Visualization of Incisive Foramen in Intraoral Periapical Radiographs- A Comparative Radiographic Study

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ABSTRACT

Introduction: Incisive foramen, a normal anatomical landmark in the anterior maxilla, appears as a radiolucency between the apices of the maxillary central incisors on intraoral periapical radiographs. This study was conducted to compare the visibility of the incisive foramen in between bisecting-angle and paralleling techniques.

Methods: An analytical cross-sectional study was conducted among 100 patients selected by consecutive sampling method. Group 1 included patients with 50 radiographs obtained for visualization of incisive foramen using bisecting angle technique and Group 2 included 50 patients with radiographs using paralleling technique. Data was entered into Microsoft Excel Sheet and analyzed in SPSS version 24. Chi square/fisher's exact test was done to determine the proportional difference between visualization of incisive foramen by using two techniques. The significance level was set at $P<0.05$.

Results: The incisive foramen was visible in 74 (74%) radiographs with a higher proportion of visible foramen observed in paralleling techniques. A statistically significant association was observed between age and visibility of the incisive foramen ($p = 0.016$) such that <35 years aged patients showed a higher proportion of visible incisive foramen (65.6%) compared to those aged 35–59 years (23.1%). However, more visualization was seen in the ≥60 years age group (80.0%). Significant association between the radiographic technique used and the visibility of the incisive foramen was seen ($P< 0.001$).

Conclusion: The findings of this study revealed better visualization of incisive foramen using paralleling technique than bisecting angle technique suggesting that paralleling technique should be preferred in routine periapical radiography of the anterior maxilla to improve visualization of the incisive foramen.

Keywords: Dental; Incisive foramen; Radiography

INTRODUCTION

The incisive foramen is one of the most significant anatomical landmarks in anterior maxilla. It represents oral opening of nasopalatine canal, which transmits the nasopalatine nerve and accompanying blood vessels from nasal cavity to oral cavity.[1] It develops from fusion of medial nasal processes during formation of the primary palate in early embryogenesis and undergoes dimensional changes during craniofacial growth, with its morphology stabilizing after skeletal maturity but potentially enlarging following tooth loss.[2]

Radiographically, the incisive foramen typically appears as a round to ovoid radiolucency in the

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midline between the apices of the maxillary central incisors. Dental experts can accurately analyze oral tissues and related disorders with proper periapical radiography.[3] Correct recognition is essential to differentiate this normal landmark from periapical pathologies such as cysts or granulomas.[4] Visibility of the incisive foramen in intraoral periapical radiographs is influenced by factors such as beam angulation, projection geometry, bone density, and imaging technique.[5] Studies have shown that the paralleling technique provides superior visualization compared with the bisecting angle technique.[6,7]

Despite its clinical relevance, the incisive foramen remains inadequately studied in routine intraoral periapical radiography. The existing literature focuses on advanced modalities like panoramic radiography and Cone beam computed tomography (CBCT). Also, there is lack of localized data from the Nepalese population. Consequently, the lack of evidence-based guidance for distinguishing normal anatomical landmarks from pathologies. Therefore, this study was conducted to compare the visibility of the incisive foramen in routine periapical radiographs using bisecting-angle and paralleling techniques.

METHODS

An analytical cross-sectional study was conducted from July to December 2025 at Oral Medicine and Radiology Unit of Tribhuvan University Teaching Hospital, Maharajgunj, Kathmandu Nepal. Ethical approval was obtained from the Ethical Review Board of Tribhuvan University (ERB-TU, Ref. no. 87/081/082) before data collection. Hundred dental patients aged between 18 years and above, requiring radiograph of maxillary central incisors were selected by consecutive sampling method and alternatively assigned to bisecting angle technique group (Group 1 = 50) and paralleling technique (Group 2 = 50). The radiographs were visualized under standard viewing conditions.

The required sample size was estimated with reference to a previous study by Raina et al.[7] conducted among the Nepalese population. Sample size was calculated by using formula, $n = (Z_{\alpha/2} + Z_{\beta})^2 \chi \{ P_1 (1-P_1) + P_2 (1-P_2) \} / (P_1 - P_2)^2$, where, n = sample size, $Z_{\alpha/2} = 1.96$ at 95% confidence interval, $Z_{\beta} = 0.84$ at 80% power, P_1 = prevalence of visualization of incisive foramen in group 1 = 63.8%, P_2 = prevalence of visualization of incisive foramen in group 2 = 36.2%. Placing these values in the formula provided above, the calculated sample size is 47.54 in each group. Adding 5% non-response rate, final sample = 49.92 ≈ 50 in each group (50X2 = 100).

