ORIGINAL ARTICLE

Radiographic assessment of the prevalence, pattern and position of maxillary canine impaction in Najran (Saudi Arabia) population using orthopantomograms – A cross-sectional, retrospective study

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Abstract  Objective: The objective of this study is to assess the prevalence and pattern of maxillary canine impaction (MCI) in the population of Saudi Arabia according to the Yamamoto classification.

Materials and methods: A total of 5000 orthopantomogram (OPG) images of 2500 males and 2500 females in the age group of 14–40 years who attended the orthodontic clinic in Najran city from a period between January 2016 to February 2019 were evaluated for the presence of maxillary canine impaction. The anatomical position of each maxillary canine impaction was matched to the seven subtypes mentioned in the Yamamoto’s classification.

Results: The prevalence of MCI was found to be 3.46% in Najran(Saudi Arabia) population. Type I (46%) accounted for the highest prevalence followed by Type II (37%) and Type VI (8%). Type III, V and VII was found to be 3% equally and no case was of Type IV was found in the studied population. MCI was more common in females and left side compared to males and right side respectively.

Conclusion: The prevalence of maxillary canine impaction was found to be 3.46% in Najran. Type I pattern of maxillary canine impaction was commonest followed by Type II, VI, III, V and VII.

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1. Introduction

When teeth do not erupt at the appropriate time and age, they are said to be impacted. Maxillary canine impaction (MCI) is one such clinical problem encountered frequently in orthodon-
tic practice. There are many available definitions for an impacted tooth, but according to Lindauer, a canine is considered to be impacted if it does not erupt after complete root formation or if the contralateral canine erupted at least 6 months previously and has complete root formation (Lindauer et al., 1992). According to Bass, impacted teeth are those which remain embedded in the jawbone or mucosa for more than 2 years following the physiological eruption time (Bass, 1967).

Permanent maxillary canines are the most commonly impacted teeth after third molars (Andreasen et al., 1997). In various studies their prevalence has found to be between 0.8 and 2.8% (Grover et al., 1985; Duchi et al., 1961). In Saudi population, the incidence was reported to 3.41% (Haralur et al., 2017). Thilander Myrberg reported a cumulative prevalence of 2.2% in 7–13-year-old children (Thilander and Myrberg, 1973). Gender wise, the females are twice commonly affected than males. Palatally impacted canines are encountered frequently than buccal canine impaction in the ratio of 12:1. (Duchi et al., 1961) Unilateral canine impaction is more common than bilateral canine impaction in the ratio of 92:8 (McConnell et al., 1996). Racially, the Caucasians have five times more canine impaction in comparison to Asians (Abron et al., 2004).

The etiology of maxillary canine impaction is multifactorial and complex. Impaction has been attributed to genetics, absence of eruption guidance from an anomalous lateral incisor, long and tortuous path of eruption, coexisting hypodontia, agenesis, aplasia and supernumerary teeth (Peck et al., 1994; Becker et al., 1995). Canine impactions are also found with conditions such as malnutrition, anemia, rickets and cleft lip and palate and are associated with certain syndromes such as cleidocranial dysplasia, achondroplasia, progeria and Downs syndrome (Bishara, 1992).

Impacted canines are often diagnosed as an indirect finding when the patient comes for some other orthodontic problem. Since MCI is mostly asymptomatic, the patient hardly approaches for it. Young adolescents of 13–16 years age group often complain of missing teeth in upper front region. In such cases, the arch is usually well aligned but the edentulous space of missing canine results in a highly unesthetic appearance. Canine impaction can also be suspected in patients with family history of palatally impacted canines, missing or peg-shaped lateral incisors. In patients older than 10 years of age, impaction can be suspected when the labial canine bulge is absent, a palatal bulge is present, or lateral incisors are proclined or tipped distally (Ericson et al., 1988). To evaluate the presence, position and pathology associated with an impacted canine, various radiographic modalities such as intra-oral periapical radiographs (IOPA), occlusal radiographs, orthopantomograms (OPG), cone beam computed tomography (CBCT) and computed tomography (CT) are available. An (OPG) is useful, readily available and provides initial overall comprehensive information of the erupted and unerupted teeth, jaws and surrounding tissues (Zafar and Alrahabi, 2015). It provides a satisfactory two-dimensional view of the impacted teeth and their location, angulation and orientation relative to the immediate teeth. This information can be used to plan the treatment and assess the region for surgical approach and direction of orthodontic force application (Jung et al., 2012).

