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# Localization of Impacted Upper Canines Using Lateral Cephalometric Radiograph

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## Abstract

Objective of the study: to verify the validity of lateral cephalogram in localization of the impacted upper canines and to compare our results with the results of other radiographic methods namely: parallax and magnification.

Method: lateral cephalometric radiography is used to localize the impacted upper canines based on the fact that lateral cephalogram is a superimposition of the two sides of the head. Along the sagittal plane, structures which lie anteriorly are truely anterior and structures which lie posteriorly are truely posterior.Therefore position of the impacted canine can be precisely detected in relation to the neigboring teeth.

Materials: The sample of the study was collected in two ways. First, retrospective analysis of the records of 515 cases, 344 females (66.8%) and 171 males (33.2%), with age range from 10 to 48 years (mean of 29 years). Second, clinical application in form of questionnaire. 23 questionnaire forms answered by oral surgeons in Albaha region, whose radiographic diagnosis of the impacted canine was based on lateral cephalogram, were retrieved.

Results: even though there is wide variation between examiners in the retrospective sample, in which kappa ranges from –0.265 to 0.776 with sensitivity of mean value of 66.1%, the prospective group showed significantly high sensitivity (93.3%) of detecting canine position. The overall mean value was 79.6%. Further analysis showed sensitivity of palatal impaction detection of 69.6% and labial detection of 51.9% in the retrospective group. The prospective group showed sensitivity of palatal impaction detection of 90% and labial detection of 100%.

Conclusion: this study showed that the use of lateral cephalometric radiographs is of good value in localizing upper impacted canines.

## 1. Introduction

An impacted tooth is one 'whose eruption is considerably delayed, and for which there is clinical or radiographic evidence that further eruption may not take place.[1]

Maxillary canines are the most frequently impacted teeth after the third molars with a prevalence ranging from 0.92 per cent [2] to 2.56 per cent [3], depending on the population examined.

Treatment options for this condition include observation, extraction, autotransplantation, and orthodontic alignment.[4]

The diagnosis of an impacted maxillary canine is based on both clinical and radiographic examination.The following clinical signs may be indicative of canine impaction: Delayed eruption of the permanent canine or prolonged retention of the primary canine. Absence of a normal labial canine bulge or presence of a palatal bulge in the canine region.Delayed eruption, distal tipping, or migration of the permanent lateral incisor.

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Loss of vitality and increased mobility of the permanent incisors.[5]

Many radiographic methods have been proposed.

Parallax

This was first introduced by clark (1909). It involves two radiographs taken at different horizontal angles with the same vertical angulation. Due to parallax, the more distant object appears to travel in the same direction as the tube shift and the object closer to the tube appears to move in the opposite direction [the so called Same Lingual Opposite Buccal (SLOB) rule; this could equally be remembered as Buccal Opposite Palatal Same (BOPS)]. Vertical parallax may also be applied when the radiographs are taken at different vertical angulations.

Magnification

This technique is based on the principle of 'image size distortion'; that is for a given 'focal spot' – film distance, objects further away from the image receptor (film) will be depicted more magnified than objects closer to the film.[6]

Other methods reported in the radiographic localization of the impacted canine are the vertex occlusal radiograph[7], image sharpness, and relationship of the canine cusp tip with the lateral incisor root in the panoramic radiograph.

Tomography, e.g. polytomography[8], and computer tomography[9] are especially useful in cases of root resorption of the adjacent teeth.

Radiographic localization of the impacted canine is an important diagnostic measure when surgical treatment is to be undertaken. For many cases, radiography is the only mean for accurate determination of the position of the unerupted canine. There are many radiographic localization techniques for impacted canine, but none of them proved ideal.

Clinicians should be encouraged to evaluate the radiographic methods currently in use -especially those entail more than one exposure to reach diagnosis- in term of the radiation dose levels to which the patients are exposed. If it can be shown that a single radiographic technique provides the required diagnostic information with less patient radiation contact, the justification for the use of those with higher exposure must be questioned.[10]

## 2. Method

History and theory

Standardized cephalometric radiograph usually utilized for cephalometric analysis. This analysis is used as reference scale for diagnosis of dentofacial deformity as well as formulation of therapeutic orthodontic and surgical planning; post orthodontic, surgical therapy evaluation and long term follow up.We studied more than 500 cephalometric views in an anthropometric study.Close observation into these views drew our attention to other diagnostic values of this view. Special attention to study impacted teeth such as wisdom, as well as canine teeth lead to the following observation:

Impacted canine can be located more easily in the maxillary arch utilizing Lateral Cephalometric view.

