Prevalence and severity of ectopic maxillary canine impaction in Southern Jordanian population: A radiographic sector analysis

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ABSTRACT

Objectives: To determine the prevalence of impacted canines and severity of impaction in different age groups using sector analysis in South Jordan population.

Methods: A total of 2700 digital panoramic radiographs with a total of 159 impacted canines were examined during this study and were selected according to specific inclusion criteria. The age of the patients ranged from 13 to 24 years, with a mean of 18.5 years. The selected digital panoramic radiographs were examined to determine the overall prevalence of impacted canines and their mesio-distal position of the tip (overlap) in relation to adjacent teeth. The panoramic radiograph was digitized and each impacted canine was placed in the correct category using sector classification that consists of six categories. Cases were divided into three age groups from 13-16 years, from 17-20 years and from 21-24 years. The impacted canine cases in both right and left sides were analyzed according to sector categories and age groups to evaluate the association between right side and left side impaction and age groups. Data were analyzed using SPSS (v. 17) and statistical significance was set at $P<0.05$.

Results: The overall prevalence of impacted maxillary canines was 4.37% (118 cases had impacted canines either unilateral or bilateral). The overall prevalence in males was 1.3% and in females 3% while bilateral impaction comprised 1.5% and unilateral impaction 2.85% of the total sample. Among the 118 cases 37 cases were males (31.4%) and 81 cases were females (68.6%), 41 cases (34.7%) had bilateral impaction and 77 cases (65.3%) were unilateral. Overall we had 159 maxillary impacted canines, among them 75 were located on the left side (47.2%) and 84 on the right side (58.8%). In both right and left impacted maxillary canine cases the distribution of cases according to sector categories showed that grade zero impaction was the most common one and grade -1 was the least common. The distribution of cases according to sector categories and age groups showed that the percentage of the mildest impaction (mesio-distally) which corresponds to sector zero was highest in the younger age group 13 – 16 years (52.8% on right side, 51.9% on left side) and the lowest in the older age group 21-24 years (8.7% on right side, 4.3% on left side) and the percentage of the most sever impaction which corresponds to sector 4 was lowest in the younger age group (2.9% on right side, 7.4% on left side) and highest in the older age group (34.8% on right side, 39.1% on left side), this was true for both right side and left side impaction and was statistically significant (p<0.05) .

Conclusion: Prevalence of maxillary canine impaction in our study was noticeable and comparable to the findings reported in other populations. It occurred more frequently in females, with unilateral impaction was more common than bilateral and with a slight preference for the right side. The mesio-distal position of the canine tip was located more frequently in sectors 0, and half of the canines were located in sectors 2 through 4. There were statistically significant more mild impaction cases in younger age group while there were more severe impaction cases in older age group.

Key words: Impacted Canine, Orthodontics, Prevalence, Sector analysis.

Introduction

Maxillary canines are considered to be the second most frequently impacted teeth after the mandibular third molars with a reported prevalence of 0.8 – 5.2 % depending on the population examined. [1] Canine impactions are twice as common in females as in males, and only 8% of maxillary impacted canines are bilateral.[2,3] An impaction is diagnosed when the tooth is in an infra-osseous position after the expected time of eruption.

Disturbances in the eruption of maxillary permanent canines are common because they have the longest

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period of development, the most superior area of development and the most difficult path of eruption compared to any other tooth in the oral cavity. Impacted canines may result in several complications such as displacement and root resorption of adjacent teeth, cystic degeneration, canine ankylosis, shortening of the dental arch, and/or a combination of all these factors.[5]

The accurate location of impacted canines and determining their relationship to the adjacent incisors and anatomical structures is an important part of the diagnostic process, and essential for successful orthodontic treatment,[6] which may lead to a less invasive procedure during canine's exposure. An early diagnosis reduces treatment time, costs, and complexity and potential complications: such as ankylosis of the canine, cysts, infections and most importantly radicular resorption of the adjacent teeth especially the lateral incisor threatening its survival rate.[7]

