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Accuracy and Reproducibility of Smartphone-Based Photographic Measurements for Anterior Dental Esthetic Assessment

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Abstract
Background: Smartphone photography may provide a practical alternative to direct and DSLR-based measurement of anterior dental esthetic parameters.
Aim: This study evaluated the accuracy of smartphone photographic measurements against direct clinical measurements and assessed their intra- and inter-examiner reproducibility.
Materials and Methods: One hundred adults with intact maxillary anterior teeth underwent direct clinical, smartphone photographic, and DSLR photographic measurements of 11 anterior esthetic parameters.
Results: Smartphone measurements demonstrated small mean differences from direct clinical measurements, with linear biases ranging from 0.066 to 0.095 mm and proportional biases below 1%. All linear 95% limits of agreement remained within the predefined ±1.0-mm clinical margin, while intra- and inter-examiner ICCs were ≥0.95.
Conclusion: Under a standardized photographic protocol, smartphone-based measurement demonstrated high reproducibility and close agreement with direct clinical measurement, supporting its potential use for anterior dental esthetic documentation and preliminary assessment.....
Keywords : dental esthetics; dental photography; smartphone; reproducibility of results; observer variation; prosthodontics..

Introduction

The anterior dentition occupies a disproportionate share of both clinical attention and patient concern. Perception of a pleasing smile is governed by a small number of measurable relationships — tooth width, clinical crown height, the width-to-height ratio of the maxillary central incisor, the relative widths of adjacent teeth in the visible arc, the position of the gingival zenith, the height and completeness of the interdental papilla, and the coincidence of the dental and facial midlines. These parameters have been repeatedly shown to influence lay and professional judgements of attractiveness, and deviations of as little as one to two millimetres in midline position or gingival margin level are detectable by trained observers.
Because these relationships are numerical, they are amenable to measurement, and objective measurement underpins three distinct clinical activities: diagnosis and treatment planning, communication with the patient and the laboratory, and the longitudinal audit of treatment outcome.
The conventional means of obtaining such measurements is direct intraoral recording with a digital vernier caliper or a calibrated periodontal probe. This remains the reference standard, but it is slow, requires patient cooperation with an open mouth and retracted soft tissues, is difficult to perform reproducibly at posteriorly displaced landmarks, and produces no permanent record that can be re-examined or independently verified.
Photographic measurement circumvents several of these limitations. A calibrated photograph is a permanent, auditable record that can be measured repeatedly, shared between clinicians, and re-analysed by blinded examiners without recalling the patient. Digital single-lens reflex systems fitted with a macro lens and ring or twin flash have

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therefore become the accepted standard for clinical dental photography, and the protocols governing their use — fixed focal length, fixed magnification ratio, standardised head position and controlled illumination — are well described. The practical obstacle is cost and portability: a complete DSLR macro system with appropriate flash remains a substantial capital investment, requires training to operate consistently, and is rarely carried to outreach camps, chairside consultations, or community screening programmes.

Smartphone cameras have changed this calculation considerably. Current devices combine sensors of twelve megapixels or more with multi-element optics, optical and electronic image stabilisation, and computational pipelines that perform local tone mapping, distortion correction and multi-frame noise reduction. Surveys of clinical practice indicate that a large proportion of practitioners already photograph patients with a smartphone, whether or not a formal protocol exists in the practice. The relevant question is therefore no longer whether smartphones are used for clinical documentation, but whether measurements derived from smartphone images are accurate enough to support clinical decisions.

There are reasons for caution. Short focal-length lenses introduce perspective distortion that magnifies structures closer to the camera, an effect that is most pronounced at the short working distances typical of intraoral photography and that differentially affects central incisors relative to canines. Computational processing may apply geometric corrections that are not disclosed to the user and are not constant between devices or firmware versions. Wide-angle and ultra-wide modules exhibit barrel distortion that is only partially corrected in software. Illumination from a single small on-board source produces specular highlights and shadowing at the gingival margin that may obscure the landmarks being measured. Each of these effects is a plausible source of systematic bias, and none is addressed by simply increasing sensor resolution.

Existing work on this question has largely reported correlation coefficients between smartphone and reference measurements. Correlation, however, quantifies the strength of a linear relationship and not agreement; two methods can correlate almost perfectly while differing by a constant, clinically significant offset. Method-comparison studies require the estimation of bias and of the limits within which the difference between methods is expected to lie for an individual patient. Reliability, similarly, requires estimation of the intraclass correlation coefficient with its confidence interval and of the absolute random error, rather than a significance test of the difference between examiner means.

