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RESEARCH ARTICLE

RELIABILITY OF PHOTOGRAPH BASED SOFT TISSUE CEPHALOMETRICS

Dr. Geetika Simhadri, *Dr. Kala Vani S.V., Dr. Aparna K., Dr. Surya Mithra G.V.N., Dr. K. Prasanna Kumar and Dr. Fayaz Basha SK

Department of Orthodontics and Dentofacial Orthopedics, C.K.S. Theja Institute of Dental Sciences and Research, Tirupati, India

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ABSTRACT

Introduction: The shift from hard tissue paradigm to soft tissue paradigm results in the establishment of numerous soft tissue cephalometric parameters to evaluate the facial esthetics in diagnosis and treatment planning.

Objective: To evaluate the reliability and diagnostic acceptance of photograph based soft tissue cephalometrics.

Materials & method: Thirty right profile photographs and lateral cephalograms were taken in natural head position (NHP) in patients around 14-30 years of age and assessed using Dolphin imaging software to evaluate the sagittal maxillary projection, mandibular projection and growth pattern in skeletal cephalometric analysis (SCA), radiographic based soft tissue cephalometrics (rSTCA), photograph based soft tissue cephalometrics (pSTCA). Kruskas-wallis and post hoc pairwise comparison tests were used to analyze the results.

Result: Statistically significant concordance was observed with parameters N per pt A vs TVL to pt A', N per Pog vs TVL to Pog', hard tissue facial angle vs soft tissue facial angle between the skeletal cephalometric analysis (SCA), radiographic based soft tissue cephalometric analysis (rSTCA) & photograph based soft tissue cephalometric analysis (pSTCA).

Conclusion: The study results suggested that the parameters taken in this study showed a positive correlation which supported the null hypothesis and reliability of photograph based soft tissue cephalometric analysis.

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INTRODUCTION

An aesthetically pleasing and balanced face is one of the main objectives of orthodontic diagnosis and treatment planning. For decades, the period of cephalometric dominance continued in which esthetics was defined primarily in terms of the profile as measured on a lateral cephalogram. Sometimes, relying entirely on cephalometric dentoskeletal analysis for treatment planning can lead to esthetic problems, especially when the orthodontist tries to predict soft tissue outcome using only hard tissue normal values (Bergman, 1999), because the soft tissue envelope of the face may vary greatly along with the dentoskeletal changes. As a result, consideration of soft tissues started in the early 20th century and continued to expand and resulted in a paradigm shift in the field of orthodontics, placing greater emphasis in conducting studies to assess the reliability of soft tissue cephalometrics on lateral cephalograms (Siddiqui *et al.,* 2016; Ackerman *et al.,* 1999).

Corresponding author: **Dr. Kala Vani S.V.,**
Department of Orthodontics and Dentofacial Orthopedics, C.K.S. Theja Institute of Dental Sciences and Research, Tirupati, India.
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Soft tissue cephalometrics provides the information regarding the soft tissue facial characteristics and also assesses the sagittal and vertical craniofacial pattern and facial harmony (Bergman *et al.,* 2013; Holdaway, 1983). Lateral cephalograms provide considerable information for diagnosis and treatment planning and considered as a gold standard in orthodontic diagnosis since are the time cephalostat was introduced in 1931, by Broadbent and Hofrath. But it is technique sensitive and requires expensive equipment. So, there is an increasing need to develop alternative reliable methods that can give similar results which is less expensive and non-invasive. In most of the cases, soft tissue characteristics on the profile photographs are sufficient to assess the harmonious relationship among external craniofacial structures as that provided by the lateral cephalogram. Thus, photographs also served well as pre-diagnostic records to evaluate the soft tissue profile and facial harmony in diagnosis and treatment planning when lateral cephalograms were not available or specially indicated. The purpose of the present study was to evaluate the diagnostic concordance of SCA, rSTCA, pSTCA and reliability and diagnostic acceptability of photograph based soft tissue cephalometrics in assessing the maxillary

projection, mandibular projection, and growth pattern. The null hypothesis was that there is no variation in these three analyses in assessing the above parameters.

MATERIALS AND METHODS

This study included right profile digital cephalometric radiographs and photographs of patients selected from the Department of Orthodontics and Dentofacial Orthopedics, CKS Theja Institute of Dental Sciences and Research, Tirupati. Selection criteria included the following:

1. The absence of reported skeletal asymmetry,
2. Minimal dental crowding,
3. No history of previous orthodontic treatment, prosthodontic treatment, facial surgery, and trauma,
4. Patients age between 14 and 30 years,
5. Digital clinical records with adequate representation of soft-tissue contours, and
6. Photographs and radiographs were taken with natural head position with teeth in centric occlusion and lips in the rest position.