The panoramic radiograph can show the position and predict eruption pathway based on different measurements [3]. It is important to assess the initial vertical and horizontal position of the maxillary impacted canines, because of its effect on: orthodontic treatment planning, duration of treatment and multiple other associated factors.[4,5,8] It has been found that the canines with cusp tips located mesial to the axes of lateral incisors required 10 more visits than the distally located canines on average and less inclined canines required longer treatment time.[8] Also, a correlation was founded between the initial mesio-distal and vertical position of the impacted canine and the post-treatment periodontal status of the impacted canine, the adjacent lateral incisor, and the first premolar.[9] Ericson and Kurol studied the effect of ectopic eruption of the impacted maxillary canines on resorption of maxillary lateral incisors, they classified the canines into mesi-distal sector ranging from 1 to 5 where 1 was the simple and mildest impaction and 5 was the most difficult one and they reported that canines in the sectors 3, 4 and 5 comprised 65% of lateral incisor root resorption and when the cusp of canine was positioned mesial to the lateral incisor, which was in sectors 4 and 5, the risk of complications increased 3 times.[10]

Although many studies were performed on impacted canines using panoramic radiography or cone beam computed tomograms (CBCT), we did not find any previous studies in Jordan that focused on the prevalence of impacted canines and/or grading the impacted canines into sectors which directly reflects the severity of impaction. The aim of the present study was to evaluate the prevalence of impacted canines and severity of impaction using sector analysis in Southern Jordan population, because there is an intimate correlation between canine positions according to sectors and orthodontic treatment planning, mechanics, duration of treatment and multiple other associated factors.[4,5,8-10]

Methods

This retrospective, radiographic study was performed at Prince Ali Bin Al- Hussain Military Hospital in Al-karak (South of Jordan) and was approved by the Higher Research and Ethical Committee at Royal Medical Services. Digital panoramic radiographs of patients attending the dentistry department between January 2013 and December 2015 for various reasons were examined for maxillary canine impaction.

The inclusion criteria were for subjects aged between 13 and 24 years with unerupted upper canines. The digital panoramic radiographs (OPGs) examined were conditioned to be clear, undistorted with good quality for diagnostic purposes. Subjects with multiple impacted teeth that may suspect to have syndromes were excluded from the study. Subjects aged 13 and 14 years were included only if the roots of all permanent teeth except the third molars were completed, and crown formation of third molars have been completed. And they suspected to have a dental age of 15 years.

All our digital panoramic radiographs were made using kodac 8000c Digital Panoramic Cephalometric System with scanning parameters of 75 Kv ,12 mA, and a scanning time of 13.9 seconds .

A total of 3638 digital panoramic radiographs were examined during this study. After applying the inclusion criteria only 2700 radiographs fit those criteria giving a response rate of 74.2% and were selected and examined for the unerupted upper canines.

On radiographs that have impacted maxillary canines, these lines were done directly on a copied digital panoramic x-ray:

(a) A tangent line was drawn on the mesial surface of both the root and the crown of the lateral incisor, central incisor and the first premolar and at the distal surface of both the root and the crown of the lateral incisor.

(b) A line was drawn along the long axis of both central and lateral incisors dividing them into two halves.

These lines would divide the area into 6 sectors (-1, 0, 1, 2, 3and 4) (Fig. 1). The tip of the impacted canine crown was used to locate the correct sector of the impacted canine.
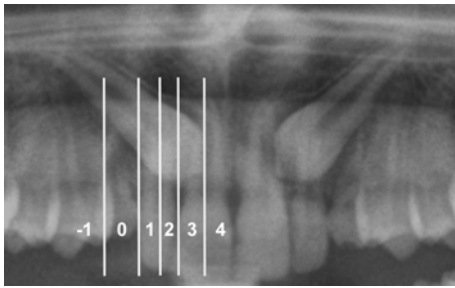
Fig.1: Sectors of impacted canines.

Each impacted canine was selected as single sample. The mesio-distal position of the canine tip (overlaping with adjacent teeth) in relation to adjacent teeth was placed into a panoramic sector classification ranging from one to six categories modified from Ericson and kurol and was used by Al-Querban *et al* .[6] The sectors categories are:

- -1 = Distal to the normal position (in the premolar region).
- 0 = Normal position (primary canine).
- 1 = Distal to the long axis of the lateral incisor.
- 2 = Mesial to the long axis of the lateral incisor.
- 3 = Distal to the long axis of the central incisor.
- 4 = Mesial to the long axis of the central incisor.

