

Maxillary Impacted Canines: A Cross-Sectional Study among Tunisian Orthodontic Population

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Abstract

Original Research Article

Dental impaction is one of the most common abnormalities encountered during orthodontic consultations. After the impacted wisdom teeth, permanent maxillary canines come in the second place concerning this malocclusion. Their prevalence varies from 1% to 3% depending on studied populations. However, there are no previous studies concerning maxillary impacted canines among Tunisian population. For this reason, we propose in this work, through a cross-sectional study, to assess the prevalence of this phenomenon among a Tunisian orthodontic sample as well as to study its associations with some factors such as: sex, dental abnormalities (shape, size, number...) and transversal abnormalities. Some consequences such as adjacent teeth's resorption are also studied. Lastly, a preposition of orthodontic traction duration was given based on recent studies.

Keywords: Tooth, impacted; Root Resorption; Cone-Beam Computed Tomography; Radiography, Panoramic.

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INTRODUCTION

Despite its very low prevalence among general population, maxillary impacted canines represent a common chief of complaint among orthodontic consultations. 1% to 3% of patients are concerned by this clinical condition, depending on studied populations. Permanent maxillary canines are the second most frequently impacted teeth. Agenesis, microdontia, other impacted teeth and others signs are frequently described with maxillary impacted canines. In some studies, these factors are presented like harmful factors while in others, they described as predictor factors. As consequences, root resorption of incisor is the main observed and assessed one. Radiographic examinations are essential to evaluate the localisation as like as the severity and depth of resorption of adjacent teeth to MICs.

The prevalence of MICs among Tunisian population is it at general average? Characterisation of such population, is it possible? Is there any significant association between this phenomenon and cited factors?

Based on previous data with absence of previous studies concerning maxillary impacted canines among Tunisian population, we made up the present

study to assess the prevalence of this phenomenon and then eventual association with some pre-cited factors.

MATERIAL AND METHODS

This is a descriptive cross-sectional study with an analytical component aims to:

- Assessing the prevalence of maxillary impacted canines (MICs) in a Tunisian orthodontic population and its characteristics (sex dimorphism, 3D information, root resorption ...)
- Studying the relationship between the impaction of maxillary canines and some factors such as dental abnormalities, 3D-localisation of MICs as well as consequences like resorption of adjacent teeth
- Assessing the traction difficulties of MICs through two scales based on 3D-index scale (KPG) according to CBCT and another based on 2D-index scale according to panoramic X-Ray.

Apart patients with craniofacial dysmorphism, labio-alveolo-palatal clefts or with systemic pathologies, child patients with temporary dentition and patients with previous orthodontic treatment, the study population is made up of 1910 adolescents or young adults of Tunisian origin belonging to the orthodontic service of the dental clinic of Monastir-Tunisia and

presenting obligatorily a panoramic radiography and / or a cone beam computed tomography CBCT. All with at least one maxillary impacted canine. A total of 66 maxillary impacted canines were studied. A clinical record (annex) with 5 components.

Different Measurements Were Calculated

- The angle *alpha* " α ": corresponding to the angle between the axis of the maxillary impacted canine and the inter-incisors medium.
- The *distance* " d " is the measure between the cusp tip of the canine included and the occlusal plane (from the first molar to the edge of the central incisor). According to Stewart *et al.*, [1]: if $d < 14$ mm then, the case was associated with shorter

treatment duration; once ≥ 14 mm, it was associated with longer treatment duration.

- The *sector* " s " corresponding to the area where the crown of impacted canine cusp is located: sectors 1-5 (sector 1: natural zone of deciduous canine, sector 2: distal half's root of lateral incisor, sector 3: mesial half's root of lateral incisor, sector 4: distal half's root of central incisor, sector 5: mesial half's root of central incisor). According to Ericson and Kuroi *et al.*, [2] canines with cusp tip position in sectors 1-2, distal to the lateral incisor vertical midline, were considered easier to treat, compared to canines with a more mesial position, corresponding to sectors 3-5.

