THE PROGNOSIS OF IMPACTED MAXILLARY CANINES AND ORTHODONTIC MANAGEMENT

Farid Bourzgui*, Samir Diouny, Mohamed Mokrane Khazana***, Zineb Serhier**** and Mohamed Bennani Othmani*****

*Department of Dentofacial Orthopaedics, Faculty of Dentistry, University Hassan II of Casablanca, Morocco., **Department of English Studies, University of Chouaib Doukkali El Jadida Morocco., ***Department of Oral Medicine Oral Surgery, Faculty of dentistry, University Hassan II of Casablanca Morocco., ****Laboratory of medical informatics, Faculty of medicine Pharmacy, University Hassan II of Casablanca, Morocco.

ABSTRACT Background: The orthodontic treatment of impacted maxillary canine is a major challenge for orthodontics, the treatment of which usually requires an interdisciplinary approach. If treatment is not initiated, there is always a risk of retention and also resorption of the roots of permanent incisors. **Aim:** The objective of this study was to assess the orthodontic treatment of impacted maxillary canines in Moroccan patients. **Methods:** A cross-sectional study was conducted on 34 consecutive patients with impacted maxillary canines (23 females and 11 males) aged 9- 36 years (mean 21 years) from December 2015 to February 2016. Our analysis incorporated patients' files, including clinical observation, X-ray imaging and iconography of good quality of patients. All the data were collected from an information collection sheet by a single operator. The assessment of the degree of difficulty of disinclusion of impacted teeth was revealed following the sector and angulation methods. **Results:** The circumstances in which inclusions were found were dominated (58.8%) by the reason for consultation in relation to delayed eruption or persistence of deciduous canine teeth. 61.9% of practitioners considered the difficulty of traction of the canines in this series as moderate to difficult. The assessment of the difficulty of placement of the retained teeth was revealed by 2 methods: (1) sector and (2) angulation methods. The sector technique showed that the majority of patients (52.9%) revealed canine inclusions in sector 4. The angulation method ranged from 21° to 82° with an average of 55.9°. The failure rate of placement represented 23.5%. **Conclusion:** The successful management of impacted canine requires close cooperation of oral surgeons and orthodontists. In this study, successful treatment was possible in approximately 76.5% of impacted canines, and the sector method associated with the angulation method on the orthopantomogram could help orthodontists to assess the prognosis of included canines.

KEYWORDS Impacted canines, diagnostic imaging, Radiography, Panoramic, Orthodontic Extrusion, orthodontic techniques, Corrective methods

Background

Tooth eruption is defined as the axial movement of a tooth from its developmental site within the alveolar bone to its functional position in the dental arch [1]. This process follows a certain chronology. Eruption begins only after mineralization of the crown is completed, and it requires resorption of the alveolar bone and, in the case of the permanent dentition, resorption of the roots of the preceding deciduous tooth [2]. The position of the teeth on the dental arch plays a major part in the aesthetics, but also in the various functions of the orofacial sphere. Tooth eruption is most often subject to chronological variations that may be early or delayed and may be maxillary, mandibular, uni or bilateral and may affect one or more teeth.

In daily practice, the orthodontist is confronted with various eruption anomalies, including inclusions. A tooth is included

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[1]Rue Abou Al Ala zahar ex Vsal - B.P 9157 Mers Sultan Casablanca; E-mail: faridbourzgui@gmail.com

when it remains retained long after its normal eruption date, (considering the dental age of the subject), the contralateral tooth being in functional occlusion. A tooth is said to be included as long as its follicular sac is intact. The management of dental inclusions depends on the shape of the tooth that could not erupt, and on the presence of obstacle to the eruption path, odontoma, cyst. Thus the management of dental inclusions requires a multidisciplinary treatment approach and must be based on a proper diagnosis of impacted canines, location of the inclusion and, above all, the prognosis for its evolution.

Considerable variation has been reported in the prevalence of impacted canine among individuals. These differences are attributed to regional genetic differences, the dental health of the population studied, and interpretation of what constitutes impaction. Previous literature reported that factors affecting the incidence of impacted canine include aging and eruption time. Genetic and environmental factors play a key role in developmental disturbances. However, diagnosis and treatment success in managing impacted canines can be strongly influenced by a better understanding of etiology]3].

Impacted canines can be detected at an early age, and maybe prevented by means of proper clinical diagnosis, radiographic evaluation and timely interceptive treatment. Surgical techniques that manage impacted canines vary depending on whether the impactions are labial or palatal, and orthodontic techniques vary according to clinical judgment and experience. With early screening, timely interception, and well-managed surgical and orthodontic treatment, impacted maxillary canines can be erupted and guided to an appropriate location in the dental arch [4].

