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A Novel In-Toto index for predicting the difficulty levels in treatment of Impacted Maxillary Canine (IMC) using CBCT

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Abstract

Background: Prediction about the treatment prognosis of impacted maxillary canines has been based largely on clinical experience and is mostly evidence based. An index that offers an improved assessment of the impacted maxillary canine can be beneficial for both patient as well as clinician. The aim of this present study was to evaluate the difficulty index of impacted maxillary canine using CBCT from perspective of an Orthodontist and an Oral surgeon.

Material & Methods: The present study was conducted in the department of Oral &maxillofacial surgery and was based on CBCT records of impacted canines in maxillary region. CBCT's were evaluated by 10 Orthodontists & 10maxillofacial surgeons and eight criteria's were formulated regarding the pre-treatment difficulty index of impacted canines which were rated by 10 Oral surgeons and 10 Orthodontists through an online survey form to predict the pre-treatment difficulty index of impacted maxillary canine. The scoring done by Orthodontist and Oral surgeons was tabulated in excel sheet and analyzed using SPSS 21.0 version, IBM, Chicago. Chi-square test was done for analyzing the data. $P< 0.05$ was considered statistically significant.

Results: The results of study showed the following sub criteria's of impacted maxillary canine were having very

difficult scoring during pre-treatment evaluation on CBCT: Palatal inclination (75%), horizontal angulation (95%), dilacerated root (45%), Greater anatomic length of canine (55%), Bone covering the impacted maxillary canine more than 6mm (95%), Dental follicle greater than 3mm (55%). Total torsion of impacted maxillary canine (100%).

Conclusion: This study concluded the parameters which should be taken into account while pre-treatment evaluation of the impacted maxillary canine on a CBCT and can easily help in eyeballing about the various parameters which are more difficult and can anticipate about the future course of treatment of impacted maxillary canines.

Keywords: Difficulty index, Maxillary impacted canine (MIC), cone beam computed tomography (CBCT)

Introduction

The prevalence of Maxillary impacted canine ranges between 1% & 3% & is the most common type of impaction following third molars[1-2]. Canine plays an important role in facial aesthetics, functional occlusion & arch development [3], because of this it is very important to preserve the canine such as with surgical exposure and Orthodontic traction [4]. The aetiology includes long root, longest period of development, torturous path of eruption, inadequate space for eruption, early loss of primary canine, abnormal position of tooth bud, genetics, endocrine disturbances& trauma to maxillary anterior region at early stage of development [5] The precise localisation of impacted maxillary canine can help in treatment decision to either expose, Orthodontically align or extract the tooth. Various evaluation modalities include clinical & radiographic assessment including angular & linear measurement & image magnification which have been suggested in literature to predict impacted canines .Identifying canine impactions from panoramic radiography is valuable for overview & prediction of tooth eruption & treatment results [6-7].However its limitations are assessing labio palatal position of impacted canines& root resorption of incisors. Cone beam computed tomography (CBCT) has been widely accepted because of excellent sensitivity & high reproducibility in terms of image quality & diagnosis accuracy. Several classifications are reported for assessing treatment difficulties [8]. Short & power [9]described The vertical position of impacted maxillary canine (IMC) crown from occlusal plane & angulation of IMC to midline .Ackerman & Field [10] described IMC as horizontal ,relative to arch & vertical ,relative to apex .As the surgical exposure & orthodontic alignment Of IMC to its normal position requires complex & lengthy treatment several indices for estimating severity & difficulty have been reported in literature .Pitt et al [11]developed treatment difficulty index based on nine parameters that influence the treatment difficulty in management of IMC. However very few studies regarding treatment difficulty index based on two specialist's point of orthodontist& maxillofacial surgeon are reported in literature. So, the objective of present study was to evaluate treatment difficulty index expected during treatment planning by orthodontist & maxillofacial surgeon during surgical exposure, removal of tooth, & alignment of impacted maxillary canine.