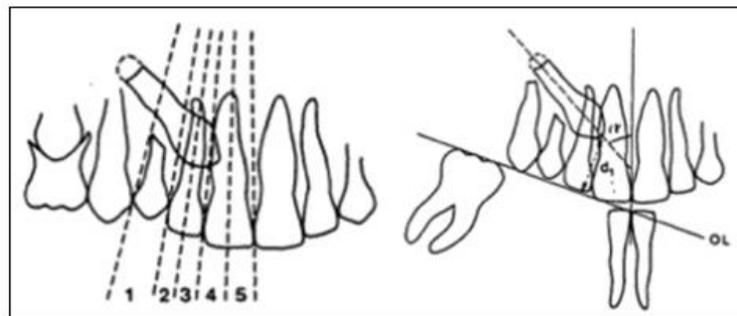


Fig-1: Angle α , Distance " d ", Sectors " s " [3]

- **2D-LRS¹**: The Two-Dimensional Leeds Resorption Scale (2-D LRS). LRS1 $\frac{1}{4}$ No resorption evident, with intact regular root contour and outline. LRS2 $\frac{1}{4}$ Suspected resorption $\frac{1}{4}$ with irregular/unclear root outline. LRS3 $\frac{1}{4}$ Resorption present, obvious resorption affecting root.
- **3-D-LORTS¹**: Three-Dimensional Leeds Orthodontic Root Resorption Target Scale, corresponding to resorption localization in vertical (V1, V2, V3) and transversal (buccal, palatal, mesial, distal) planes in addition to level of severity of this resorption: depth (cementum, 50% in dentine, pulp).
- **KPG Index²**: KPG index was calculated adding together the scores, from 0 to 5, assigned to cusp tip and root tip on x , y , and z planes (Figures 1, 2, 3, and 4): in the original version scores in the range 0-9 fell into the category of easy, 10-14 were moderate, 15-19 were difficult, and 20-30 were extremely difficult; in the modified version the category of easy was reduced to 0-6 scores, extending the category of moderate from 7 to 14. In order to compare the KPG index with 2D indexes, these four categories were reduced to two, creating

an easy-moderate category in the range 0-14 and a difficult-very difficult category in the range 15-30.

X^2 test and the Pearson correlation coefficient were used to compare the results and see if there is a significant association between studied parameters from different nature (quantitative and qualitative variables).

RESULTS

The average age of our population was evaluated at 21.13 years \pm 8.131. 53.7% of patients are undergoing treatment; 64.8% presented panoramic radiography and cone beam (CBCT) without observing a family history of dental impaction among the patients of our studied population.

The prevalence of MICs was estimated at 2.83% among the 64.8% with a predominant presence of this phenomenon among women with a percentage of 83.3% against 16.7%. On the other hand, the bilateral character seems to be more prominent compared to a unilateral impaction with 78% percentages against 22%.

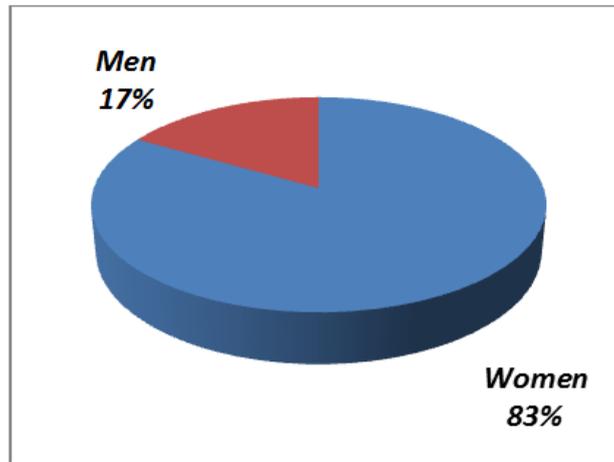


Fig-2: Distribution of study population according to gender

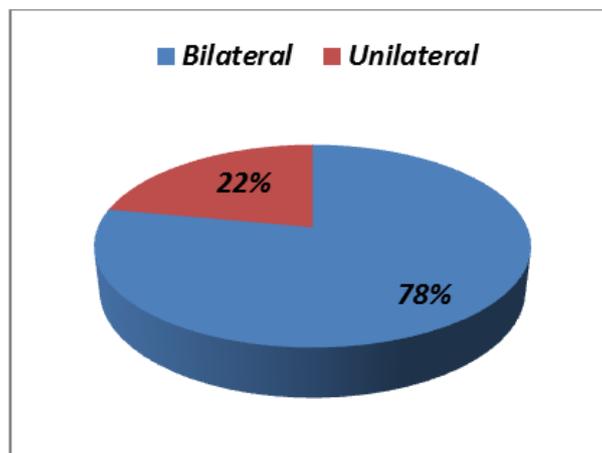


Fig-3: Distribution of study population according to type of impaction

The association of MICs with some dental anomalies such as agenesis of the lateral incisors or dysmorphism of the latter as well as microdontia, was very weak. Indeed, the presence of other impacted teeth apart from the canines was observed in 1.9% of

cases. In 5.6% of the cases, agenesis and / or associated microdontia were observed. While 7.4% of patients had at least one lateral rice-shaped incisor. Thus, if these dental abnormalities are present that was described with a very small percentage.