All selected radiographs were examined by two orthodontic examiners using the same consistent method to categorize the exact location of impaction and to put the impacted canines in the correct category. The data of the two orthodontists were collected and then the inter-examiner testing was applied to verify whether there was a significant difference in the evaluation or not. The percentage of agreement was 97% of cases. In the cases where the two observers were differing, a forced consensus was reached by discussion. SPSS Statistic Version 17 was used for Statistical analysis (SPSS Corporation, Chicago, IL, USA). Chi-square test was used to determine the prevalence of maxillary canine impaction and to correlate impacted maxillary canine cases of both right and left side in relation to age groups and sectors categories. Level of significance was set at 0.05.

Results

This study comprised 2700 digital panoramic radiographs of patients with age ranged between 13 and 24 years with a mean age of 18.5 years. Out of 2700 digital panoramic radiographs that were examined, only 118 of them had impacted canines (4.37%). Among the 118 cases, 37 cases were males (31.4%) and 81 cases were females (68.6%), 41 cases (34.7%) had bilateral impaction and 77 cases are unilateral (65.3%) (Table I and Table II). Overall we had 159 maxillary impacted canines, 75 were located on the left side (47.2%) and 84 on the right side (58.8%). Cases were divided into three age groups, the first age group (13 to 16 years), the second age group (17 to 20 years) and the third age group (21 to 24 years). The number of cases in each age group was nearly the same (Table III). In this study the impacted canine cases in both right and left side were analyzed according to sector categories and age groups (Table IV and Table V). Statistical analyses showed that there was a statistically significant association between right side impaction and age groups and left side impaction and age groups (p<0.05). In both right and left impacted maxillary canine cases the distribution of cases according to sector categories showed that grade zero impaction was the most common sector for impaction and grade -1 was the least common (Table VI and Table VII). The distribution of cases according to sector categories and age groups showed that the percentage of the mildest impaction mesio-distally which correspond to sector zero was highest in the younger age group 13 to 16 years (52.9% on right side, 51.9% on left side) and lowest in the older age group 21 to 24 years (8.7% on right side,4.3% on left side) and also the percentage of the most sever impaction which correspond to sector 4 was lowest in the younger age group (2.9% on right side, 7.4% on left side) and highest in the older age group (34.8% on right side, 39.1% on left side) and this was true for both right and left sides impaction and was statistically significant (p<0.05) as shown in (Table IV and Table V).

Table I: Sex distribution of cases

Gender	Frequency	Percentage
Male	37	31.4
Female	81	68.6
Total	118	100.0

Table II: Bilateral / Unilateral distribution of cases

Type	Frequency	Percentage
unilateral	77	65.3
bilateral	41	34.7
Total	118	100.0

Table III: Age categories of cases and frequency of cases in each group

Age	Frequency	Percentage
13-16 years	39	33.10
17-20 years	42	35.55
21-24 years	37	31.35
Total	118	100.0

Table IV: Right impacted maxillary canine cases distribution according to age groups and sector categories (the association between the grades of impaction and the age groups)

Grades of impaction		Age groups (years)			p-value	Chi-square test
		13-16 n(%)	17-20 n(%)	21-24 n(%)		
Grade zero impaction	18(52.9)	9(33.3)	2(8.7)			
Grade 1 impaction	6(17.6)	4(14.8)	5(21.7)			
Grade 2 impaction	3(8.8)	2(7.4)	4(17.4)			
Grade 3 impaction	6(17.6)	5(18.5)	4(17.4)		0.031	19.812
Grade 4 impaction	1(2.9)	6(22.2)	8(34.8)			
Grade -1 impaction	0(0.0)	1(3.7)	0(0.0)			

The P value denotes the significance level of (Chi-square test). n=number

Table V: Left impacted maxillary canine cases distribution according to age groups and sector categories (the association between the grades of impaction and the age groups)