This observation is our concern in this study. Usually such patients are under orthodontic treatment which requires a lateral cephalogram as one of their diagnostic radiographs.

Utilization of lateral and posteroanterior cephlogram had been advocated by Broadway and Gould.[11] Their study was published under the title: surgical requirements of the orthodontists in the British dental journal (1960).

In this study we will utilize lateral cephalogram to develop a method of diagnosing the position of the displaced upper canine on the basis of its radiographic characteristic, as a single view based method of localization.

Standard lateral cephalograph introduced by Bolton Broadbent (1922), to who goes credit of cephalometric analysis. He designed the Cephalostat, a radiographic machine, with which standardized lateral cephalograph of the skull positioned in the lateral view from a calculated distance from the object to the camera lens (was 6 feet) is produced.

X-ray machine with 65 KV and 7.5 mA, namely planmeca 2002 proline, was used for taking x-ray

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views. Lateral cephalograph films green sensitive type, Kodak product, was used.

The philosophy of this method is based on the way lateraral cephalograph is taken:

This view is reproduced in away that, the two sides of the head are exactly superimposed over each other. There fore each cephalometric point, which actually exists bilaterally in posterioanterior view, such as Gonion (Gn) or menton (Me), is superimposed in the lateral Cephalograph and exist as one point.

The most anterior structure lies anteriorly as it is in reality. If we take the sagittal plane, of the maxilla, soft tissue of the lip will come first, followed by alveolar buccal mucosa, then bone at point A, then incisor teeth roots, then palatal alveolar bone then palatal mucosa.

In this manner, impacted canine tooth lying within this plane can be located by direct observation by assessing:

A) amount of bone existing labial or palatal to the root or crown of the impacted canine.

B) position of incisor tooth root in relation to the impacted canine.

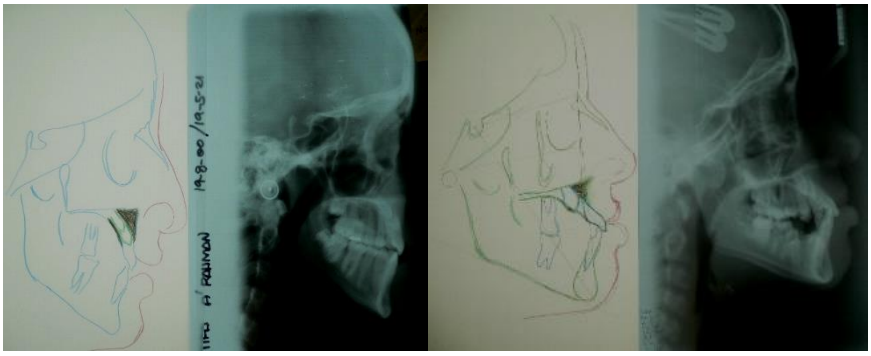
By applying lateral cephalography Pattern of reproduction, if the root of incisor tooth observed palatal to the impacted canine tooth, then the canine exists labial to it, and can be safely approached labially. In the same time as the view is built on a single point representation, there is no chance for picture duplication, and only one root will be observed. Given that the view is truly taken dead lateral.

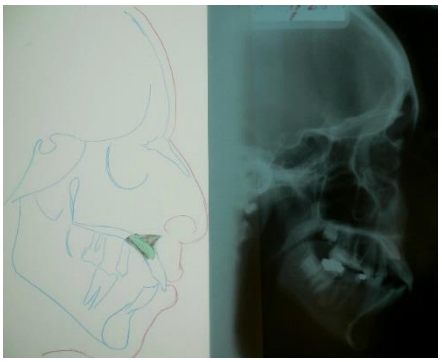
Therefore, the tooth can be approached labially; as the root of the incisor tooth is not expected to be first encountered.

Method of diagnosis:

Viewing the radiograph on the screen as it is the case in all other radiographic images.

Direct or indirect tracing measurements of the thickness of the bone layer labial and palatal to the impacted canine within the maxillary arch.





*Advantages*

Easy and direct viewing to reach diagnosis (no need for intermediate aid for interpretation).

Avoid unnecessary patient subjection to excess x-ray radiation (Lateral cephalograph usually ordered by the orthodontist).

*Limitation*

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In cases of bilaterally impacted canines, even though it is possible to be located in term of labial or palatal position, it is not easy to specify which is right and which is left. Additional clinical and radiographic informations may be required to differentiate between the two sides.