Radiographic examinations were executed using the NEW TOM. Standardised profile photographs were taken using camera NIKON (D60) mounted on a leveled tripod. All the radiographs and photographs were taken in natural head position (NHP) proposed by Raju *et al.* 2001. Subjects were asked to stand 9 feet in front of the mirror left to the suspended plumb line. A vertical moving light source was held on the right wall and then subjects were asked to determine the self-balanced position of the head by tilting the head backward and forward with decreasing amplitude to find the most neutral position in between as described by Cooke and Wei (1988). At this position, two point markings were placed along the shadow line on right side of the face. Metal markings were placed before positioning the patient in the cephalostat and radiographs were obtained in Centric Occlusion (CO) with lips in the rest position. A total of 50 subjects were selected, who met the selection criteria. A preliminary skeletal evaluation was performed and three subsets were created according to the STEINERS (Raju *et al.,* 2001) ANB cephalometric values (ANB= 2º±2º) using Dolphin Image management software, version 11.8

Class I subjects (^ANB= 2º±2º) – 25
Class II subjects (^ANB > 4º) – 15
Class III subjects (^ANB < 0º) - 10

From each subset, 10 subjects were selected randomly. A final sample of 30 lateral cephalometric radiographs and 30 right profile photographs were obtained. Customized parameters were taken to compare the SCA, rSTCA, pSTCA (Arnett *et al.,* 1999; Steiner, 1959; McNamara, 1984; Tweed, 1969). Cephalometric parameters used to compare these three analyses are as follows: (Figures 1, 2 & 3)

Skeletal parameters

- Sagittal maxillary projection - N perpendicular to point A – (2 ± 2 mm).
- Sagittal mandibular projection - N perpendicular to Pogonion (Pog) – (6.6 ± 3.3 mm)
- FMA – FH to Tweed's mandibular plane (MP) – ($29.3^0 \pm 4.5^0$).
- Facial angle – FH to NPog – ($86.2^0 \pm 3^0$)

Soft tissue parameters

- Sagittal maxillary projection - TVL to soft tissue point A' – (-2 ± 3.7 mm)
- Sagittal mandibular projection - TVL to soft tissue Pogonion (Pog') – (6.5 ± 5.8)
- Extraoral FMA – Soft tissue FH' to MP' – ($26^0 \pm 4.5^0$)
- Soft tissue facial angle – Soft tissue FH' to N'Pog' – ($89.4^0 \pm 7.0^0$)

The soft tissue parameters were assessed both in the rSTCA and pSTCA. Data analysis was performed using SPSS Statistics software. Normal distribution of data was preliminarily checked. Kruskas Wallis one-way analysis of variance (ANOVA) was used to verify if the diagnosis was affected by the three different cephalometric methods. Post hoc pairwise comparisons were calculated to find individual differences among the considered cephalometric methods. The level of significance was set at $P < 0.05$.

RESULTS

The cephalometric method was found to affect the diagnostic outcomes ($P < 0.05$) as revealed by the Kruskas–Wallis one-way ANOVA. Performing post hoc pairwise comparisons, no significant differences were found between SCA and rSTCA , rSTCA and pSTCA and between SCA and pSTCA in defining sagittal maxillary projection ($P < 0.05$), sagittal mandibular projection ($P < 0.05$), and FMA ($P < 0.05$). Significant differences were found between SCA and rSTCA and between SCA and pSTCA in defining the facial angle. No difference was found between rSTCA and pSTCA ($P > 0.05$) for the same diagnostic parameter. Distributions of diagnostic outcomes obtained with the three analyses were reported. (Table 1 & 2).

Table 1. Distribution of diagnostic outcomes obtained with SCA, rSTCA, pSTCA

	DIAGNOSIS	SCA	rSTCA	pSTCA
	NORMAL	12 (40.0 %)	20 (66.66 %)	18 (60.00 %)
MAXILLA	PROTRUSION	5 (16.66 %)	4 (13.33 %)	4 (13.33 %)
	RETRUSION	13 (43.30 %)	6 (20.00 %)	7 (23.33%)
	NORMAL	11 (36.66 %)	6 (20.00 %)	7 (23.33%)
MANDIBLE	PROTRUSION	7 (23.33%)	6 (20.00 %)	5 (16.66 %)
	RETRUSION	12 (40.0 %)	18 (60.00 %)	18 (60.00 %)
	AGP	15 (50 .00 %)	13 (43.33 %)	13 (43.33 %)
FMA	HGP	15 (50 .00 %)	16 (53.33 %)	16 (53.33 %)
	VGP	0	1 (3.33 %)	1 (3.33 %)
	AGP	17 (56.66 %)	28 (93.33%)	27 (90.00%)
FACIAL ANGLE	HGP	9 (40.00 %)	2 (6.66 %)	3. (10.00%)
	VGP	4 (13.33 %)	0	0