The management of impacted canine in different populations and ethnic groups was the subject of several studies. However, no investigation to date has taken into account the difficulty of orthodontic treatment based on epidemiological data. The purpose of this study was to assess orthodontic treatment difficulty of impacted canines in the Moroccan population.

Methods

A cross-sectional study was conducted on 34 consecutive participants (23 females and 11 males) aged 9- 36 years (mean 21 years) from December 2015 to February 2016. Our analysis incorporated patients' files, including clinical observation, X-ray imaging and iconography of good quality of patients. All the data were collected from an information collection sheet by a single operator, which included 5 main parts:

- Patient identification (age and gender)
- Preoperative examination (chief complaint, discovery circumstances, radiological assessment to find out the number of teeth retained: by indicating which tooth, the situation of dental retention: vestibular, palatal, or intermediate, the level of inclusion: was the inclusion low or high, the presence or not of transposition, the presence or not of the obstacle: by specifying if it was about supernumerary teeth, cyst odontomas or any other type of obstacle, the presence or not of resorption at the level of adjacent teeth while specifying which tooth was affected. The sector of the location of the retained tooth : quantitative variable showing the sector of dental retention and corresponding to the anterior region of the orthopantomogram (OPT) shot which was divided into sectors 1,2,3,4 by the method of Ericson and Kurol [5] : we draw the longitudinal axis of the lateral, a tangent along the mesial face of the lateral incisor, a tangent the along the distal side of the lateral incisor (Figure 1). Angulation measurements by Stivaros and Mandall [6]: to know the degrees of angulation of the dental inclusion ; a horizontal bicondylar line was drawn and then the line corresponding to the major axis of the included tooth was drawn (Figure 2).
- Preoperative orthodontics is used to open up space with or without extraction necessary for the placement of the retained tooth after its surgical release as it could consist of the preparation of traction anchorage.
- The surgical phase itself specifying the surgical approach: vestibular (Figure 3), palatal (Figure 4) or both (Figure 5), the type of flap performed: displaced (Figure 6) or replaced (Figure 7), the presence or not of a window (Figure 8), the osteotomy: performed or not, using rotating instruments, the bonding: was it done preoperatively (Figure 4) or was it deferred to a session after surgery (Figures 6-8).
- The evolution of the teeth retained: By the appearance of the tooth on the arch, the failure to place the retained tooth, the duration of treatment, the postoperative complications, the OPT at the end of treatment and the probability of following the same operating protocol if the same case could be treated as well as the estimation of the degree of difficulty of the therapeutic act on a scale of 1 to 5 according to the practitioner.

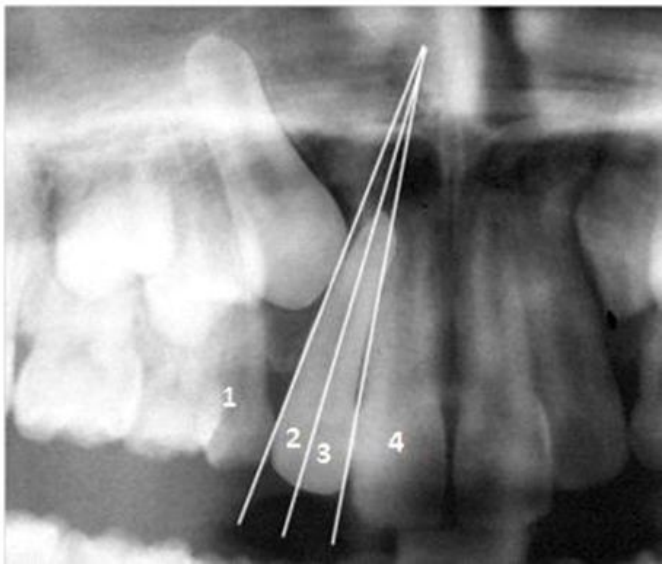

Fig. 1: Sectors 1, 2, 3, 4 by the method of ERICSON and KUROL [1].

The data were transferred into an Excel file and the statistical analysis of the data was carried out by Epi-info 3.5.4 software. Association correlations were performed using the Spearman test with a $p < 0.005$. Data processing was carried out at the Medical Informatics Laboratory of Casablanca School of Medicine and Pharmacy. Ethical clearance was obtained from the Ethics Committee at the School of Dentistry, Hassan II University in Casablanca.