Material & Methods

This scoring-based study was conducted in department of Oral & Maxillofacial surgery. CBCT records (Figure 1) of the patients with maxillary impacted canines available in the department were examined and certain criteria were laid down pertaining to the pre-treatment difficulty index of the impacted canines which were validated by four experts: 2 Oral surgeons and 2 Orthodontists. Finally, eight criteria's were shortlisted

each having 3 sub criteria's (Table 1). An online survey form was created using Google Forms platform (Figure 2) and circulated among 10 Orthodontists and 10 Oral surgeons. The online form consisted of the description about the study, participants name and other details with all eight criteria's having three sub-criteria each, which were to be scored either 1 or 2 or 3 for each sub criteria in terms of difficulty (Table 2) by 20 examiners which included 10 oral surgeons and 10 Orthodontists who were selected through a list available online by random allocation method. The submitted online forms were collected and the data was tabulated using excel sheets and sent for statistical analysis. Chi-square test was applied.

Table 1: Difficulty criteria are for impacted maxillary canine.

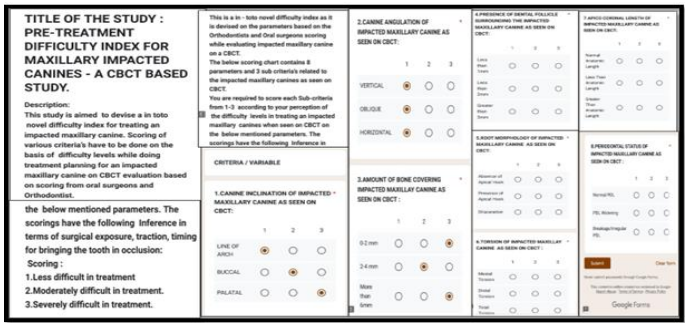
Parameter	**Sub criteria**
1.canine inclination	Line of arch
	Buccal
	Palatal
2.canine angulation	Vertical
	Oblique
	Horizontal
3.amount of bone covering imc	0-2 mm
	2-4 mm
	More than 6mm
4.presence of dental follicle	Less than 1mm
	Less than 2mm
	Greater than 3 mm
5.root morphology of IMC	Absence of apical hook
	Presence of apical hook
	Dilaceration
6.torsion of IMC	Mesial torsion
	Distal torsion
	Total torsion
7.apico coronal length	Normal anatomic length
	Less than anatomic length
	Greater than anatomic length
8.periodontal status of IMC	Normal PDL
	Pdl widening
	Breakage/ irregular pdl

Table 2: scoring and their inference

Scoring	Inference
1	Less difficult
2	Moderately difficult
3	Very difficult

Figure 1: CBCT images of impacted maxillary canine

Figure 2: Online Google form



Results

Table 1 and table 2 shows the results of the scoring given by Orthodontists and Oral surgeons.The results showed Canine inclination with line in arch (65.0%) and buccal (45.0%) was reported to pose less difficulty whereas palatally placed canine (75.0%) was found very difficult to deal by most of the participants. For both the specialists, vertical canine angulation posed less difficulty (85.0%), oblique angulation posed moderate difficulty (50.0%) and horizontally angulated canine was very difficult to manage (95.0%).

Bone covering of 0-3 mm posed less difficulty (100.0%), 4-6mm posed moderate difficulty (50.0%) and more than 6 mm was very difficult to manage (95.0%). Presence of dental follicle irrespective of the size was found to pose less difficulty. Amongst the features of root morphology, absence of hook posed less difficulty (100.0%), presence of apical hook posed moderate/less difficulty (40%) and dilaceration was very difficult to manage (45.0%). Mesial torsion was reported to pose less difficulty (100.0%), distal torsion to pose moderate difficulty (55.0%) and total torsion was reported to be very difficult to manage (100.0%). Normal anatomic root length was reported to be less difficult (95.0%), less than normal anatomic length was reported to be moderate difficult (60.0%) and more than normal anatomic length was reported to be very difficult to manage (55.0%). Impacted canine with normal periodontal status were found to be less difficult (100.0%), with PDL widening were found to be moderate difficult and with PDL breakage/ irregular PDL were found to be very difficult to manage. On comparing between the Orthodontist and oral surgeons, it was found that the amount of difficulty experienced by orthodontists and oral surgeons in managing canines with different grades of inclination and angulation was statistically non-significant (p value >.05). Bone covering of 4-6 mm was reported to be less difficulty by oral surgeons (100.0%) whereas