Table 2. P value for pairwise comparisons (post hoc) btw SCA, rSTCA, pSTCA

VARIABLES	PAIRWISE COMPARISONS (POST HOC)	
	SCA versus rSTCA	0.178
MAXILLA	SCA versus pSTCA	0.356
	rSTCA versus pSTCA	0.910
	SCA versus rSTCA	0.460
MANDIBLE	SCA versus pSTCA	0.712
	rSTCA versus pSTCA	0.913
	SCA versus rSTCA	0.514
FMA	SCA versus pSTCA	0.478
	rSTCA versus pSTCA	0.082
	SCA versus rSTCA	0.001**
FACIAL ANGLE	SCA versus pSTCA	0.000**
	rSTCA versus pSTCA	0.076

** Highly significant

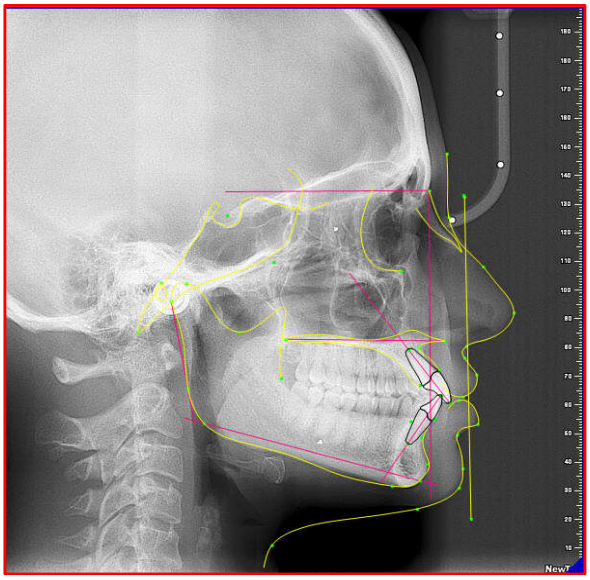

Figure1. Cephalometric tracing of skeletal analysis (SCA) & soft-tissue analysis performed on radiograph (rSTCA)

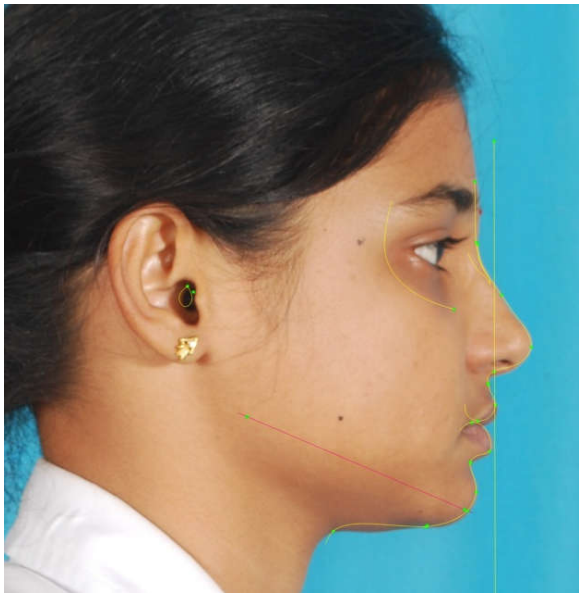

Figure2. Cephalometric tracing of soft-tissue analysis performed on the photograph (pSTCA).

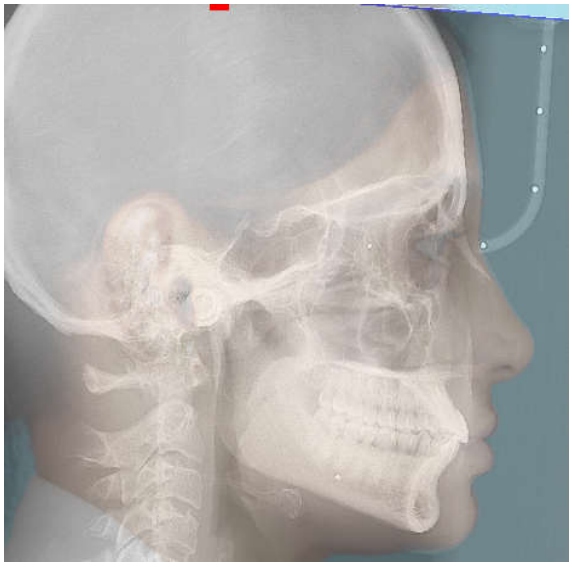

Figure 3. Superimposition of lateral cephalometric radiograph on profile photograph