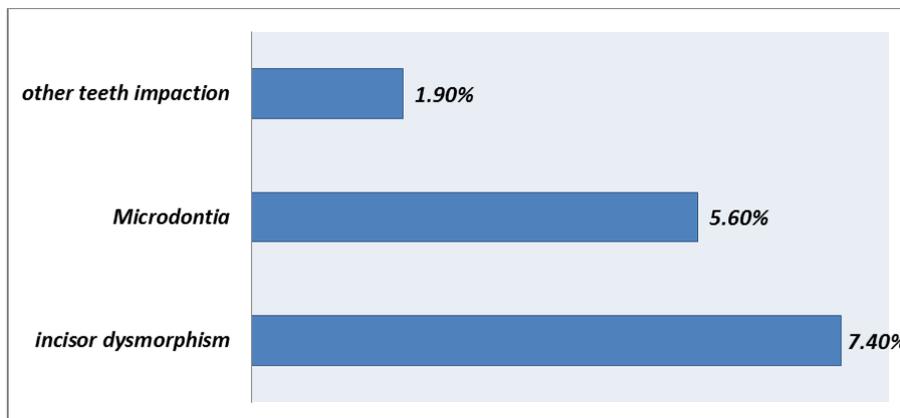


Fig-4: Prevalence of some associated signs to MICs

As for the distribution of the study population according to the transverse anomalies, almost 2% had

maxillary endognathia and only 37% with symmetric or asymmetric narrow maxillary.

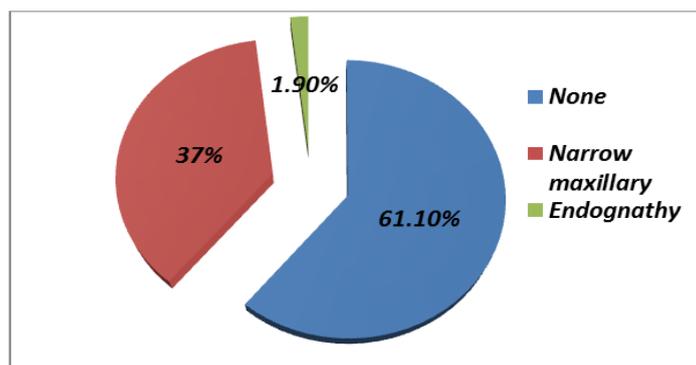


Fig-5: Distribution of study population according to type of transversal anomalies

In 51.8% the deciduous maxillary canines were present and different degrees of its resorption were observed. On the other hand, in 83.3% of the cases

there were no signs of kinking or apical deformities for MICs.

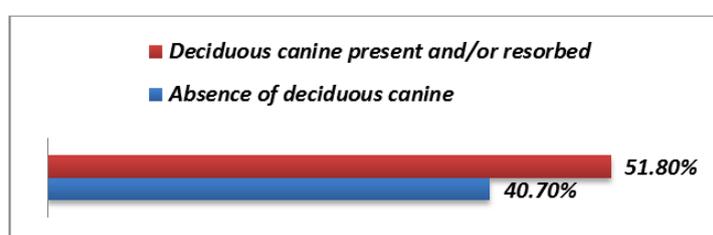


Fig-6: Distribution of study population according to type of transversal anomalies

One of inherent phenomena associated to dental impaction is the resorption of adjacent teeth with which canines are intimately related. Among the so-called risk factors for this resorption are the angulation of MICs to medial sagittal plane, its position in the transverse plane and vertical plane, vestibulo-lingual

position, width of follicular cyst and its relationship with the lateral incisors and finally mesio-distal position of MICs. Aside from the first factors, the latter one showed an almost significant relationship with incisor's root resorption ($p=0.071$) Actually.