orthodontists reported it to be a factor causing moderate difficulty (100.0%) (p value <.05). Presence of dental follicle (less than 1 mm) was reported to cause less difficulty by a significantly greater number of Orthodontists compared to oral surgeons (100.0% vs 60.0%) (p value <.05). Presence of dental follicle (1-2 mm) was reported to cause less difficulty by a significantly greater number of orthodontists compared to oral surgeons (60.0% vs 0.0%), for dental follicle more than 3mm, 70.0% oral surgeons rated such canines were very difficult to manage (p value <.05). Canines with apical hook and dilacerations were less difficult to manage by oral surgeons compared to orthodontists (p value <.05). Canine with distal torsion was less difficult to manage for oral surgeons whereas it was moderately difficult to manage by orthodontists (p value <.05). Canine with less the normal anatomic length was reported to pose less difficulty by greater proportion of oral surgeons compared to orthodontists (40.0% vs 0.0%) (p value<.05). According to a significantly greater number of oral surgeons, canine with PDL or irregular PDL is moderately difficult to manage whereas for orthodontists such canines were very difficult to manage (p value<.05).

Table 3: Distribution of study participants based on their responses towards canine inclination, canine angulation, root morphology and apico-coronal length.

Factor		Difficulty level	Group A: Orthodontists	Group B: Oral surgeons	Total	Chi-square value	df	P value
Canine inclination	Line of Arch	Less difficult	7 (70.0%)	6 (60.0%)	13 (65.0%)	.220	1	.639
		Moderately difficult	3 (30.0%)	4 (40.0%)	7 (35.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
	Buccal	Less difficult	6 (60.0%)	3 (30.0%)	9 (45.0%)	2.143	2	.343
		Moderately difficult	3 (30.0%)	4 (40.0%)	7 (35.0%)			
		Very difficult	1 (10.0%)	3 (30.0%)	4 (20.0%)			
	Palatal	Less difficult	0 (0.0%)	1 (10.0%)	1 (5.0%)	1.067	2	.587
		Moderately difficult	2 (20.0%)	2 (20.0%)	4 (20.0%)			
		Very difficult	8 (80.0%)	7 (70.0%)	15 (75.0%)			
Canine angulation	Vertical	Less difficult	7 (70.0%)	10 (100.0%)	17 (85.0%)	3.529	1	.060
		Moderately difficult	3 (30.0%)	0 (0.0%)	3 (15.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
	Oblique	Less difficult	4 (40.0%)	3 (30.0%)	7 (35.0%)	.476[a]	2	.788
		Moderately difficult	5 (50.0%)	5 (50.0%)	10 (50.0%)			
		Very difficult	1 (10.0%)	2 (20.0%)	3 (15.0%)			
	Horizontal	Less difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)	1.053	1	.350
		Moderately difficult	1 (10.0%)	0 (0.0%)	1 (5.0%)			
		Very difficult	9 (90.0%)	10 (100.0%)	19 (95.0%)			
Root morphology of impacted	Absence of apical hook	Less difficult	10 (100.0%)	10 (100.0%)	20 (100.0%)	-	-	-
		Moderately difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			

