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Comparative Accuracy of Modified Profilometer & Lateral Cephalography for Assessment of Profile Angle

[1]Vaidehi Chakradhar Waghmare*, [2]Piyush Khandelwal, [3]Javed Sodawala
[1]Postgraduate student, [2]Professor, [3]Professor and Head of the Department,
Department of Orthodontics and Dentofacial Orthopedics,
Chhattisgarh Dental College and Research Institute, Sundra, Rajnandgaon, Chhattisgarh, 491441

***Corresponding Author:**
Vaidehi Chakradhar Waghmare
Postgraduate Student, Department of Orthodontics and Dentofacial Orthopedics,
Chhattisgarh Dental College and Research Institute, Sundra, Rajnandgaon, Chhattisgarh, 491441

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Abstract

Introduction: Precise evaluation of the profile angle is fundamental in orthodontic diagnosis and treatment planning. Conventional cephalometric techniques, although widely accepted, demand specialized radiographic equipment and are susceptible to operator variability. This study aimed to validate the accuracy and reliability of a modified profilometer for profile angle measurement, using lateral cephalometric analysis as the reference standard.

Materials & Methods: An observational study was conducted over two months involving 50 orthodontic patients aged 18–25 years. Profile angles were measured using both the modified profilometer and standardized lateral cephalograms. Statistical analysis, including intraclass correlation coefficient test and paired t test, were performed using SPSS software v23.0 and the P value was set at 0.05.

Results: Profilometric measurements showed no statistically significant differences compared with cephalometric values ($P > 0.05$). Intra- and inter-examiner reliability were excellent, with intraclass correlation coefficients (ICC) of 1.000 and 0.997, respectively ($P < 0.001$). Agreement with cephalometric measurements was also excellent (ICC = 0.996–0.997; r = 0.995–0.999), demonstrating the high accuracy, reproducibility, and reliability of the profilometer.

Conclusion: The profilometer proved to be a reliable and clinically useful tool for profile angle measurement. Its strong agreement with cephalometric standards highlights its potential as an accessible, non-radiographic alternative for routine orthodontic evaluation, enhancing diagnostic efficiency and accuracy.

Keywords: Cephalometry, Profilometer, Profile angle, Soft tissue analysis, Reliability, Orthodontics

Introduction

The profile angle is a critical parameter in orthodontics, reflecting the sagittal relationship of facial soft tissues and serving as a guide in diagnosis, treatment planning, and post treatment evaluation. Accurate measurement of this angle is essential for assessing facial esthetics and skeletal harmony. This angle is formed by connecting soft tissue glabella, subnasale, and soft tissue pogonion. [1,2]

Traditionally, the profile angle has been assessed using lateral cephalometric radiographs, which remain the gold standard. Cephalometry provides reproducible skeletal and soft tissue landmarks, but it requires specialized radiographic equipment, exposes patients to ionizing radiation, and is subject to operator dependent variability in landmark identification. Other approaches, such as direct anthropometry and photographic analysis, have been explored, yet they often lack consistency and standardization.

In response to the need for non-invasive, radiation free, and chairside diagnostic tools, Singh et al. [3] originally developed a profilometer to measure the profile angle directly from the patient's soft tissue outline. Building upon this innovation, we have introduced modifications to enhance ease of use and clinical applicability. While promising, the accuracy and reproducibility of the improved profilometer must be validated against cephalometric methods before clinical adoption.

This study therefore evaluates the reliability and validity of the modified profilometer in measuring the profile angle, comparing its results with standardized cephalometric radiographs, and analyzing intra and inter examiner consistency. The null hypothesis tested is that there is no significant difference between profile angle measurements obtained using the modified profilometer and those derived from cephalometric analysis.

Materials & Methods

This observational study was conducted over two months at the Department of Orthodontics & Dentofacial Orthopedics, involving 50 adult patients undergoing orthodontic evaluation. Ethical approval for the study was obtained from the Institutional Ethics Committee (Ref: CDCRI/DEAN/ETHICSCOMMITTEEORTHO/PG-07/2025).

The study included adult patients aged 18–25 years who reported for orthodontic evaluation or treatment planning and presented with well-defined, reproducible facial landmarks suitable for profile angle measurement. Only those who provided written informed consent were enrolled. Patients with skeletal deformities such as craniofacial syndromes or cleft lip and palate, which could distort facial landmarks, were excluded. Individuals with incomplete or unclear cephalometric records, as well as participants unable to comply with study protocols due to physical or cognitive impairments, were not considered. Children and adolescents were also excluded owing to their developing craniofacial structures.