Many classification systems are available to assess the level and severity of maxillary canine impaction. Sector classification (Ericson and Kurol, 1988) is based on the location of the canine tip in relation to the root of the lateral incisor. Becker classified canine impaction based on the transverse relationship of the canines to the dental arch and the height of the canine in relation to the occlusal plane (Becker, 1998). Ackerman and Fields classified impacted canines as horizontal in relation to the arch and vertical in relation to the apex (Proffit et al., 2007). In this study, we used the classification proposed by Yamamoto et al. which described seven subtypes of maxillary canine impaction according to the angle between the long axis of the tooth and the occlusal plane as identified on orthopantomograms (Yamamoto et al., 2003) The purpose of this study is to evaluate the prevalence of each subtype of maxillary canine impaction in the population of Najran, Saudi Arabia using orthopantomograms.

2. Material and methods

A total of 5000 (OPG) images of 2500 males and 2500 females in the age group of 14–40 years were included in the study. The mean age of the sample was 21 ± 1.83 years. The mean ages were 22 ± 1.65 years and 20 ± 1.97 years for the males and females respectively. The OPGs were collected routinely for screening and pre-treatment diagnostic purposes in these patients attending the orthodontic clinic in Najran from a period between January 2016 to February 2019. None of the OPGs were taken primarily for this research project. The study protocol was approved by Najran University Research Ethics Committee.

This is a descriptive, cross-sectional and retrospective study in which all the OPG images were screened by a single examiner for the presence of impacted teeth. The screened OPG images were then filtered according to the inclusion and exclusion criteria.

2.1. Inclusion criteria

Age group of 14–40 years
Presence of impacted permanent maxillary canine which are not likely to erupt
Dentulous patients with permanent dentition
No history of orthodontic treatment

2.2. Exclusion criteria

Surgical/Intentional extraction of maxillary canine
Distorted OPGs with poor quality and visibility in canine region

A total of 5000 OPGs images were screened, 173 individuals (72 males and 101 females) with maxillary impacted canine fulfilled the selection criteria. The OPG of these individuals were categorized according to the classification system proposed by Yamamoto et al. (2003). The anatomical position of maxillary canine impaction (MCI) in each OPG image was matched to the seven subtypes mentioned in the classification as shown Fig. 1. The gender and side of impaction was also recorded. The data was collected, sorted and tabulated in Excel (Version:2003, Microsoft, Redmond, USA). The data was then statistically analysed descriptively using IBM SPSS (Version 20) to assess the prevalence of various subtypes of maxillary canine impaction in the population of Najran, Saudi Arabia.
3. Results

A total of 5000 OPG of individuals were screened in this study. 173 individuals had maxillary canine impaction. The prevalence of MCI was 3.46% in the studied population. In terms of gender, the prevalence of impacted maxillary canines was higher in females, (n = 101, 58.38%) than in males (n = 72, 41.62%) (Table 1). Evaluation of the side of canine impaction showed that approximately 48% of canine impaction occurred on the right side, and 52% occurred on the left side. In males, approximately 53% of canines were impacted on the right side, and the remaining 47% were impacted on the left side. In females, approximately 45% of the canines were impacted on the right side, and 55% were impacted on the left side (Table 2).

On assessing the seven subtypes of MCI according to Yamamoto et al. classification it was found that Type I (46%) accounted for the highest prevalence in the studied population. It was followed by Type II (37%) and Type VI (8%). Type III, V and VII was 3% equally and no case was of Type IV was found in the studied population (Table 3).