Table-1: Correlation between Root resorption of lateral incisor scale (2D-LRS) and position of MICs according to panoramic X-Ray

2D-LRS scale (score 3)	Pearson Correlation coefficient	P value (X^2 test)
Angulation to MSP (Angle α)	0.184	0183
Mesial-Distal position (Sectors 'S')	0.248	0.071
Transversal position (maxillary medium raphe)	-0.156	0.371

The average of Angle $\alpha = 38.9 \pm 16.36$. About root resorption of adjacent teeth according to different positions of MICs in 3 space dimensions, results showed that among patients with apical position in vertical plane (sector 4): only 16.7% presented score 3 of 2D-LRS scale of root resorption from panoramic X-Ray. Same for patients having MICs related to distal half of lateral incisor's root (sector 4), only 20% presented this LRS 3 score and for those with a CIM in the sector 5 in the direction M ° D (1/2 mesial IC): we

have only 16.7% with LRS 3 score. On the other hand, 28.6% of patients with vestibular position presented the same score, while for follicular width cyst, all patients with a grade "4", have a LRS 2 score with a majority with a grade "1" and LRS 1 score which is not statistically significant. So all of these factors cannot be considered as risk factors, however can be qualified as pre-disposing for root resorption appearing to be inherent canine's impaction.

Table-2: Correlation between Root resorption of lateral incisor scale (2D-LRS) and positions of MICs according to radiographic examination (panoramic X-Ray)

MICs positions	Score 3 of 2D-LRS	Pearson Correlation coefficient
Vertical plane	sector 4: apical +	16.7%
Mesial-Distal position	sector 4 : mesial ++	20%
Anterior-posterior plane	Buccal +	28.6%
Relationship with lateral incisor	Grade 3: ½ distal of lateral IC	20%

To be more accurate when diagnosing root resorption of incisors particularly lateral incisors, we used two scales: the first one based on panoramic X-Ray and the second one based on cone beam computed tomography CBCT and we choose two scores to be compared: score "3" from both scales 2D-LRS and 3-D-LORTS . Results showed that among patients with score

3 from 2D-LRS scale (panoramic X-Ray), only 33.3% had shown root resorption at the apical region and buccal position from CBCT (3D-LRS). Concerning severity and depth of root resorption, higher percentage was found, about 66.7% with pulp involvement are detected when the resorption is classified in score 3 according to 2D-LRS scale from panoramic X-Ray.

Table-3: Correlation between two Root resorption of lateral incisor scales: (2D-LRS) according panoramic X-Ray and 3D-LRS according to CBCT

3-D-LORTS (Score 3)	2D-LRS (Score 3)
Vertical position (apical)	33.3%
Anterior-posterior position (Buccal)	33.3%
Severity / depth of resorption	66.7%

At the end, we proposed to study the concordance between 3 treatment parameters assessing difficulty and/or duration of treatment: OPG measurements based on determination of distance "d" for the first one and characterizing sectors "s" for the second one; both are based on panoramic X-Ray (2-D imagery) and on the other hand KPG Index characterizing the level of treatment's difficulty. Contrary to what has been found in the literature: a

statistically significant association was found between: KPG and distance "d" with Pearson coefficient = 0.39 and p value = 0.02. On the other hand, no significant relationship between OPG measurements (distance "d" and sectors "s") was observed with Pearson coefficient = 0.081 and p value \gg 0.05. Finally, Pearson coefficient = 0.328 and p value = 0.054 were found when comparing Ericson/Kuroil measurements to KPG index.

Table-4: Correlation between three treatment parameter: OPG measurements and KPG Index

	Pearson Correlation coefficient	P value (X^2 test)
KPG / Distance "d"	0.39	0.02
OPG measurements ("d" and "s")	0.081	\gg 0.05
Sectors "s" / KPG Index	0.328	0.054

DISCUSSION

The impacted canines affect 1 to 3% in general population [4-7]. It is known to be a multifactorial phenomenon and "environmental and genetic factors have been suggested [8]. In some other cases, no accurate explication can be established. So it can be idiopathic phenomenon. Many etiologic possible factors can be associated with impacted canines. Most common causes as the result of any one or a combination of the following factors according to Bishar [9]: arch length discrepancies, tooth size, prolonged retention of deciduous canine or its early loss, abnormal position of the tooth bud, alveolar cleft, cystic or neoplasia, ankylosis, root's dilaceration, iatrogenic injury and an idiopathic condition with no apparent cause.

2.83% found in our studied population is in the average of prevalence described in literature concerning maxillary impacted canines. However, in other studies, the prevalence of this clinical condition is estimated to be 1-2% in the general population [10].