maxillary canine	Presence of apical hook	Less difficult	0 (0.0%)	8 (80.0%)	8 (40.0%)	14.000	2	.001*
		Moderately difficult	6 (60.0%)	2 (20.0%)	8 (40.0%)			
		Very difficult	4 (40.0%)	0 (0.0%)	4 (20.0%)			
	Dilaceration	Less difficult	0 (0.0%)	8 (80.0%)	8 (40.0%)	17.333	2	.001*
		Moderately difficult	1 (10.0%)	2 (20.0%)	3 (15.0%)			
		Very difficult	9 (90.0%)	0 (0.0%)	9 (45.0%)			
Apico coronal length	Normal anatomic length	Less difficult	10 (100.0%)	9 (90.0%)	19 (95.0%)	1.053	1	.305
		Moderately difficult	0 (0.0%)	1 (10.0%)	1 (5.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
	Less than normal anatomic length	Less difficult	0 (0.0%)	4 (40.0%)	4 (20.0%)	8.000	2	.018*
		Moderately difficult	6 (60.0%)	6 (60.0%)	12 (60.0%)			
		Very difficult	4 (40.0%)	0 (0.0%)	4 (20.0%)			
	Greater than normal anatomic length	Less difficult	0 (0.0%)	1 (10.0%)	1 (5.0%)	1.091	2	.580
		Moderately difficult	4 (40.0%)	4 (40.0%)	8 (40.0%)			
		Very difficult	6 (60.0%)	5 (50.0%)	11 (55.0%)			

Chi-square test. *p value <.05 was considered statistically significant.

Table 4: Distribution of study participants based on their responses towards amount of bone covering, presence of dental follicle around the impacted maxillary canine, Torsion of impacted maxillary canine and periodontal status of impacted maxillary canine.

Factor		Difficulty level	Group A: orthodontist	Group B: Oral surgeon	Total	Chi-square value	df	P value
Amount of bone covering	0-3 mm	Less difficult	10 (100.0%)	10 (100.0%)	20 (100.0%)	-	-	-
		Moderately difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
	4-6 mm	Less difficult	0 (0.0%)	10 (100.0%)	10 (50.0%)	20.000	1	.001*
		Moderately difficult	10 (100.0%)	0 (0.0%)	10 (50.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
	More than 6	Less difficult	0 (0.0%)	1 (10.0%)	1 (5.0%)	1.053	1	.353
		Moderately difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
		Very difficult	10 (100.0%)	9 (90.0%)	19 (95.0%)			
Presence of dental follicle around the impacted maxillary canine	< 1mm	Less difficult	10 (100.0%)	10 (100.0%)	20 (100.0%)	-	-	-
		Moderately difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.00%)			
	1-2 mm	Less difficult	10 (100.0%)	6 (60.0%)	16 (80.0%)	5	1	.025*
		Moderately difficult	0 (0.0%)	4 (40.0%)	4 (20.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			

	3mm or more	Less difficult	6 (60.0%)	0 (0.0%)	6 (30.0%)	9.818	2	.007*
		Moderately difficult	0 (0.0%)	3 (3.0%)	3 (15.0%)			
		Very difficult	4 (40.0%)	7 (70.0%)	11 (55.0%)			
Torsion of impacted maxillary canine	Mesial	Less difficult	10 (100.0%)	10 (100.0%)	20 (100.0%)	-	-	-
		Moderately difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
	Distal	Less difficult	0 (0.0%)	9 (90.0%)	9 (45.0%)	16.364	1	.001*
		Moderately difficult	10 (100.0%)	1 (10.0%)	11 (55.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
	Total	Less difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)	-	-	-
		Moderately difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
		Very difficult	10 (100.0%)	10 (100.0%)	20 (100.0%)			
Periodontal status of impacted maxillary canine	Normal	Less difficult	10 (100.0%)	10 (100.0%)	20 (100.0%)	-	-	-
		Moderately difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
		Very difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)			
	PDL widening	Less difficult	0 (0.0%)	1 (10.0%)	1 (5.0%)	7.143	2	.028*
		Moderately difficult	5 (50.0%)	9 (90.0%)	14 (70.0%)			
		Very difficult	5 (50.0%)	0 (0.0%)	5 (25.0%)			
	Breakage or irregular PDL	Less difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)	8.571	1	.003*
		Moderately difficult	0 (0.0%)	6 (60.0%)	6 (30.0%)			
		Very difficult	10 (100.0%)	4 (40.0%)	14 (70.0%)			

Chi-square test. *p value <.05 was considered statistically significant.