For bisecting angle technique, SNAP – A – RAY intraoral film holder, Size 2 Dental X-ray film (31 mm X 41 mm) were used for intraoral periapical radiographs. Exposure was made using standard protocol [Voltage: 70 KvP, Tube current: 3mA, Time: 0.8 sec] and radiographs were obtained.

When using the bisecting angle technique, the head position is important, therefore, the following rule for head position or patient's position was considered: the occlusal plane of the teeth to be radiographed was placed parallel to the floor, the sagittal plane was placed perpendicular to the floor, here ala-tragus line was parallel to the floor, the film was placed as close as possible to the tooth, the central ray was directed perpendicular to a line bisecting the angles formed by the long axis of the tooth and the plane of the film.

For paralleling technique, RIN XCP (extension cone paralleling) holder for anterior teeth, Size 2 Dental X-ray film (31 mm X 41 mm) was used. The film was placed as close as possible to the object being radiographed. As far as practical,

the long axis of the object was kept parallel to the film. The central ray was considered nearly perpendicular to the film as possible to record the adjacent structures in their true spatial relationship.

The data obtained were entered into Microsoft Excel Sheet and analyzed in SPSS (Statistical Package for Social Sciences) software version 24. Mean, standard deviation was computed for quantitative data and frequency, percentage for qualitative data. Chi square test/fisher's exact test was done to determine the association between different radiographic techniques with age, gender and visualization of incisive foramen. The significance level was set at P<0.05.

RESULTS

A total of 100 patients were included in the study, with 50 radiographs obtained using the bisecting angle technique (Group 1) and 50 using the paralleling technique (Group 2). The mean age of the participants was 34.67 ± 15.95 years (range: 18–70 years, Table 1). Overall, 71 (71%) were males and 29 (29%) were females (Figure 3). Overall, the incisive foramen was visible in 74% of radiographs with more proportion of visible foramen observed in paralleling technique (Figure 4). Table 2 shows the visibility of the incisive foramen according to age group and gender among the study participants (n = 100). A statistically significant association was observed between age and visibility of the incisive foramen (p = 0.016). Participants aged <35 years showed a higher proportion of visible incisive foramen 21 (65.6%) compared to those aged 35–59 years, where visibility was observed in only 3 (23.1%) of cases. In the ≥60 years age group, the incisive foramen was visible in 4 (80.0%) of participants. With respect to gender, males demonstrated a higher proportion of visible incisive foramen (22, 62.9%) compared to females (6, 40.0%); however, this difference was not statistically significant (p = 0.136). A chi-square test revealed a statistically significant association between the radiographic technique used and the visibility of the incisive foramen ($\chi^2 = 16.84$, df = 1, $p < 0.001$), indicating that the paralleling technique provides superior visualization of the incisive foramen compared to the bisecting angle technique (Table 3).

Table 1: Age of study participants (n = 100, 50 in each group)

Group	Age in years (Mean age ± SD)	Minimum age in years	Maximum age in years
Bisecting angle group	34.60 ± 15.75	18	70
Paralleling technique group	35.30 ± 15.64	18	70
Total	34.95 ± 15.62	18	70

Table 2: Visibility of incisive foramen in different age groups and genders (n=100)

Variables	Category	Not visible n (%)	Visible n (%)	P value
Age in years	<35	11 (34.4)	21 (65.6)	0.016[a]
	35-59	10 (76.9)	3 (23.1)	
	≥60	1 (20.0)	4 (80.0)	
Gender	Male	13 (37.1)	22 (62.9)	0.136*
	Female	9 (60.0)	6 (40.0)	

*Chi square test [a]Fisher's exact test

Table 3: Visibility of incisive foramen according to radiographic technique (n=100, 50 in each group)

Technique	Not visible n (%)	Visible n (%)	P value*
Bisecting angle	22 (44.0)	28 (56.0)	<0.001
Paralleling	4 (8.0)	46 (92.0)	

