However, the p value obtained for 'upper lip projection' was less than 0.05 suggestive of a difference in the cephalometric and photographic values.

Descriptive Analysis						
	Group	N	Minimum	Maximum	Mean	Std. Deviation
Profile Angle	IMAGE	10	155.84	169.1	161.7295	4.34883
	CEPH	10	152.58	168.41	161.1342	5.3902
Nasofacial Angle	IMAGE	10	35.23	44.09	40.0563	2.90962
	CEPH	10	33.09	46.07	41.8958	3.62243
Nasofrontal Angle	IMAGE	10	132.31	149.07	142.3454	5.78416
	CEPH	10	128.17	155.12	140.0508	8.53157
Nasolabial Angle	IMAGE	10	59.38	109.44	92.4536	13.0441
	CEPH	10	65.14	104	87.2257	11.80681

Nasomental Angle	IMAGE	10	116.33	129.33	122.348	4.27438
	CEPH	10	115.76	133.04	120.4764	5.64908
Mentocervical Angle	IMAGE	10	86.79	118.44	100.5396	9.48743
	CEPH	10	88.41	118.02	102.6548	10.87466
Max. Sulcus Contour	IMAGE	10	65.07	118.26	95.4667	13.85998
	CEPH	10	70.02	109.55	91.9133	12.45155
Mand Sulcus Contour	IMAGE	10	87.49	122.23	105.2908	11.77769
	CEPH	10	79.89	112.86	100.7919	10.51542
Upper Lip Projection	IMAGE	10	1	5	3	1.1547
	CEPH	10	1	6	4	1.2693
Lower Lip Projection	IMAGE	10	0	5	2.5	1.56347
	CEPH	10	0	6	2.85	2.05548

Table 1: Descriptive analysis on the Data obtained from the software on cephalograph and photograph

Mann-Whitney U Test						
	GROUP	N	Mean	Std. Deviation	Mean Difference	P
Profile Angle	IMAGE	10	161.7295	4.34883	0.59530	0.821
	CEPH	10	161.1342	5.39020		
Nasofacial Angle	IMAGE	10	40.0563	2.90962	-1.83950	0.131
	CEPH	10	41.8958	3.62243		
Nasofrontal Angle	IMAGE	10	142.3454	5.78416	2.29460	0.406
	CEPH	10	140.0508	8.53157		
Nasolabial Angle	IMAGE	10	92.4536	13.04410	5.22790	0.199
	CEPH	10	87.2257	11.80681		
Nasomental Angle	IMAGE	10	122.3480	4.27438	1.87160	0.174
	CEPH	10	120.4764	5.64908		
Mentocervical Angle	IMAGE	10	100.5396	9.48743	-2.11520	0.940
	CEPH	10	102.6548	10.87466		
Max. Sulcus Contour	IMAGE	10	95.4667	13.85998	3.55340	0.290
	CEPH	10	91.9133	12.45155		
Mand Sulcus Contour	IMAGE	10	105.2908	11.77769	4.49890	0.364
	CEPH	10	100.7919	10.51542		
Upper Lip Projection	IMAGE	10	3.0000	1.15470	-1.00000	0.044
	CEPH	10	4.0000	1.26930		
Lower Lip Projection	IMAGE	10	2.5000	1.56347	-.35000	0.674
	CEPH	10	2.8500	2.05548		

Table 2: Mann-Whitney U test on the Data obtained from the software on cephalograph and photograph

Results and discussion

The morphology of the craniofacial structures has always been of great importance for artists, dentists, and practically every individual who is interested in his or her facial appearance.[5] Cephalometrics assists in understanding the dentofacial growth and development and from the clinical perspective, it is indispensable as it aids in orthodontic treatment planning, to record the progress and analyze the changes derived from the orthodontic treatment.