4. Discussion

Orthodontic treatment of impacted canines is often challenging for the clinician. It is of utmost importance to locate the actual position, angulation and orientation of the tooth to achieve occlusion (OPGs) are routinely used for the initial assessment of impacted canines. With the advent of technology, cone-beam computed tomography (CBCT) can be used to visualize the impacted region, but this method is associated with higher cost and radiation exposure and is subject to availability and ethics standards (Jung et al., 2012). OPGs have previously been used to assess the incidence, prevalence and frequency of impacted canines. Since impacted canines are considered to involve a major genetic component, their prevalence varies among various racial and ethnic populations.

Table 1  Prevalence of maxillary canine impaction based on the gender and side of impaction.

| Gender (n = 173) | Males (n = 72) | Females (n = 101) | Right MIC (n = 83) | Left MIC (n = 90) |
|----------------|---------------|-------------------|-------------------|-------------------|
| Prevalence (%) | 41.62%        | 58.38%            | 48%               | 52%               |
| Total (%)      | 100%          | 100%              |                   |                   |

Table 2  Prevalence of maxillary canine impaction in each gender based on the side of impaction.

| Gender (n = 173) | Males (n = 72) | Females (n = 101) |
|-----------------|---------------|-------------------|
|                 | Right MIC (n = 38) | Left MIC (n = 34) |
| Prevalence (%)  | 53%            | 47%               |
| Total (%)       | 100%           | 100%              |

| Gender (n = 173) | Males (n = 72) | Females (n = 101) |
|-----------------|---------------|-------------------|
|                 | Right MIC (n = 45) | Left MIC (n = 56) |
| Prevalence (%)  | 45%            | 55%               |
| Total (%)       | 100%           | 100%              |
Studies report a prevalence of 0.8–2.8% in the European population, (Grover et al., 1985; Kramer et al., 1970) and 5.1% in the Turkish population (Celikogluet al., 1986). The lowest prevalence of maxillary canine impaction has been found in Chinese and Japanese populations (Takahama et al., 1982). In this study, we have evaluated the population in the region of Najran, Saudi Arabia. The prevalence of maxillary impacted canine has been found to be 3.46% in this studied population. Other studies conducted on the population of Saudi Arabia have found it to be 3.41% (Haralur et al., 2017), 2.5% (Al-Zoubi et al., 2017) 10.1% (Alkadhi et al., 2017) and 7.5% (Fawzan et al., 2017).

Yamamoto et al. (2003) proposed a classification system describing seven subtypes of maxillary canine impaction based on the orientation of the long axis of the impacted canine and the occlusal plane. In this study, OPGs of 173 maxillary impacted canines were evaluated based on Yamamoto et al. classification and it was found that around 46% had Type I, 37% had Type II, 8% had Type VI, 3% had Type III, V and VII. None of the canines had Type IV canine impaction. The maximum number of impactions were of Type I (46%) and minimum was Type IV (0%). The results are in contrast to a similar study done by Al-Zoubi et al., 2017 which has reported the highest proportions of maxillary impacted canine of Type II (51.6%), followed by Type IV (28.2%), Type I (12.5%), Type III (4.8%), Type VII (2.3%), Type VI (0.6%) and Type V (0%).

The high incidence of Type I impaction (46%) can be attributed to the typical longer developmental and eruption pattern of the maxillary canines. The tooth germ of the maxillary canines develops at approximately 24 weeks of gestation and remains unerupted until 12 years of age. In contrast, the lateral incisor tooth germ develops at 5 months of gestation and erupts earlier than the canine, at 8–9 years of age. Additionally, the first premolar starts developing at birth, and eruption occurs by the age of 10–11 years (Andreasen et al., 1997; Archer, 1975). Moreover, as stated by McBride, the canines have the longest and most tortuous path of eruption from their point of formation until their final destination in the occlusion (McBride, 1979). The maxillary canines travel a distance of 22 mm between 5 and 15 years of age (Coulter et al., 1997). This large duration and path between the formation of canine tooth germ and eruption in occlusion requires the space to be maintained between the lateral incisors and first premolars. Any deviation, displacement or rotation in the eruption pattern predisposes the canine to erupt in an abnormal position or remain impacted.

Type II canine impaction, occurred at a rate of 37% in this study, is mostly associated with the resorption of the root of the lateral incisors. According to Miller’s guidance theory, the canines have a more mesial path of development which is guided downward along the distal aspect of the root of the lateral incisor (Miller, 1963). According to Ericson and Kurol, 48% of lateral incisors show root resorption in the presence of an impacted canine. It can be suspected when there is labial and distal displacement of the long axis of the tooth.

Type III canine impactions were found in only 3% of the cases in the current study. This type of impaction occurs mainly due to the distal inclination or rotation of the canine tooth germ. In this study Type IV, V and VI impactions were found in 0%, 3% and 8% of cases, respectively. These types of impaction can be attributed to the displacement of the erupting canine due to its inability to break through the dense hard palate or the thick palatal mucosa (Ericson and Kurol, 1986). Additionally, physiologic pressure from the adjacent bony anatomical structures such as maxillary sinus, nasal wall and orbital cavity can lead to unfavourable impaction of the canine (Andreasen et al., 1997).

According to the genetic theory, (Peck et al., 1994) inherited traits combined with tooth size reduction, tooth agenesis, supernumerary teeth and ectopic eruptions have been associated with maxillary canine impaction. Litsas et al. (2011) has shown the involvement of the MSX-1 and PAX-9 gene in cases involving impacted canines. Becker found impaction to be associated with peg-shaped or missing lateral incisors and agenesis of third molars.

In terms of gender, this study has found that women (58.38%) are more likely to be affected by impacted canines than men (41.62%). This finding is in accordance with previous studies conducted by Becker (1998), Dachi et al. (1961), Al-Zoubi et al. (2017), Hou et al. (2010), Oliver et al. (1989).

Women tend to have a smaller sized skull and jawbones, which can contribute to this gender difference (Archer, 1975).

This study reports a higher prevalence of maxillary canine impaction on the left side (52%) than on the right side (48%), which is similar to the findings of Takahama et al. and Al-Zoubi et al. This higher prevalence of left-sided maxillary canine impaction can simply be attributed to a general trait of malocclusion because there is no scientific evidence to justify its occurrence.

The classification system used in this study was proposed by Yamamoto et al. (2003). This is a clinician-friendly method helpful in determining the degree of impaction and formulating a treatment plan accordingly. It utilizes an orthopantomogram which is easily available, is simple to analyse, classification can be done on any part of the face (right, left, upper jaw or lower jaw). The disadvantages of this classification lies in the fact that, it is a two dimensional representation of a three dimensional image. Tooth rotation, labio-lingual relationship and exact root position cannot be determined. Hence is has been recommended to correlate the findings with macroscopic inspection, palpation and other projection radiography. For complex cases, Cone Beam Computed Tomography (CBCT) is advised to determine the exact location of impacted tooth.

5. Conclusion

The maxillary canines play a vital role in aesthetics, arch development and occlusion. In an orthodontic practice, maxillary impacted canines pose a clinical challenge depending upon its severity of impaction. The precise location of these canines is important to formulate the best treatment plan for its eruption into occlusion. In this study Yamamoto’s classification has been used to determine the pattern of MIC. The conclusions of this study are:

1. The prevalence of MCI was found to be 3.46% in the Najran population.
2. Type I (46%) pattern of maxillary canine impaction was highest followed by Type II (37%) and Type VI (8%). Type III, V and VII was found to be 3% equally and no case was of Type IV pattern was found.
3. MCI was more common in females compared to males.
4. MCI was more common on left side compared to right side.

Interestingly, every impacted canine is unique in itself and needs a tailor-made mechanical approach with scientific backing in order to achieve desired movement and position in occlusion. Hence diligent and critical analysis of the pattern of impaction is of utmost importance in treating a case of maxillary canine impaction.

**Declaration of Competing Interest**

Author declares that there is no conflicts of interest.

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