*Chi square test

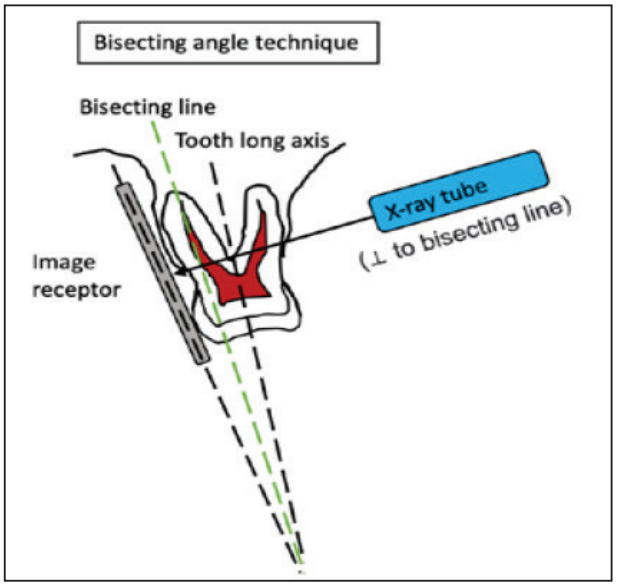

Figure 1: *Diagram of bisecting angle technique illustrating the relationship of the film, the teeth and the central ray3*

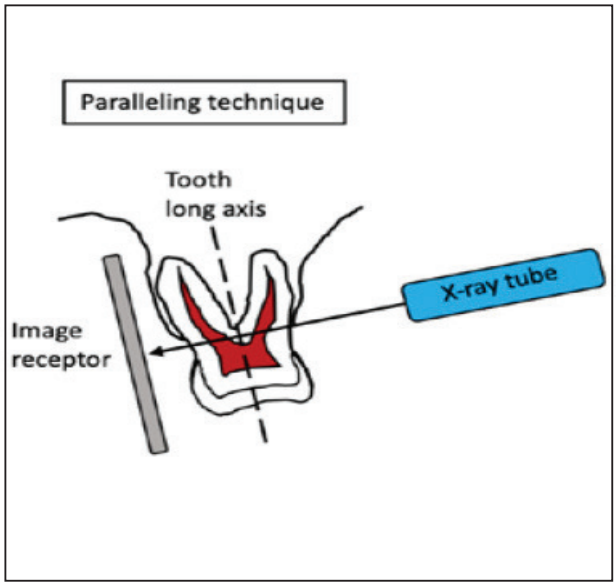

Figure 2: *Diagram of bisecting angle technique illustrating the relationship of the film, the teeth and the central ray3*