DISCUSSION

The present study evaluated the diagnostic concordance between the skeletal cephalometric analysis (SCA), radiograph based soft tissue cephalometric analysis (rSTCA), photograph based soft tissue cephalometric analysis (pSTCA). Nowadays, there is an increased interest in individuals towards orthodontic treatment due to social and esthetic awareness. In order to meet the esthetic expectations of patients, orthodontic treatment includes the thorough evaluation of soft tissue facial profile. The efficiency of a diagnostic record can be tested only by evaluating its validity and consistency in identifying the state of the disease. However, neither malocclusion nor facial disharmony represents a pathological condition. Also, malocclusion cannot be defined through universally accepted golden standards i.e., it is not possible to evaluate the validity of diagnostic records in orthodontics. So, in the absence of a true state of disease, a comparative analysis of validity and consistency between diagnostic methods represents a suitable alternative to investigate their effectiveness (Ribarevski *et al.,* 1996; Wenzel *et al.,* 2000). For many years, lateral cephalometric radiographs were used as standard diagnostic records in assessing the malocclusion (Kim and Mupparapu, 2009). Standardized photographs have currently gained significance both clinically and in research, mainly because they reproduce the soft tissues in detail. Ideally, information from thorough clinical examination, dental casts, intra- and extra oral photographs are sufficient to formulate the treatment plan (Han *et al.,* 1991). Apart from providing evidence of pathological conditions or disease or nerve injury, taking lateral cephalographs and panoramic radiographs enable us to quantify the anatomical proximity between hard and soft tissues as well as to depict the changes brought about by orthodontic tooth movement (Espelid *et al.,* 2003). Margolis (Margolis, 1947), demonstrated a method of relating the anatomic and soft tissue structures to the facial profile by superimposing profile photographs over lateral cephalic radiographs while discussing basic facial pattern. In the present study, the reliability of photograph based soft tissue cephalometric analysis (pSTCA) as a diagnostic aid was assessed by comparing the skeletal cephalometric analysis (SCA) with radiograph based soft tissue cephalometric analysis (rSTCA) and photograph based soft tissue cephalometric analysis (pSTCA).

The results of this study indicate that photograph based soft tissue cephalometric analysis (pSTCA) does not differ with skeletal cephalometric analysis (SCA) and radiograph based soft tissue cephalometric analysis (rSTCA) in defining the sagittal maxillary & mandibular projections, and FMA. Significant differences were found in defining the facial angle, between SCA and rSTCA and between SCA and pSTCA. No difference was found between rSTCA and pSTCA ($P > 0.05$) for the same diagnostic parameter. This suggests that there is a good concordance between the SCA, rSTCA, and pSTCA, supporting the null hypothesis of this study. Nucera *et al.,* 2016 conducted a similar study, which supports the reliability of soft tissue cephalometric analysis on the photograph as a diagnostic aid as an alternative to skeletal cephalometric analysis and soft tissue cephalometric analysis on radiographs. On the contrary to the present study, they reported a poor diagnostic concordance between skeletal cephalometrics and both radiographic and photographic soft tissue cephalometrics in defining the maxillary and mandibular projections but shows a positive correlation with the lower facial height. Because the

parameters considered in defining the maxillary and mandibular projection by Nucera et al are SNA and SNB respectively which were also influenced by the position of anterior cranial base (Zebeib and Naini, 2014). Another advantage of photograph based cephalometric analysis is reduced exposure to radiation, and to assess the subsequent changes in the soft tissue facial appearance during the orthodontic treatment could be appreciated easily. Findings of our study suggested that photographs were reliable and at par with lateral cephalograms, and the clinician can use them for qualitative assessment of soft tissue facial profile. There is no evidence that suggests the difference in enhancing the treatment results, reduction in treatment time and quality whether lateral cephalographs or photographs were used as diagnostic aids in evaluating the facial profile.

Conclusion

- The parameters taken in this study in defining the maxillary projection, mandibular projection and growth pattern on skeletal cephalometrics and soft-tissue cephalometrics on both radiographs and photographs showed strong diagnostic concordance.
- This study suggests that soft-tissue analysis performed on the photograph is a reliable method to thoroughly evaluate soft-tissue profile in diagnosis and treatment planning in most of the cases.

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