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Original Research Article

Diagnostic evaluation of skeletal cephalometric parameters and photograph-Based soft tissue parameters in Malwa Population

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ABSTRACT

Introduction: The primary goal of orthodontic diagnostic and treatment planning is to create a balanced and aesthetically attractive face. During the decades-long period of cephalometric dominance, the "aesthetic" of the face was predominantly used to describe the profile as observed on a lateral cephalogram However, the paradigm has now shifted to soft tissue-based diagnosis and treatment planning. This creates the need for soft tissue-based analysis especially on photographs considering its evaluation of myriad populations.

Aim: To evaluate the skeletal cephalometric parameters and photograph-based soft tissue parameters in the Malwa population.

Materials and Methods: The study was conducted using 50 lateral cephalometric radiographs and 50 profile photographs.

Results: Data were analyzed for probability distribution using the Shapiro-Wilk test. Descriptive statistics were performed and data were presented as median and inter-quartile range. Correlation between the variables was assessed using Spearman's correlation coefficient. P value < .05 was considered statistically significant.

Conclusion: Our reported values of both photographic and lateral cephalogram parameters are different not only from the international population, but also different values are observed from the not only Indian population, but also from various subsets of the Indian population. Therefore, the average value of lateral profile photographic parameters as well as cephalometric parameters in my study can be used as floating norms for the Malwa population.

1. Introduction

Since the introduction of the cephalogram, Broadbent[1] (1931), for diagnostic & treatment planning, the lateral cephalogram has provided valuable information and has been regarded as the gold standard in orthodontic diagnosis. However, cephalometry has two main drawbacks:

Patients are exposed to deleterious radiation. It requires not only expensive equipment and skilled labor but also a high level of sensitivity to technique."

One of the primary goals of orthodontic diagnostic & treatment planning is to establish a balanced and aesthetically attractive face. Meanwhile era of cephalometries, facial aesthetics was principally used to describe the profile as observed on a lateral cephalogram.[2] However, the paradigm has shifted to soft tissue-based diagnosis and treatment planning.

Although literature is replete with studies to assess soft tissue parameters on lateral cephalogrampost-treatment, and retention phase of orthodontic treatment, despite the paradigm change toward soft tissue-based diagnosis, treatment planning, and outcome evaluation, there has not

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been much research on standard profile photographic view of the Malwa community.

There is a harmonious relationship between the exterior craniofacial structures, which is often visualized on lateral cephalograms and is the framework for the soft tissue features observed in profile pictures.[2]

Soft-tissue cephalometric analysis variables can be assessed from the patient's profile picture, making it a useful tool for orthodontic treatment planning, especially in cases where cephalometric radiographs are contraindicated. Soft-tissue cephalometric analysis variables can be assessed from the patient's profile picture, making it a useful tool for orthodontic treatment planning, especially in cases where cephalometric radiographs are contraindicated.

Therefore, our objective in this study is to assess the relationship between skeletal cephalometric and soft tissue cephalometric parameters in the Malwa population.

2. Aims & Objective

1. Photograph-based soft tissue cephalometric parameters in Malwa population.
2. Soft tissue norms on profile photographs of the Malwa population.
3. To evaluate the skeletal cephalometric parameters and photograph-based soft tissue parameters in the Malwa population.
4. To evaluate the relationship of the skeletal cephalometric and soft tissue cephalometric parameters in the Malwa Population.
5. To establish the angular photogrammetric values of soft tissue in the Malwa population.

3. Materials and Methods

The study analyzed pre-treatment lateral cephalograms and profile photographs of patients at the Department of Orthodontics, IIDS, Indore.

Good quality lateral cephalogram, good quality profile photograph, lack of obvious skeletal asymmetries, Well-aligned upper and lower dental arches, Subjects aged between 18 to 30 years, and their grandparents must be belonging to Malwa Region.

Syndromic, severe anteroposterior & or vertical dysplasia, Any previous face surgery, orthodontic therapy, or trauma history, Cleft lip, and cleft lip & cleft palate subject.

3.1. Method

The participants of this study were selected at random from the OPD of the Index Institute of Dental Sciences, Department of Orthodontics, located in Indore, Madhya Pradesh, India. The study employed lateral cephalometric radiographs and profile images. A table of random numbers was used for the randomization process. Standardized profile photographic records were obtained using a photographic setup in the Department of Orthodontics at the IIDS in Indore. In total, 50 photographic records were taken.