MATERIALS

Standardized lateral cephalometric radiographic views (Bolton 1922) were used in this study to locate canine position in the Maxillary arch.

Samples for the study were collected in two ways:

*1-Retrospective case analysis*

Records of 515 cases, treated in Albaha medical centers, were collected. Most of these cases received Orthodonic therapy, others are oral surgery cases. Of the total number, 344 were females (66.8%) and 171 were males (33.2%), with the age ranges from 10 to 48 years (mean of 29 years).

*2-Prospective case analysis*

23 questionnaire forms were collected from different hospitals in albaha region. The clinicians used lateral cephalogram to diagnose the position of the impacted canine and perform surgery according to this diagnosis. In the same time, we will present three case reports diagnosed with this method and treated according to this diagnosis.

The following criteria were used in order to select the sample:

1. For every patient there should be a standardized lateral cephalometric radiograph of acceptable diagnostic quality.

2. A surgical diagnosis of the position of the impacted canine should be clearly stated in the operation records, otherwise the patient was excluded.

*Radiographic examinations*

Of the total (515 cases), 31 patients have impacted canines. 22 cases (9 cases out of 31 cases were excluded) were used in this study to diagnose the position of the impacted canines.

9 examiners were involved in the study. Experience and scientific classification of the examiners is as follow:

one consultant maxillofacial surgeon (A), one oral and maxillofacial surgery board student (B), 2 residents (C & D), one orthodontist (E), one pedodontist (F), one consultant in oral medicine and diagnostic sciences (G), one general practitioner (H), and one new graduate dentist in internship program (I).

The X-ray examination was standardized: the radiographs were studied on conventional X-ray illuminator. The 22 lateral cephalometric radiographs were given numbers and the names & hospital numbers on the radiographs were hidden. All radiographs were taken at the Department Of Radiography, Dental center of Albaha region hospitals . Radiographic examination was blind, i.e., the examiners did not know the surgical outcome.

*Familiarity*

With the exception of one examiner who was to some extent familiar with the method, all other examiners were not.

*Statistical analysis*

In the retrospective study group, the predicted positions of the impacted canines, as registered by the examiners, were compared with the true position for each. The percentage of agreement and cohen's kappa statistic were used to obtain results.

In the prospective study group, 23 questionnaire forms were answered by oral surgeons in Albaha region and will be statistically analyzed. The percentage of agreement compared to the true position was calculated. The results obtained will be compared with the results of other radiographic methods namely: parallax and magnification.

Tables and graphs were utilized for both studies.

## 3. Results

In the retrospective study group, a total of 515 lateral cephalometric radiographs were used to diagnose location of the impacted upper canines in term of labial or palatal position within the maxillary arch. Of these, 31 cases have impacted upper canines (6%) [23 females

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(4.5%) and 8 males (1.5%) with ages range from 13 to 48 years (mean of 30.5 years)]. 23 of the canines were unilaterally impacted (74.2%) and 8 of them were bilaterally impacted (25.8%). Of the 22 cases included in the study, 19 canines were impacted palatally (86.36%) and 3 canines were impacted labially (13.64%). The data were inserted in the computer through SPSS program and data analysis was done. Tables and graphs were used to correlate the obtained results with both position and international data

**Table 1** Different kappa values scored by the nine examiners.

| Examiner code | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| Kappa | -0.265 | 0.492 | 0.776 | 0.397 | 0.124 | -0.071 | 0.197 | 0.049 | 0.049 |

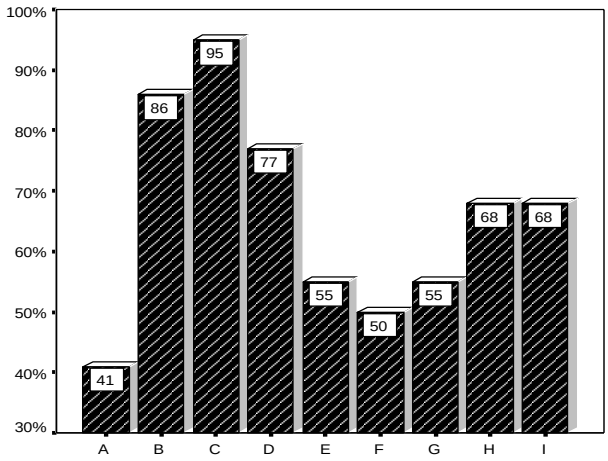


**Figure 2** Different percentages of agreement for the nine examiners (including the table).

**Table 2** The percentage of right and wrong diagnosis in questionnaire result.

| Diagnosis | Frequency | Percent |
|---|---|---|
| Wrong | 1 | 6.7% |
| Right | 14 | 93.3% |
| Total | 15 | 100% |

