TECHNIQUES FOR LOCALIZATION OF IMPACTED MAXILLARY CANINES

RADIOGRAPHS; A NEW CLASSIFICATION SYSTEM BASED ON THE PRINCIPLES OF LOCALIZATION

Surej Kumar LK¹, Nikhil M Kurien², Adersh GA³, Mathew Tharakan⁴

Abstract
Maxillary canines are the second common teeth having potential for displacement from its normal position during eruption. The ideal challenge for treating the impacted maxillary canines is its localization. Many radiographic techniques of localization are described in the literature based on the radiographs used. Most of them are based on arbitrary methods and ratios. We are summarizing those techniques based on the principles used.

Author Affiliations:
¹,²,³Department of Oral and Maxillofacial Surgery, P.M.S. College of Dental Science and Research, Thiruvananthapuaram, Kerala, India.

Keywords: Maxillary canines, radiographic localization, principles of localization, classification

*Corresponding Author:
Dr. Adersh G.A
Postgraduate Student, Postgraduate student
Dept of Oral and Maxillofacial Surgery, P.M.S. College of Dental Science and ResearchThiruvananthapuaram, Kerala, India.

INTRODUCTION
After third molars, maxillary canines are the common teeth having potential for displacement from its normal position during eruption. This occurs two times more frequently than mandibular canine impactions [¹]. Among the population having
impacted canines, 8% show bilaterally affected canines \(^{(2)}\). Radiographic evaluation of the impacted maxillary canine has got both diagnostic and prognostic values. Possibilities of the canines to get impacted can be predicted through radiographic analysis. After knowing the chances of impaction, interceptive managements can be started for the prevention of displacement of the erupting canine. Radiographs are also used for the localization of the canine before surgical intervention. Localization techniques are summarized in many literatures on the basis of the radiographs used. In this paper we are trying to summarize and classify the radiographic techniques for localization of the impacted maxillary canines based on the principles used for the localization, irrespective of the type of radiograph used.

**TECHNIQUES OF LOCALIZATION**

1) **TECHNIQUES APPLIED ON SINGLE PLANE**

a) **PARALLAX**

The word parallax came from the French word ‘parallaxe’ which means ‘fact of seeing wrongly’. It is the displacement of apparent position of an object when viewed from two different positions. When it is applied on radiology it can be described as change in apparent position of an image corresponding to actual change in the angulation of the x-ray beam \(^{(3)}\). The parallax technique is the basis of many localization techniques. The image of the object (tooth) that is away from the x-ray tube moves in the same direction as the tube, whereas the image of the object closer to the x-ray tube moves in the opposite direction to the tube (Fig.1).

![Fig 1: An illustration showing parallax technique. A; the normal projection. B; image of the canine follows the same direction to the tube movement. C; the image shifted to the opposite direction to the tube movement.](image)

Clark in 1909 used the parallax technique for localization of objects in the radiographs \(^{(4)}\). He used two intra oral periapical radiographs projected with different horizontal angulations.
for the localization of the tooth. Thus it was also known as horizontal tube shift method. The major disadvantage of using intra oral periapical radiographs was that it covers only small area when compared to occlusal radiographs. Richards in 1952 adapted the similar technique in vertical plane, which was termed as vertical parallax technique (5). He used this method for localizing mandibular canals using periapical radiographs. With these two types of parallax, combinations of radiographs were used by many authors for localization. Evan used three periapical radiographs in 3 different angulations in the horizontal axis for the localization of the cuspids (6). In 1986 Keur used two occlusal radiographs in different horizontal angulations for the localization of impacted maxillary canines (7). Vertical parallax technique is more applicable to occlusal radiographs because of its wide area of coverage. In the same year he described the use of one orthopantamogram and an intraoral periapical radiograph with change in vertical angulation for the localization of impacted maxillary canine (7). Rayne in 1969 used one periapical radiograph and one maxillary anterior occlusal radiograph with change in vertical angulation of the tube (8). Southall and Gravely in 1987 used vertical parallax technique on one maxillary anterior occlusal and one maxillary lateral occlusal radiographs to identify the canine position.

For the effective shifting of the images on the radiographs while tube shifting, two distances has to considered. One is the distance between the impacted tooth and the reference tooth material and another one is the distance shifted by the tube for the second radiograph. The distance shifted by the image is directly proportional to these two factors. Greater the image is shifted greater will be the diagnostic quality (9). Jacobs in the year 1999 found that if the vertical angulation is increased by 10º - 15º than the normal projection in an occlusal radiograph, the image is shifted farther away (9).

b) MAGNIFICATION

Magnification refers increase in the size of an object only in appearance and not in physical aspects. In radiology magnification is considered as both distortion of the image size and also a tool for localization (10). An object when placed away from the source of the X ray will produce a smaller image when compared to the image produced by the object of similar size when placed nearer to the source (Fig.2). This is the principle behind magnification. So for an object to produce an
image similar to its size, it has to be placed so close to the film (10). In 1976 Ostrofsky tried to use this principle of localization with Status X radiography. He found that the palatally impacted canines are more magnified than the buccally impacted canines.