		Age groups (years)			p-value	Chi-square
		13-16 n(%)	17-20 n(%)	21-24 n(%)		
Grades of impaction	Grade zero impaction	14(51.9)	5(20.0)	1(4.3)		
	Grade 1 impaction	6(22.2)	2(8.0)	4(17.4)		
	Grade 2 impaction	3(11.1)	11(44.0)	6(26.1)	.002	28.107
	Grade 3 impaction	2(7.4)	3(12.0)	3(13.0)		
	Grade 4 impaction	2(7.4)	3(12.0)	9(39.1)		
	Grade -1 impaction	0(0.0)	1(4)	0(0.0)		

The P value denotes the significance level of (chi-square test). n=number

Table VI: Right impacted maxillary canine cases distribution according to sector categories**.**

	Frequency	Percentage
Grade zero impaction	29	34.45
Grade 1 impaction	15	17.90
Grade 2 impaction	9	10.65
Grade 3 impaction	15	17.90
Grade 4 impaction	15	17.90
Grade -1 impaction	1	1.20
Total	84	100.0

Table VII: Left impacted maxillary canine cases distribution according to sector categories.

Impaction sector	Frequency	Percentage

Grade zero impaction	20	26.70
Grade 1 impaction	12	16.00
Grade 2 impaction	20	26.65
Grade 3 impaction	8	10.70
Grade 4 impaction	14	18.65
Grade -1 impaction	1	1.30
Total	75	100.0

Discussion

The main objective in this study was to investigate the prevalence and severity of ectopic maxillary canine impaction in Southern Jordanian population as determined by sector analysis (mesio-distal horizontal location of the impacted canine tip). The severity was investigated mesio-distally as indicated by sector grades from -1 to 4 where grade zero was the mildest and the easy impaction to deal with and the grade 4 was the most sever and the most difficult impaction to deal with. The incidence of impacted maxillary canines was rather high, and alignment of the impacted canine into the dental arch has become a regular task in every orthodontic practice [6].The prevalence of impacted maxillary canines in this study was 4.37% which was reported to be within the reported ranges in the literature on epidemiological studies with a prevalence ranging from 0.8 to 5.2%. [6,7,11,12,18,27,33-35] Our results were similar to a study carried out on Arab population in Israel by Watted and Abu-Hussein in 2014 where they reported an overall prevalence of 4.3 % [12], however the prevalence of the current study was lower than that reported by Abu Alhaija et al. in 2005 who reported a prevalence of 5.9% for ectopic canines in 13-15 year-old North Jordanian school children [13]. It has been reported that a prevalence of impacted maxillary canine was 9.7% in India,[14] 5.3% in Mexico [15]. Becker et al. in 1981 obtained a prevalence of 13.9 %,[16] Lempesi et al. in 2014 observed 5.6% of canine retaining [17]. The current study prevalence was higher than that reported by Ericson who reported that the rate of impacted maxillary canines was in the range of 0.9 - 2 %.[18] Other studies also reported a lower prevalence than our study as the prevalence of impacted maxillary canine was 3.6% in Saudi,[31] 3.29% in Turkey [19], 1.5% in Israeli [20], 0.92 % in USA and 1.8% in Icelandic population [21]. According to gender our results showed that impacted maxillary canines were more frequent in females 68.6% and this was similar to that reported by other authors such as Nieri et al.[2], Ericson and kurol [18], hitchin,[21] Lempesi et al. [17], dachi and howell [22], mossey et al. [23] and Becker et al.[16], who reported in their studies a higher impaction prevalence in females. In the current study maxillary canine impaction occured unilaterally more than bilaterally. 65.3% of cases were unilateral while 34.7% were bilateral and predominantly on the right side (53.2%). This distribution coincided with those reported by Becker et al. where they reported a unilateral percentage of 54.6%