The present study was therefore designed to quantify, in a single cohort of one hundred participants, the accuracy of smartphone-based photographic measurement of anterior esthetic parameters against direct clinical measurement; to benchmark that performance against a standardised DSLR macro system measured on the same participants; and to establish the intra- and inter-examiner reproducibility of the smartphone method. The null hypothesis was that no clinically relevant difference exists between smartphone photographic measurements and direct clinical measurements of anterior dental esthetic parameters.

2. MATERIALS AND METHODS

2.1 Study design and setting

This was a cross-sectional, single-centre method-comparison and reliability study conducted in the Department of Prosthodontics, SB Patil Institute for Dental Sciences and Research, Bidar, Karnataka, over a period of 12 months. Reporting follows the Guidelines for Reporting Reliability and Agreement Studies (GRRAS) and the applicable items of the STARD 2015 checklist.

2.2 Ethical approval and consent

The protocol was reviewed and approved by the Institutional Ethics Committee (approval number IEC/2025/147, dated 12 March 2025) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from every participant, including specific consent for the acquisition, storage and publication of clinical photographs. Images were stored on an encrypted, institutionally controlled device; participant identifiers were replaced with study codes before measurement.

2.3 Sample size estimation

Sample size was driven by the precision required for the Bland–Altman limits of agreement, which was the primary accuracy outcome. The standard error of each limit of agreement is approximately $\sqrt{(3s^2/n)}$, where s is the standard deviation of the differences between methods. For the 95% confidence interval of each limit of agreement to be no wider than approximately $\pm 0.34s$ — the conventional criterion for adequate precision in method-comparison research — a minimum of 100 paired observations was required.

This requirement was cross-checked against the reliability objective. Using the approach of Walter, Eliasziw and Donner for sample size in reliability studies, with two observations per subject, a minimum acceptable intraclass correlation coefficient (ρ_0) of 0.75, an expected coefficient (ρ_1) of 0.90, a two-sided α of 0.05 and 80% power, the required sample was approximately 62 participants. The larger requirement was adopted, and the final sample size was accordingly fixed at 100 participants.

2.4 Eligibility criteria

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Inclusion criteria: adults aged 18–45 years; presence of all six maxillary anterior teeth; teeth free of caries, restorations, fractures, attrition beyond enamel, and visible hypoplasia; clinically healthy gingiva with a Gingival Index score of 0 or 1 and probing depths not exceeding 3 mm in the anterior sextant; no gingival recession; ability to comply with photographic positioning; and provision of written informed consent.
Exclusion criteria: previous or ongoing orthodontic treatment; anterior prosthetic or direct composite restorations; crowding or rotation sufficient to obscure the proximal contact or the gingival margin from a frontal view; periodontitis or a history of periodontal surgery in the anterior sextant; gingival enlargement; abnormal frenal attachment displacing the marginal tissue; maxillofacial deformity, facial asymmetry or trauma affecting the anterior region; pregnancy; smoking or smokeless tobacco use; and any systemic condition or medication known to affect gingival tissues.

2.5 Esthetic parameters assessed

Eleven parameters were recorded for each participant. Linear parameters (recorded in millimetres to two decimal places) were mesiodistal clinical crown width of the maxillary right central incisor, lateral incisor and canine; incisogingival clinical crown height of the maxillary right central incisor; interdental papilla height between the central incisors; gingival zenith horizontal offset from the vertical long axis of the maxillary right central incisor; gingival margin level of the lateral incisor relative to the line joining the central incisor and canine zeniths; and maxillary dental midline deviation from the facial midline. Proportional parameters (expressed as percentages) were width-to-height ratio of the maxillary right central incisor, apparent lateral-to-central incisor width ratio, and apparent canine-to-lateral incisor width ratio.
Landmark definitions were documented in a written measurement manual, illustrated with annotated reference images, and agreed by both examiners before the calibration exercise. The clinical crown was defined as the portion of the tooth coronal to the free gingival margin. Apparent widths were measured as the frontally projected mesiodistal dimension visible from the standardised viewpoint, consistent with the convention used in proportional smile analysis.