In previous studies, women appear to be more concerned with the included canines than men [11-16]. Females are twice as frequently affected (1.17%) as males (0.51%) [6]. Our results meet those ones with a percentage of 83.3% against 16.7%. In a recent prospective study among French orthodontic

population, 62.5% are female patients with MICs against 37.5% [17].

Maxillary impacted canines are often found in palatal side than buccal side according to many studies [11, 13, 15, 16, 18-20]. In fact, Palatally displaced canines are three times more frequent than buccal displacements [21]. However this result is reversed in other publications [4, 11, 14]. For example, according to the study among French orthodontic sample, buccal and palatal impacted maxillary canines were found at same proportion (44.1% against 48.4%) [17].

Unilateral impacted canines are more frequently found than bilateral [4]. And if it is found, it concerns more palatal canines; consequently, those canines are subject to longer treatment [22]. In contrary to what is described previously, bilateral MICs seem to be more often observed among the patients of our studied population. This discordance can be explained by differences between studied samples. In fact, our study concern only orthodontic patients consulting orthodontic ward. Surely, this sample can not characterize accurately the whole Tunisian population but, in some way give us an idea about it. Therefore, further prospective studies are needed.

Agensis, microdontia and some other dental shape abnormalities were described in association to

impacted canines. However, the presence of those dental troubles is not as frequent as it is thought. In some rare cases, an anomaly of the lateral incisor can be a warning sign of an impacted canine. This was described in literature with a percentage of 16% of patients who present abnormality of shape or agenesis of the adjacent teeth have at the same time palatal impacted canine [8, 13, 19, 23-25].

Generally, correlation between the length of the arch and buccally impacted canines is statistically significant but the difference is so small that it is considered non-clinically significant [26]. This may explain the very low percentage of endognathia found among our sample (2%). Concerning palatally impacted canines, the shape of the maxillary arch is more narrow and longer, and the palatal vault is deeper in comparison to those impacted in buccal side [23, 27]. Our results seem to be in concordance with those later results and the 37% with narrow maxillary presented MICs in palatal side.

In the same context, the recent study of D' Oleo-Aracena and coll [28] based on CBCT comparing two sides among subjects with unilateral palatally impacted canine conducted to this conclusion "The width from the median raphe to the first premolar is lower in the side of maxillary palatal impacted canines than in the side without impaction with significant statistical differences (2 mm, $p < 0.001$). Lateral angulations of incisors were distally tilted on the side of impacted canines. Both conditions have clinical implications in the orthodontic treatment".

In the other hand, the lower the canine is located, the more it is vertical and conversely the higher it is, the more its inclination is horizontal. The canine will become vertical with its evolution. For the canines with intermediate position, different inclinations can be observed [17].

Based on literature review and the fact that canine impaction diagnosis cannot be confirmed without radiographic assessments, cone beam computed tomography CBCT, sophisticated modern imagery technique, seems to be more accurate than 2-D imagery to establish the initial diagnosis dental impaction among which maxillary canines and their relationship with adjacent teeth but the treatment plan does not seem to differ [29-43]. Resorptions also seem to be more accurately detected and assessed with the cone beam computer tomography CBCT [44-53]. Actually, the introduction of CBCT has made possible the acquirement of 3-D information leading to improved detection rates (up to 66.7%) of root resorption [54]. Therefore, many authors developed many scales to classify the severity and magnitude of adjacent teeth's resorption.

2D-LRS based on *Lavender and Malmgren scale*, with reference to panoramic X-Ray and 3-D-LORTS scale with reference to cone beam computed tomography CBCT were developed by authors of recent study (*Jawad Z. and coll.*) published in 2016 to compare results of resorption from panoramic X-Ray and CBCT [55].

Is there any concordance between severity of root resorption of adjacent teeth, observed in 2D-imagery and those detected in CBCT? Does the position of MICs impact the severity of root resorption of adjacent teeth? If it is the case, what kind of relationship does exist between them? In our study, we tried to response those questions. For patients with both panoramic X-Ray and CBCT, we applied both of previously cited scales: 2D-LRS and 3-D-LORTS. Most important results from the present study showed that more buccal and mesial (sector 4) MICs are situated, higher is risk of root resorption of lateral incisor with score 3 according to 2D-LRS. In the study of A. Alqerban and Coll [56] in 2015, they proposed a prediction model for root resorption "RR" based on panoramic radiographs which could be a helpful tool in justifying the need of additional CBCT examination. However, those findings do not meet those found according to 3-D-LORTS scale with reference to CBCT. Actually, in only 33.3% of cases, buccal and mesial positions of MICs present score 3 of 3D-LRS scale. The difference in location of the impacted canines between the two methods can be explained by "distortion, superimposition of anatomical structures located in the different planes of space" [57].