and a bilateral percentage of 45.4% [16]. Lempesi et al.[17] also reported a unilateral impaction of 65.7% of cases, Stewart et al. (2001) reported 61% of unilateral retention and 38.3% of bilateral retention and as in our study they reported a higher percentage (50.8%) of retaining canines in the right side [24]. Crescini et al. found that right impaction (53.6%) was more than left side impaction (46.4%).[4] Regarding mesio-distal (horizontal) location of impacted canine tip in our study, most canines either in right side or left side were present in sector 0 (Normal position) and this was similar to studies carried out by Alqerban et al. in 2014,[6] Robert et al. in 2013 [25] and Nagpal et al. in 2009 [26] who reported that canines distal to lateral incisor on primary canine position were the most common. Warford et al. in 2003 also reported that 82% of all impacted canines were classified in sectors 2 through 4.[27] In this study nearly 50% of all retained canines were presented in sectors 2 through 4 and these sectors usually coincide with poor prognosis and associated with difficult treatment mechanic and need longer treatment time. [4,5,8,10,28] These locations of impacted canines have many effects on the orthodontic treatment of impacted canines. The prognostic value for localization by sectors is much more important than diagnostic value.[32] In the current study, the distribution of cases according to sector categories and age groups showed that the percentage of mildest impaction mesio-distally which correspond to sector zero was highest in younger age group (13 – 16 years) and the lowest in older age group (21-24 years) and also the percentage of the most severe impaction which corresponded to sector 4 was lowest in the younger age group and highest in the older age group. This was statistically significant and this is true for both right side and left side impaction cases as shown in (Table IV and Table VI) .This suggests that the older the patient the more severe the impaction should be expected and the more difficult the orthodontic treatment will be. Or this may suggest that as patients become older the severity of impaction increases due to the change in impacted canine position if it remains untreated for longer time, meaning that the early treatment of impacted canines is much better than later treatment because impacted canine may be found in a less severe impaction sector grade. It is important to show the significance and the intimate association between sectors of impacted canine and orthodontic treatment duration. The treatment duration of impacted canines was affected by sectors with the treatment being

longer if the canine was found in sector 3 or 4, shorter if it was in sector 0 or 1, with respect to sector 2.[8,32] Warford et al. founded that sector location provided a greater influence on the prediction of impaction than on angulation, with canine location in the more mesial sectors substantially predictive of impaction [27]. The need for orthodontic treatment and the degree of treatment difficulty increases as this sector increase making the sector a valid indicator for treatment time duration.[4] Fleming *et al.* concluded that accurate prediction of treatment duration for orthodontic alignment of palatally impacted maxillary canines was difficult. However, the mesio-distal position of the canine may be a useful predictor of treatment duration.[28] Olive in 2005 reported that canines impacted in sectors 4 and 5 (which correlated to sector 3 and 4 in our study) emerged after 21 months of treatment and canines in sectors 2 and 3 (which correlated to sector 1 and 2 in our study) emerged after 8 months of treatment.[29] Lindauer et al 1992 said that from panoramic radiographs most canines destined to become palatally impacted had cusp tips overlapping or mesial to lateral incisor root.[30] Ericson and Kurol reported that canines in the sectors 3, 4 and 5 (which correlated to sector 2,3 and 4 in our study and represent 50% of our impacted canines) comprised 65% of lateral incisor root resorption and when the cusp of canine was positioned mesial to the lateral incisor, which was in sectors 4 and 5 (which correlated to sector 3 and 4 in our study), the risk of complications increased 3 times.[10] Jung et al. 2011 reported that when canine impactions were suspected in sectors 3, 4 and 5 (which correlated to sector 2, 3 and 4 in our study) on panoramic radiograph, CBCT should be considered for those with suspected incisor root resorption.[5] This shows the importance and the intimate association between sectors of impacted canine and treatment duration. This study covered both the prevalence of maxillary canine impaction and sectors analysis of this impaction and its relation to severity of impaction. None of the studies done previously in Jordan have covered this subject although it has intimate relation with other variables such as duration of orthodontic treatment and treatment planning, and multiple other associated factors. One of the limitations of our study is that it still could not be confirmed that the severity of impaction increases as age increases, because the study is a cross sectional study and devoid of control group. Therefore further research is still needed to compare sectors of impacted canines and age groups.

Conclusion

In this study the reported prevalence of impacted maxillary canines was similar to that reported in the literature. It occurred more frequently in females, with unilateral impaction more common than bilateral, with a slight preference for the right side. The mesio-distal position of the canine tip was located more frequently in sectors 0, and half of the impacted canines were located in sectors 2 through 4. According to mesio-

distal position of the canine tip, there was more statistically significant mild impaction in younger age group while there was more severe impaction in older age group.

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