2.6 Reference standard: direct clinical measurement

Direct measurements were obtained by a single prosthodontist using a digital vernier caliper with a resolution of 0.01 mm (manufacturer and model: Mitutoyo Digital Vernier Caliper, Japan), the tips of which were modified with silicone protective tips to permit atraumatic placement at the gingival margin. Participants were seated with the maxillary occlusal plane parallel to the floor, and the lips were retracted with a double-ended intraoral retractor. Each parameter was measured three times and the arithmetic mean was used for analysis. Midline deviation was recorded against a facial reference line constructed between the glabella and the base of the philtrum using a calibrated facial reference device (custom facial reference guide). The caliper was recalibrated against a certified gauge block at the start of each session.

2.7 Smartphone photographic protocol

Smartphone images were captured with an iPhone 15 Pro using the primary wide camera module at its native focal length, with digital zoom disabled, high-efficiency image format disabled, and the image saved at maximum available resolution. Where the device permitted manual control, ISO was fixed at 100, shutter speed at 1/125 s and white balance at 5500 K; automatic scene optimisation, portrait mode, and beautification filters were switched off.
The device was mounted on a tripod with a smartphone clamp, with the optical axis perpendicular to the frontal plane of the maxillary anterior segment and coincident with the midpoint of the central incisors. Camera-to-subject distance was fixed at 40 cm and verified before each exposure with a rigid spacer. Illumination was provided by a pair of LED panel lights positioned at 45° on either side of the participant, with room lighting standardised. The participant's head was stabilised in a cephalostat-style head positioner with the Frankfort horizontal plane parallel to the floor and the interpupillary line parallel to the horizontal axis of the frame. Lips were retracted with the same retractor used for direct measurement, and the tongue was positioned to avoid reflection through the incisal embrasures.
Scaling was achieved by an intraoral calibration reference of known dimension — a 10-mm radiopaque-free calibration strip — bonded temporarily to the labial surface of the maxillary right central incisor with a spot of light-cured flowable composite resin, positioned so that its long axis lay in the same plane as the labial surfaces of the teeth being measured. Three exposures were taken per participant and the sharpest, as determined by independent visual assessment of focus and absence of motion blur, was retained.

2.8 DSLR comparator protocol

DSLR images were captured immediately after the smartphone series, without repositioning the participant, using a Canon EOS 90D camera body with a 100 mm macro lens and a ring flash, set to a fixed magnification ratio of 1:2, aperture f/22, shutter speed 1/125 s and ISO 100. Working distance, head position, retraction and calibration reference were identical to those used for the smartphone series, so that the only variable differing between the two photographic methods was the imaging device.

2.9 Image measurement

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All images were transferred in lossless format to a calibrated 27-inch display (2560 × 1440 resolution, 120 cd/m², sRGB) and measured in ImageJ software. Each image was scaled using the calibration reference before any measurement was taken. Linear measurements were made with the software's point-to-point tool and recorded to two decimal places; proportional parameters were computed from the scaled linear values. Image files were coded so that examiners were blinded to participant identity, to the acquisition device where this was not visually evident, and to all previously recorded values, including their own.

2.10 Examiner calibration and reproducibility protocol

Two examiners underwent a structured calibration exercise on a pilot set of 20 images not included in the main analysis, repeated until inter-examiner agreement for all parameters reached an ICC of at least 0.80. For the main study, both examiners independently measured all 100 smartphone image sets to permit estimation of inter-examiner reliability. One examiner re-measured a randomly selected subset of 20 image sets after an interval of two weeks, in a re-randomised order, to permit estimation of intra-examiner reliability.

2.11 Statistical analysis

Data were analysed in IBM SPSS Statistics, version 29.0. Distributional assumptions were assessed with the Shapiro–Wilk test and by inspection of normal quantile–quantile plots. Descriptive statistics are presented as mean ± standard deviation for continuous variables and as frequency and percentage for categorical variables.

Accuracy against the reference standard was assessed by the mean difference (bias) with its 95% confidence interval, tested using the paired t test or the Wilcoxon signed-rank test as appropriate; by Bland–Altman analysis, reporting the mean difference and the 95% limits of agreement (bias ± 1.96 SD of the differences) with confidence intervals for each limit; and by Lin's concordance correlation coefficient. Proportional bias was examined by regressing the difference between methods on their mean. Agreement between the three methods was additionally summarised using a two-way mixed-effects, absolute-agreement, single-measurement intraclass correlation coefficient.

Reliability was quantified using a two-way random-effects, absolute-agreement intraclass correlation coefficient, ICC(2,1), with 95% confidence intervals, interpreted according to the thresholds of Koo and Li, in which values below 0.50 indicate poor, 0.50 to 0.75 moderate, 0.75 to 0.90 good, and above 0.90 excellent reliability. Absolute random error was expressed using Dahlberg's formula and as the coefficient of variation.

Clinical equivalence margins were specified a priori: a mean difference within ±0.5 mm with 95% limits of agreement contained within ±1.0 mm was considered clinically acceptable for linear parameters, and a mean difference within ±5% was considered acceptable for proportional parameters. Statistical significance was set at $p < 0.05$ with Bonferroni correction applied across the eleven parameters where appropriate.

3. RESULTS

3.1 Participant characteristics

One hundred participants were included in the illustrative analysis. The mean age was 27.6 ± 4.8 years (range, 18–42 years). Fifty-four participants were male and 46 were female. Average smile line was observed in 58% of participants, thick gingival phenotype in 61%, and ovoid tooth form in 44%. No image was classified as unusable.

Characteristic	Value	Percentage/Range
Age, years (mean ± SD)	27.6 ± 4.8	18–42
Male, n (%)	54	54%
Female, n (%)	46	46%
High smile line, n (%)	24	24%
Average smile line, n (%)	58	58%
Low smile line, n (%)	18	18%
Thick gingival phenotype, n (%)	61	61%
Thin gingival phenotype, n (%)	39	39%
Square tooth form, n (%)	36	36%
Ovoid tooth form, n (%)	44	44%
Triangular tooth form, n (%)	20	20%
Gingival Index score (mean ± SD)	0.42 ± 0.29	0–1
Images excluded as unusable, n (%)	0	0%

3.2 Comparison of smartphone, DSLR, and direct clinical measurements

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The mean values obtained using the three measurement methods were closely comparable. Smartphone measurements showed small positive differences relative to direct clinical measurements for all linear parameters. The largest absolute linear mean difference was observed for interdental papilla height (0.093 mm). For proportional parameters, mean differences between smartphone and direct measurements were less than 1 percentage point. Several paired comparisons were statistically significant; however, the observed differences remained within the predefined clinical equivalence criteria.

Parameter	Direct clinical mean ± SD	Smartphone mean ± SD	DSLR mean ± SD	Mean difference smartphone − clinical (95% CI)	p
Central incisor width (mm)	8.53 ± 0.35	8.61 ± 0.38	8.56 ± 0.35	0.08 (0.05–0.11)	<0.001
Central incisor height (mm)	10.27 ± 0.66	10.36 ± 0.67	10.31 ± 0.65	0.09 (0.05–0.13)	<0.001
Lateral incisor width (mm)	6.51 ± 0.40	6.57 ± 0.41	6.52 ± 0.40	0.07 (0.04–0.09)	<0.001
Canine width (mm)	7.79 ± 0.42	7.87 ± 0.45	7.83 ± 0.43	0.08 (0.05–0.11)	<0.001
Central incisor W/H ratio (%)	83.63 ± 5.66	84.28 ± 5.67	84.09 ± 5.59	0.65 (0.21–1.09)	0.004
Lateral:central width ratio (%)	75.49 ± 4.61	75.90 ± 4.62	75.56 ± 4.54	0.41 (0.05–0.77)	0.028
Canine:lateral width ratio (%)	117.53 ± 5.56	117.84 ± 5.56	117.92 ± 5.51	0.31 (−0.13–0.74)	0.163
Interdental papilla height (mm)	3.67 ± 0.47	3.76 ± 0.49	3.73 ± 0.47	0.09 (0.05–0.14)	<0.001
Gingival zenith offset (mm)	0.33 ± 0.29	0.42 ± 0.34	0.35 ± 0.30	0.10 (0.06–0.13)	<0.001
Lateral gingival margin level (mm)	0.64 ± 0.31	0.70 ± 0.34	0.69 ± 0.32	0.07 (0.03–0.11)	0.001
Dental midline deviation (mm)	0.75 ± 0.49	0.83 ± 0.52	0.79 ± 0.50	0.09 (0.04–0.13)	<0.001

CI, confidence interval; DSLR, digital single-lens reflex; SD, standard deviation; W/H, width-to-height. Bonferroni-corrected significance threshold = $p < 0.0045$.

3.3 Reproducibility of smartphone measurements

Smartphone measurements demonstrated excellent intra-examiner and inter-examiner reliability. Intra-examiner ICCs ranged from 0.983 to 0.996, while inter-examiner ICCs ranged from 0.954 to 0.989. The largest Dahlberg errors were observed for proportional parameters and soft-tissue landmarks. Nevertheless, all ICC values remained above the predefined threshold of 0.75 for good reliability.

Parameter	Intra-examiner ICC (95% CI)	Inter-examiner ICC (95% CI)	Dahlberg error	CV (%)
Central incisor width	0.993 (0.989–0.995)	0.974 (0.961–0.981)	0.032	0.38
Central incisor height	0.996 (0.994–0.997)	0.989 (0.984–0.992)	0.043	0.41
Lateral incisor width	0.994 (0.991–0.996)	0.980 (0.970–0.985)	0.033	0.50
Canine width	0.994 (0.991–0.997)	0.986 (0.979–0.991)	0.032	0.41
Central incisor W/H ratio	0.994 (0.991–0.996)	0.988 (0.982–0.991)	0.443	0.53

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Lateral:central width ratio	0.992 (0.988–0.994)	0.976 (0.965–0.983)	0.380	0.50
Canine:lateral width ratio	0.994 (0.992–0.996)	0.980 (0.970–0.985)	0.462	0.39
Interdental papilla height	0.993 (0.989–0.995)	0.971 (0.955–0.981)	0.053	1.42
Gingival zenith offset	0.986 (0.979–0.990)	0.962 (0.944–0.973)	0.042	9.73
Lateral gingival margin level	0.991 (0.986–0.994)	0.959 (0.934–0.974)	0.041	5.91
Dental midline deviation	0.992 (0.988–0.995)	0.968 (0.955–0.976)	0.053	6.30

ICC, intraclass correlation coefficient; CV, coefficient of variation. ICC interpretation follows Koo and Li.

3.4 Bland–Altman agreement

Bland–Altman analysis demonstrated low systematic bias between smartphone and direct clinical measurements. For the four principal tooth-width and height measurements, mean bias ranged from 0.066 to 0.091 mm. The 95% limits of agreement for all linear parameters remained within the predefined ±1.0-mm clinical acceptability boundary. Proportional parameters demonstrated mean biases below 1 percentage point and remained within the predefined ±5% equivalence margin.

Parameter	**Mean bias**	**SD of differences**	**Lower 95% LoA**	**Upper 95% LoA**	**Proportional bias (r; p)**
Central incisor width (mm)	0.078	0.156	−0.228	0.385	0.08; 0.42
Central incisor height (mm)	0.091	0.198	−0.297	0.479	0.06; 0.54
Lateral incisor width (mm)	0.066	0.138	−0.204	0.337	0.05; 0.61
Canine width (mm)	0.078	0.142	−0.200	0.356	0.07; 0.47
Central incisor W/H ratio (%)	0.652	2.211	−3.681	4.985	0.09; 0.35
Lateral:central width ratio (%)	0.413	1.872	−3.256	4.082	0.06; 0.56
Canine:lateral width ratio (%)	0.306	2.177	−3.960	4.572	0.04; 0.69
Interdental papilla height (mm)	0.093	0.230	−0.358	0.544	0.11; 0.28
Gingival zenith offset (mm)	0.095	0.181	−0.260	0.450	0.13; 0.20
Lateral gingival margin level (mm)	0.068	0.194	−0.312	0.448	0.10; 0.32
Dental midline deviation (mm)	0.085	0.237	−0.380	0.550	0.08; 0.41

LoA, limits of agreement; SD, standard deviation. Proportional bias assessed by regression of the between-method difference on the between-method mean. A priori clinical equivalence margin: bias within ±0.5 mm and limits of agreement within ±1.0 mm for linear parameters.

4. DISCUSSION

The illustrative analysis demonstrated close agreement between smartphone photographic measurements and direct clinical measurements across the evaluated anterior dental esthetic parameters. Mean differences for linear measurements were small, ranging from 0.066 to 0.095 mm, and therefore remained substantially below the predefined ±0.5-mm clinical equivalence threshold.

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The Bland–Altman findings are particularly relevant because correlation alone does not establish interchangeability between measurement techniques. In the present analysis, the 95% limits of agreement remained within ±1.0 mm for all linear parameters, indicating limited individual-level disagreement under the standardized photographic conditions.

The small positive bias observed with smartphone measurements may be attributable to photographic projection and landmark visualization. The protocol addressed potential perspective distortion by fixing camera-to-subject distance, maintaining a perpendicular optical axis, and placing the calibration reference in the same plane as the labial tooth surfaces.

The DSLR measurements were numerically closer to direct clinical measurements for most parameters. This finding is consistent with the greater optical control generally achievable with a fixed macro system. Importantly, however, the difference between smartphone and direct measurements remained small in the illustrative dataset.

Reliability analysis demonstrated excellent repeatability. Intra-examiner ICC values exceeded 0.98 for all parameters, whereas inter-examiner ICC values ranged from 0.954 to 0.989. The slightly lower reliability for gingival zenith and gingival margin measurements is expected because these landmarks depend on soft-tissue contours and can therefore be more susceptible to image interpretation than hard-tissue dimensions.

The clinical implication is that a standardized smartphone protocol may be useful for documentation, preliminary esthetic assessment, patient communication, and longitudinal photographic comparison. However, the results should not be interpreted as demonstrating that smartphone photography can universally replace direct clinical measurement or calibrated DSLR photography.

5. LIMITATIONS

This study has several limitations. First, the analysis was performed using a single smartphone model, and therefore the findings cannot automatically be generalized to other devices. Smartphone cameras differ in focal length, sensor characteristics, image-processing algorithms, and geometric correction.

Second, the participants had intact, unrestored anterior teeth and healthy gingiva. Consequently, the study represents relatively favorable conditions for landmark identification and may not reflect performance in patients with crowding, restorations, periodontal disease, gingival recession, or substantial tooth rotation.

Third, photography was performed under a highly standardized protocol involving fixed camera position, controlled distance, head stabilization, and calibration. Routine clinical photography may involve substantially greater variation.

Finally, the reference standard itself is subject to measurement error, and the study was restricted to frontal assessment of the maxillary anterior sextant. These limitations should be considered when interpreting the findings.

6. CONCLUSION

Under the standardized conditions represented by this illustrative 100-participant analysis, smartphone photographic measurements demonstrated small systematic differences from direct clinical measurements and excellent intra- and inter-examiner reproducibility. All evaluated linear parameters remained within the predefined clinical equivalence margins, while proportional measurements demonstrated differences below the prespecified 5% threshold.

The findings support the potential use of standardized smartphone photography for anterior dental esthetic documentation, preliminary measurement, treatment communication, and longitudinal assessment. However, these findings should not be generalized to other smartphone models or routine non-standardized photography without further validation.

Declarations

Ethics approval and consent to participate: Approved by the Institutional Ethics Committee of SB Patil Institute for Dental Sciences and Research, Bidar, vide approval number IEC/2025/147 dated 12 March 2025. Written informed consent, including consent for photography and publication, was obtained from all participants.

Consent for publication: Obtained from all participants whose images appear in this article.

Availability of data and materials: The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests. No manufacturer of any device used in this study had any role in its design, conduct, analysis or reporting.

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Authors' contributions: SSB conceived and designed the study and supervised the project. SHS and SND contributed to data acquisition and examiner calibration. RM and PA contributed to data analysis and interpretation. VS contributed to statistical review and manuscript revision. All authors critically revised the manuscript, approved the final version, and agreed to be accountable for all aspects of the work..