A photographic setup was used for taking pictures. It included a tripod that held a Canon 1500D DSLR camera with a macro lens of 55-210mm. The tripod was used to ensure the camera was vertically placed correctly, according to the height of the participants. The shutter speed was set to 100 ISO, and the focal aperture of the camera was 5.6mm. The distance between the camera and the subject was 8 feet. The photographs and lateral cephalometric images were digitized and standardized using EPSON V800 and Nemoceph software. For better lighting and shadowless images, two flash umbrellas were used along with an illuminated white background.

As a part of our study, we utilized 50 lateral cephalograms of the subjects that were already taken as mandatory records before commencing orthodontic treatment and/or treatment planning. These lateral cephalograms were digitized and imported to Nemoceph software where they were calibrated. Once the calibration process was completed, the respective lateral cephalograms of the subjects were color-printed on A-4 sheets. In cases where the soft copy was not available, the hard copy was digitized using EPSON V-800 software. The second record of the same subject was photographs, which were, calibrated using Adobe Photoshop 7.0 and calibrated the image to 1:1 magnification. Calibrated photographs were color printed on A- 4 sheets. All the photographs and lateral cephalogram printouts were analyzed using the following parameters.

On images of soft tissue, the following angles were measured (see Table 1)

1. N'-Trg'- Sn'
2. N' -Trg'- Me'
3. Sn'- Trg'-Me'
4. Trg'- Me'- MP'
5. N'-Sn' / Sn'-Me' mm (Figure 3)

On the lateral cephalogram, the following angular parameters were measured:

1. Y-axis: Angle between Sella Gnathion & Frankfort Horizontal Plane (Figure 4)
2. P: Angle between Sella Nasion and Mandibular Planes (Figure 5)
3. Maxillary to Mandibular Planes angle: Angle between Maxillary to
4. Mp (Figure 6)
5. SN to GoGn: Angle between Sella Nasion to Mandibular Planes (Figure 7)
6. Angle: Angle between N to Co & Me (Figure 8)
7. N-ANS /ANS -Me mm (Figure 9)

Description of points on lateral cephalogram and onphotograph.

Table 1: Description of various parameters studied usingLateral Cephalogram.

	Median	Inter-quartile range	Mean	Standard deviation	Minimum	Maximum
Y- axis	64.0	61.0-66.0	63.7600	4.18725	55.00	75.00
SN-MP	26.0	20.0-30.0	26.2800	6.89584	15.00	47.00
MMA	20.0	15.75-25.00	20.2800	6.09463	10.00	37.00
SN-GoGn	25.0	20.0-30.0	25.6000	6.57764	15.00	50.00
R- angle	70.0	65.75-73.00	70.0800	5.64544	58.00	84.00
N-ANS/ANS-Me	0.7725	0.7074- 0. 8333	0.7779	0.08380	0.63	0.98

Table 2: Description of various parameters studied using lateral cephalogram.

Sr.no	Points	Definition
1.	N’	Soft tissue Nasion(N’): The deepest part of the soft tissue outline in front of Nasion.
2.	Me’	Soft tissue Menton (Me’): The lowest point on the outline of soft tissue chin
3.	Sn’	Soft tissue Subnasale (Sn): Junction of nasal septum and upper lip in the sagittal plane.
4.	Trg’	Soft tissue tragus (Trg’): The tragus is a small pointed eminence of the external ear, situated in front of the concha, and projecting backward over the meatus.
5.	S	Sella (S): Mid-point of sella turcica
6.	Or	Orbitale (Or): Inferior border of the orbit.
7.	Po	Porion (Po): highest point on the upper margin of the external auditory or ear rod
8.	Gn	Gnathion (Gn): Most anteroinferior point on the bony chin
9.	N	Nasion (N): Midpoint of frontonasal suture.
10.	Me	Menton (Me): Lowest point on the symphysis of the mandible
11.	Go	Gonion (Go): it is a constructed point at the junction of ramas plane and mandibular plane
12.	ANS	Anterior nasal spine (ANS): Anterior point of maxilla
13.	PNS	Posterior nasal spine (PNS):Posterior point of maxilla
14.	Co	Condylion (Co): The most superior point on the head of the condyle.

Table 3: Description of various parameters studied using lateral cephalogram.

	Median	Inter-quartile range	Mean	Standard deviation	Minimum	Maximum
Y-axis	64.0	61.0-66.0	63.7600	4.18725	55.00	75.00
SN-MP	26.0	20.0-30.0	26.2800	6.89584	15.00	47.00
MMA	20.0	15.75-25.00	20.2800	6.09463	10.00	37.00
SN-GoGn	25.0	20.0-30.0	25.6000	6.57764	15.00	50.00
R- angle	70.0	65.75-73.00	70.0800	5.64544	58.00	84.00
N-ANS/ANS-Me	0.7725	0.7074- 0. 8333	0.7779	0.08380	0.63	0.98

The median (inter-quartile range) and mean ± standard deviation of the Y-axis, SN-MP, MMA, SN-GoGn, R- R-angle, and N-ANS/ANS-ME ratio have been presented in Table 2.