Photographs are widely used by dentists for documentation and mostly used for qualitative analysis. Photographic analyses are comparatively an economic option, as not all patients are willing to pay before the commencement of treatment.[6] It also avoids harmful radiation exposure of the patient and could bring forth a better presentation of external craniofacial structures, including the contribution of adipose tissue and muscle. The lack of morphological imbalance of the skeletal components is often masked by the contribution of the soft tissue components. In the earlier times, photographs took precedence over the other techniques but currently despite having various advantages quantitative evaluation is seldom performed, as the standardization of taking the pictures and their evaluation is not properly documented.[3]

The present study provides a preoperative soft tissue analysis on the cephalograph as well as the photograph in 13 to 18-year-old patients who are undergoing orthodontic treatment. The values obtained from the cephalograph and photograph were compared to find any difference in the results. The mean of the photographic analysis for profile angle is 161.7295 and for cephalometric analysis is 161.1342, therefore the difference is insignificant. The mean nasofacial angle in the image is 40.0563 and for the cephalograph is 41.8958, the p-value is 0.131 ($p > 0.05$) thereby making the difference insignificant. The mean of the photographic analysis for nasofrontal angle is 142.3454 with the standard deviation of 5.78416 and for cephalographic analysis is 140.0508 with the standard deviation of 8.53157 and p-value is 0.406 ($p > 0.05$) therefore, the difference is insignificant. The mean of the photographic analysis for nasolabial angle is 92.4536 and for the chephalograph is 87.2257 but the p-value is 0.199 ($p > 0.05$) as the standard deviation is more, 13.04410 and 11.80681 respectively for photograph and cephalograph thereby making the difference insignificant despite having a difference in the mean of 5.22790. The mean of the photographic analysis for nasomental angle is 4.27438 and for cephalographic analysis is 5.6490 and the p-value was 0.174 ($p > 0.05$) therefore the difference obtained is insignificant. The mean of the photographic analysis for mentocervical angle is 100.5396 and for the cephalometric analysis is 102.6548 with a higher standard deviation and p-value 0.940 ($p > 0.05$) therefore the difference obtained is insignificant. The mean difference of the photographic analysis and cephalometric analysis for maxillary and mandibular sulcus contour is significant but the standard deviation is high and the p-value is more than 0.05 (0.290 and 0.364) making the difference between the two insignificant. The mean of the photographic analysis for lower lip projection is 2.5 and of the cephalographic analysis is 2.8500, therefore the difference is insignificant. The mean of the photographic analysis for upper lip projection is 3.0 and of the cephalographic analysis is 4.0 with the standard deviation of 1.15470 and 1.26930 and the p-value is 0.044 ($p < 0.05$) therefore the result has a significant difference. (Table 2)

The result obtained showed that there was not much difference in the values of photographic and cephalometric with for profile angle, nasofacial angle, nasofrontal angle, nasolabial angle, nasomental angle, mentocervical angle, maxillary sulcus contour, mand

sulcus contour, and lower lip projection whereas the upper lip projection have a significant difference which could be due to the lip position while clicking the picture and the angulation of the head.

The orthodontic practice and theory have always considered the Angle paradigm the gold standard. The facial beauty was thought to depend on perfect occlusion making the goal of treatment to align teeth in perfect occlusion.[7] However, the goal of treatment is not the skeletal proportions, but the soft tissue proportions.[7] Proffit et al., have shifted the paradigm and highlighted the clinical examination of the patient and soft tissue assessment, and improved the accuracy of the treatment plan by emphasizing on the dentoskeletal change that occurs with age.[8]

The photographic analysis could be applied in daily clinical practice as it is a simple, and inexpensive method for soft tissue analysis. The radiation exposure during the growing period could have harmful side effects which can be avoided by opting for the photography method.[9] This method is also better accepted by the patient since the public is more familiar with it. Dolly P Patel et al compared the cephalometric and photographic variables, and found a significant correlation($r>0$, $P < 0.05$), and concluded photographs may be used reliably.5 Dr. Suranjan B et al., stated that there is a significant positive correlation exist between cephalometric and lateral photographic analysis.[10]

There are certain limitations of the study, firstly it cannot completely replace the cephalograph but it is a better alternative for soft tissue assessment. The analysis can only be carried out in clean shaved individuals, as beard may interfere in locating soft tissue landmarks on the upper lip area and chin area. These should not be used alone as they are both a 2-D representation of 3-D structures, so other methods, like model analysis and OPG, should also be explored. The sample size chosen is relatively small so more studies should be conducted with a bigger sample size.[5]

Conclusion

Photography could be used as an alternative in 3rd world countries, like India, diagnostic and treatment planning procedures for diagnostic and treatment planning procedures, where exorbitant cephalometric apparatus is not accessible everywhere.[5] Although photography cannot replace cephalometrics completely as they both measure different craniofacial aspects but it is equally important diagnostic aid for soft tissue analysis. Therefore, photographs can be used for epidemiological work, record maintaining, initial consultations and cases where radiation needs to be avoided.

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