Libyan Med J. 2026;18(11):754-759
https://doi.org/10.69667/lmj.26112

Libyan Medical Journal

https://lmj.ly/index.php/ojs/index *eISSN: 3107-0426*

Original article

Patient Positioning Techniques for Improved Radiographic Image Quality in Dentistry: An Evaluation of Intraoral and Panoramic Radiography

Mohamed Abour

Faculty of Medicine, Al-Joufra University, Libya
Email. *Mohdabour@ju.edu.ly*

Keywords
Dental Radiography, Intraoral Paralleling Technique, Bisecting-Angle Technique, Panoramic Radiography, Patient Positioning Errors.

ABSTRACT

High-quality dental radiographs are essential for accurate diagnosis, treatment planning, and prognostic assessment. Technical errors in patient positioning represent the leading cause of non-diagnostic image quality, leading to unnecessary ionizing radiation exposure through repeat exposures. To perform an empirical statistical evaluation of the impact of various patient positioning techniques and error conditions on image quality across intraoral (paralleling, bitewing, bisecting-angle) and extraoral panoramic radiographic modalities. A comprehensive dataset of 234 patient observations (N = 234 valid image quality scores evaluated on a continuous 1.0–5.0 scale) was analyzed. Parametric (t-test, One-Way ANOVA, Tukey HSD) and non-parametric tests (Mann-Whitney U, Kruskal-Wallis H) were conducted. Confounding demographic effects (age, sex) were evaluated using Pearson correlation and independent t-tests. Intraoral techniques achieved significantly superior image quality scores (3.62 ± 0.40) compared to panoramic radiography (2.60 ± 0.33; $t = 20.92$, $p < 0.0001$). Within intraoral radiography, the paralleling technique yielded the highest diagnostic score (3.99 ± 0.13), significantly outperforming bitewing (3.47 ± 0.15) and bisecting-angle techniques (3.03 ± 0.11; $F = 484.19$, $p < 0.0001$). Among panoramic positioning conditions, head rotation caused the most severe degradation in diagnostic quality (1.99 ± 0.10; $F = 247.48$, $p < 0.0001$). Patient age ($r = 0.0376$, $p = 0.5667$) and sex ($t = -0.1676$, $p = 0.8671$) demonstrated no statistically significant association with quality scores. The intraoral paralleling technique remains the gold standard for dimensional fidelity and clarity. In panoramic imaging, preventing head rotation is critical for preserving diagnostic value. Implementation of standardized alignment protocols and AI-assisted quality assurance is strongly recommended.

Introduction

Diagnostic imaging forms the cornerstone of modern dental practice, facilitating early detection of dental caries, periapical lesions, alveolar bone loss, impacted teeth, and maxillofacial pathologies [1,2]. The diagnostic utility of any radiograph relies fundamentally on image quality, defined by spatial resolution, visual contrast, structural sharpness, and minimal geometric distortion [3]. Suboptimal image quality compromises diagnostic accuracy and violates the ALADA (As Low As Diagnostically Acceptable) radiation safety principle by necessitating repeat exposures [3].

Patient positioning errors represent the single largest category of technical faults in dental radiography, exceeding exposure or processing errors in digital workflows [4,5]. Intraoral techniques (paralleling, bitewing, bisecting-angle) and extraoral panoramic radiography each possess unique geometric principles, mechanical constraints, and susceptibility to positioning variances [1,2].

Intraoral radiography involves placing an image receptor directly inside the oral cavity, adjacent to the anatomical structures of interest [1]. The three principal intraoral radiographic techniques—paralleling, bitewing, and bisecting-angle—differ in their geometric principles and receptor and beam alignment. The paralleling technique is considered the reference standard for periapical imaging, as it involves positioning the image receptor parallel to the long axis of the tooth and directing the central X-ray beam perpendicular to both the tooth and the receptor [2]. Position-indicating devices (PIDs) equipped with film or sensor holders help maintain accurate spatial alignment, thereby minimizing image magnification and geometric distortion [2,4].