Discussion

Management strategies of impacted maxillary canine (IMC) requires thorough understanding of severity of IMC &anticipated treatment difficulties. The complexity & treatment difficulty is influenced by several clinical & radiographic factors.Various treatment difficulty indices have been proposed to estimate the severity of impaction [12-13]. In dentistry various classifications have been used to determine the difficulty or status of patient's dentition. In 0rthodontics to predict difficulty, various classification has been used based on two radiographs.[14] until recently cone beam CT based on three-dimensional radiography [15] Cone beam CT can identify the location of IMC very precisely [16]. The precise localization of impacted canine helps to diagnose and decide the treatment planning which is important to decrease the patient's need for surgical exposure and prolonged Orthodontic treatment with increased costs and side effects. Another factor that affects the severity of IMC is based on age. According to AL Abdullah [17] growing elder increases the chance of impacted teeth worsening in position, particularly when the angle of tooth's long axis to the midline increases. In the present study, Canine inclination with line in arch (65.0%) and buccal (45.0%) was reported to pose less difficulty whereas palatally placed canine (75.0%) was found very difficult to deal by most of the specialists. Contrary to these findings, a study[19] concludes that the treatment

decision is influenced by the Bucco-palatal position of the canine crown, the palatally impacted canines are more likely to be exposed, and those in the line of the arch or buccally positioned more likely to be removed which is attributable to the increased problems of managing the attached gingivae with buccally positioned impacted canines as compared with palatal impactions.

Kuftinec and Shapira[20] [in] their study stated that the canines angulated towards the horizontal are difficult to manage and have a poorer alignment prognosis when treated Orthodontically. Which is in alignment with the present study where the vertical canine angulation posed less difficulty (85.0%), oblique angulation posed moderate difficulty (50.0%) and horizontally angulated canine was very difficult to manage (95.0%) according to both the specialists. However, on comparing between the Orthodontist and oral surgeons, the amount of difficulty experienced with different grades of inclination and angulation of impacted canines was statistically non-significant (p value >.05). Amongst the features of root morphology, absence of apical hook posed less difficulty (100.0%), presence of apical hook posed moderate/less difficulty (40%) and dilaceration was very difficult to manage (45.0%). Canines with apical hook and dilacerations were less difficult to manage by oral surgeons compared to Orthodontists for whom presence of apical hook (60%) and dilaceration (90%) were very difficult parameters for a impacted maxillary canine(p value <.05) which can be attributable to the fact that the traction of such teeth can delay and cause hindrance in Orthodontic alignment while as extracting such teeth can be quite tedious and cause apical fractures, but contrary to this oral surgeons scored it as less difficult. All the specialists reported the Normal anatomic root length of tooth to be less difficult (95.0%) and more than normal anatomic length was reported to be very difficult to manage (55.0%). From Orthodontic point of view, greater than normal anatomic length can cause problem in traction of canine into occlusion, while as for oral surgeons extraction of such unfavourably maxillary impacted teeth with greater anatomic length can cause difficulty. It has been reported that the higher above the occlusal plane the canine is positioned, the poorer the prognosis for orthodontic traction and alignment.[11]In the present study the Bone covering of 0-3 mm posed less difficulty (100.0%), 4-6mm posed moderate difficulty (50.0%) and more than 6 mm was very difficult to manage (95.0%) as scored by both the specialists. Mcsherry[21] statedthe 'the vertical rule of thirds' and suggested that a good, fair or poor prognosis depends upon whether the canine cusp tip is at which level of the amelocemental junction of the adjacent incisor. Bone covering of 4-6 mm was reported to be less difficult by oral surgeons (100.0%) whereas, Orthodontists reported it to be a factor causing moderate difficulty (100.0%) (p value <.05). However, a bone covering of more than 6mm was considered very difficult by orthodontist (100%) and by Oral surgeons (90%) which can be attributed to fact that greater bone removal during surgical exposure has more chances of trauma to the impacted canine and Orthodontically also would be challenging as the canine has to traverse through good amount of bone during orthodontic traction as well as bonding attachment in such situation will be quite tedious and there are more chances of gingival overgrowth during the course of treatment. Yan et al [22]has reported about the physical proximity between lateral incisor roots and follicles of impacted canines greatly affects the incidence of impacted canines associated root resorption. Many studies indicated that pressure from canine dental follicles was similar to Orthodontic force, and can be risky for external apical

root resorption.[22,23,24] Larger dental follicle promotes more mesial migration and the incidence of resorption. However, in the current study, Presence of dental follicle irrespective of the size was found to pose less difficulty for treatment by both the specialists. Presence of dental follicle (1-2 mm) was reported to cause less difficulty by a significantly greater number of orthodontists compared to oral surgeons (60.0% vs 0.0%), for dental follicle more than 3mm, 70.0% oral surgeons rated such canines were very difficult to manage (p value <.05). Since the follicle has to be removed surgically during exposure so that can be the reason for oral surgeons scoring more for the dental follicle greater than 3mm size. In terms of Torsion or rotated impacted maxillary canine, Mesial torsion was reported to pose less difficulty (100.0%), distal torsion to pose moderate difficulty (55.0%) and total torsion was reported to be very difficult to manage (100.0%). Canine with distal torsion was less difficult to manage for oral surgeons whereas it was moderately difficult to manage by orthodontists (p value <.05). Total torsion was considered equally difficult by Oral surgeons and Orthodontists (100%). Getting the totally rotated impacted teeth into alignment is more difficult as compared to distal and mesial torsion and same goes for the extraction of such impacted maxillary canines.

According to the results of this study, a significantly greater number of oral surgeons rated canine with PDL widening or irregular PDL as moderately difficult to manage, whereas for Orthodontists (100%) such canines were very difficult to manage (p value<.05) which can be attributed to the fact that widening or breakage of PDL can cause difficulty in tooth movement and PDL breakage can cause ankylosis which can pose a problem while extraction of such impacted maxillary canines.

Such studies should be done on long term basis so that pre-treatment difficulty index can be compared with the outcome also and also larger sample should be included. There is less literature regarding the CBCT study on Mandibular canine impaction which is a topic for future research.

Conclusion

The present study gave in-toto index for difficulty levels for impacted maxillary canines and laid parameters which are less difficult, moderately difficult and very difficult. Among the less difficult are: impacted canine at the line of arch, Bone covering 0-3mm, Vertical angulation, absence of hook, mesial torsion, normal anatomic length and normal PDL. Among the very difficult parameters were: Palatal inclination, horizontal angulation, dilaceration, greater anatomic length, bone covering of more than 6mm, Dental follicle more than 3mm, total torsion, PDL breakage. This study concluded that treatment of impacted maxillary canine varies from surgical exposure to Orthodontic bonding, traction, alignment into normal occlusion also the difficulty index perception from Orthodontist& maxillofacial surgeons' point of view regarding pre-treatment CBCT evaluation of impacted maxillary canines varies. The clinicians should analyse each case thoroughly to anticipate all consequences so as to develop best treatment plan & every case has to be considered on individual basis.

References

1. AL-Mayali, A.M.Y.; Nahidh, M.; Alnajar, H.A.; Fahad, A.H. Impaction prevalence of permanent teeth pattern from orthodontic view. Eurasian J. Biosci. 2020, 14, 2823–2828.
2. AlA mri, A.; Alshahrani, N.; Al-Madani, A.; Shahin, S.; Nazir, M. Prevalence of impacted teeth in Saudi patients attending dental clinics in the Eastern province of Saudi Arabia: A radiographic retrospective study. Sci. World J. 2020, 2020, 8104904.
3. Wated N, Abu-Hussein M. Prevalence of impacted canines in Arab population in Israel. Inter J PubHealth Res 2014; 2:71-77.

4. Pico CL, do Vale FJ, Caramelo FJ, Corte-Real A, Pereira SM.Comparative analysis of impacted upper canines: panoramic radiograph Vs Cone Beam Computed Tomography. J Clin Exp Dent 2017;9(10):e1176–e1182 6 Shin H, Park M, Chae JM, Lee J, Lim

5. Al-Turaihi BA, Ali IH, Alhamadani GM, et al. Patterns of maxillary canine impaction in Iraqi population.Pesqui Bras Odontopediatria Clín Integr 2020; 20: e5266.

6. Counihan K, Al-Awadhi EA, Butler J. Guidelines for the assessment of the impacted maxillary canine. Dent Update 2013; 40:770-7.

7. Incerti Parenti S, Gatto MR, Gracco A, Alessandri Bonetti G.Reliability of different methods for measuring the inclination of the maxillary canines on panoramic radiographs. Orthod Cranio fac Res 2013; 16:177-84.

8. Ren H, Chen J, Deng F, Zheng L, Liu X, Dong Y. Comparison of cone-beam computed tomography and periapical radiography for detecting simulated apical root resorption. Angle Orthod 2013; 83:189-95.

9. Power, S.M.; Short, M.B. An investigation into the response of palatally displaced canines to the removal of deciduous canines and an assessment of factors contributing to favourable eruption. Br. J. Orthod. 1993, 20, 215–223. [CrossRef]

10. Beckwith F R, Ackerman Jr R J, Cobb T M, Tira D E 1999 An evaluation of factors affecting duration of orthodontic treatment. American Journal of Orthodontics and Dentofacial Orthopaedics 115: 439–447

11. Pitt, S.; Hamdan, A.; Rock, P. A treatment difficulty index for unerupted maxillary canines. Eur. J. Orthod. 2006, 28, 141–144. [crossref]

12. Miresmaeili, A.; Basafa, M.; Mahvelati Shams Abadi, R.; Farhadi an, N.; Moghymbeigi, A.; Mollabashi, V. Treatment decision analysis for palatally-displaced canines based on orthodontists' opinion and CBCT. Int. Orthod. 2017, 15, 625–639. [CrossRef]

13. Bolooki, H.; Hameed, O.; Sherriff, M.; Minhas, G. Positional factors affecting the surgical management of impacted permanent mandibular canines. J. Orthod. 2022, 14653125221084318. [CrossRef] [PubMed

14. Dalessandri D, Migliorati M, Visconti L, Contardo L, Kau CH, Martin C. KPG index versus OPG measurements: A comparison between 3D and 2D methods in predicting treatment duration and difficulty level for patients with impacted maxillary canines. Biomed Res Int 2014; 2014(1): 537620-25

15. Tadinada A, Schneider S, Yadav S. Role of cone beam computed Tomography in contemporary orthodontics. Semin Orthod 2018; 24(4): 407–15.

16. Diop Ba K, Diouf JS, Badiane A, Ngom PI, Diagne F. OrthopanTomographic analysis of the intraosseous position of the maxillary canines. Int Orthod 2019;17(02):324–332

17. Al-Abdallah M, alhadidi A, Hammad M, Dar-Odeh N. What factors affect the severity of permanent tooth impaction? BMC Oral Health 2018;18(01):184

18. Daniel E. Martín S. The KPG index-a novel 3D classification system for maxillary canine impactions. Tax Dent J 2012; 129(3): 265–74.

19. Stivaros N, Mandall N A 2000 Radiographic factorsaffectingthemanagement of impacted upperpermanent canines. Journal ofOrthodontics 27: 169–173

20. Kuftinec MM, Shapira Y 1984 The impacted maxillary canine: orthodonticconsiderations and management. Quintessence International 9: 921–926.

21. McSherry P F 1996. The assessment of and treatment options for the buried maxillary canine. Dental Update 23: 7–10

22. Yan B, Sun Z, Fields H, Wang L. Maxillary canine impaction increases root resorption risk of adjacent teeth: a problem of physical proximity. Am J Orthod Dentofacial Orthop 2012; 142:750-7

23. Chaushu S, Kaczor-Urbanowicz K, Zadurska M, Becker A. Predisposing factors for severe incisor root resorption associated with impacted maxillary canines. Am J Orthod Dentofacial Orthop2015; 147:52-60

24. Ballard DJ, Jones AS, Petocz P, Darendeliler MA. Physical properties of root cementum: part 11. Continuous vs intermittent controlled orthodontic forces on root resorption. A microcomputed-Tomography study. Am J Orthod Dentofacial Orthop 2009; 136:8. e1-8: discussion 8-9.