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EVALUATION OF RELIABILITY OF PANORAMIC RADIOGRAPH IN LOCALIZATION OF LABIO-PALATAL POSITION OF MAXILLARY IMPACTED CANINE: A RETROSPECTIVE STUDY

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KEYWORDS

Impacted canine localization, CBCT, panoramic radiograph

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ABSTRACT

Introduction: Maxillary permanent canines are one of the most commonly impacted teeth in the oral cavity, and the accurate localization of impacted canine position is of utmost importance in effective treatment planning and management. **Aim:** To assess the reliability of a single panoramic radiograph in determining the labio-palatal position of maxillary impacted canine throughout certain constructed linear and angular measurements. **Materials and Methods:** A total of 120 radiographs of 60 patients (60 panoramic and 60 CBCT scans) with unilateral maxillary impacted canines were included in the present retrospective study. Standardized panoramic and CBCT radiographic records of the same patient were used for analysis. The CBCT scans were used to identify the actual site of impaction whether labial or palatal, 6 measurements were constructed on each panoramic radiograph (3 angular, 1 linear and 2 sectors) for comparison with the non-impaction side to examine the reliability of panoramic radiographs in determining the impaction site. **Results:** Analysis of the constructed radiographic reference points did not identify any consistently reliable angles or measurements that could be used to definitively classify the labio-palatal position of the canine impaction site. **Conclusion:** From the results of the present study, it was concluded that; a single panoramic radiograph is not reliable for localization of the labio-palatal position of the maxillary impacted canine based on the current linear and angular measurements used for assessment.

INTRODUCTION

With the exception of the third molars, the maxillary permanent canines are the teeth that are most commonly impacted. The prevalence of impaction of maxillary canines is between 1-2.5% (1). Females are reported to be two to three times more susceptible to impaction than males in literature, a finding that suggests that there may be a gender-dependent tendency in canine impaction. Maxillary canine impaction can have more than one cause. In addition to dental misalignment or insufficient space, the existence of both soft and hard tissue diseases is thought to be one of the etiological variables that can obstruct the regular course of maxillary canine eruption. Because maxillary permanent canines have the longest development period and eruption path compared to other teeth, disturbances in their eruption are widespread (2).

Early diagnosis and prompt intervention are imperative in the management of maxillary canine impaction since it minimizes treatment time and costs, lowers the possibility of complications or unfavorable outcomes, and promotes orthodontic mechanics [3].

The importance of maxillary canines lies in that occlusion, stability, form, and function of the arch are all determined by them. Canine impaction not only causes aesthetic and functional issues, but also may cause adjoining teeth's roots to resorb, requiring orthodontic treatment or surgical intervention to move the affected tooth to a more advantageous location within the dental arch. A number of problems, including canine ankylosis, cystic degeneration, displacement and root resorption of neighboring teeth, shortening of the dental arch, and combinations of these, can arise from impacted canines. Reducing the chance of central incisor root resorption and, in certain cases, lateral incisor root resorption—which might eventually result in tooth loss—is also crucial [4].

The preferred course of treatment of canine impaction involves the surgeon first exposing and bonding the canines, and the orthodontist subsequently bringing these teeth out to the alveolus. Identifying the position of the impacted tooth whether on the buccal or palatal side of the alveolus allows for easier and more convenient surgical exposure and bonding. A canine that is closer to the buccal cortex of the maxilla and, thus, easier to access on the buccal vestibular side is said to be in a buccal placement of the tooth. A canine that exhibits palatal inclination is in close proximity to the palatal cortex, and optimal access will be via the palate mucosa [5].

In general, 85% of patients exhibit palatal position of impaction, while only 15% are presented with buccal canine impaction. While other recent studies reported a ratio of 1:3 for buccal to palatal displacement [6].

Different radiographic approaches and researches have been conducted over the years, with varying degrees of success, to identify the exact location of impacted permanent maxillary canines. However, only a small number of research had taken into account using a single panoramic radiograph for this purpose. In general, panoramic radiographs are the most often prescribed screening radiograph, since they provide relatively less radiation, are simple to administer, affordable, and easily accessible, making them an attractive potential tool for localizing impacted maxillary canines in comparison to three-dimensional imaging [7]. Thus, the purpose of the current study is to assess the accuracy of a single panoramic radiograph in locating the labio-palatal position of an impacted maxillary canine.