For sample size estimation, a population size of 50 was considered, representing the approximate number of patients meeting the inclusion and exclusion criteria and reporting to the department OPD. A margin of error of 5%, a confidence level of 95%, and a response distribution of 50% were applied. After finite population correction, the estimated sample size was determined to be 50, indicating that a minimum of 50 measurements were required to ensure, with 95% confidence, that the true value would lie within ±5% of the observed measurement.

The design and fabrication protocol of the profilometer were adopted from the methodology described by Singh et al. [3]. The device was constructed from a standard protractor and stainless-steel wires cut to specified lengths (one 13-cm piece, two 12-cm pieces, and two 20-cm pieces of 0.019 × 0.025" wire). The 13-cm wire ends were bent at 90° at 1 cm from the tip, and the 20-cm wires were given two 90° step bends (2–2.5 mm) at 14 cm and 16 cm. Horizontal arms were finished with ball ends by soldering to eliminate sharp edges. A 2–2.5 mm hole was drilled at the midpoint of the protractor circumference to receive the middle horizontal arm, which was fixed perpendicular to the protractor's back surface. The two 20-cm wires were placed in a crisscross pattern to form the upper and lower vertical arms, each wrapped 180° around the protractor edge. Two 12-cm wires were attached to the longer ends of the 20-cm wires using j-hook sliders to create the upper and lower movable horizontal arms; all three horizontal arms (upper, middle, and lower) were aligned in a single plane parallel to one another and perpendicular to the vertical arms (Figure 1 A, B).

Profile angles were measured using both a profilometer and standardized cephalometric radiographs. Profile angle measurement with the profilometer was performed as per the technique by Singh et al. [3]. The protractor was oriented with its convex surface facing the patient anteriorly and its base posteriorly. The soft tissue subnasale (Sn) was first aligned parallel to the middle horizontal arm; the upper and lower vertical and horizontal arms were then glided and rotated until they were parallel to the soft tissue pogonion (Pg) and soft tissue glabella (G), respectively, allowing the horizontal arms to passively contact the landmark points (Figure 2A, B). For convex and straight profiles, the profile angle was read as the angle formed by the smaller vertical arm on the protractor (Figure 2 A, B). For severe concave profiles (angles > 180°), the protractor was reversed 180° and

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the measured angle between the smaller vertical arms was subtracted from 360° to obtain the profile angle.

Cephalometric measurement and interpretation were performed on standardized lateral cephalograms by identifying the soft tissue glabella (G), subnasale (Sn), and soft tissue pogonion (Pg), drawing lines G–Sn and Sn–Pg, and measuring the angle between these lines as the profile angle (Figure 3). Profile angles obtained with the profilometer were compared with cephalometric measurements to assess agreement and clinical relevance. A standard or balanced profile generally falls between 165˚ and 175 ˚. Angle less than this indicates a convex profile (common in Class II malocclusions), while higher angle indicates a concave profile (often Class III).

Data were analyzed using appropriate statistical methods to evaluate reliability and agreement between the profilometer and cephalometric measurements. Intraclass correlation coefficient (ICC) analysis was performed to assess both intra- and inter-examiner reliability: intra-rater reliability was determined by having a single clinician measure the profile angle on two separate occasions 15 days apart, while inter-rater reliability was evaluated by comparing measurements obtained independently by two clinicians. Agreement between the profilometer and standardized cephalometric radiographs was assessed using Pearson correlation analysis, and a P value ≤ 0.05 was considered statistically significant. The measurements obtained with the profilometer were therefore directly compared with those derived from lateral cephalograms to determine the device's reliability and clinical utility.

Results

Table 1 presents the comparison of mean profilometric measurements with the mean cephalometric measurement in 50 participants. The mean profilometric values for the first Examiner at T1 (P1T1) and at T2 (P1T2) were 159.54 ± 5.71°, 159.62 ± 5.75° respectively and for the second Examiner (P2) the value was 159.64 ± 5.64°, compared with the cephalometric mean (C) of 159.42 ± 5.81°. Independent t-test analysis revealed no statistically significant differences between profilometric and cephalometric measurements at any time point ($P > 0.05$).

Intra-examiner reliability was excellent: comparison of P1T1 and P1T2 yielded an intraclass correlation coefficient (ICC) of 1.000 ($P < 0.001$), indicating highly consistent repeated measurements by the same examiner (Table 2). Inter-examiner reliability between P1T1 and P2 was similarly high (ICC = 0.997, $P < 0.001$), demonstrating near perfect agreement between two independent clinicians (Table 3).