The median (inter-quartile range) and mean ± standard deviation of N’-Trg’- Sn’, N’-Trg’-Me’, Sn’- Trg’- Me’, Trg’- Me’ -Mp’ and N’-Sn’/Sn’-Me’ ratio has been presented in Table 2.

The data was entered into an Excel sheet and analyzed using SPSS (Statistical Package for Social Sciences) version 21.0 by IBM in Chicago. The data was tested for probability distribution using the Shapiro-Wilk test, which revealed that the data was not normally distributed. Therefore, non-parametric tests of significance were applied. Descriptive statistics were performed, and the data was presented as the median and interquartile range. The correlation between variables was assessed using Spearman’s correlation coefficient. A p-value less than .05 was considered statistically significant.

In orthodontics, pre-treatment soft-tissue analysis has long been used to asses face attractiveness, giving doctors a valuable tool. By employing lateral skull radiographs, traditional, quantitative evaluations of soft-tissue profiles have been carried out, and numerous cephalometric analyses have been devised and suggested.

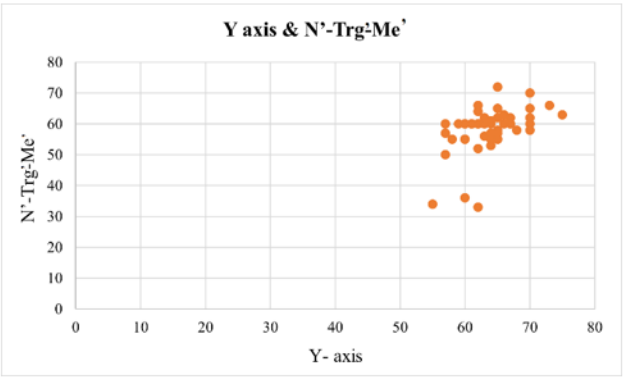
Table 4: Description of various parameters studied using soft tissue analysis.

	Median	Inter-quartile range	Mean	Standard deviation	Minimum	Maximum
N'-Trg'- Sn'	28.0	25.0-30.0	28.8400	5.58555	21.00	58.00
N'-Trg'-Me'	60.0	55.75-62.00	58.2600	7.37566	33.00	72.00
Sn'- Trg'- Me'	33.0	30.0-35.0	34.5400	7.45383	27.00	62.00
Trg- Me' -Mp'	24.0	22.0-27.25	24.7800	4.08726	17.00	35.00
N'-Sn'/Sn'-Me'	0.82	0.74-0.91	0.8322	0.11645	0.60	1.07

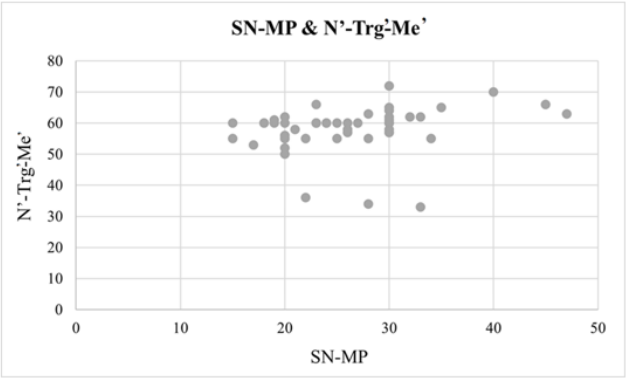
Table 5: Correlation between soft tissue parameters and other parameters of lateral cephalogram.

		Y- axis	SN-MP	MMA	SN-GoGn	R-angle	N-ANS/ANS-Me' ratio
N'-Trg'- Sn'	Correlation Coefficient	.054	.250	.181	.243	.055	.103
	P value	.707	.080	.208	.090	.705	.475
N'-Trg'-Me'	Correlation Coefficient	.463	.375	.568	.399	.397	-.120
	P value	.001*	.007*	.001*	.004*	.004*	.405
Sn'- Trg'- Me'	Correlation Coefficient	.288	.222	.152	.046	.321	-.319
	P value	.043*	.121	.291	.753	.023*	.024*
Trg'- Me' -Mp'	Correlation Coefficient	-.077	-.018	.018	.089	-.042	.027
	P value	.597	.900	.904	.540	.772	.850
N'-Sn'/Sn'-Me' ratio	Correlation Coefficient	-.061	-.082	.062	.050	-.085	.469
	P value	.673	.571	.671	.732	.558	.001**

*p value <.05 was considered statistically significant.



Graph 1: Correlation between Y-axis and N'-Trg'-Me'.



Graph 2: Correlation between SN-MP and N'-Trg'-Me'

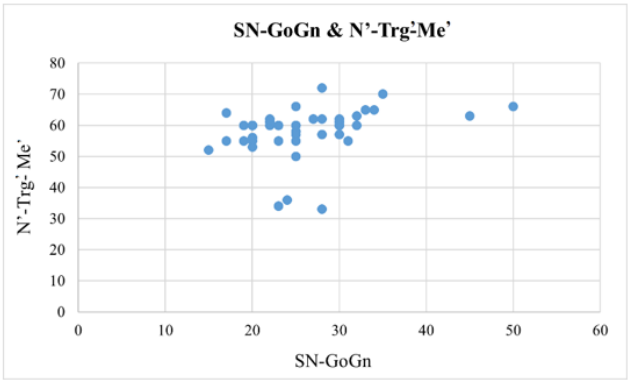
Aesthetic ideals have frequently been identified using photographs. When it comes to analyzing human profiles, photogrammetric analysis has several benefits. Enlargement has little impact on the angular measures, unlike cephalometric analysis. Thus, the method is therapeutically applicable for both pre-treatment planning and postoperative outcome evaluation.

This investigation's goal was to assess the lateral cephalometric parameters, and soft tissue parameters based on photographs, and in the Malwa people. The characteristics of the soft tissue profile are impacted by several factors, including ethnicity. To find normative values that can help with diagnostic and treatment planning for patients seeking orthodontic treatment, inclusion criteria and methodology were developed.

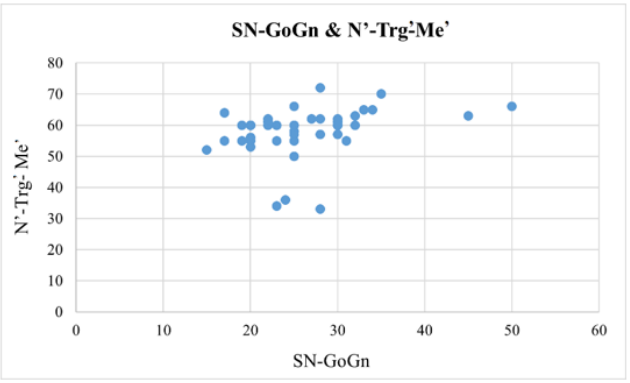
In our research, we found that the mean value of N'-Trg'-Sn'

Figure 1: Profile photograph

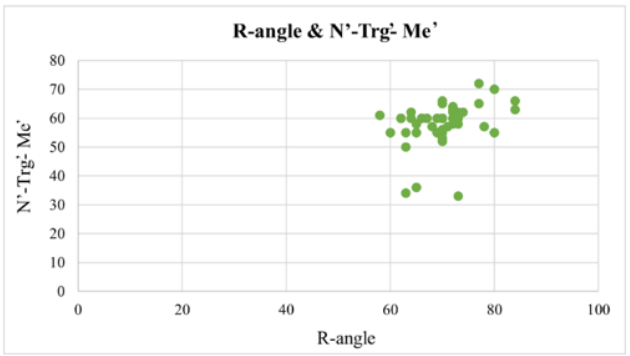
Figure 2: Lateral cephalogram



Graph 3: Correlation between SN-GoGn and N'-Trg'-Me'.



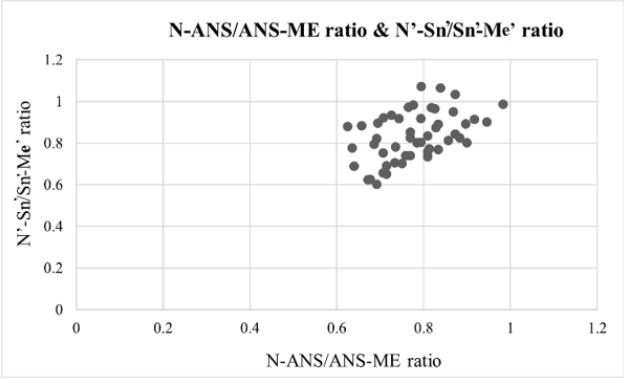
Graph 4: Correlation between R-angle and N'-Trg'- Me'



Graph 5: Correlation between N-ANS/ANS-Me ratio and Sn'-Trg'- Me'

was 28.84º with a standard deviation of 5.58º. In comparison, Jing Mao's 2019[3] study on Chinese patients with Angle's class I found a mean value and SD of 27.53 ± 2.16 for N'-Trg'-Sn'. (see table no.3) This suggests that the mean value in our study, which was conducted on the Malwa population, is higher than that found in the Chinese population.

Additionally, Pandian KS, Krishnan S, and Kumar's 2018[4] study on the soft-tissue facial profile of Indian adults



Graph 6: Correlation between N-ANS/ANS-Me ratio and N'-Sn'/Sn'-Me ratio.

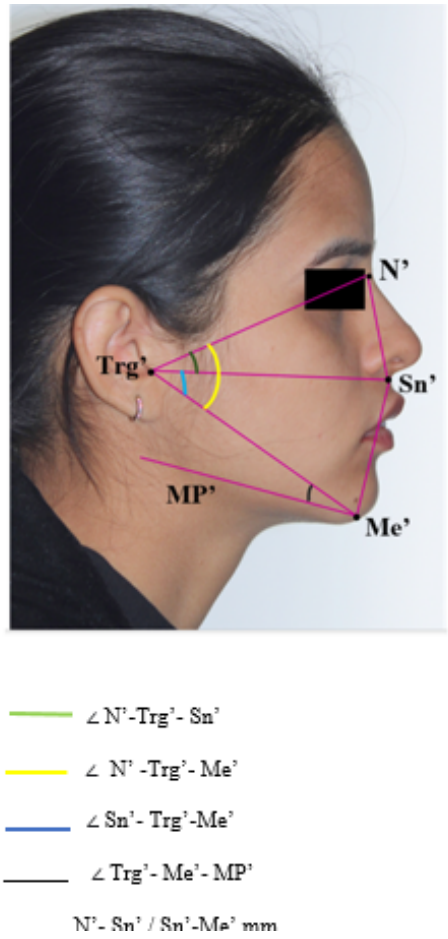


Figure 3: Angles measured on soft tissue Photograph.

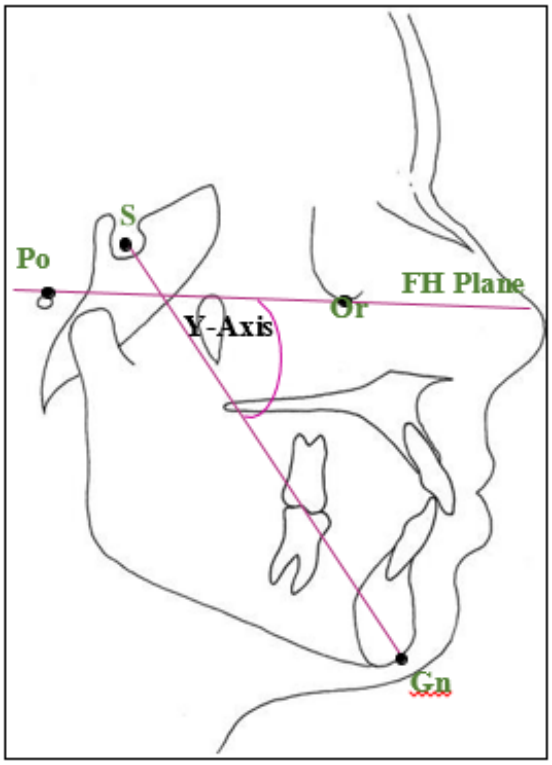


Figure 4: Y-Axis.

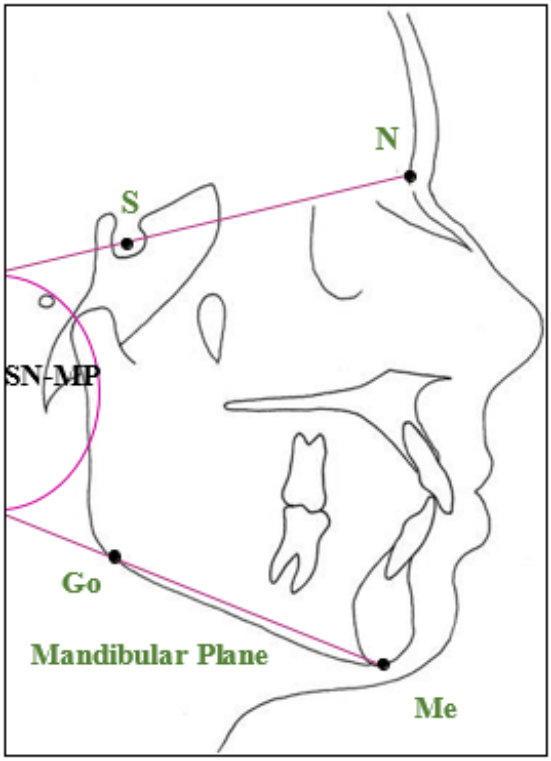


Figure 5: SN-MP

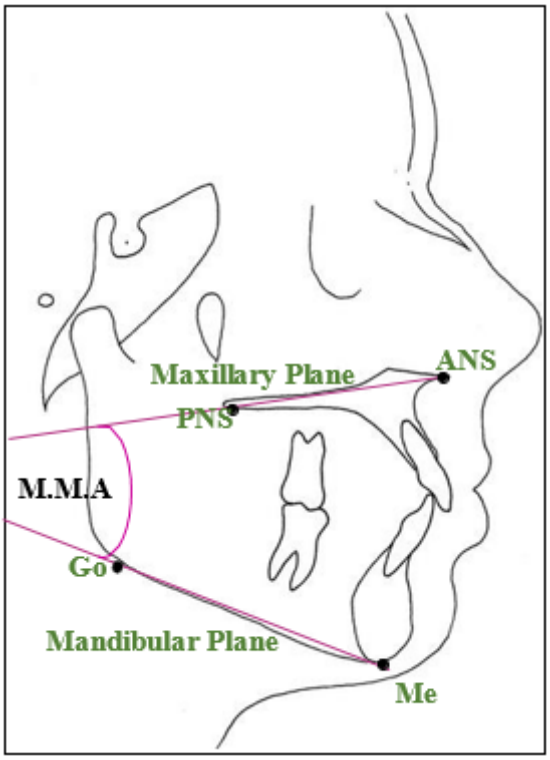


Figure 6: M.M.A.