Fig 2: An illustration showing principle behind magnification, as the object moves away from the source the size of the image is decreased.

The palatal canines are more close to the source of X ray as the tube is projected from the back of the head (11). Three years later Wolf et al studied the efficacy of this principle with 116 cases of impacted maxillary canines on panoramic radiographs. He found that the palatal canines are magnified more than buccal canines on the radiograph (12). Fox et al in 1995 did a similar study using panoramic radiographs and found the magnified palatal canines (13). The disadvantage of these two studies is that they could not quantify the amount of magnification mandatory for differentiating palatal and buccal canines. Pointing out this disadvantage, Chausu et al proposed an index that uses central incisor of the same side of the impacted canine as index tooth and calculated the ratio of the mesiodistal diameter of the impacted canine to that of ipsilateral central incisor (Fig.3). They concluded that if the ratio is more than 1.15 for the palatal canines. They termed the index as CII (Canine Incisor Index).

Fig 3: Panoramic radiograph showing application of technique of magnification proposed by Chausu et al. Yellow line represents the widest mesiodistal diameter of the impacted canine and the white line represents that of the ipsilateral central incisor.

In the same study they created another index using used the contralateral erupted canine as index tooth. That was termed as Canine Canine Index (CCI). They applied the concept of vertical restriction (Fig.4), in which the root of the ipsilateral central incisor is arbitrarily
divided into three zones named coronal middle and apical zones. Most of the palatal canines appeared in the middle zone and the buccal canines represented the coronal zones (14).

Fig 4: Application of vertical restriction according to Chausu et al. The tip of the impacted canine can be located at the middle zone

C) ANGLES AND SECTORS

In planar geometry, an angle is described as a figure formed by two rays meeting at a point called vertex. When these two rays are constructed as radii of a circle, the area enclosed by these two radii and an arc becomes a sector. Many authors believed that, the angle formed between the long axis of the canine and any reference lines on radiographs has got diagnostic and prognostic values. Some of them located the erupting canines on radiographs during mixed dentition period and predicted their prognosis. Others used angular measurements for finding the position of the impacted canines.

Ericson and Kurol in 1988 did a sector study on panoramic radiographs and defined three sectors, Sector I is between the inter-incisor median line and the long axis of the central incisor. Sector II is located between the major axes of the lateral and central incisors and Sector III is located between the major axis of the lateral and the first premolar. The prognosis of the treatment for impacted maxillary canines will be good if the canine belongs to sector III. It worsens if the canine belongs to sector I. They found that if the angle formed between the inter incisor midline and the major axis of the impacted canine (‘α’) is more than 25°, treatment difficulty increases. They also found that the treatment difficulty increases if the perpendicular distance between the cusp tip of the impacted canine and the occlusal plane (‘d’) increases (15, 18).

Four years later, Lindauer et al modified the sectors proposed by Ericson et al. Sector I is located distal to a tangent to the distal surface of crown and root of the lateral incisor; sector II covers the area from the tangent on the distal surface to a midline bisector of the
lateral incisor tooth; sector III represents the area from the midline bisector to a tangent to the mesial surface of the lateral incisor crown and root; sector IV includes all areas mesial to sector III. Chances of impaction are more when the cusp tips of the impacted maxillary canines are present in the sectors II, III and IV.

Warford used bicondylar line drawn between the condylar heads on panoramic radiographs as reference line. He measured the angle formed between the long axis of the impacted maxillary canine and the bicondylar line. Angulation was higher for non-impacted teeth, with a mean of 75.12°. The canine is predicted to be get impacted if the angulation is less. He incorporated the sectors modified by Lindauer in his study and found that the value of the prediction for impacted maxillary canine is the function of angular measurements and sectors in which the later one has higher prognostic value. Similar angulation technique can be used with the lateral cephalograms showing erupting maxillary canines. The angle formed between the long axis of the impacted maxillary canines and the Frankfurt horizontal plane is considered. Necessity of treatment is there if the angle is between 15°-25°.

Afore mentioned techniques predict the prognosis and treatment difficulties of the erupting canines and they are performed in radiographs taken when the subject is at the age of 8-9 years. Angulation technique can also be used for locating the maxillary canines after they get impacted.

