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Mpacted Anterior Teeth Localisation: Cognition over Radiation

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Abstract

Impacted anterior teeth are an impediment to treatment planning in Dentistry. Therefore, proper localisation of the impacted tooth is imperative. CBCT is the gold standard of imaging such teeth; however, poor availability of such devices in rural areas and the economic costs involved often deter patients. Additionally, the high radiation from such devices cannot be ignored. As technology advances and we move towards a 'smart world', we need to retrospect on whether we are foregoing our cognitive skills at the expense of patient radiation. Previous studies have proven that plain film radiographs are highly sensitive and specific at anterior impacted teeth localisation. Here we review different localisation techniques that can enable us to identify correct tooth position using plain films.

Keywords: Localisation, Impacted, Maxillary anterior teeth, Conventional Radiography, CBCT.

Introduction

Impacted tooth is the one that fails to erupt into dental arch within the expected developmental period. Localization is determination of the site or place of any process or lesion.

Impacted anterior teeth can be localised by three methods – visual inspection, palpation & radiography. Clinically, impaction of anterior teeth is determined by the lack of a bulge in the buccal sulcus at the age of 10 years, prolonged retention of a primary teeth, delayed eruption of the permanent teeth, asymmetry in the exfoliation of primary canines and eruption of the right and left permanent canines, loss of vitality and increased mobility of a permanent incisor.

But, radiographic examination is the best method for the determination of position of an impacted canine.

Accurate localization in three planes of space normally requires the use of more than one film. Precise localization is crucial for predicting the direction of subsequent orthodontic forces and planning the means of surgical access to the impacted teeth. Currently, there are accurate radiographic methods that can be used to localize an impacted teeth: horizontal tube shift, vertical tube shift, right angle technique, stereoscopy, panoramic radiography, cone beam computed tomography. Of these,

the horizontal tube shift and the vertical tube shift are of special interest because they utilize radiographs that are most commonly taken during a routine initial assessment. (1) This paper reviews different localisation techniques that can enable us to identify correct tooth position using plain films.

Localisation Using Periapical Radiographs

Simplest radiographs having minimum exposure which provide us with the information regarding state of development of teeth, presence of follicle and resorption of adjacent tooth.

1 – **Horizontal Tube Shift Technique**

In 1910, Clark introduced horizontal tube shift technique using three periapical radiographs, based on the principle of parallax.

Principle of Parallax : In radiologic terms, parallax is the apparent displacement of an image relative to the image of a reference object and is caused by an actual change in the angulation of the x-ray beam. The change in angulation of the beam is caused by a change in the x-ray tube position. The reference object is normally the root of an adjacent tooth. The image of the tooth that is farther away from the x-ray tube moves in the same direction as the tube, whereas the image of the tooth closer to the x-ray tube moves in the opposite direction to the tube. (2).

2 - Vertical Tube Shift Technique

The horizontal tube technique was later adapted by Richards in 1952 to shift the tube in vertical plane. He coined the term buccal object rule when he introduced the concept of a VTS. Richard stated that, the radiographic image of a buccal object could be shifted in direction, relative to the image of a lingual object simply by aiming the X-Ray beam in the desired direction.. The acronym SLOB can assist in recalling the principle of tube shift: Same: Lingual, Opposite: Buccal (same direction of movement of the image of the impacted tooth as the tube moves then the tooth is lingual, opposite direction of movement to the tube then the tooth is buccal) (3).

Localisation Using Occlusal Radiographs

Occlusal radiographs are taken using various projections: the most frequently used is that perpendicular beam to the film through the glabella. In occlusal radiograph, if the cusp of the impacted tooth is positioned in front of the ideal line connecting the apices of the adjacent teeth the position will be labial. (4)

1 – Millimeter Rule

In millimeter rule by maxillary occlusal radiograph, taken at + 60 to 65 degrees, the bucco-palatal position of the impacted maxillary tooth was assessed using the line of dental arch as a reference. This line was identified on each occlusal film by drawing a curve through the midpoints of the crowns of adjacent erupted teeth incisal /occlusal surface (Fig 1).