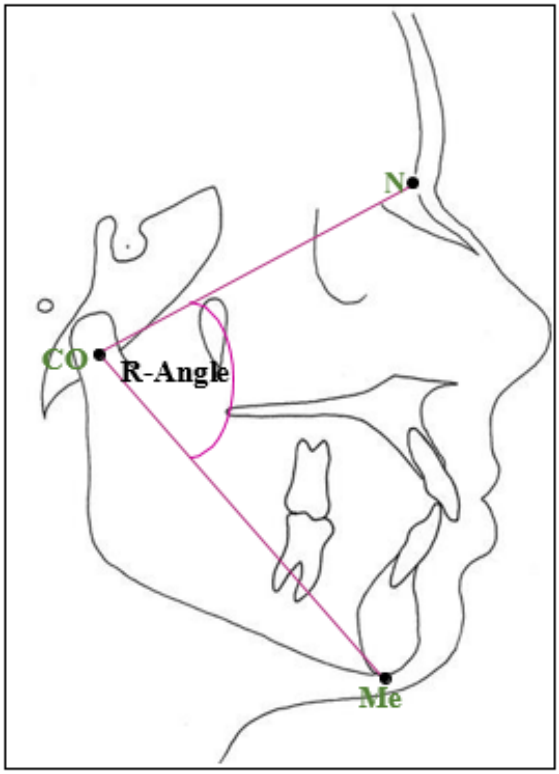


Figure 8: R-Angle

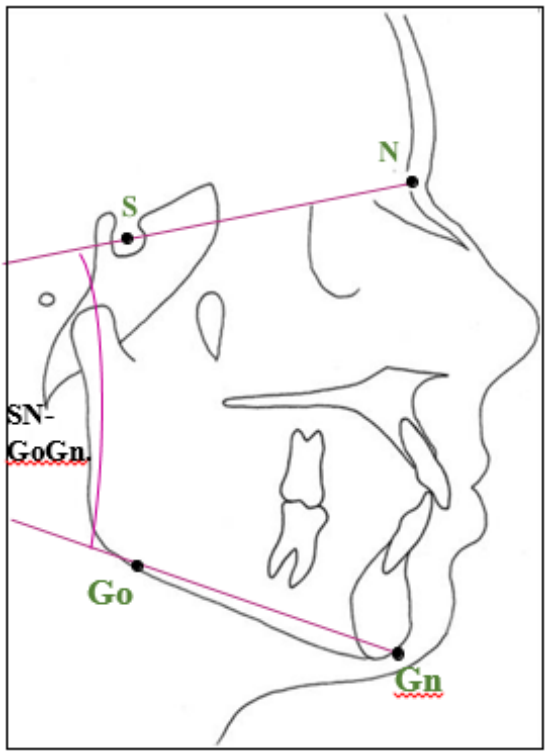


Figure 7: SN-Go Gn

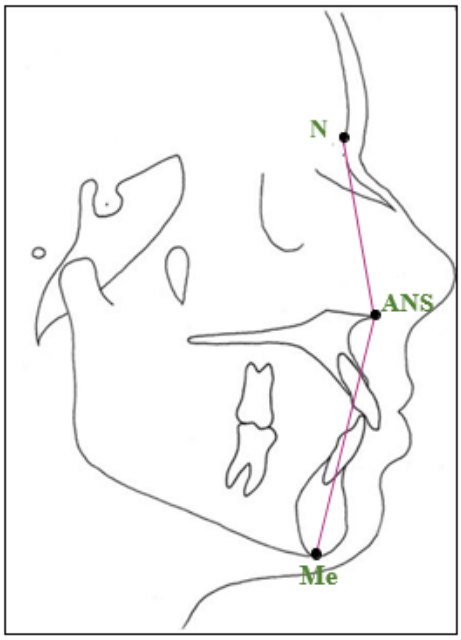


Figure 9: N-ANS /ANS –Me

reported a mean value of N'-Trg'-Sn' for males of 25.38 ± 2.20º and females of 26.59 ± 2.03º. (see table no.3) This indicates that both values are lower than the mean value found in our study on the Malwa population.

In this study N.'- Trg.'- Sn.', was found to have no statistically significant correlation with Y axis, SN to MP, M.M.A, SN to GO Gn, R angle, and N-ANS/ANS-Me ratio (p-value>.05).

In our study, N.'- Trg.'- Me.' mean value of 58.26 ± SD 7.37°. (see table no.3) N.'- Trg.' –Me.', was found to have a statistically significant correlation with, the Y axis, S N to MP, M.M.A, S N GO Gn, and R angle (p value<.05). N.'- Trg.'- Me.' A statistically significant correlation was shown between the Y-axis and MMA (p-value <.05). N.'- Trg.' -Me.' was found to have a statistically significant correlation with S N to MP, S N to GO Gn, and R angle (p-value <.05). N.'- Trg.'- Me.' was discovered not to be statistically significantly correlated with N-ANS/ANS-Me ratio (p-value>.05). Therefore, for Malwa population N.' - Trg.'- Me.' measured on the photograph can be used as a replacement measurement for Y axis, S N - MP, M.M.A, SN - GoGn and R angle on lateral cephalogram.

Our investigation revealed that the angle between the Sella-Nasion (Sn.), the tragion (Trg.), and the Menton (Me.) is 45° with a mean of 34.54°. In research by Vahid Moshkelgosha et al. (2015)[5] on adolescent Persians, it was found that the average temperature for men is 37.44° with a standard deviation (SD) of 2.61°, and for women is 35.3° with an SD of 2.6°. This suggests that the mean value found in our study, which was conducted on the Malwa population, is higher than that of their study. Pandian KS, Krishnan S, and Kumar (2018)[4] presented the results of their research on the soft-tissue facial features of people in India.

The mean value of Sn. -Trg. -Me. (see Table 3) for males was 29.58º ± 2.69º, and for females was 29.46º ± 2.53. Both mean values were obtained from a study conducted on the Indian adult population, and they are lower than the mean value found in our study on the Malwa population. Jing Mao (2019)[3] compared the soft tissue of the face before and after orthodontic treatment in Chinese patients. They reported a value of Sn. -Trg. -Me. in class I subjects with a mean value and SD of 36.60 ± 0.91º. This suggests that the mean value found in their study on the Chinese population is higher than that of our study on the Malwa population.

Sn.'- Trg.'- Me.,' showed a statistically significant correlation with the Y axis, R angle, and N-ANS/ANS-Me ratio (p-value <.05). Sn.'- Trg.'- Me.' and was shown to have a statistically significant link Y-axis and R-angle, and statistically significant correlation with N-ANS/ANS-Me ratio (p-value <.05). Sn.'- Trg.'- Me.' was found to have no statistically significant correlation with SN to MP, M.M.A, and SN to GO Gn (p-value>.05). Hence, for Malwa population Sn.'- Trg.'- Me.' Measured on profile photograph can be used as replacement measurement for Y axis, R angle &N – ANS/ANS-Me ratio.

In our study, Trg.'-Me.'-Mp.' mean value found to be was 24.78º with SD. 4.08 º. (see Table 3) Trg.'- Me.' -Mp.' it was found to have no statistically significant correlation with Y axis, SN to MP, M.M.A, SN to GO Gn, R angle, and N – ANS/ANS-Me ratio (p value>.05).