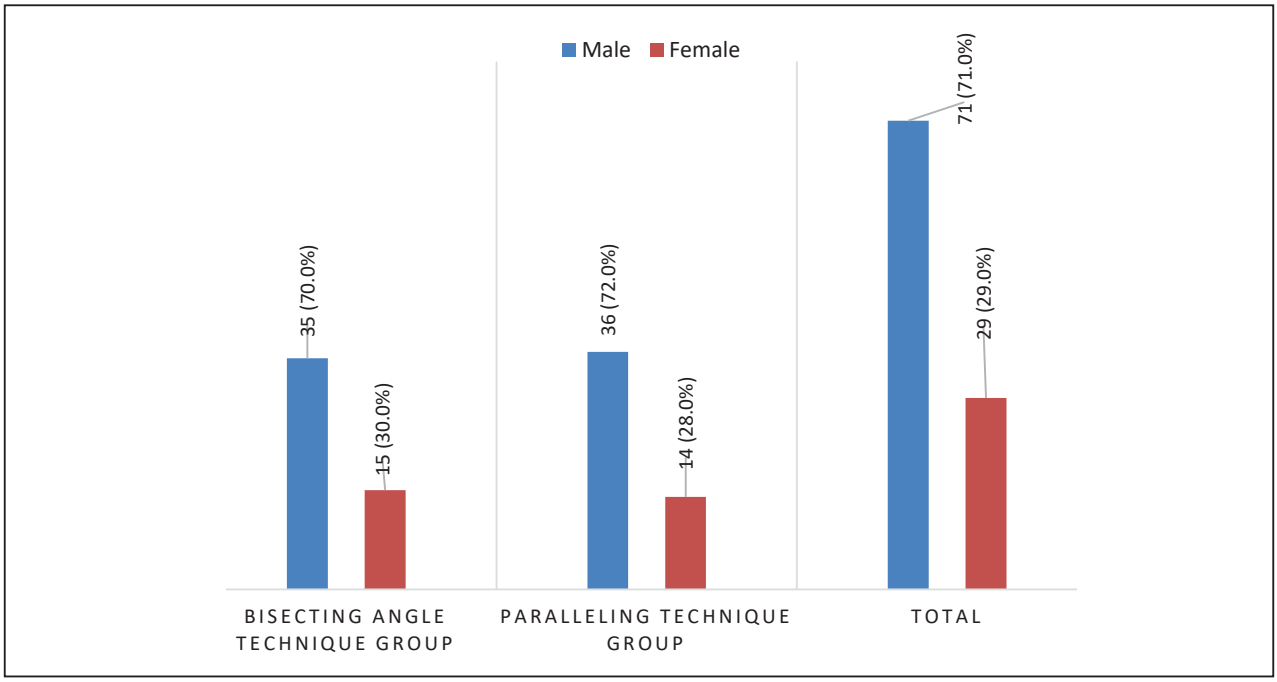

Figure 3: *Gender distribution of study participants (n=100, 50 in each group)*

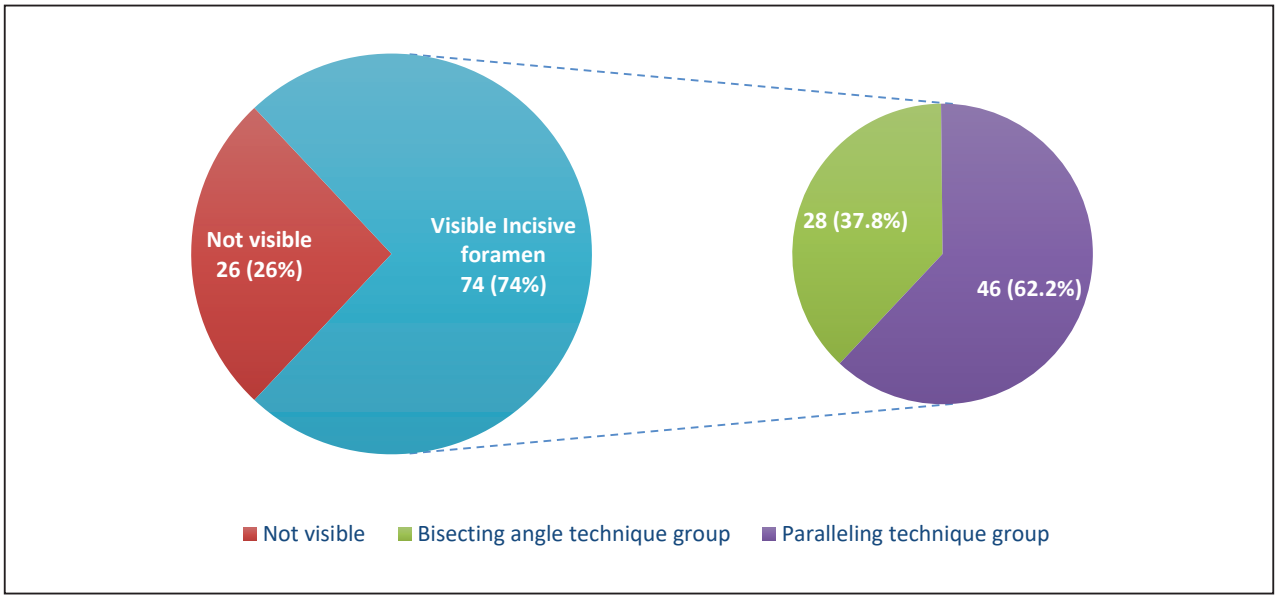

Figure 4: *Visualization of the incisive foramen (n=100, 50 in each group)*

DISCUSSION

This study was conducted to evaluate the visibility of the incisive foramen (IF) in routine intraoral periapical radiographs and to compare its visualization between the bisecting-angle and paralleling techniques. The incisive foramen represents the oral opening of the nasopalatine canal and is an important anatomical landmark in the anterior maxilla. It runs parallel to the maxillary central incisors, and the possibility of surgical invasion has been reported. Thus, accurate recognition of this structure is essential in oral radiology to differentiate normal anatomical radiolucency from periapical pathology and to avoid unnecessary interventions.[8]

In the current study, the incisive foramen was visualized in 56% of radiographs taken using the bisecting-angle technique, whereas 92% of radiographs taken through the paralleling technique. This difference was found to be statistically significant ($p < 0.001$), indicating that the paralleling technique provides superior visualization of the incisive foramen compared to the bisecting-angle technique. Thus, selection of an appropriate radiographic technique, particularly the paralleling technique, ensures superior visualization of incisive foramen, improving diagnostic accuracy and contributing to safer clinical and surgical procedures by minimizing the risk of neurovascular damage and other implant-related complications.

The improved visualization observed with the paralleling technique can be attributed to its geometric accuracy. In this method, the film or sensor is positioned parallel to the long axis of the tooth, and the X-ray beam is directed perpendicular to both. This reduces distortion and superimposition, resulting in more reliable representation of the incisive foramen. In contrast, the bisecting-angle technique is more operator-dependent, with variations in vertical angulation often causing elongation, foreshortening, and superimposition of anatomical structures over the apices of the central incisors. [3] These technical limitations may explain the lower visibility rate observed in bisecting radiographs.

The findings of this study are consistent with previously published literature[6] reported higher visibility of the incisive foramen using the paralleling technique (76.7%) compared to the

bisecting method (40%). Similarly, Raina et al., in a Nepalese population, demonstrated better visualization with the paralleling approach.[7] Although the visibility percentages in the present study were comparatively lower, the overall trend remains consistent: the paralleling technique provides improved anatomical depiction.

Radiographic and cone-beam computed tomography (CBCT) studies consistently demonstrate that the morphology and dimensions of the incisive foramen and nasopalatine canal undergo age-related changes. Progressive bone remodeling, alveolar bone resorption, and tooth loss contribute to alterations in the size, shape, and spatial position of the incisive foramen within the anterior maxilla. CBCT studies reveal that there is an increase in the diameter of the incisive foramen and nasopalatine canal with advancing age. However, the strength of this association varies across populations and study designs. [9,10]

Larger dimensions of the incisive foramen commonly observed in older edentulous patients may be attributed to alveolar ridge resorption following tooth loss that may alter the morphology and relative position of the incisive canal increasing its radiographic prominence. It has important implications for surgical procedures in the anterior maxilla, especially in preoperative evaluation for dental implant planning.[11,12] In the present study, visibility of incisive foramen was observed in 80% of participants older than 60 years. While this finding may appear age-related, it could also be attributed to edentulism and associated remodeling of the anterior maxillary bone.

Al-Amery et al. reported that males generally exhibit a larger canal and greater anterior bone thickness thereby highlighting gender as an important factor.[13] They also noted that anterior maxillary bone thickness decreases with advancing age, even in fully dentate individuals. In the present study, however, the gender distribution among participants was not proportional, and therefore a direct comparison of gender-based differences in incisive foramen visibility could not be reliably established.

The clinical significance of these findings is considerable. A prominent incisive foramen may mimic periapical lesions such as cysts or granulomas, potentially leading to misdiagnosis and unnecessary interventions.[8] Furthermore, in implant planning for the anterior maxilla, failure to recognize the nasopalatine canal region may result in neurovascular injury, bleeding, or sensory disturbances.[14,15] Therefore, improved visualization through the paralleling technique enhances diagnostic accuracy and contributes to safer surgical planning.

This study is particularly important in the Nepalese context as limited comparative evidence exists regarding the visibility of the incisive foramen on routine intraoral radiographs. Since craniofacial morphology and anatomical variations may differ among ethnic groups,[16] localized data are valuable for improving radiographic interpretation and revising diagnostic criteria.

LIMITATIONS

Despite its contributions, the study has certain limitations. Convenience sampling and a single-center setting may limit its applicability. Intra-observer variability was not done, leaving the consistency and reliability of the single expert's scoring. The comparison between the two methods could have been further improved if the same participants had been subjected to both the radiographic techniques. This would have better controlled for individual anatomical variations in the anterior maxilla. However, standard protocols and observer calibration were applied. Future studies with larger sample sizes, multicenter participation, and correlation with CBCT imaging will provide better

understanding of the anatomical diversity and diagnostic accuracy.

CONCLUSION

This study revealed that the incisive foramen was visible in 74% of the radiographs observed. The findings indicated that the incisive foramen was visualized more in radiographs obtained through paralleling technique than through bisecting angle technique. Hence, adoption of paralleling technique for obtaining radiographs in routine clinical practice could improve diagnostic accuracy, minimize interventions, and enhance patient safety in the anterior maxillary region. Future research with larger, multicenter samples is recommended to strengthen population-specific evidence and establish standardized diagnostic guidelines on various aspects of dentistry.

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