MATERIALS AND METHODS

Study design

The current study is a retrospective in-vitro one conducted on 60 panoramic radiographs as well as 60 CBCT records of the same patients having unilateral impacted maxillary canines collected from the data-base of the Oral Radiology department, Faculty of Dentistry, Suez Canal University. The study was waived from ethical reviewing by the Research Ethics Committee (REC) of the faculty with reference number 338/2021.

Sample size calculation

We performed a power analysis (G power version 3.1 statistical software, Franz Faul, Universität Kiel, Germany) based on the results of Alqerban et al. [3] to calculate the sample size. Their results showed that, with a 95% power and an α of 5%, a minimum sample size of n = 60 samples (panoramic radiographs) was required.

Panoramic grouping:

The 60 panoramic radiographs of unilateral impacted maxillary canine were divided equally into 2 groups (30 each). The CBCT records were only used in identifying the position of the impacted canine, and to group panoramic radiographs into:

Group (1): Panoramic radiographs with labially impacted canine.

Group (2): Panoramic radiographs with palatally impacted canine.

Selection of Radiographs:

Unidentified radiographs were used in the current study of patients who previously underwent radiographic examination for orthodontic diagnosis.

The CBCT scans were acquired using SCANORA* 3DX-Cone Beam CT scanner (SORDEX Finland) installed at the Radiology Department at the Faculty of Dentistry Suez Canal University. The radiographs were analyzed by On-Demand software. Being a 3-dimensional imaging modality, the CBCT records' role was to aid in dividing the 60 panoramic radiographs into two groups, buccally impacted group and palatally impacted group. On the other hand, the panoramic radiographs were acquired using Sirona ORTHOPHOS panoramic X ray and analyzed by SIDEX XG-Sirona Imaging software.

The panoramic images included in the study were selected to fulfil the following eligibility criteria:

Inclusion criteria

1. Radiographic records of patients with unilateral impacted maxillary canines.
2. Radiographic records of high quality.
3. Radiographic records with full set of permanent dentitions.
4. Radiographic records of both genders aging from 15 years and above.

Exclusion criteria

1. Radiographs revealing the presence of congenitally missing or malformed lateral incisors.
2. Radiographs with transposed maxillary canines and premolars or transposed maxillary canines and lateral incisor.
3. Radiographs with definitive obstructions (ex, odontoma or supernumerary teeth).
4. Radiographs with craniofacial anomalies (ex, cleft lip or palate).
5. Radiographs with multiple impacted teeth or congenitally missing teeth.
6. Blurred radiographic images.
7. Radiographs of mixed dentition stage.
8. Presence of orthodontic appliances seen in radiographs.

Radiographic measurements

Panoramic records who met the inclusion criteria were assessed using the SIDEX XG-Sirona software; on which, two reference planes, the maxillary occlusal plane (MOP) (maxillary incisal plane passing through the incisal edges of the maxillary central incisors) and maxillary dental midline (ML) (vertical line passing through maxillary central incisors) were determined [9] then study-specific data were measured. The modified sector class and depth of vertical impaction grading suggested by ***Power and Shor***t [8] were among the radiographic characteristics that were recorded. The maxillary occlusal plane (MOP) and the maxillary dental midline (ML) were used to build three angular and one linear parameter.

Radiographic measurements

I- Three angular and one linear measurement were obtained as follows:

a- Angular measurements:

1- Angle A: Is the angle between the long axis of impacted canine and the dental midline [9].

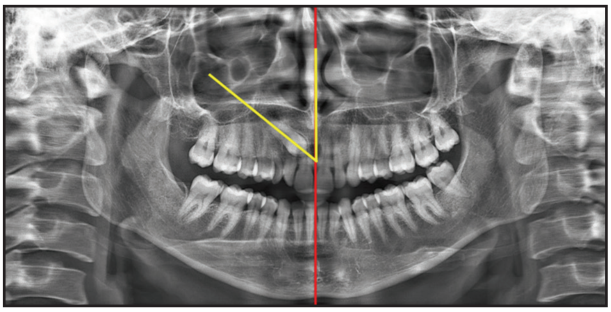

Fig. (1) Panoramic radiograph showing long axis of impacted canine to the dental midline

2- Angle B: Is the angle between the long axis of impacted canine and long axis of the maxillary lateral incisor [9].

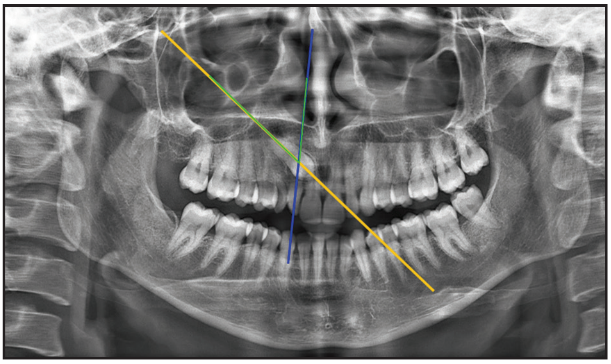

Fig. (2) Panoramic radiograph showing long axis of impacted canine to long axis of lateral incisor

3- Angle C: Is the angle between the long axis of impacted canine and the maxillary occlusal plane [9].

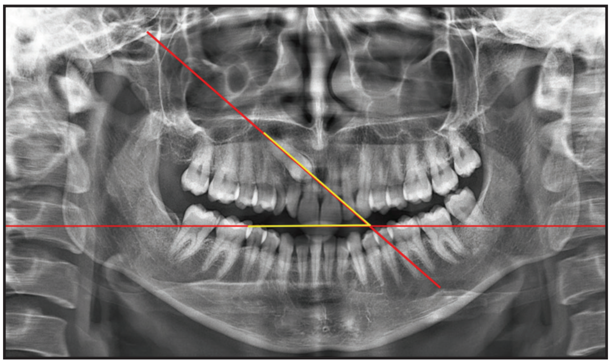

Fig. (3) Panoramic radiograph showing long axis of impacted canine to maxillary occlusal plane

b- Linear measurement: Distance D: Is the perpendicular distance from the canine cusp tip to the maxillary occlusal plane [9].

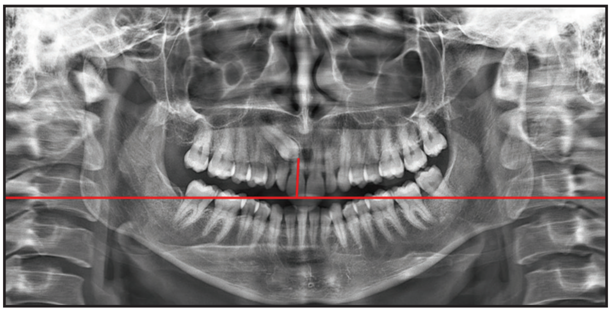

Fig. (4) Panoramic radiograph showing Perpendicular distance of canine cusp tip to the maxillary occlusal plane

II-Horizontal sectors

The panoramic x rays were split into two sides through the maxillary midline, into normal side and impaction side. The normal side was divided into horizontal sectors. The constructed sectors were drawn according to the modified sector class and depth of vertical impaction depth grading proposed by ***Power and Short*** [8] Mirroring of the sectors constructed on the normal side were done on the opposite side (impaction side).

Horizontal position evaluation (H): Horizontal sector determination of the tip of impacted canine was obtained from the constructed sectors.

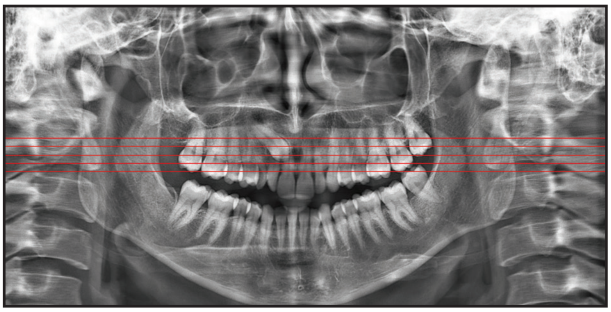

Fig. (5) Panoramic radiograph showing Horizontal sectors

III- Vertical sectors

The panoramic x rays were split into two sides through the maxillary midline, into normal side and impaction side. The normal side was divided into vertical sectors. The constructed sectors were drawn according to the modified sector class of impaction grading proposed by ***Ericson*** [10]. Mirroring of the sectors constructed on the normal side were done on the opposite side (impaction side).