Agreement between profilometer and cephalometric measurements was also excellent, with ICC values ranging from 0.996 to 0.997 and Pearson correlation coefficients (r) between 0.995 and 0.999 across examiners and time points (Table 4).

Discussion

The present study was undertaken to address the need for a simple, reliable, and radiation-free method of assessing the facial profile angle in routine orthodontic practice. Although lateral cephalometric radiography remains the gold standard, its dependence on radiographic equipment, radiation exposure, and specialized infrastructure limits its routine use for repeated assessments and mass screening.

The original profilometer by Singh et al. [3] had used e-modules to secure the three horizontal arms on the two vertical arms, which helped the arms glide for the measurement. In our modified design the sliders of J-hook were used instead of the e-module, which proved to be more stable and easier to use. The development of the profilometer as described by Singh et al. [3] offers a potentially accessible and reproducible method for profile angle assessment. Singh et al. [3] proposed the device as an alternative to traditional cephalometry and photogrammetry; however, they also noted the need for further validation across diverse populations. The present study contributes to that validation by demonstrating strong agreement with cephalometric measurements in our sample, while recognizing that broader validation is still required.

Validating the modified profilometer against cephalometric measurements is essential to determine whether it can provide comparable accuracy and reproducibility. Establishing its clinical reliability would support its use as a cost-effective, chairside alternative for diagnosis, treatment planning, and follow-up, particularly in settings where access to cephalometric facilities is limited.

The findings of the present study demonstrated that the modified profilometer produced profile angle measurements that were comparable to those obtained using lateral cephalometric radiography, with no statistically significant differences between the two methods (P > 0.05). Furthermore, the device exhibited excellent intra- and inter-examiner reliability, indicating that measurements were highly reproducible irrespective of the examiner or the time of assessment. The very high agreement and strong correlation between profilometric and cephalometric measurements suggest that the modified profilometer is both accurate and reliable for clinical assessment of the facial profile angle.

Moshkelgosha et al. [4] assessed the facial convexity angle, in Persian adolescents using standardized photogrammetry and reported mean values of 165.17 ± 5.07° in males and 165.90 ± 5.30° in females, with no significant sex difference for this parameter. Compared with their findings, the mean profile angle in the present study (159.42 ± 5.81°) was approximately 5–6° lower. Moshkelgosha et al. [4] evaluated adolescents with ideal Class I occlusion and balanced facial profiles, whereas the present study included orthodontic patients with varying skeletal and dental relationships. This also attributed to differences in ethnicity and age.

Similarly, Swarup et al. [5] evaluated the angle of facial convexity, in individuals with different vertical growth patterns. They reported mean values of approximately 166.2 ± 6.1° in horizontal growers, 162.2 ± 9.7° in average growers, and 156.5 ± 8.5° in vertical growers, with significant differences among the three groups. The mean value observed in the present study (159.42 ± 5.81°) as similar to this study.

Cernova et al. [6] also measured the Gl–Sn–Pg angle in adolescents with Angle Class I, II, and III malocclusions using standardized profile photographs. They reported mean values of 169.42 ± 4.75° in Class I, 165.75 ± 5.22° in Class II, and 173.34 ± 4.68° in Class III, with statistically significant differences among all three malocclusion groups. The mean value obtained in the present study (159.42 ± 5.81°) is lower than this study. This difference can be due to ethnic variability.

Ethnic variation in soft tissue profiles is an important consideration in cephalometric analysis. Jean-Bertin et al. [7] highlighted differences in soft tissue profiles between Ivorian and Lebanese populations, and Hwang et al. [8] reported significant profile differences between Korean and European-American adults. These studies underscore the need for population-specific cephalometric norms rather than reliance on generalized standards, since ethnic differences can materially affect diagnostic interpretation and treatment planning.

Skeletal morphology and soft tissue thickness also influence facial proportions. Perović et al. [9] demonstrated that mandibular divergence affects facial soft tissue thickness and proportions even in otherwise balanced Class I relationships. Such findings reinforce the importance of integrating skeletal pattern and soft tissue assessment into diagnostic workflows to ensure individualized treatment planning.

Farha et al. [10] further refine our understanding of cephalometric and soft tissue interactions by showing how vertical growth patterns, particularly hyperdivergence, influence facial profiles in Class I and Class II adults. Together, these studies emphasize a multidimensional diagnostic approach that accounts for ethnic norms, skeletal divergence, and soft tissue characteristics.