Results

Our sample consisted of 34 consecutive patients with impacted maxillary canines (23 were female and 11 male) aged 9 years to

Table 1 The circumstances of the discovery of the retained teeth.

The circumstances of the discovery	Percentage
Fortuitous discovery after radiological examination	11.8%
Radiological discovery as part of the orthodontic record	29.4%
Delayed eruption or persistence of deciduous canine teeth	58.8%
Total	100%

Table 2 The estimation of the difficulty of treatment by the treating practitioners.

The difficulty of treatment	Percentage
1	5.9%
2	14.7%
3	35.3%
4	17.6%
5	26.5%

Table 3 The correlations of association between angulation measurement, practitioner's perceived degree of difficulty and overall treatment duration.

Treatment duration	Correlation coefficient	p
Degree of difficulty	0.37	0.039*
Angulation measurement	0.13	0.483

*Significant p<0,005

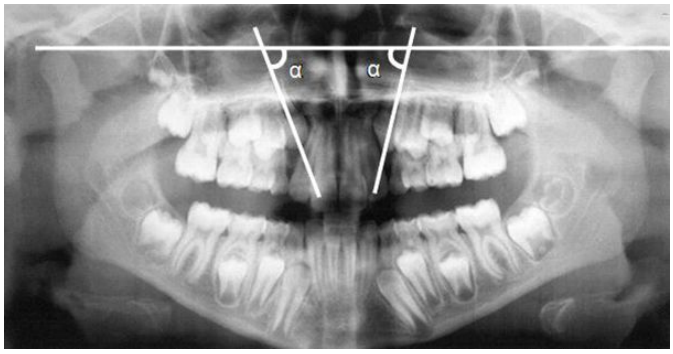

Fig. 2: Angulation measurements to know the degrees of angulation of the dental inclusion.

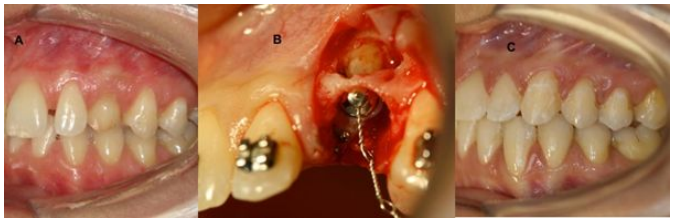

Fig. 3: A: Starting treatment with persistence of deciduous canine teeth. B: Vestibular flap and gluing of the button. C: Placing on the arch of the permanent canine teeth.

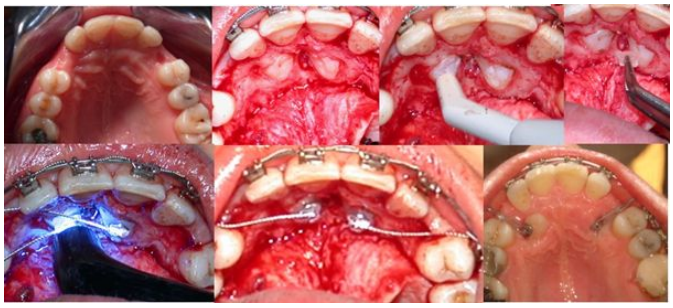

Fig. 4: Palatal flap replaced and bonding of traction attachment in peroperatory.

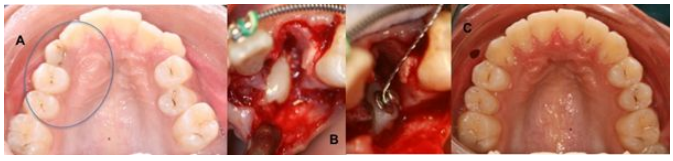

Fig. 5: Intermediate flap, (vestibular and palatal) repositioned and bonding of traction attachment in peroperatory.

Fig. 6: Displaced flap, attachment bonding was delayed after healing.

Fig. 7: A: Palatal flap. B: bonding of traction attachment. C Flap replaced with window. D : Placing on the arch of the permanent canine teeth.

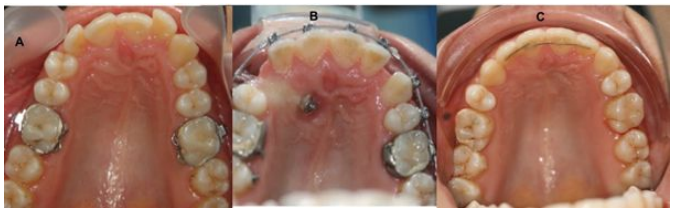

Fig. 8: A: Starting treatment. B: window for traction. C : Placing on the arch of the permanent canine teeth.