Vertical position evaluation (depth of the impaction - V): Vertical sector determination of the tip of impacted canine was obtained from the constructed sectors.

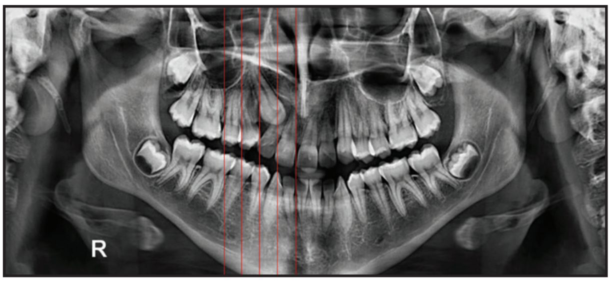

Fig. (6) Panoramic radiograph showing mirroring of the constructed vertical sectors on impaction side

Statistical analysis

Data was fed to the computer and analyzed using IBM SPSS software package version 26.0. (Armonk, NY: IBM Corp). Quantitative data were described using range mean, standard deviation and independent t test was used for comparing between groups. Logistic regression analysis was performed to assess the association between palatal and buccal impacted canines and the radiographic variables. ROC curve was used for predicting the site of the impacted canine. Differences were set to be statistically significant when p value ≤ 0.05.

RESULTS

Table 1 represents the comparison between palatally impacted canine and labially impacted canine regarding all assessed radiographic parameters, namely; angle A, angle B, angle C, linear vertical measurement D, as well as measurements H and V. Results showed that there was a statistically insignificant difference between both groups regarding angle A, angle B, angle C and vertical measurement V where P ≥ 0.05. However, there was a statistically significant difference between both groups regarding distance D and Horizontal measurement H where P value ≤ 0.05.

Receiver operating characteristic (ROC curve)

Table 2 and Figure (7) show ROC curve for prediction of the palatal from buccal impacted canine.

The AUC (Area Under the Curve) of Angle A was 0.148 (p = 1.000) had no ability to predict palatal impacted canine. **Angle A:** Cutoff: ≥25.55or higher, it predicts palatally impacted canine while values below predict buccally impacted canine

AUC of Angle B was 0.676 (p = 0.071) and had no ability to predict the palatal impacted canine. **Angle B:** Cutoff: ≥27.75 or higher, it predicts palatally impacted canine while values below predict buccally impacted canine.

AUC of Angle C was 0.519 (p = 0. 849) had no ability to predict the palatal impacted canine. **Angle C:** Cutoff: ≥38.45 or higher, it predicts palatally impacted canine while values below predict buccally impacted canine.

AUC of Angle D was 0. 352 (p = 0. 129) had no ability to predict the palatal impacted canine. **Angle D:** Cutoff: ≥14.05 or higher, it predicts palatally impacted canine while values below predict buccally impacted canine.

AUC of H was 0. 694 (p = 0. 046) had considered acceptable ability to predict the palatal impacted canine. **H:** Cutoff: ≥3.5 or higher, it predicts palatally impacted canine while values below predict buccally impacted canine.

AUC of V was 0. 426 (p = 0. 448) had no ability to predict the palatal impacted canine. **V:** Cutoff: ≥1.5 or higher, it predicts palatally impacted canine while values below predict buccally impacted canine.

Table (1) *Comparison between the palatally impacted canine and buccally impacted canine regarding all assessed radiographic parameters*

Parameters	Palatal impaction		Buccal impaction		t-test	p
	Mean	SD	Mean	SD		
Angle A	34.2222	11.44776	28.5833	11.79373	1.456	0.155 NS
Angle B	38.6111	12.49861	37.9333	16.26519	0.140	0.889NS
Angle C	55.7000	12.20848	61.1033	13.04211	-1.283	0.208 NS
Distance D	11.5111	2.72049	14.7000	0.80147	-4.770	0.000 S
H	3.5556	0.70479	3.0000	0.59409	2.557	0.015 S
V	1.7778	0.64676	2.0000	0.84017	-0.889	0.380 NS

SD: Standard deviation S: statistically significant Independent t-test (P ≤ 0.05) NS: Non-significant

Table (2) *AUC-ROC curve of prediction of the palatally from buccally impacted canine*