The bitewing technique is primarily used to assess the interproximal surfaces of the crowns of posterior teeth and the height of the crestal alveolar bone. In this technique, the image receptor is stabilized using a bite tab or holder positioned between the opposing occlusal surfaces [1]. Appropriate beam alignment requires a slightly positive vertical angulation, generally between +5° and +10°, to compensate for receptor inclination and anatomical variations, while correct horizontal angulation is essential to prevent overlapping of proximal contact areas [1,6].

The bisecting-angle technique is based on Cieszynski's rule of isometry, whereby the image receptor is positioned close to the tooth, forming an angle with its long axis [2,4]. The central X-ray beam is then directed perpendicular to an imaginary plane that bisects the angle formed between the tooth and the receptor [4]. Although this technique is useful in situations where anatomical limitations, such as a shallow palate or the presence of tori, or difficulties with patient cooperation

Copyright *Author (s) 2026. Distributed under Creative Commons CC BY 4.0*
Received: *30-08-2026 -* ***Accepted:*** *28-10-2026 -* ***Published:*** *06-11-2026*

Libyan Med J. 2026;18(11):754-759
https://doi.org/10.69667/lmj.26112
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index eISSN: 3107-0426

prevent the use of the paralleling technique, it is more susceptible to geometric distortion. Deviations in vertical beam angulation from the true bisector may result in image elongation or foreshortening, potentially compromising diagnostic accuracy [4]. Panoramic radiography (orthopantomography) utilizes curved motion tomography to visualize the entire maxilla, mandible, and surrounding dentoalveolar structures on a single extraoral projection [1,5]. The X-ray tube head and receptor rotate synchronously around a shifting center of rotation, creating a horseshoe-shaped three-dimensional zone of sharp focus termed the focal trough or image layer [5,7].

Anatomical structures positioned precisely within the focal trough are recorded with optimal detail and minimal distortion [5]. However, because the focal trough is narrow—especially in the anterior region (only 3–6 mm wide)—minor deviations in patient position significantly alter horizontal and vertical image geometry [5,7]:

- **Anteroposterior Displacement:** Positioning the patient anterior to the focal trough causes horizontal compression (narrowing) of anterior teeth, whereas posterior displacement results in horizontal magnification (widening) and blur [5].
- **Head Rotation:** Twisting the head around the vertical axis shifts structures relative to the rotation center, causing severe horizontal asymmetry—structures closer to the receptor appear narrowed, while those further appear magnified [5,7].
- **Chin Elevation / Depression:** Tipping the Frankfort horizontal plane upward causes a flattened occlusal plane ("frown") and radiopaque palatal ghosting over maxillary roots. Tipping downward exaggerates the occlusal curve ("smile") and foreshortens the mandibular condyles [5].
- **Incorrect Tongue Positioning:** Failure to press the tongue flat against the hard palate leaves a prominent palatoglossal air space, casting a dark radiolucent band across maxillary periapical regions [1,5].

Methods

Study Design and Sample Selection

This retrospective observational study analyzed a standardized evaluation dataset comprising 234 consecutive patient radiographic procedures (N = 234 complete evaluations). Radiographs were collected across institutional diagnostic clinics operating under standardized exposure parameters.

Image Quality Scoring Framework

Each radiograph was graded by experienced oral and maxillofacial radiologists using a validated 5-point quality assessment scale:

- **Grade 5.0 (Excellent):** Perfect anatomical representation, optimal density/contrast, zero positioning or alignment flaws.
- **Grade 4.0 (Good):** High diagnostic utility; minor non-interfering technical flaw.
- **Grade 3.0 (Acceptable):** Adequate for primary diagnostic intent, moderate distortion or contact overlap present.
- **Grade 2.0 (Sub-diagnostic):** Severe positioning error resulting in structural obscuration or significant asymmetry; repeat radiograph considered.
- **Grade 1.0 (Non-diagnostic):** Total diagnostic failure requiring mandatory exposure repeat.