In our study, N.'-Sn.'/Sn.'-Me.' mean value is 0.83*o* with SD. 0.11º. (see table no.3) N.'-Sn.'/Sn.'-Me.', ratio was shown to have a statistically significant correlation N –ANS/ANS-Me, ratio (p value <.05). N.'-Sn.'/Sn.'-Me.' ratio was found to have no statistically significant correlation with Y axis, SN to MP, M.M.A, S N to GO Gn and R angle (p-value>.05). Therefore, it can be said that measure on photograph N.'-Sn.'/Sn.'-Me.' can be used as a counterpart parameter in place of N – ANS/ANS-Me (see Table 4) measured on lateral cephalograms.

In our study Y axis mean value was found to be 63.76 º with SD 4.18º. (see Table 2) Paranhos et al (2014),[6] conducted a study to determine the impact of various malocclusions Y-axis of growth on the sagittal skeletal pattern. The result of their study showed a mean value of 68.64 º with SD 5.4º. (see Table 1) Proposing that the mean value found in the study is more than that of our study which was done on the Malwa population.

In our study, we found that the MM plane angle had a mean value of 20.28º with a standard deviation of 6.09º. (see Table 2). In a study conducted by Hall-Scott. J (1994).[7] the objective was to evaluate the clinical use of the MM plane angle and its relation to other occlusal planes. They reported a mean value of 25.5±5º for adults and advised that the mean value found in their study was higher than that of our study, which was conducted on the Malwa population.

In our study, S N to Go Gn (see Table 2). showed a mean 25.60 º value with SD 6.57º. Paranhos LR et al (2014),[6] the result of their study showed that mean value of 35.93º with an SD of 5. 75º.The mean value found in the study was more than that of our study which was done on the Malwa population.

In our study R - the angle mean value presented as 70.08 º with SD 5.64º. (see Table 2). Mohammed Rizwan, (2013),[8] reported that R angles range between 70.5 º to 75.50º imply average angles, above 75.50º suggest high angles, and below 70.50º show situations with low angles. The lesser value of the R angle suggested that the Malwa population has more low-angle tendencies than the South Indian population.

In our study N– ANS/ANS-Me mean value 0.7 with SD 0.083. (see Table 2). Al-Barakati etal.[9], reported in their study that was done on the Egyptian population to assess the precision and reproducibility of linear and angular measurements, obtained by conventional and digital cephalometric methods. The result of their study of conventional tracing showed that the mean value and SD. of ANS- Me is 0.1 ± 0.7 º. This value indicates that the Malwa population tends to have lower facial height in comparison

to the upper facial height when compared to the Egyptian population.

3.2. Critical evaluation

It would be helpful to conduct a study that involves a larger and more diverse population to provide valuable data. This study should be gender-specific and multicentric. Additionally, future studies should consider using photographic parameters for both profile, frontal, and three-quarter views to explore new avenues.

4. Conclusions

Within the limitation of the present study, the following conclusions were drawn:

The findings of the current study have revealed that there is a statistically significant correlation between certain measurements. For the Malwa population, certain measurements taken from profile photographs can be used as replacement measurements for those taken from lateral cephalograms.

1. Specifically, N- Trg. - Me. measured on the photographs can be used as a replacement measurement for the Y axis, SN - MP, M.M.A, SN – Go Gn, and R angle on lateral cephalogram. Similarly, Sn. - Trg. - Me. measured on profile photograph can be used as a replacement measurement for Y axis, R angle, and N - ANS/ANS-Me ratio.
2. Additionally, N.-Sn. /Sn. -Me., a new angle introduced in the study, has a statistically significant correlation with N - ANS/ANS-Me ratio. Therefore, it can be said that N.-Sn. /Sn. -Me. measured on the photograph can be used as a counterpart parameter in place of N-ANS/ANS-Me measured on lateral cephalogram.
3. Furthermore, the study has introduced a new angle which is profile photographs Trg. - Me. - Mp. This angle has a mean value of 24.78º ± 4.08 º.
4. Finally, the study suggests that soft-tissue analysis on lateral profile photographs can be a trustworthy way to assess soft-tissue profiles when compared to soft-tissue analysis on cephalograms.
5. The Malwa population showed more horizontal growth pattern than average vertical growth pattern as shown by lower R angle, SN – MP, M..MA, and Y axis, also Malwa population have lower anterior facial height than upper facial height when compared to other population.
6. It has been observed that the values of photographic and lateral cephalogram parameters differ not only from the international population but also from various subsets of the Indian population. Therefore, the average value of lateral profile photographic parameters and cephalometric parameters obtained from my study can be used as floating norms for the Malwa population.

5. Source of Funding

None.

6. Conflict of Interest

None.

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