A limitation of this device is its construction from thin-gauge stainless steel wire, which makes it relatively fragile and less stable during use. Careful handling is required to prevent deformation, and any bent or distorted wires must be replaced to maintain measurement accuracy.

Future research should focus on validating the profilometer in larger, multi-center studies involving more diverse age groups, ethnic populations, and varying skeletal malocclusion patterns to enhance the generalizability of the findings. Longitudinal studies evaluating its effectiveness in monitoring treatment progress and post-treatment stability would further establish its role in routine orthodontic practice. Comparative investigations assessing the profilometer against advanced digital cephalometric and three-dimensional imaging techniques could provide deeper insight into its diagnostic accuracy.

Conclusions

The modified profilometer demonstrated excellent repeatability and reproducibility for profile angle

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measurement, with strong agreement between repeated measures and between different examiners. Measurements obtained with the profilometer closely matched those from standardized lateral cephalograms, indicating good concordance with the radiographic gold standard. These results support the profilometer as a valid, practical chairside tool for soft-tissue profile assessment in adults. Further multicenter and population-diverse studies are recommended to confirm generalizability and define its role alongside radiographic methods.

References

1. Legan HL Burstone CJ. Soft tissue cephalometric analysis for orthognathic surgery. J Oral Surg. 1980;38(10):744-51.
2. Bergman RT. Cephalometric soft tissue facial analysis. Am J Orthod. Dentofacial Orthop. 1999;116(4):373-89
3. Singh PR, Ambekar AS, Kangane SK. A Device to Measure Profile Angle Clinically: Profilometer. J Indian Orthod. Soc. 2022;56(2):196-9.
4. Moshkelgosha V, Fathinejad S, Pakizeh Z, Shamsa M, Golkari A. Photographic facial soft tissue analysis by means of linear and angular measurements in an adolescent Persian population. Open Dent. J. 2015 ;9:346-56
5. Swarup VB, Chalasani S, Devanna R, Sharmila N, Amanda KS, Sanjana C. Evaluation of soft tissue profile of face in individuals with different growth patterns using photogrammetric analysis. IP Indian J Orthod. Dentofacial Res. 2026;12(1):48-56.
6. Cernova K., Abeltins A., Radzins O., Slaidina A. Evaluation of Facial Soft Tissue Angles in Adolescents with Angle Class I, II, and III Malocclusion Using Profile Image Analysis. Dent. J. 2026;14(6):324.
7. Jean-Bertin B, Monique BA, Jacques GNJ. Ethnic soft tissue profile differences: Arelevant clinical issue in daily orthodontic practice. Indian J Orthod Dentofacial Res. 2017;3(4):207-17
8. Hwang HS, Kim WS, McNamara JA Jr. Ethnic differences in the soft tissue profile of Korean and European-American adults with normal occlusions and well-balanced faces. Angle Orthod. 2002;72(1):72-80.
9. Perović TM, Blažej M, Jovanović I. The influence of mandibular divergence on facial soft tissue thickness in class I patients: a cephalometric study. Folia Morphol (Warsz). 2022;81(2):472-80.
10. Farha P, Arqub SA, Ghoussoub MS. Correlation Between Cephalometric Values and Soft Tissue Profile in Class I and Class II Adult Patients based on Vertical Patterns. Turk J Orthod. 2024; 37(1): 36-43

List of Figures

Figure 1: Components of the profilometer: A) Front view, B) Top view

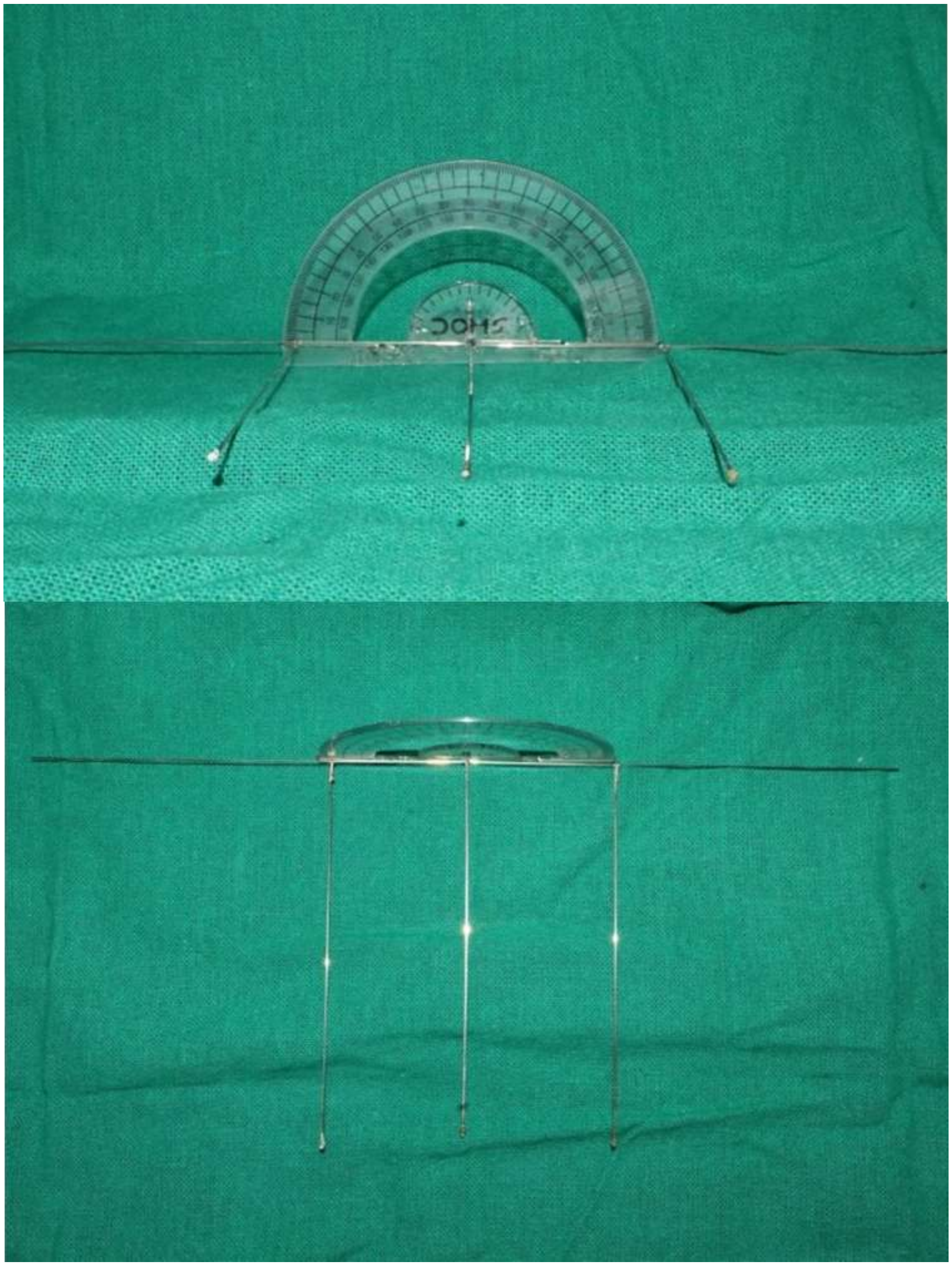

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Figure 2: Measurement of profile angle using profilometer: A) Frontal view, B) Lateral view

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Figure 3: Measurement of profile angle using the lateral cephalogram

Table 1: Comparison of mean profilometric measurements with cephalogram

<table>
<tr><th colspan="2">Profilometer (P)</th><th rowspan="2">Cephalogram (C)
Mean ± SD</th><th rowspan="2">p-value</th></tr>
<tr><th>Examiner</th><th>Mean ± SD</th></tr>
<tr><td>First Examiner at T1 (P1T1)</td><td>159.54 ± 5.71°</td><td rowspan="3">159.42 ± 5.81°</td><td>0.849</td></tr>
<tr><td>First Examiner at T2 (P1T2)</td><td>159.62 ± 5.75°</td><td>0.863</td></tr>
<tr><td>Second Examiner (P2)</td><td>159.64 ± 5.64°</td><td>0.917</td></tr>
</table>

Independent t test

Table 2: Intra-examiner reliability (P1T1 vs P1T2)

ICC	p-value
1.000	<0.001*

* indicates very highly significant correlation at p<0.001

Table 3: Inter-examiner reliability (P1T1 vs P2)

ICC	p-value
0.997	<0.001*

* indicates very highly significant correlation at p<0.001

Table 4: Assessment of corelation between profilometer and cephalometric measurements;

Correlation	ICC	r-value
P1T1 vs Cephalogram	0.997	0.999
P1T2 vs Cephalogram	0.997	0.995
P2 vs Cephalogram	0.996	0.996

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