Categorization of Variables

The data recorded for each observation included demographic characteristics, specifically age (in years) and sex (male or female), as well as the imaging modality used, which was categorized as either intraoral radiography or extraoral panoramic radiography.

Positioning Condition / Technique:

- *Intraoral Modality:* Paralleling technique, Bitewing technique, Bisecting-Angle technique.
- *Panoramic Modality:* Correct panoramic reference alignment, Chin elevation/depression, Incorrect tongue positioning, Anterior/posterior displacement, Lateral head tilt, Head rotation.

Primary Diagnostic Criteria Evaluated: Image distortion, interproximal contact visibility, occlusal plane geometry, maxillary root shadow obscuration, structural symmetry, and anatomical magnification.

Statistical Power and Analytical Protocols

Statistical computations were executed using SciPy (v1.11) and Statsmodels (v0.14) in Python 3.11. Continuous parameters were evaluated for normality via Shapiro-Wilk testing and visual Q-Q inspection. Summary statistics are presented as Mean ± Standard Deviation (SD) alongside Median and Interquartile Range (IQR).

Hypothesis testing protocols included:

Copyright *Author (s) 2026. Distributed under Creative Commons CC BY 4.0*
Received: *30-08-2026 -* ***Accepted:*** *28-10-2026 -* ***Published:*** *06-11-2026*

Libyan Med J. 2026;18(11):754-759
https://doi.org/10.69667/lmj.26112
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index eISSN: 3107-0426

- **Demographic Confounder Control:** Pearson product-moment (r) and Spearman rank (ρ) correlations evaluated age vs. quality score. Independent two-sample t-tests evaluated sex-based quality variations.
- **Modality-Level Analysis:** Independent Student's t-test and Mann-Whitney U test evaluated global Intraoral vs. Panoramic performance.
- **Group-Wise Comparisons:** One-Way Analysis of Variance (ANOVA) and Kruskal-Wallis H-tests evaluated differences across all 9 positioning sub-categories and within modality subgroups.
- **Post-Hoc Pairwise Testing:** Tukey's Honest Significant Difference (HSD) test was performed with adjusted significance thresholds ($p_{adj} < 0.05$) to control Type I error across multiple comparisons.

Results

The total evaluated sample (N = 234) spanned a broad adult and pediatric demographic range from 13 to 71 years, with an overall mean age of 33.61 ± 14.29 years (Median: 33.0 years, IQR: 18.0 years). The gender distribution was balanced, comprising 118 females (50.6%; mean age 34.60 ± 15.13) and 116 males (49.4%; mean age 32.60 ± 13.35).

Rigorous demographic confounder testing confirmed that patient age had no statistically significant correlation with image quality scores ($r = 0.0376$, $p = 0.5667$; Spearman $\rho = 0.0322$, $p = 0.6237$). Furthermore, image quality scores did not differ significantly by sex ($t = -0.1676$, $p = 0.8671$; Female Mean = 3.14 ± 0.65, Male Mean = 3.15 ± 0.68). These results confirm that technical positioning factors, rather than patient demographic characteristics, were the sole drivers of image quality variations.

Intraoral radiography procedures consistently achieved higher diagnostic quality scores than extraoral panoramic projections across all evaluated instances (Table 1).

Table 1: Comprehensive Statistical Summary by Imaging Modality

Imaging Modality	N	Mean Score	SD	Median	IQR	Min	Max	95% CI (Mean)
Intraoral Radiography	124	**3.62**	0.40	3.60	0.70	2.80	4.30	[3.55, 3.69]
Panoramic Radiography	110	**2.60**	0.33	2.60	0.40	1.80	3.20	[2.54, 2.66]

Parametric test: $t = 20.917$, $p < 0.0001$; Non-parametric test: Mann-Whitney $U = 13318.0$, $p < 0.0001$.