In the other hand, a significant relationship was described concerning the severity of root resorption of lateral incisors based on panoramic radiography or CBCT. Therefore, 2D-imagery also remains a reliable examination in diagnosis and management of MICs [40, 46, 58-62].

Concerning timing and treatment strategy, controversial opinions were presented. For example, results concerning involvement of age in canine impaction and duration of treatment are contradictory according to articles [22, 63, 64]. Depending on 3D position of maxillary impacted canine(s), various therapeutic attitudes are described. Ortho-surgical intervention is at the most time used and the average of treatment duration is 28 months (range, 4 to 92 days) [22]. On the other hand, the average treatment duration is 28.3 months (13 to 50 months): 25.8 months (13 to 40 months) if the impacted canine is unilateral and 32.3 months (23 to 50 months) if it is bilateral. In both cases, this is longer comparatly to classic treatment without dental impaction, the overall treatment duration is 22.4 months (10 to 41months) [22]. According to some studies [63, 64, 26, 65, 66], "every additional 5° of angle α requires an additional week of traction; same for distance d : every extra millimeter requires an

additional week of traction and when the cusp tip is in the zone 1, six additional weeks of traction are required compared to canines found in zone 3" [8, 67]. This conclusion is contradicted by other publications for which sexual dimorphism, age, location and root building of impacted canines does not affect the duration of treatment significantly.

In our study, we were referred to the article of *Dallessendri and coll* [67] comparing between orthopantomography (OPG) based 2D measurements and the KPG index based on 3D images (CBCT), in predicting difficulty level and orthodontic treatment duration of impacted maxillary canines. Results showed higher level of prediction with KPG Index with statistically significant association between all the indexes according to Pearson's coefficients. Our results showed weak level of concordance between the two parameters except for distance "d" measurement which localize MIC in the vertical plane and KPG Index based on adding together the scores, from 0 to 5, assigned to cusp tip and root tip on *x*, *y*, and *z* planes, where the results are statistically significant ($p=0.02$). This result is in contradiction with what was found in the previously cited study [67]. In fact, according to its authors "Inter- and intrarater reliability were higher with KPG compared to 2D methods. Pearson's coefficients showed a statistically significant association between all the indexes, while the χ^2 with Yates correction test resulted in a statistically significant rejection of independency only for one 2D index". Thus those results lead us to conclude that 2D indexes based on OPG measurements are often discordant concerning predicting impacted maxillary canines' treatment difficulty and duration; therefore using a 3D index such as KPG index could be efficient and more accurate concerning this issue.

The purpose of our study was not to assess an average of treatment duration as the sample includes only patients before or undergoing treatment. Generally, the traction of unilateral canine takes about 1 year and some months longer than classic treatment. Of course, when the impaction is bilateral, treatment duration is longer but we can conclude about difficulty. Actually, it depends directly the 3-D position of impacted canine(s) and to traction technique of orthodontist. CBCT gives grater help in those cases by accurate positioning of impacted canines and giving guidelines to therapeutic approach. So, sides effects can be prevented from the beginning and more stable results can be established.

CONCLUSION

Except its limitations, the present study allowed us to have an idea about the prevalence of maxillary impacted canine(s) among Tunisian population despite its particular characteristic.

Further prospective multicentric studies are needed to assess accurately this clinical condition in order to reduce statistic biases.

Cone Beam computed tomography CBCT is more often demanded in case of dental impaction, not only for initial diagnosis but also for detection of its relationship with surrounding structures (teeth and anatomical structures) so it is more accurately delineated and finally for prediction of difficulty level and treatment duration of MICs according to its position in 3 planes of space. So it should be systematically demanded in those cases ensuring optimal ortho-surgical management.

Various prediction index for root resorption (RR), difficulty level and treatment duration whether it is based on OPG or CBCT imagery help us to have an idea about therapeutic approach, risks and especially inform in advance patients about all these conditions.

Abbreviations:

MICs: Maxillary Impacted Canines

RR: root resorption

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