Parameter	AUC	Cutoff	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
Angle A	0.148	≥25.55	1.000	0.000	0.298
Angle B	0.676	≥27.75	0.071	0.500	0.852
Angle C	0.519	≥38.45	0.849	0.322	0.715
Angle D	0.352	≥14.05	0.129	0.161	0.543
H	0.694	≥3.5	0.046	0.523	0.866
V	0.426	≥1.5	0.448	0.235	0.617

AUC 800-900: Excellent AUC 600-700: Weak AUC 700-800: Acceptable AUC 500-600: Has no ability

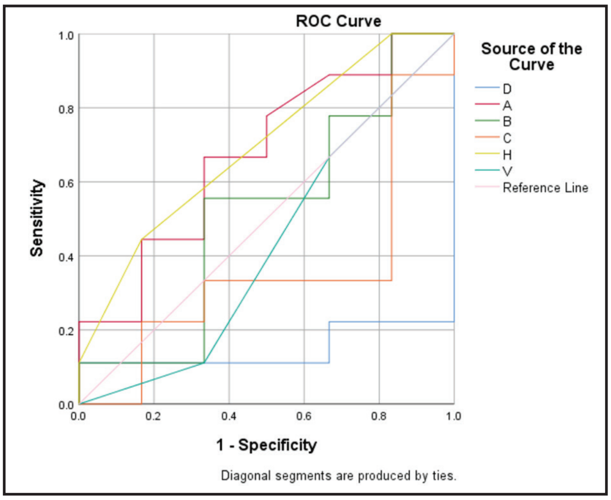

Fig. (7) Showing constructed Receiver operating characteristic curve.

DISCUSSION

Maxillary permanent canines play a crucial part in creating the arch form, contribute to a beautiful smile, and are involved in functional occlusion; therefore, they are widely acknowledged as extremely significant teeth. Furthermore, when it comes to the most commonly impacted teeth, they are surpassed only by the third molars. The practicality of the surgical method to expose the impacted canine, the optimal access for exposure, and the direction in which orthodontic pressures are applied are all significantly influenced by the accurate localization of the impacted tooth (11).

Panoramic radiograph is a widely used imaging technique that can provide a general overview of the dental arches and the surrounding structures. However, panoramic radiograph has some drawbacks, such as distortion, magnification, overlapping, and superimposition of the images, which can affect the accuracy and reliability of the diagnosis. One of the main challenges of panoramic radiograph is to determine the labio-palatal position of MICs, which is essential for planning the surgical exposure and orthodontic traction of these teeth (12).

Based on the results of several studies and on the search of different databases, there is no definitive answer to whether panoramic radiograph can or cannot predict the labio-palatal position of MICs. This depends on several factors, such as the quality and resolution of the images, the experience and training of the observers, the selection criteria and sample size of the patients, and the statistical methods used for analysis. Switching to a three-dimensional imaging modality necessitates the exposure of the patient to additional amounts of radiation, such decision depends on the clinical judgment of the dentist, who should weigh the benefits and risks of each imaging technique according to each case's needs and circumstances (12).

In the present study an easily constructed linear and angular measurements, angles A, B, C and point D (9), sector H (8) and sector V (10) was chosen from previous studies to be easily applied and constructed by other researchers on digital panoramic radiographs by simple editing tools that it requires no specific software or complicated procedures.

CBCT was used for accurate localization and defining the actual position of the impacted canines being a widely used three-dimensional modality utilized by clinicians and researchers.

Results of the current study showed that the means of Angles A, B, C, and vertical measurement V did not significantly differ between palatally and buccally impacted canines. However, a statistically significant difference was shown between palatal and buccal impacted canines regarding the horizontal measurement H and Distance D where P value was less than 0.05.

On the other hand, based on the results of the Receiver operating characteristic (ROC curve), the AUC (The Area Under Curve) of Angles A, B, C, Distance D, sectors H and V had no ability to predict the palatal and labial position of the impacted canine since the P value was statistically insignificant.

Results of previous studies conducted by ***Alqerban et al*** [(3)] and ***Nagpal et al*** [(8)], align with those of the present study, where after establishing specific prediction criteria for maxillary canine impaction localization in young patients, they found their parameters to be either weak or harbor, and with no predictive power, therefore, they agreed on the weak reliability of panoramic radiograph to localize or predict the location of the impaction of maxillary canine, or to determine the validity and reproducibility of their suggested method.

In contrast, other studies by K***atsnelson et al***[(13)]***, Ngo et al***[(12)]***, Jung et al***[(14)]***, Kim et al***[(15)], disagreed with results of the present study when attempting to locate the position of impacted maxillary canines using panoramic radiographs. They found that panoramic radiographs are useful in predicting the location of impacted maxillary canines, therefore, assisting in deciding the appropriate surgical approach required for canine exposure and orthodontic appliance attachment when computed tomography or CBCT is unavailable or unnecessary.

While each of the above-mentioned studies used different variables in an attempt to determine a specific angle or sector class to use for locating the exact site of maxillary impacted canine through panoramic radiograph without using CBCT, ***Jung et al***[(14)], and ***Ngo et al***[(12)], used the same sector class as the present study to locate the maxillary impacted canines, while ***Malik et al***[(16)], relied solely on angles B and C. It is worth mentioning that the present study utilized a larger number of radiographic variables for assessment.

CONCLUSION

In summary, based on the chosen linear and angular measurements, and on the results of the present study, a panoramic radiograph cannot be utilized for the reliable localization of impacted maxillary canines; rather, it can only be used as an addition to other modalities.

REFERENCES

1. Ericson S, & Kurol J. Radiographic assessment of maxillary canine eruption in children with clinical signs of eruption disturbance. Eur J Orthod 1986; 8(3): 133–140.
2. Becker A, & Chaushu S. Etiology of maxillary canine impaction: A review. Am J Orthod Dentofac Orthop 2015; 148(4): 557–567.
3. Alqerban A, Jacobs R, Fieuws S, & Willems G. Predictors of root resorption associated with maxillary canine impaction in panoramic images. Eur J Orthod 2016; 38(3): 292–299.
4. Felsenfeld AL & Aghaloo T. Surgical exposure of impacted teeth. Oral Maxillofac Surg Clin North Am 2002; 14: 187–199
5. Alqahtani H. Management of maxillary impacted canines: A prospective study of orthodontists' preferences. SPJ. 2021; 29(5):384-90.
6. Jena AK, Duggal R. The pattern of maxillary canine impaction in relation to anomalous lateral incisors. JOCPD 2010; 35(1):37-40.
7. Sudhakar S, Patil K, Mahima VG. Localization of impacted permanent maxillary canine using single panoramic radiograph. Indian J Dent Res 2009; 20(3):340-345.
8. Power SM, & Short MB. An investigation into the response of palatally displaced canines to the removal of deciduous canines and an assessment of factors contributing to favorable eruption. Br J Orthod 1993; 20: 215–223.
9. Katsnelson A., Flick W. G., Susarla S., Tartakovsky J. V. & Miloro, M. Use of Panoramic X-Ray to Determine Position of Impacted Maxillary Canines. Journal of Oral and Maxillofacial Surgery. 2010; 68(5), 996–1000. https://doi.org/10.1016/j.joms.2009.09.022

10. Ericson S, & Kurol J. Resorption of maxillary lateral incisors caused by ectopic eruption of the canines A clinical and radiographic analysis of predisposing factors. Am J Orthod Dentofacial Orthop 1988; 94(6):503-513.

11. Nagpal A, Pai KM, Setty S, & Sharma G. Localization of impacted maxillary canines using panoramic radiography. J Oral Sci 2009;51:37–45.

12. Ngo CT, Fishman LS, Rossouw PE, Wang HSO. Correlation between panoramic radiography and cone-beam computed tomography in assessing maxillary impacted canines. Angle Orthod 2018;1:384–389

13. Katsnelson A, Flick W, Susarla S, Tartakovsky V. Use of Panoramic X-Ray to Determine. J Oral Maxillofac Surg 2010;68:996–1000.

14. Jung YH, Liang H, Benson BW, Flint DJ & Cho BH. The assessment of impacted maxillary canine position with panoramic radiography and cone beam CT. Dentomaxillofac Radiol 2012;41(5):356-360.

15. Kim SH, Son WS, Yamaguchi T, Maki K, Kim SS, Park SB, Kim YI. Assessment of the root apex position of impacted maxillary canines on panoramic films. Am J Orthod Dentofac Orthop 2017;152:489–493.

16. Malik S, Fida M, & Sukhia RH. Correlation between radiographic parameters for the prediction of palatally impacted maxillary canines. J Orthod 2019;46(1):6-13.