The overall mean quality score for intraoral radiographs (3.62 ± 0.40) exceeded that of panoramic radiographs (2.60 ± 0.33) by 1.02 score units. Both parametric ($t = 20.917$, $p < 0.0001$) and non-parametric tests ($U = 13318.0$, $p < 0.0001$) confirmed that this modality gap is highly statistically significant. Disaggregating the data into specific positioning techniques and technical error conditions revealed marked performance contrasts across the 9 sub-categories (Table 2).

Table 2: Disaggregated Image Quality Metrics Across All Positioning Conditions

Modality	Technique / Positioning Condition	Primary Evaluation Focus	N	Mean	SD	Median	Min	Max
Intraoral	Paralleling Technique	Image quality & geometric distortion	58	3.99	0.13	4.00	3.70	4.30
Intraoral	Bitewing Technique	Interproximal contact & crestal bone	40	3.47	0.15	3.50	3.20	3.80
Intraoral	Bisecting-Angle Technique	Contact visibility & periapical detail	26	3.03	0.11	3.05	2.80	3.20
Panoramic	Chin Elevation / Depression	Occlusal-plane line curvature	14	3.02	0.07	3.00	2.90	3.10
Panoramic	Incorrect Tongue Positioning	Maxillary root shadow clarity	20	2.97	0.10	3.00	2.80	3.20
Panoramic	Anteroposterior Displacement	Focal trough magnification/compression	19	2.56	0.07	2.50	2.50	2.70
Panoramic	Lateral Head Tilt	Condylar & ramus height symmetry	12	2.54	0.07	2.50	2.50	2.70
Panoramic	Correct Panoramic Positioning	Reference overall diagnostic quality	30	2.52	0.11	2.50	2.30	2.70
Panoramic	Head Rotation	Midsagittal asymmetry & horizontal blur	15	1.99	0.10	2.00	1.80	2.20

Copyright *Author (s) 2026. Distributed under Creative Commons CC BY 4.0*
Received: *30-08-2026 -* ***Accepted:*** *28-10-2026 -* ***Published:*** *06-11-2026*

Libyan Med J. 2026;18(11):754-759
https://doi.org/10.69667/lmj.26112
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index eISSN: 3107-0426

A global One-Way ANOVA across all 9 positioning groups demonstrated extreme statistical significance ($F(8, 225) = 795.43$, $p = 2.29 \times 10^{-160}$), confirming that patient positioning parameters strongly dictate image quality outcomes. The non-parametric Kruskal-Wallis test corroborated this outcome ($H = 221.41$, $p = 1.94 \times 10^{-43}$). Within the intraoral modality ($n = 124$), significant differences were identified between techniques ($F(2, 121) = 484.19$, $p = 1.82 \times 10^{-58}$; Kruskal-Wallis $H = 105.14$, $p < 0.0001$). Post-hoc Tukey HSD pairwise comparisons demonstrated significant differences across all three techniques ($p_{adj} < 0.0001$):

Table 3: Tukey HSD Post-Hoc Pairwise Comparisons for Intraoral Techniques

Comparison Pair (Technique A vs. Technique B)	Mean Diff. (A - B)	Std. Error	95% Confidence Interval	Adjusted p-value
Paralleling vs. Bisecting-Angle	+0.9550	0.0381	[+0.8791, +1.0309]	**< 0.0001**
Paralleling vs. Bitewing	+0.5247	0.0332	[+0.4585, +0.5908]	**< 0.0001**
Bitewing vs. Bisecting-Angle	+0.4304	0.0407	[+0.3493, +0.5114]	**< 0.0001**

The intraoral paralleling technique achieved an outstanding mean score of 3.99 ± 0.13, reflecting high reproducibility and minimal geometric distortion. Bitewing projections performed moderately (3.47 ± 0.15), while the bisecting-angle technique scored lowest among intraoral approaches (3.03 ± 0.11).

Subgroup analysis of panoramic positioning conditions ($n = 110$) yielded significant variance ($F(5, 104) = 247.48$, $p = 4.64 \times 10^{-56}$; Kruskal-Wallis $H = 89.72$, $p < 0.0001$). Head Rotation was identified as the most severe positioning error in panoramic radiography, producing a mean score of 1.99 ± 0.10—significantly lower than all other panoramic conditions ($p < 0.0001$). Rotational misalignment causes catastrophic horizontal distortion, making structural symmetry impossible to evaluate.

Table 4: Key Post-Hoc Pairwise Comparisons for Panoramic Positioning Conditions

Comparison Pair	Mean Diff.	95% Confidence Interval	Adjusted p-value	Clinical Interpretation
Head Rotation vs. Correct Positioning	-0.5300	[-0.6082, -0.4518]	**< 0.0001**	Severe diagnostic degradation due to asymmetry
Ant/Post Displacement vs. Correct Pos.	+0.0400	[-0.0312, +0.1112]	0.8114	Comparable score due to focal trough depth
Lateral Head Tilt vs. Correct Pos.	+0.0200	[-0.0594, +0.0994]	0.9856	Minor effect on central diagnostic zone
Chin Elevation vs. Correct Pos.	+0.5000	[+0.4182, +0.5818]	**< 0.0001**	Specific criterion score weighting artifact
Incorrect Tongue vs. Correct Pos.	+0.4500	[+0.3792, +0.5208]	**< 0.0001**	Isolated air-gap shadow impact

Discussion

The empirical findings of this study demonstrate the clear diagnostic superiority of the intraoral paralleling technique (3.99 ± 0.13) over all other intraoral and extraoral imaging modalities [2]. This clinical advantage stems from basic geometric optics: by maintaining a parallel relationship between the image receptor and tooth axis and directing the central ray perpendicularly, geometric magnification and dimensional foreshortening/elongation are minimized [2,4].

Position-indicating devices (PIDs) equipped with rigid ring-guided holders physically enforce correct beam-receptor alignment, eliminating operator error in calculating vertical and horizontal angulations [2,6]. In contrast, the bisecting-angle technique relies on manual estimation of the imaginary bisecting plane [4]. Slight operator inaccuracies in estimating this plane introduce geometric distortion, explaining the lower mean score (3.03 ± 0.11) observed for bisecting-angle radiographs in this dataset [4]. Bitewing projections demonstrated intermediate performance (3.47 ± 0.15). While bitewing tabs provide reliable horizontal contact alignment, minor vertical angulation shifts can lead to overlapping enamel contacts or crestal bone obscuration [1,6].

The overall mean score for panoramic radiography (2.60 ± 0.33) was significantly lower than that of intraoral radiography (3.62 ± 0.40; $p < 0.0001$). This gap reflects the inherent physical constraints of extraoral focal trough tomograms, which possess lower spatial resolution and higher susceptibility to positioning artifacts than direct intraoral digital sensors [1,5].

Among panoramic error states, head rotation caused the most severe diagnostic loss (1.99 ± 0.10). Rotating the patient's head around the vertical axis moves one side of the mandible closer to the X-ray source and the opposite side closer to the receptor [5,7]. Because horizontal magnification in panoramic imaging depends on object-to-receptor distance, rotation

Copyright Author (s) 2026. Distributed under Creative Commons CC BY 4.0
Received: 30-08-2026 - **Accepted:** 28-10-2026 - **Published:** 06-11-2026

Libyan Med J. 2026;18(11):754-759
https://doi.org/10.69667/lmj.26112
Libyan Medical Journal
https://lmj.ly/index.php/ojs/index eISSN: 3107-0426

creates dramatic horizontal asymmetry: posterior teeth on the rotated side appear artificially narrowed, while the contralateral side appears magnified and blurred [5]. This renders condylar comparison, arch width measurement, and bilateral caries assessment non-diagnostic [5,7].

Anteroposterior displacement (2.56 ± 0.07) and lateral head tilt (2.54 ± 0.07) produced moderate diagnostic degradation, performing close to baseline panoramic reference positioning (2.52 ± 0.11). Interestingly, chin elevation/depression (3.02 ± 0.07) and incorrect tongue positioning (2.97 ± 0.10) received slightly higher numerical scores within the dataset due to scoring rubrics that evaluated localized criteria (e.g., occlusal line shape or maxillary clarity) independently of overall geometry [1,5]. Nevertheless, palatoglossal air gaps created by improper tongue positioning remain a frequent cause of obscured maxillary root apices [5].

The optimization of patient positioning is fundamentally linked to radiation safety and the ALADA (As Low As Diagnostically Acceptable) principle [3]. While modern digital receptors have significantly reduced radiation dose per exposure compared to traditional film, unnecessary repeat exposures resulting from technical errors remain the primary driver of cumulative diagnostic radiation dose in dental practices [3,8]. Sub-diagnostic images (scores ≤ 2.0) frequently require complete re-imaging, doubling the radiation dose to the patient for that diagnostic encounter [3]. In this study, head rotation in panoramic imaging yielded an average score of 1.99, placing it directly in the sub-diagnostic retake category. Standardizing patient setup with laser alignment lights (midsagittal, Frankfort plane, canine location) and bite blocks is essential to eliminate these preventable retakes [5,7].

Clinical Practice Guidelines & Standard Operating Protocols

Based on the statistical findings, clinical practice should adopt mandatory standardized operating protocols for radiographic positioning to improve image quality, reduce positioning errors, and minimize the need for repeat examinations [6,9]. For intraoral periapical radiography, the paralleling technique should be the standard approach, using sensor-holding positioning devices (PIDs) equipped with aiming rings to ensure accurate alignment of the X-ray beam and image receptor [2]. The bisecting-angle technique should be reserved for situations in which anatomical limitations make parallel sensor placement impractical [4].

For panoramic radiography, clinicians should routinely verify three-dimensional patient positioning before image acquisition. The midsagittal plane should be perpendicular to the floor and aligned with the central laser light to prevent head rotation, while the Frankfort horizontal plane should remain parallel to the floor to avoid excessive chin elevation or depression [5]. Additionally, the patient's incisors should be correctly positioned within the groove of the bite rod to ensure appropriate anteroposterior alignment within the focal trough [5,7].

Furthermore, standardized patient instructions should be provided before panoramic image acquisition. Patients should be instructed to swallow and maintain their tongue flat against the roof of the mouth throughout the entire exposure cycle. This positioning helps eliminate the palatoglossal air space and reduces the likelihood of radiographic artifacts that may compromise image interpretation [1,5].

Conclusion

This empirical evaluation of 234 patient observations provides strong statistical evidence of the influence of radiographic positioning techniques on image quality in dental imaging. The intraoral paralleling technique demonstrated the highest diagnostic quality score (3.99 ± 0.13), significantly outperforming the bitewing (3.47 ± 0.15) and bisecting-angle (3.03 ± 0.11) techniques ($p < 0.0001$). These findings support the preferential use of the paralleling technique for periapical radiography, with appropriate position-indicating devices (PIDs), to ensure optimal image quality and diagnostic accuracy.

A significant difference was also observed between imaging modalities, with intraoral radiography achieving a higher overall diagnostic quality score (3.62 ± 0.40) than extraoral panoramic radiography (2.60 ± 0.33; $p < 0.0001$). This finding highlights the importance of intraoral imaging for high-resolution, localized dental diagnostic assessments, while recognizing the complementary role of panoramic radiography in broader maxillofacial evaluation.

Among the positioning errors evaluated in panoramic radiography, head rotation had the most detrimental effect on image quality, reducing the mean quality score to a subdiagnostic level (1.99 ± 0.10). This emphasizes the importance of accurate midsagittal plane alignment using positioning guides and laser indicators to minimize positioning errors and reduce the need for repeat examinations. Furthermore, neither patient age ($p = 0.5667$) nor sex ($p = 0.8671$) demonstrated a statistically significant association with radiographic quality scores, suggesting that variations in image quality within this sample were more closely related to technical factors and positioning accuracy than to demographic characteristics.

Conflict of interest. Nil

References

1. Suparno NR, Faizah A, Nafisah AN. Assessment of panoramic radiograph errors: An evaluation of patient preparation and positioning quality at Soelastri Dental and Oral Hospital. *The Open Dentistry Journal*. 2023;17:e187421062309120. doi:10.2174/0118742106261974230925073155

Copyright *Author (s) 2026. Distributed under Creative Commons CC BY 4.0*
Received: *30-08-2026 -* ***Accepted:*** *28-10-2026 -* ***Published:*** *06-11-2026*

2. Yen M, Yeung AWK. The performance of paralleling technique and bisecting angle technique for taking periapical radiographs: A systematic review. *Dentistry Journal*. 2023;11(7):155. doi:10.3390/dj11070155
3. Tadin A, Poljak-Guberina R, Gavic L. Retake analysis and patient radiation dose reduction in digital dental radiography. *Radiation Protection Dosimetry*. 2022;198(14):1089-1097. doi:10.1093/rpd/ncac182
4. Nardi C, Taliani GG, Calistri L. Comparative geometric distortion between paralleling and bisecting-angle intraoral radiography: A phantom study. *Radiologia Medica*. 2021;126(8):1102-1110. doi:10.1007/s11547-021-01372-x
5. Ameli N, Mostafavi M, Assadi M. Automated quality evaluation of dental panoramic radiographs using deep learning classification models. *Imaging Science in Dentistry*. 2024;54(2):115-124. doi:10.5624/isd.20240232
6. Devlin H, Horner K. Guidelines for image quality and patient positioning in intraoral and extraoral dental radiography. *International Dental Journal*. 2020;70(5):312-320. doi:10.1111/idj.12578
7. Miles DA, Van Dis ML. Common errors in digital intraoral and panoramic radiography: Detection and prevention. *Dental Clinics of North America*. 2020;64(2):345-358. doi:10.1016/j.cden.2019.12.004
8. Jacobs R, Salmon B, Codari M. Digital dental radiography and image optimization strategies: A consensus statement. *Periodontology 2000*. 2022;89(1):180-193. doi:10.1111/prd.12435
9. Patel S, Harvey V. Technical quality assessment of intraoral periapical radiographs in general dental practice. *British Dental Journal*. 2022;232(7):461-468. doi:10.1038/s41415-022-4091-8
10. Choi EJ, Hwang JJ, Lee C. Artificial intelligence-based detection of technical positioning errors in panoramic radiography. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology*. 2023;135(4):542-550. doi:10.1016/j.oooo.2022.11.008
11. Bagherpour A, Paziresh M, Javadzadeh A. Assessment of common positioning errors in digital panoramic radiography. *Journal of Dental Materials and Techniques*. 2021;10(3):145-151.
12. Horner K, Eaton KA. Selection criteria for dental radiography: Summary of European guidelines. *Community Dental Health*. 2021;38(2):98-104.
13. Rushton VE, Horner K. Quality assessment of panoramic radiography in general dental practice. *Journal of Dentistry*. 2020;98:103370. doi:10.1016/j.jdent.2020.103370
14. Shah N, Bansal A. Evaluation of common technical positioning errors in digital intraoral bitewing and periapical radiographs. *Journal of Oral Biology and Craniofacial Research*. 2023;13(2):210-216. doi:10.1016/j.jobcr.2023.01.005
15. Whaites E, Drage N. *Essentials of Dental Radiography and Radiology*. 6th ed. Elsevier Health Sciences; 2021.
16. White SC, Pharoah MJ. *Oral Radiology: Principles and Interpretation*. 8th ed. Elsevier; 2024.

Copyright *Author (s) 2026. Distributed under Creative Commons CC BY 4.0*
Received: *30-08-2026 -* ***Accepted:*** *28-10-2026 -* ***Published:*** *06-11-2026*