This helps in determining the surgical access to the tooth for exposing the same. Simpson et al described a simple technique using occlusal radiographs. He constructed an arbitrary line connecting the root tips of the two lateral incisors, and found that the tip of the buccally impacted maxillary canines are in front of the line and the palatal canines are behind the line (fig.5).

Fig 5: Upper occlusal radiograph showing the cusp tip of the impacted canine anterior to the line connecting (red line) the apices of the lateral incisor.
If we consider the line as the diameter of a circle, the areas anterior and posterior to the line can be considered as sectors. The projection used in this technique was in such a way that the perpendicular beam was set to be passing through the glabella. One of the latest localization technique proposed by Katsnelson et al in 2011 used the same principle of angulation. The reference line used in their study was the line connecting the mesio buccal cusp of the first molar of both sides that represented the occlusal plane. A line connecting the cusp tip of the impacted maxillary canine and its root tip is extended to the reference line. The angle formed between these two lines is measured. If the angle is more than 65°, chance for the tooth to get buccally impacted is 26.6 times.

2) **TECHNIQUES APPLIED ON MULTIPLE PLANES**

A normal single radiograph gives the images of three dimensional objects in a single plane. This makes the clinician to depend on multiple radiographs and tedious localization techniques for finding the impacted tooth position. It is easier to locate the tooth if its image is able to be produced in at least two planes.

a) **RIGHT ANGLE TECHNIQUE**

Waggener in 1960 found that two different projections can be made through a tooth at right angle to its long axis. He used this right angle technique to produce images of the impacted tooth on two different planes. He used periapical and occlusal radiographs for the localization procedure. In the same year Broadway and Gould used lateral cephalograms and postero-anterior cephalograms for the localization of the impacted maxillary canine. Similar radiographs were used by Wraith and Ballard in 1969; they found that it is necessary to add on another intraoral radiograph for the detailing of the impacted tooth. Later Coupland in 1987 described the use of lateral cephalograms along with panoramic radiographs for localization of the impacted maxillary canine. Southall et al did a study to find out a better combination of the radiographs that can be used for the localization of the impacted canine. He found that the combination of a rotational panoramic radiograph along with true occlusal
and a periapical radiograph is needed for the finite localization.

b) THREE DIMENSIONAL LOCALISATION

Introduction of computed tomography for localization of the impacted maxillary canines changed the concept of viewing the images in two dimensions to three dimensions. For the treatment of the impacted maxillary canines, it is important to know its relation with the lateral incisor. Most of the cases resorption of the root of lateral incisor is evident. It is difficult to identify the resorption in normal radiographs as the overlapping of the images occurs. Ericson and Kurol in 1988 found that the resorption of the lateral incisor can be identified precisely along with proper localization of the impacted canine using computed tomography \(^{(25)}\). After few years Preda et al used spiral CT for the localization of the impacted maxillary canines. Nowadays most of the clinicians support the use of Cone Beam Computed Tomography for the localization of the impacted maxillary canines \(^{(26)}\). There are some add on benefits for using CBCT, it helps in measuring the follicular size, alveolar width of the impacted region and the type of impaction \(^{(27)}\). Alqerban et al in 2015 found that prognosis of the erupting canines can be predicted with CBCT. The angulation of the erupting canine to the lateral incisor on the coronal view, the distance between canine cusp tip to the occlusal plane on the sagittal view, and the canine crown position were the strongest predictors based on the CBCT radiographs \(^{(28)}\).

Three dimensional printers were introduced for making prototypes of the impacted maxillary canines. The prototypes were made from light cured acrylic resins. The models were used for localization of the tooth, communicating with the patient and for the fabrication of the attachment used for orthodontic traction of the impacted maxillary canines \(^{(29)}\). (Fig 6)

Fig 6: Panoramic radiograph showing application of Katsnelson’s technique of angulation. Red line represents the long axis of the impacted maxillary canine. Yellow line represents the occlusal plane.
Conclusion:
Techniques used for radiographic localization of impacted maxillary canines can be summarized based on the principles applied. Broadly they can be categorized based on the number of the planes used for localization. Images of impacted maxillary canines can be visualized in single plane or multiple planes. The parallax technique, the magnification technique, angulation and sector techniques can be applied on single plane. The right angle technique uses two planes and computed tomography uses multiple planes for the localization (table 1). Most of the authors consider the use of advanced radiographic modalities for the localization of the impacted maxillary canines (27, 28). It helps to avoid multiple radiographs taken for localization. Various factors associated with the impacted maxillary canines can be identified along with its localization.

Conflict of Interest Statement-
There is no conflict of interest.

REFERENCES:


