IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 20, Issue 4 Ser.12 (April. 2021), PP 07-12
www.iosrjournals.org

Maxillary Canine Impaction: Diagnosis and Guidelines for Assesment of Impaction

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Abstract: *Canines contribute significantly in functional occlusion and form the foundation of an esthetic smile. So, any factor that interferes with the normal development and eruption of canine has serious consequences. Early diagnosis of canine impaction is essential for proper deimpaction of canine. Determination of the prognosis of the impacted canine is essential before orthosurgical approach for management of this specific malocclusion. Proper knowledge of the position of canine in relation to the other anatomical structure is very important in surgical exposure and orthodontic management of impacted maxillary canine. In the present article, with an overview on diagnosis, prognosis of impacted canine. Key words: Diagnosis, Impacted canine, Guidelines*

Date of Submission: 14-04-2021 Date of Acceptance: 28-04-2021

I. Introduction

Impacted tooth is one that fails to erupt and will not attain its anatomical position beyond the chronological eruption date even after its root completion. Impacted maxillary canine is one of the common problem faced by clinical orthodontists in terms of diagnosis, treatment planning and treatment management. However it is possible to diagnose the palatal displacement and impaction of maxillary canine in an early stage[1].Previous study shows that maxillary canines are the most impacted tooth after maxillary and mandibular third molars with most of them in palatal[2]. Literature shows that the incidence was 1.7 %.Considering the gender difference females are most commonly affected by canine impaction and the prevalence of maxillary canine impaction ranges from .92 to 4.3[3].

There is no single or unique reasons for maxillary canine impaction previous studies in literature regarding the cause of maxillary canine impaction shows that dental discrepancy or lack of space, presence of hard and soft tissue pathologies are considered as etiological factors-Elimination of etiological factors results in the auto correction or spontaneous eruption of maxillary impacted canines.In clinical orthodontics early detection of maxillary canine impaction is crucial because it reduces the costs and time of treatment and the complications or adverse out comes and facilitates orthodontic mechanics[4].An accurate determination of position of impacted canine plays an important role in planning the orthodontic treatment. Diagnosis by clinical examination and palpation provides an idea about position of impacted maxillary canines and radiographic evaluation provides more detailed information[5].

In this article we mainly discussing the methods of diagnosing maxillary canine impaction and various guidelines for assessment severity of maxillary canine impaction.

Diagnosis of maxillary canine imapction

The clinical diagnosis of maxillary canine impaction mainly done on the basis of clinical and radiographic evaluation.

Clinical examination

Following clinical signs might be indicative of canine impaction in the clinical evaluation[6].

1. Delayed eruption of the permanent canine or prolonged retention of the deciduous canine beyond 14 to 15 years of age,
2. Absence of a normal labial canine bulge
3. Presence of a palatal bulge
4. Delayed eruption, distal tipping, or migration of the lateral incisor

Palpation

The position of erupting canine is assessed by palpating the labial and lingual mucosa simultaneously using the index finger of both hand. In normal clinical situations the canines are palpable from 1 to 1.5 years before they emerge, the absence of the canine bulge after the age of 10 years is a good indication that the tooth

is displaced from its normal position, and this is an indicative of ectopic eruption or impaction of the maxillary canines[7].

Radiographic assessment

The proper localization of the unerupted maxillary canine plays a crucial role in the diagnosis impaction in an early stage. It can help to recognize the tooth displacement in mixed dentition to prevent subsequent impaction. It also aids in determining the feasibility as well as the proper access for the surgical approach and the proper direction for the application of orthodontic force. Various radiographic exposures, including panoramic views, periapical view, occlusal films, posterior-anterior views and lateral cephalogram and 3-dimensional radiographic techniques including Computed Tomography (CT), Spiral CT, and Cone Beam Computed Tomography (CBCT) were introduced.

Periapical radiograph

Periapical radiographs are most commonly used in routine clinical practice and are valuable diagnostic aids. Periapical radiograph gives information regarding stage of eruption, size of follicle, root resorption. Erickson et al. in their study concluded that by individualizing the radiologic investigation according to a stepwise program, it is possible to minimize the total radiation exposure without losing essential information[8].

Postero-Anterior views

Postero-anterior radiographic image is mainly used for evaluating the medio-lateral position of the canines with respect to a reference line connecting the inferior borders of the orbits. However, this technique is more useful for carrying out a prognostic evaluation rather than providing a diagnosis of position. decreases[9].

Lateral cephalogram

In patients with 8-9 years of age the presence or absence of maxillary canines can be easily assessed with the help of a lateral cephalogram that is routinely taken for orthodontic purposes. This technique is useful in establishing the height of the impacted tooth and the anterop mosterior position of the impacted canine with respect to the apices of the incisors. In this way it is possible to determine whether the impaction is palatal or labial[10].

Panoramic radiograph

Panoramic radiograph gives prediction of palatal canine in 80% of patients .In the diagnosis of canine impaction panoramic radiographs used as an additional source of information with other methods. overlapping canine and lateral incisor in panoramic radiographs after the root completion in incisor may be a sign of eruptive disorders of the canine, an indicative of starting preventive measure to prevent impaction .In the early diagnosis of impaction the panoramic radiographs are essential which helps in prevention of impaction .Previous studies in the literature gave certain findings for identification of impacted canine in panoramic view[11].

Occlusal radiographs

This may be carried out according to various projections: the most frequently used is that of Simpson (perpendicular beam to the film through the glabella). If, in the image produced by this technique, the cusp of the canine is positioned in front of the ideal line connecting the apices of the lateral incisors, the position will be labial.

Tube shift method

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. Two radiographs of the object are taken. First using the proper technique and angulation as prescribed and the second, radiograph is taken keeping all the parameters constant and equivalent of those of the first radiograph, only changing the direction of the central ray either with a different horizontal angulation or vertical angulation.If the tooth shifts in the same direction as the tube then the tooth is lingually placed and if it moves in the opposite direction then it is buccally placed (SLOB-same lingual opposite buccal)[12].

Horizontal tube shift

Usually, periapical radiographs (PAS) are used in illustrations of a horizontal tube shift but occlusal radiographs (OR) are superior because they cover a larger area. Therefore, the tube can be moved much more between the two exposures resulting in the shift of the image of the impacted canine being easier to determine[13].

Vertical tube shift

In 1986, Keur described a vertical tube shift (VTS) using a rotational panoramic radiograph (PR) and an OR. The PR tube is actually positioned behind the head at an angle of -7° to the occlusal plane, and the film is in front of the head. However, to aid interpretation of the VTS, the tube can be considered to be in front of the head at an effective angle of +7° because the relationship of the image of the canine to the image of the lateral incisor is unaltered. The OR is taken at an angle of +60° to 65° to the occlusal plane ,i.e., there is an effective difference of 53° to 58° between the taking of the two films. The image of the palatally impacted canine that is farther away from the x-ray tube moves in the same direction as the tube[13].

Right angle technique

The right angle technique uses two radiographs taken at right angles to each other. According to Wraith, Ballard suggested the use of the combination of a lateral cephalometric radiograph with a postero-anterior cephalometric radiograph for localization of impacted maxillary canines. 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[13].

Magnification method

This method uses the difference in magnification of the crowns of ectopic upper canines on the same panoramic radiograph to determine the position of one canine relative to the other canine. The crown of a palatally displaced canine will appear magnified compared with the image of a contralateral tooth that is in the line of the arch or buccally displaced[14].

Computed Tomography

The relative introduction of spiral CT has significantly improved scanning by reducing the examination time and minimizing movement artefacts. Multiple Trans axial images can be retrospectively reviewed from a single spiral CT scan data set with varying degrees of overlap, thus optimizing multiplanar reformations with better longitudinal resolution[15]. Tomography offers greater diagnostic yield, but it is difficult to perform, entails high radiation exposure, and often fails to demonstrate minimal root resorption. The major limitation of CT is radiation risk which is especially greater in children[16].

Cone Beam Computed Tomography

The most recognized need for CBCT imaging in orthodontics is that of impacted canine evaluation. CBCT imaging is precise in determining not only the labial/lingual relationship but also a more exact angulation of the impacted canine. These 3D images are beneficial in determining the proximity of adjacent incisor and premolar roots, which can be invaluable in determining the ease of uncovering and bonding and the vector of force that should be used to move the tooth into the arch with a lesser chance of damage to adjacent tooth.It also has the potential of providing clear images of highly contrasted structures and is useful in evaluating bone. The analysis that is novel and unique to cbct and helps in aid clinicians to quickly estimate the difficulty of treatment involving impacted canines, without having to do multiple measurements of angles and distances, to relay the approximate treatment plan to the patient[17].

Three-Dimensional localization using MRI

Magnetic resonance imaging (MRI) is an imaging modality widely used for medical diagnosis which does not use any ionizing radiation. In dentistry, MRI has been mostly used for imaging of the morphology and function of the temporomandibular joint, soft tissues, and tumours and for implant planning.The crowns of the teeth could be visualized due to the saliva retained in the subject mouth during scanning which played the role of contrast medium in the oral cavity. Additional administration of gadolinium-based oral contrast medium enabled three-dimensional visualization of tooth crowns with a very high resolution and measurement of caries lesions in vivo based on penetration of the contrast medium into the demineralized tooth substance.Three-dimensionality and the absence of ionizing radiation make dMRI a flexible and safe tool for orthodontic and surgical treatment planning. dMRI is well suited to three-dimensional localization of impacted teeth in children and adults[18].

Rapid prototyping

This technique comprises several technologies that use data from computer-aided design files to produce physical models and devices by a process of material addition. Dental modelling by means of rapid prototyping was an efficient auxiliary method in diagnosis, orthodontic treatment planning, and communication with this patient and the orofacial surgeon. Rapid prototyping technology made possible the fabrication of an

attachment for forced canine eruption. Rapid prototyping dental modelling might become the diagnostic procedure of choice in the evaluation of impacted maxillary canines[19].

Guidelines for assesment of impaction

Sector classification

Ericson and Kurol in 1988 defined number of sectors to denote different types of impaction. Here the radiographic position of canine crown described as being in one of the five sectors. In order to formulate sector classification they assessed the medial position of canine cusp and related it to root resorption of lateral incisors[20] .

Sector 1: Normally positioned canine
Sector 2: Distal half of lateral incisor root overlapped by the caninr crown
Sector3: Mesial half of the lateral incisor root overlapped by the canine crown
Sector4: Distal half of the central incisor root overlapped by the canine crown
Sector5: Mesial half of the central incisor root overlapped by the canine crown

For accessing the vertical inclination of the canine path of eruption in the frontal plane they used angle α to represent the angle formed between the inter incisor midline and long axis of canine and "d" as the perpendicular distance of the peak of the cuspid of the impacted canine with respect to the occlusal plane.

Lindauer modification

Linduaer et al. modified the Ericson and Kurol sector classification in the year 1992, gave another sector classification[21].

Steven Lindaeur modification are
Sector 1: Was the area distal to a line tangent to the distal heights of contour of the lateral incisor crown and root
Sector 2: Was mesial to sector I, but distal to a line bisecting the mesiodistal dimensions of the lateral incisor along the long axis of the tooth
Sector 3: Was a mesial to sector II but distal to a line tangent to the mesial heights of contour of the lateral incisor crown and root
Sector 4: Included all areas mesial to sector III

Power & Short analysis

The angulation of canine to midline, canine overlap relative to the nearest adjacent incisor and eruptive level of canine in relation to nearest incisor root are assessed here[22].

Overlap relative to the nearest adjacent incisor

On assessing the overlap of canine to nearest adjacent incisor they revealed that if no overlap of the lateral incisor was present then 100% success was achieved.

Angulation to the mid-sagittal plane

The chance of a successful return of the canine to a normal eruptive pathway decreased if the original canine angulation exceeded 31^0.

Eruptive level relative to the nearest incisor root

The greatest success was seen when the canine was at a level between 1/4 and 3/4 the length of the nearest incisor root.

Mc Sherry and Pit etal methods

Four aspects of canine position should be assessed, as well as the age of the patient carefully being taken into account. The prognostic factors have been investigated by McSherry and Pitt et al, who suggested the use certain factors in an index to estimate treatment difficult[23,24].

These factors are discussed below:

The amount the canine crown horizontally overlaps the adjacent incisor

The closer the canine lies to the midline, the poorer the prognosis for alignment. No horizontal overlap of the adjacent incisor would indicate good prognosis, overlap up to half the root width suggests average prognosis and complete overlap of root would indicate poor prognosis.

Vertical height of the canine crown

The more apical the position of the crown, the poorer the prognosis for alignment. From the level of the cementoenamel junction to less than halfway up the root of the lateral incisor would indicate a good prognosis; more than halfway up the root but less than the full length root length would indicate average prognosis; and above the full length of root would have poor prognosis.

Canine angulation to the midline

As canine angulation to the midline increases, the prognosis decreases. Angulation of 0−15° would point towards a good prognosis, angulation of 16−30° an average prognosis, and angulation of 31° or more, a poor prognosis.

The position of the canine root apex in the horizontal plane

If the canine apex is located above the normal canine position, prognosis for alignment is good, if the apex is above the first premolar region, prognosis is average, and if it is above the second premolar, prognosis is poor.

Treatment Difficulty Index

Treatment difficulty index (TDI) was developed by Pitt etal and used to measure the difficulty that would be expected during the alignment of an unerupted maxillary canine[23].

The factors considered in this study are

1. Rotation.
2. Angulation to midline.
3. Age of patient.
4. Coincidence of arch midlines.
5. Alignment and spacing of the upper labial segment.
6. Vertical height.
7. Bucco-palatal position.
8. Condition of primary canine.
9. Missing teeth.
10. Horizontal position.

A rank value from 4 (most important) to 1 (least important) was allocated to each factors

The TDI was assessed using the following equation

Difficulty score = Constant –8 + Horizontal position 2.0 + Age 1.5 + Vertical height 1.5 + Bucco-palatal position 1.5 + Rotation 1.0 + Midline 1.0 + Angulation 1.0 + Alignment 0.5.

KPG Index

In this index ,depending canines location, the cusp tip and the root tip are each given a number 0–5 in three dimensions taken from a pre-treatment image. The sum of the cusp tip and root tip scores in the three views dictated our anticipated difficulty of treatment .A grid-like scale was devised of the three different views (x, y and z) in order to grade the difficulty of impaction and the potential efficacy of treatment[25].

The x axis of locating the canine

Is the relationship of the canine cusp tip or root tip to the adjacent teeth. For this scale, they used a traditional panoramic X-ray view. They numbered areas in the x axis relative to the adjacent teeth.

The y axis of locating the canine

The height of the cusp or root tip determined and scaled relative to its normal developmental position.

The z axis of locating the canine

This was done using the axial views on the CBCT machine and makes the index unique, as this section is not normally seen with traditional radiographs. This scale uses distances measured perpendicularly in 2 mm increments from the cusp or root tip to the curved line of the occlusal arch. The divisions of the 0–5 scale are based solely on the distance of the impacted tip to the occlusal reference arch, different from the other two views, which are based more on anatomical location.

Assessment of difficulty

After scoring the cusp tip and root tip in the three views, the degree of difficulty of treatment is categorized as simple, moderately difficult and nearly impossible. These categories are determined by the sum of all scores for each individual tooth. Scores in the range 0–9 fall into the category of easy; 10–14 are moderate; 15–19 are difficult; and 20 and above are extremely difficult.

II. Conclusion

Recognition of tooth disturbances in early mixed dentition which are genetically associated with canine impaction can aid the clinicians in the early diagnosis of this clinical situation. If the displacement of the canines is detected early, the clinicians should then focus on the means of preventing a possible impaction. Clinically common radiograph used to determine position of impacted canine is occlusal radiograph or Clark's method using two periapical radiographs, the reason being the ease of availability and assessment. Other supplemental radiographs like OPG, lateral cephalogram etc can be used to decide the prognosis of impacted canine.

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Rahul Madhavan, et. al. "Maxillary Canine Impaction: Diagnosis and Guidelines for Assesment of Impaction."*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 20(04), 2021, pp. 07-12.