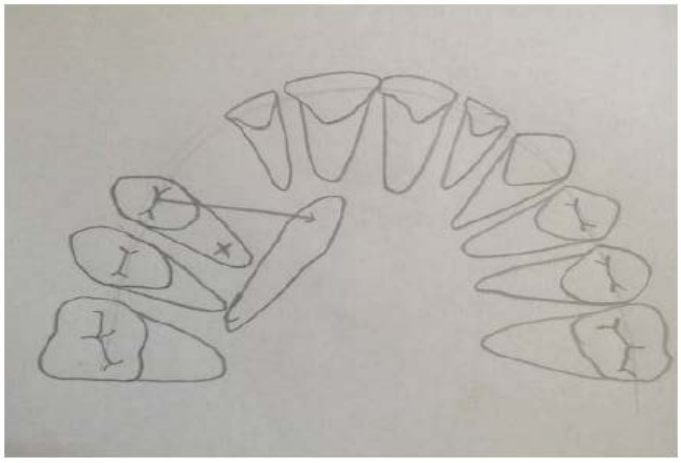

Fig. 1 – Illustration of Millimeter rule

For example, measurements were made using a millimeter rule from the midpoint of the impacted tooth crown to the line of dental arch along a line passing perpendicular to the arch. When the midpoints were aligned with the “line of dental arch” or were within 1 mm of it, the impacted canine was assessed as being in the arch. Outside this range, the position of the impacted canine was recorded as either buccal or palatal. (5).

Localisation Using Panoramic Radiographs

A dental panoramic radiograph (OPG) is commonly used in dentistry for assessing the presence, position and morphology of the unerupted teeth. From the panoramic view, the impaction of maxillary anterior tooth is an occasional but a significant finding. It, would, therefore, be advantageous if this single film could be reliably used for the localization of impacted teeth.

1 – Principle of Magnification

The panoramic localization was based on the principle of magnification. On a panoramic radiograph, the images of teeth situated at the palatal aspect of the dental arch, i.e. closer to the tube and farther from the film, are magnified, whereas those on the labial are diminished when compared with the size of the images of the teeth in the line of the arch. Palatally located teeth will be projected higher, even though they may be at the same height above the occlusal plane. As a result, the height of the tooth on the panoramic radiograph will be exaggerated both by its bucco-palatal displacement as well as by its vertical height above the occlusal plane. An expression of the vertical factor is therefore necessary to achieve a valid magnification index. (5)

Widest mesio – distal dimension of the impacted tooth measured on a line perpendicular to its long axis. The widest mesio distal dimension of the ipsilateral central incisor measured on a line perpendicular to its long axis. In each case, when the contra lateral impacted tooth is in correct position, its widest mesio-distal dimensions also measured. In case of canines,

$$\text{Canine Incisor index} = \frac{\text{Widest MD dimension of canine}}{\text{Widest MD dimension of ipsilateral central incisor}}$$

In unilaterally impacted canines,

$$\text{Canine – Canine Index} = \frac{\text{Widest MD dimension of impacted canine}}{\text{Widened MD dimension of contralateral erupted canine}}$$

When the value of CII or CCI greater than or equal to 1.15, it indicated palatal location; less than 1.15 indicated buccal location. This is based on the fact that for a given focal spot – film distance, objects placed palatal to the image layer excessively magnified in the horizontal plane, while buccally located objects appear proportionally diminished.(6)

2 – Angulation Method

Angle between the long axis of the impacted tooth and a horizontal line joining mesio-buccal cusp tip of the right and left first molars are measured and denote as angle α. When the value of α was less than or equal to 65°, it indicated palatal location; greater than 65° indicated buccal location. (7)

3 – By Using Sectors

Impacted anterior tooth in panoramic radiograph divided into, Sector 1: if the cusp tip of the impacted tooth is between the inter-incisor median line and the long axis of the central incisor Sector 2: if the peak of the crown of impacted tooth is between the major axes of the adjacent teeth Sector 3: if the peak of the crown of the impacted tooth is between the major axis of the adjacent teeth.

Angle α to represent the angle formed between the inter-incisor midline and long axis of canine. If the angle α greater than 25°, impacted teeth is in sector 1 or 2. (8)

To predict anterior tooth impaction relative to the erupted adjacent tooth root, there is another method.

Sector I - area distal to a line tangent to the distal heights of contour of the adjacent tooth crown and root

Sector II - mesial to sector I, but distal to a line bisecting the mesio-distal dimension of the lateral incisor along the long axis of the tooth;

Sector III- mesial to sector II, but distal to a line tangent to the mesial heights of contour of the lateral incisor crown and root;

Sector IV - all areas mesial to sector III and long axis of central incisor

Sector V - area bounded by sector IV and the midline between the upper central incisors. (Fig. 2).

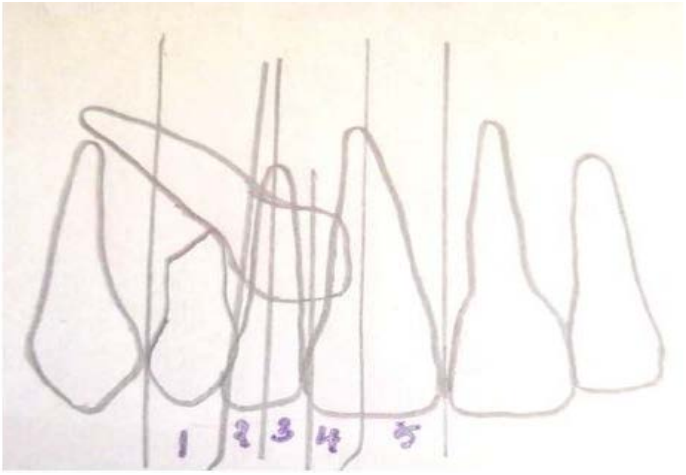

Fig. 2 – Illustration of sector method

If impacted tooth cusp tips located in sector II, III, IV, they are palatally impacted (9)

4 – Using Vertical Restriction Criteria

Root length of ipsilateral central incisor measured and divided into 3 equal zones perpendicular to its vertical axis by marking two horizontal lines.

Apical zone – apical third of the root

Middle zone – middle third of the root

Coronal zone – remainder of the root

Palatally impacted canine will be in the middle zone and buccally impacted canine in the coronal zone. (6)

5 – Using Superimposition Method

This method is only fit for the "superimposed" canines. The impacted maxillary canine that was superimposed on the root or neck of the central incisor was considered as a palatally impacted canine. (10)

Localisation of Impacted Tooth Using Multiple Radiographs

Ballard suggested the use of the combination of a lateral cephalometric radiograph with a posterior-anterior cephalometric radiograph for localization of impacted maxillary anterior tooth. However, the position of the impacted tooth is often difficult to interpret, and an additional intraoral film is required to see the fine detail of the impacted tooth and its surrounding structures. (11)

2 occlusal radiographs rather than 2 periapical radiographs for a horizontal tube shift can be used because 2 occlusal radiographs cover a larger area. This has 2 advantages: (1) the tube can be moved much more between the 2 exposures, resulting in the shift of the image of the impacted maxillary tooth being easier to determine and (2) it will show the impacted tooth in its entirety, which is usually not the case with periapicals. The radiation dose from 2 occlusal radiographs is very similar to that from 2 periapicals (12)

Two distances are important in localization: the distance between the impacted tooth and its reference tooth, and the distance over which the x-ray tube is moved. First, the larger the distance between the impacted tooth and the reference tooth the greater will be the shift of the image of an impacted tooth with a given x-ray tube movement, resulting in an easier determination of its position. Second, with a given distance between the impacted tooth and the reference tooth, a larger movement of the tube will result in a larger shift of the image. Therefore, by moving the tube over as great a distance as possible between the 2 exposures, the clinician can facilitate interpretation of the position of impacted teeth located close to the dental arch.(3)

Localisation of Impacted Tooth Using 3d Techniques

Because of superimposition of structure on the film it become difficult to distinguish the details which makes the diagnosis and treatment planning difficult with conventional radiographic methods.

In recent years, cone-beam computed tomography (CBCT) systems for acquiring 3D images of oral structures have been preferred due to their relatively low

cost and low radiation dose. But, the benefit to- risk assessment of CBCT imaging is still controversial. Although CBCT exposes the patient to higher levels of radiation compared with conventional modalities, the long-term effects of excessive ionizing radiation above background levels of ionizing radiation remain unknown. Some studies have reported that CBCT imaging is clearly advantageous in the management of impacted teeth. Other studies have reported that CBCT allows orthodontists to improve diagnostic capabilities and that it is more accurate at localizing maxillary impacted canines CBCT is more accurate when compared with horizontal, vertical parallax, or a combination of both. Specialty training also affects the amount of information obtained through CBCT and conventional radiographs: radiologists use conventional images more effectively than do orthodontists. In addition, it has been shown that observers had greater complications in diagnosing buccal canines versus palatal ones. (13)

Although this article deals only with the localisation of impacted maxillary anterior teeth, the principles of radiographic localisation can be used to localise any tooth in either arch.

Two scenarios are discussed here. Both of them have CBCT, which is confirmatory for the exact location of the tooth. These examples illustrate how the location of impacted tooth can be accurately anticipated by appropriate interpretation of the radiographs.

Example 1:

The IOPARs (Fig 3A, 3B) show that the maxillary right permanent central incisor is impacted. When the horizontal tube shift technique is used and the tube is shifted mesially from the position of taking 3A to that of 3B, the crown of the impacted incisor is moved distally, from the middle third of 21 to the interdental space between 21 and 11. ie., in the opposite direction to the shift of the tube. Therefore, it can be deducted that the crown of the impacted tooth is buccal.

Fig.3A – Scout IOPAR

Fig. 3B – IOPAR taken using mesial shift

In the occlusal radiograph (Fig 4), measurements were made using a millimeter rule from the midpoint of the impacted tooth crown to the line of dental arch along a line passing perpendicular to the arch. The distance from the midpoint of the impacted central incisor to the line of dental arch is more than 1 cm. This is more than 1 mm, so the position of impacted canine is either buccal or palatal.

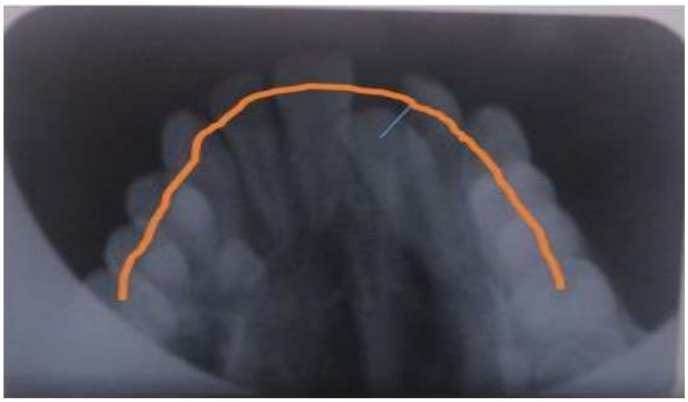

Fig. 4 – Maxillary occlusal radiograph depicting millimetre rule.

In the panoramic radiograph using principle of magnification for unilaterally impacted tooth.

$$CII = \frac{\text{Widest MD dimension of impacted tooth}}{\text{Widest MD dimension of contralateral erupted tooth}}$$

Widest MD dimension of impacted 11 is 7.2. Widest MD dimension of contralateral dimension of erupted 21 is 6.9. CII is 1.043. If CII is less than 1.15, tooth is buccal impacted (Fig. 5)

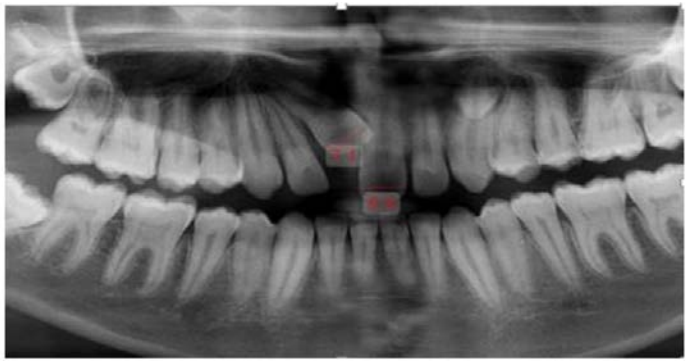

Fig. 5 – Panoramic radiograph showing magnification index

By the angular method, angle between the long axis of the impacted canine and a horizontal line joining mesio-buccal cusp tip of the right and left first molars are measured and it is 226.9°, which is greater than 65°, indicating buccal position (Fig. 6)

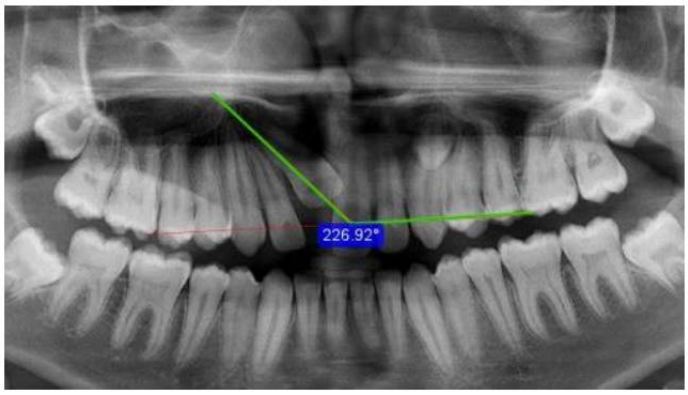

Fig. 6 – Panoramic radiograph showing localisation with angular method.

For the confirmation, CBCT has been taken. CBCT images have been given below (Fig. 7A, Fig 7B).

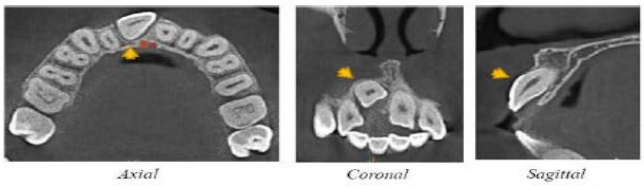

Fig. 7 A

Fig 7B

Surgical exposure of the impacted anterior tooth revealed a buccally placed anterior tooth (Fig 8)

Fig.8 – Surgical Exposure of the impacted teeth

This conforms the diagnosis of bucally impacted maxillary anterior tooth.

Example 2

The IOPARs (Fig 9A, 9B) show that the maxillary left permanent canine is impacted. The IOPAR was taken at an effective angle of +7° to the occlusal plane. When the horizontal tube shift technique is used and the tube is shifted mesially from the position of taking 9 A to that of 9 B, the crown of the impacted canine is moved mesially, from the interdental area of 21 and 22 to the apical one-third of 21. ie., in the same direction to the shift of the tube. Therefore, it can be deducted that the crown of the impacted tooth is palatal.

Fig. 9A - Scout IOPAR

Fig. 9B – IOPAR taken using mesial shift

In the panoramic radiograph using principle of magnification for unilaterally impacted tooth

$$CII = \frac{\text{Widest MD dimension of impacted tooth}}{\text{Widest MD dimension of contralateral erupted tooth}}$$

Widest MD dimension of impacted 11 is 7.8. Widest MD dimension of contralateral dimension of erupted 21 is 6.5. CII is 1.2. If CII is greater than 1.15, tooth is slightly palatally impacted (Fig. 10)