**Table 3** The sensitivity to labial and palatal impaction localization in retrospective and prospective studies.

| Sensitivity / The study | Labial | Palatal | Overall |
|---|---|---|---|
| Retrospective study | 51.9% | 69.6% | 66.1% |
| Prospective study | 100% | 90% | 93.3% |

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## 4. Discussion

*Retrospective sample*

The sample for the study consisted of patients who had undergone surgery for an impacted canine.

Most of the patients had been referred by the Department Of Orthodontics at the hospital where lateral cephalometric radiographs are routinely taken

Our examiners speciality includes orthodontics, pedodontics, and oral medicine and diagnostic sciences and these are not in contact with surgical practice of canine management. The others are oral surgeons. The correct diagnosis of the impacted canine position varied quite markedly between the nine examiners (the range of kappa was from -0.265 to 0.776) (Table 1).

All of the examiners are not familiar with this method. The highest percentage of agreement (95%) (Figure 2) and highest kappa score (0.776) is high and can be categorized as ideal. This result scored by a resident who has knowledge about the method. In the same time he has a good experience in surgical management of the impacted canine tooth. The second examiner with a percentage of agreement (86%) is an oral and maxillofacial surgery board student with good surgical experience, but is not totally familiar with the method. The examiner with the lowest percentage of agreement (41%) is the consultant oral surgeon who has a good surgical experience, but not familiar with the method.

General practitioner (with a percentage of agreement of 68%) has no surgical experience and is not familiar with the method and not The pedodontist and the consultant in oral medicine and diagnostic sciences (with percentages of agreement of 50% and 55% respectively) have no surgical experience and are not for each patient. familiar with the lateral cephalogram reading.

Intern dentist has the least practical experience (scored a percentage of agreement of 68%) and also is not familiar with the technique. The percentage of agreement of the orthodontist was 55%. He has no surgical experience and not familiar with the method, but he is familiar with the lateral cephlogram.

familiar with the method and with the lateral cephalogram.

In concerning the worst result of the consultant oral surgeon, it seems that it is a problem with the reading and interpretation. Even though, this result will not be excluded.

The sensitivity of localizing impacted canine with this method in this group is 66% in the mean value of all examiners. Sensitivity to localization of the labially impacted canine is 51.8%, whereas sensitivity to localization of the palatally impacted canine is 69.5% in this group. This result is not satisfactory.

It is to be noted that reproducibility to check intra-examiners variation was not performed.

*Prospective study group*

All the participants in this sample are oral surgeons with good surgical experience and familiarity with the lateral cephalogram reading, but they are not familiar with the method.

Every one of this group had surgically managed impacted canine with diagnosis based on the lateral cephalogram reading.

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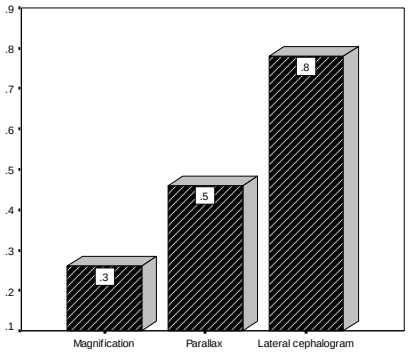


| The method | kappa |
|---|---|
| Parallax | 0.46 |
| magnification | 0.26 |
| Lateral cephalogram | 0.78 |

**Figure 3** Comparison between kappa results for parallax, magnification (results taken from other study), and lateral cephalograph (including a table).