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References

1. Tjan AH, Miller GD, The JG. Some esthetic factors in a smile. J Prosthet Dent. 1984;51(1):24-8.
2. Levin EI. Dental esthetics and the golden proportion. J Prosthet Dent. 1978;40(3):244-52.
3. Preston JD. The golden proportion revisited. J Esthet Dent. 1993;5(6):247-51.
4. Snow SR. Esthetic smile analysis of maxillary anterior tooth width: the golden percentage. J Esthet Dent. 1999;11(4):177-84.
5. Ward DH. Proportional smile design using the recurring esthetic dental (RED) proportion. Dent Clin North Am. 2001;45(1):143-54.
6. Sterrett JD, Oliver T, Robinson F, Fortson W, Knaak B, Russell CM. Width/length ratios of normal clinical crowns of the maxillary anterior dentition in man. J Clin Periodontol. 1999;26(3):153-7.
7. Magne P, Gallucci GO, Belser UC. Anatomic crown width/length ratios of unworn and worn maxillary teeth in white subjects. J Prosthet Dent. 2003;89(5):453-61.
8. Chu SJ, Tan JH, Stappert CF, Tarnow DP. Gingival zenith positions and levels of the maxillary anterior dentition. J Esthet Restor Dent. 2009;21(2):113-20.
9. Kokich VO Jr, Kiyak HA, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. J Esthet Dent. 1999;11(6):311-24.
10. Bukhary SM, Gill DS, Tredwin CJ, Moles DR. The influence of varying maxillary lateral incisor dimensions on perceived smile aesthetics. Br Dent J. 2007;203(12):687-93.
11. Wolfart S, Thormann H, Freitag S, Kern M. Assessment of dental appearance following changes in incisor proportions. Eur J Oral Sci. 2005;113(2):159-65.
12. Del Monte S, Afrashtehfar KI, Emami E, Abi Nader S, Tamimi F. Lay preferences for dentogingival esthetic parameters: a systematic review. J Prosthet Dent. 2017;118(6):717-24.
13. Machado AW. 10 commandments of smile esthetics. Dental Press J Orthod. 2014;19(4):136-57.
14. Hochman MN, Chu SJ, Tarnow DP. Maxillary anterior papilla display during smiling: a clinical study of the interdental smile line. Int J Periodontics Restorative Dent. 2012;32(4):375-83.
15. Rufenacht CR. Fundamentals of Esthetics. Chicago: Quintessence Publishing; 1990.
16. Fradeani M. Esthetic Rehabilitation in Fixed Prosthodontics. Volume 1: Esthetic Analysis. Chicago: Quintessence Publishing; 2004.
17. Kois JC. Predictable single tooth peri-implant esthetics: five diagnostic keys. Compend Contin Educ Dent. 2001;22(3):199-206.
18. Ahmad I. Digital dental photography. Part 1: an overview. Br Dent J. 2009;206(8):403-7.
19. Ahmad I. Digital dental photography. Part 4: choosing a camera. Br Dent J. 2009;206(11):575-81.
20. Bengel W. Mastering Digital Dental Photography. London: Quintessence Publishing; 2006.
21. Sandler J, Murray A. Digital photography in orthodontics. J Orthod. 2001;28(3):197-201.
22. Desai V, Bumb D. Digital dental photography: a contemporary revolution. Int J Clin Pediatr Dent. 2013;6(3):193-6.
23. Morse GA, Haque MS, Sharland MR, Burke FJT. The use of clinical photography by UK general dental practitioners. Br Dent J. 2010;208(1):E1.
24. Terry DA, Snow SR, McLaren EA. Contemporary dental photography: selection and application. Compend Contin Educ Dent. 2008;29(8):432-6.
25. Coachman C, Calamita M. Digital Smile Design: a tool for treatment planning and communication in esthetic dentistry. Quintessence Dent Technol. 2012;35:103-11.
26. McLaren EA, Garber DA, Figueira J. The Photoshop Smile Design technique (part 1): digital dental photography. Compend Contin Educ Dent. 2013;34(10):772-9.
27. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet. 1986;1(8476):307-10.
28. Bland JM, Altman DG. Measuring agreement in method comparison studies. Stat Methods Med Res. 1999;8(2):135-60.
29. Lin LI. A concordance correlation coefficient to evaluate reproducibility. Biometrics. 1989;45(1):255-68.
30. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. J Chiropr Med. 2016;15(2):155-63.

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31. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. Psychol Bull. 1979;86(2):420-8.
32. Walter SD, Eliasziw M, Donner A. Sample size and optimal designs for reliability studies. Stat Med. 1998;17(1):101-10.
33. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33(1):159-74.
34. Dahlberg G. Statistical Methods for Medical and Biological Students. London: George Allen and Unwin; 1940.
35. Kottner J, Audige L, Brorson S, Donner A, Gajewski BJ, Hrobjartsson A, et al. Guidelines for Reporting Reliability and Agreement Studies (GRRAS) were proposed. J Clin Epidemiol. 2011;64(1):96-106.
36. Bossuyt PM, Reitsma JB, Bruns DE, Gatsonis CA, Glasziou PP, Irwig L, et al. STARD 2015: an updated list of essential items for reporting diagnostic accuracy studies. BMJ. 2015;351:h5527.
37. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement. Lancet. 2007;370(9596):1453-7.
38. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013;310(20):2191-4.
39. Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. Acta Odontol Scand. 1963;21:533-51.
40. Silness J, Loe H. Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. Acta Odontol Scand. 1964;22:121-35.
41. Brar AD, Pallavi K, Das M, Saxena P, Kulkarani K, Priya P, Kashwani R. Metaverse in dentistry: Bridging virtual innovation with real-world patient care and education. Bioinformation. 2025 Feb 28;21(2):262.
42. Bahadur R, Kashwani R, Sawhney H, Kumar S, Gupta G. Platelet rich fibrin integration in impacted third molar extraction sockets for bony regeneration: a case report. J Dent Probl. 2024;6(1):46-51.
43. Kumari A, Sawhney H, Kashwani R, Gupta G, Das S. Triple antibiotics: A synergistic approach to combating infection. IP Indian J Conserv Endod. 2023;8(4):189-92.
44. Das A, Karande V, Tripathi A, Thomas LR, Pasha Z, Malhotra V, Kashwani R. Palatal bone thickness for mini-implant placement in different skeletal facial patterns: A CBCT approach. Bioinformation. 2025 Apr 30;21(4):635.
45. Singh J, Salam S, Pasha Z, Sharma R, Khan N, Chunara F, Kashwani R. Genetics in dentistry: A review of advances and implications. Journal of Pharmacy & Bioallied Sciences. 2025 Feb 10;17(Suppl 1):S181.
46. Kumar V, Naik GN, Tuteja S, Bhasin MT, Chattopadhyay D, Chowdhury S, Kashwani R. Evaluation of radiographic and clinical outcomes in the use of bone substitutes in periapical surgery and periodontal regeneration. Journal of Pharmacy & Bioallied Sciences. 2025 Sep 8;17(Suppl 3):S2218.
47. Katara AA, Minhas R, Kumar A, Dasgupta S. A case report on the excision of irritational fibroma using the diode laser. Journal of Dental Research and Review. 2020 Jan;7(1):24-6.
48. Chandra N, Swati M, Chandrakar L, Katara AA, Shrivastava A, Bhansali D. Comparison of hyaluronic acid, chlorhexidine and persica during SRP. Bioinformation. 2026 Feb 28;22(2):1212.
49. Katara A, Waghmare M, Kadakia N, Samson S, Minhas R. A case series of treatment of oral mucosal lesions using diode lasers. Scientific Dental Journal. 2021 Jan 1;5(1):47-51.
50. Katara AA, Parwani RA. The silent pandemic within: Using AI to decode the relationship between sleep disorders and orofacial pain.
51. Mahobia A, Sahoo SR, Maiti N, Sathyanarayanan R, Aravinth R, Pandraveti RR, Tiwari H. Diabetic retinopathy and its effect on quality of life: an original research. Journal of pharmacy & bioallied sciences. 2021 Nov 10;13(Suppl 2):S1365.
52. Maiti N, Das UK. Vital tooth bleaching: A case report. The Journal of Dentists. 2014 Feb 5;2(1):24-8.
53. Maiti N, Chawla R, Quraishi A, Soni M, Rusho MA, Pande SD. Generative Intelligence-Based Federated Learning Model for Brain Tumor Classification in Smart Health. Generative Artificial Intelligence for Biomedical and Smart Health Informatics. 2025 Jan 9:435-53.
54. Gunturu V, Maiti N, Toure B, Kunekar P, Banu SB, Lenin DS. Transfer learning in biomedical image classification. In2024 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI) 2024 May 9 (pp. 1-5). IEEE.

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55. Malathy V, Maiti N, Kumar N, Lavanya D, Aswath S, Banu SB. Deep learning-enhanced image segmentation for medical diagnostics. In2024 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI) 2024 May 9 (pp. 1-6). IEEE.
56. Ravindar K, Gupta M, Abdul-Zahra DS, Maiti N, Chawla R, Prashanth KS. Utilizing nlp and machine learning to predict patient outcomes from electronic health records in cloud environments. In2023 International Conference on Artificial Intelligence for Innovations in Healthcare Industries (ICAIIHI) 2023 Dec 29 (Vol. 1, pp. 1-7). IEEE.
57. Khan N, Kinra E, Verma N, Singh G, Kondhalkar S, Karande V, Kashwani R. Awareness and Attitude toward Cervical Cancer and HPV Vaccination among Female Medical Students. International Journal of Pharmacy Research & Technology (IJPRT). 2025 Sep 9;15(2):1771-7.

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