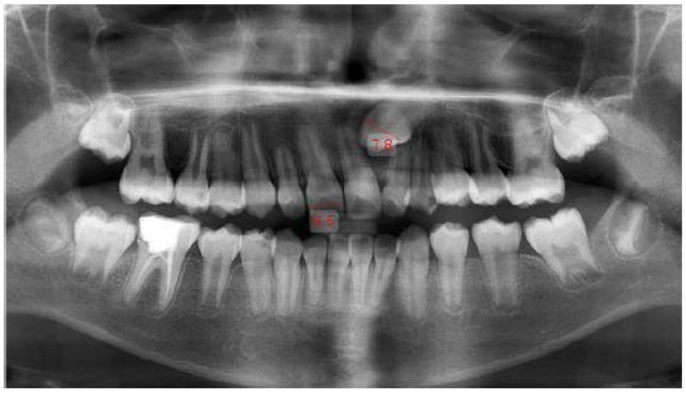

Fig. 10 – Panoramic radiograph showing localisation with Magnification idex

By angulation method, the angle between the horizontal line joining the mesiobuccal cusps of permanent molar and the long axis of impacted canine is 35.79°, which is less than 65°, indicating palatal impaction (Fig. 11)

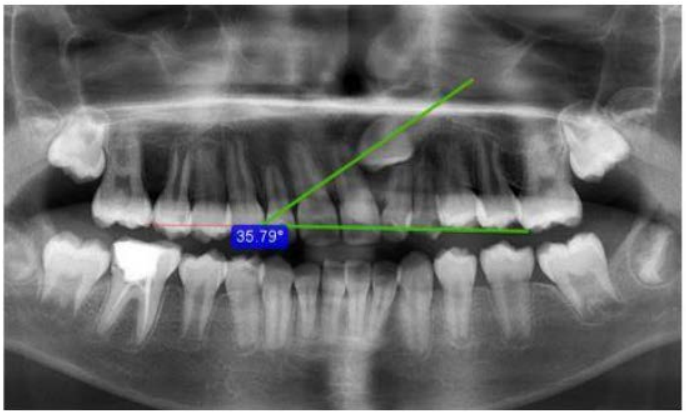

Fig. 11 – Panoramic radiograph showing localisation with angular method

By sector method, the cusp tip of impacted canine comes between sector IV, indicating palatal impaction.

CBCT image also confirms the diagnosis of palatal impaction (Fig. 12A, 12B)

Surgical exposure revealed palatally placed canine (Fig. 13) This confirms.

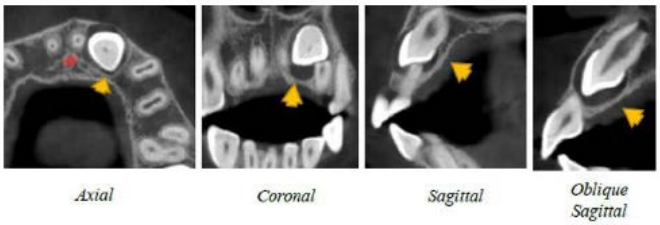

Fig. 12 A

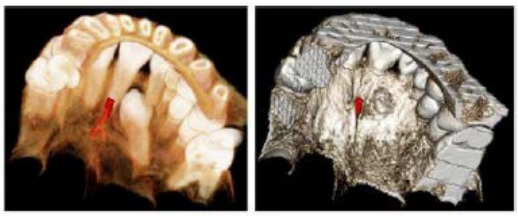

Fig. 12 B

Surgical exposure revealed palatally placed canine (Fig. 13)

Fig. 13

This confirms the diagnosis of palatally impacted canine.

Conclusion

The images discussed prove that when proper techniques are followed the diagnostic value of plain film radiography is on par with CBCT in localisation of impacted anterior teeth. However, fine details and measurements are not possible and CBCT should only be preferred for such cases as in implant planning. Further studies are needed to compare plain films to CBCT images in order to establish sensitivity and specificity. Following the principles of ALARA, plain film

radiographs should always be preferred over CBCT images wherever feasible.

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