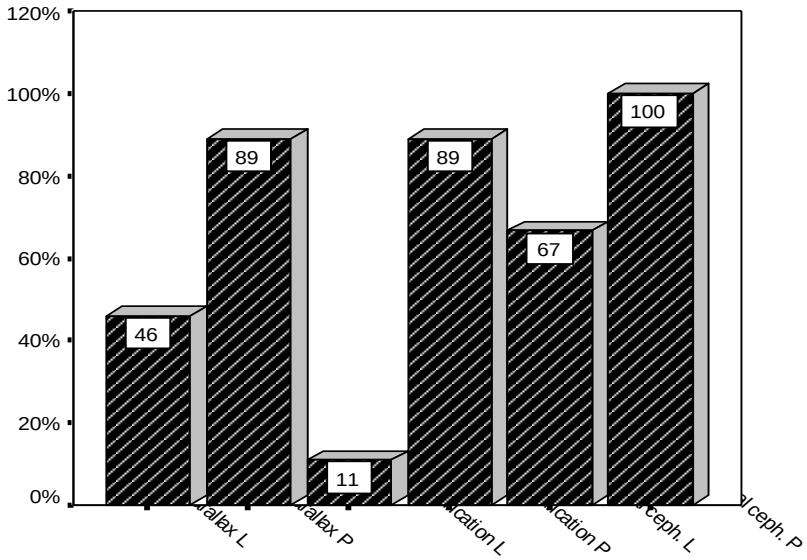


**Figure 4** Comparison between sensitivity of labial (L) and palatal (P) impacted canine localization for different techniques (for the best examiner).

14 cases (93.3%) [from the total of 15 cases] achieved the correct position compared to his diagnosis from the lateral cephalogram. Only one achieved wrong diagnosis (6.7%) (Table 2).

The sensitivity of localizing impacted canine with this method in this group is 66% in the mean value of all participants. Sensitivity to labial position is 100%, whereas sensitivity to localization of the palatal impacted canine is 90% in this group. This result is satisfactory. This result showed that the method can be relied on for diagnosis of the impacted upper canine.

Comparison between retrospective and prospective studies was done (Table 3).

The results of this study are further compared to other studies results obtained by other methods such as parallax and magnification (Table 4). Also incidence obtained in this study is compared with the international data available (Table 5). The incidence of labial and palatal canine impaction is also compared between English and Saudi populations (Table 6). Cohen's kappa and percentage of agreement for the best examiner were compared with the different techniques (Figures 3 and 4).

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**Table 4** Comparisons between sensitivity to labial, palatal, and overall impacted canine localization of different techniques.

| Sensitivity / Technique | Labial | palatal | Overall |
|---|---|---|---|
| Parallax | Less than 50% | 90% | 76% |
| Magnification | 10% | 90% | 66% |
| Lateral cephalogram | 51.9% | 69.6% | 79.6% |

**Table 5** Comparison between the incidence of upper canine impaction in different populations.

| Population | Saudi (our study) | English | Turkish |
|---|---|---|---|
| Incidence | 60% | 1-3% | 3.58% |

**Table 6** Comparison between incidence of labial and palatal canine impaction in English and Saudi populations.

| Population / Impaction | Saudi (our study) | English |
|---|---|---|
| Palatal | 86.4% | 2-5 times palatal more than labial |
| Labial | 13.6% | 2-5 times palatal more than labial |

*Clinical case report*

These are surgical clinical cases with diagnosis based on lateral cephalogram. The diagnosis was correct compared to the true location found surgically (100%) which is ideal result.

The mean value of the three samples will be equal to 85.94%. From the above, if the clinician was given the chance of training about the method, their reproducibility will definitely increase and may possibly approach ideal.

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**Figure 5** Lateral cephalogram of case1 patient showing the impacted canines.

CASE 1

24 years old Saudi male patient was referred from the orthodontic clinic for extraction of bilaterally impacted upper canines (teeth #13 and 23). Tooth #23 was palpated labially. The surgeon was given the lateral cephalometric radiograph to estimate the position of the impacted canines before the surgery. The surgeon diagnosed both impacted canines from lateral cephalometric radiograph as labially impacted teeth.

The surgical approach was done labially and tooth #23 was identified and extracted (Figures 5 and 6).

CASE 2

14 years old Saudi female patient referred from orthodontic clinic for extraction of impacted upper canine (tooth # 23) which was not palpable clinically. The surgeon was given the lateral cephalometric radiograph to estimate the position of the impacted canine. He diagnosed the canine as palatally impacted tooth. The surgical approach was done palatally and the tooth identified and extracted palatally (Figures 7 & 8).

**Figure 6** Tooth #23 was extracted through labial approach.

**Figure 7** Lateral cephalometric radiograph of case 2 patient showing the impacted canine.

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**Figure 8** Tooth #23 exposed surgically through palatal approach.

## 5. Conclusion

1) The method proved to be of good diagnostic value concerning location of impacted canine in the maxillary arch.

2) The method has additional value in reducing patient's radiation exposure.

3) With good training, the diagnostic value of the method may reach ideal.

It is to be noted that the number of sample study is at the lowest margin of the reliable data number (46 cases). Further study is still required.

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