36 years with an average age of 21 years and 6 months. The circumstances of the discovery of the retained teeth were revealed after radiological examination in 11.8% of the cases, and a radiological discovery as part of the orthodontic record in 29.4% of the cases. A reason for consultation related to delayed eruption or persistence of deciduous canine teeth was reported in 58.8% of the cases (Table 1).

The assessment of the degree of difficulty of disinclusion of impacted teeth was revealed following the sector and angulation methods. The sector technique showed that 17.6% of the patients had canine inclusions in sector 1 while sector 2 involved only 5.9% of patients and 20.6% of patients had canine inclusions in sector 3, although more than half of the patients (52.9%) revealed canine inclusions in sector 4. The angulation method was 21° to 82° with a mean of 55.9°, the standard deviation was 16.5.

Concerning the symmetry of inclusion, 88.2% were unilateral, while 11.8% were bilateral. Regarding the estimation of the level and situation of retention, according to the practitioners, 29.4% were low, while 70.6% were high. While retention was significant in the palatal region interesting 61.8%, the intermediate level presented 11.8% and finally, the vestibular region presented 25.5%.

The transposition affected more than half of the patients (55.9%), while the obstacle assessment was positive in 11.8% of the cases. Concerning the resorption estimation, according to the practitioners, only 17.6% of the patients had resorption of the adjacent central and lateral incisors.

It was important to note that 67.6% of the patients benefited from orthodontic treatment without extraction, while 32.4% of the patients required extraction. For the treatment decision, the majority of patients (88.2%) benefited from traction. While 8.8% of patients had a non-traction eruption, only 2.9% of patients benefited from a corticotomy.

The surgical approach was undertaken more often on the palatal side (67.6%) than on the vestibular side (23.5%) and only 5.9% were intermediate. The surgical access flap was replaced for all cases. Regarding the presence of a window, 73.5% of the cases benefited from the closed eruption technique while 23.5% of the cases used the open eruption technique. The osteotomy was performed in 21 patients (61.8%), while for 38.2%, it was not necessary.

Concerning the bonding time, for the majority of the patients

(94.1%), bonding was performed preoperatively, and was delayed after healing for 5.9% of the patients. 76.5% of the patients had their canines included set in place, 5.9% of these patients had a second intervention.

The length of treatment ranged from 18 to 36 months with an average of 26 months. It was noted that 7 patients had postoperative complications such as pain, bad quality of the periodontium due to poor hygiene, and the root resorption of the lateral. 76.5% of the patients affirmed the reliability of their operating protocol, and if the treatment were to be repeated, they would have followed the same therapeutic approach.

The estimation of the difficulty of treatment by orthodontists revealed a low difficulty in 5% of the cases, a moderate difficulty in 35.3% of cases, and a major difficulty in 26.6% of cases (Table 2).

The correlations of association between angulation measurement, practitioner's perceived degree of difficulty and overall treatment duration indicated a positive correlation between the practitioner's perceived degree of difficulty and treatment duration, $p < 0.039$. In contrast, all the other correlation associations were negative, in particular, the association between overall treatment duration and angulation measurement the inclusion of the canine (Table 3).

Disussion

The purpose of this research was to assess orthodontic treatment difficulty of impacted canines among 34 Moroccan patients. The circumstances in which these inclusions were detected were dominated (58.8%) by the reason for consultation in relation to delayed eruption or persistence of deciduous canine teeth. 61.9% of orthodontists considered the difficulty of traction of the canines in this series as moderate to difficult. The assessment of the difficulty of placement of the retained teeth was revealed by 2 methods: (1) sector and (2) angulation methods. The sector technique showed that the majority of patients (52.9%) revealed canine inclusions in sector 4. The angulation method ranged from 21° to 82° with an average of 55.9°. The placement rate of the included canines was 76.5%, while 23.5% represented the failure rate.

The average age of consultation was 21 years, ranging from 9 to 36 years. The findings in this study were consistent with a previous study, conducted on the same population in 2009 [7], based on the collection of clinical records and concerning all dental retentions. The sample comprised 30 patients represented by their clinical files (mean age was 17 years +/- 8.141). However, other studies showed a much earlier average age at the time of consultation. For example, in Anand and Sajnani's study [8], involving the complications associated with the treatment of the impacted canines, on a sample of 533 patients, the average age of discovery was 16.17 years. In contrast, the average age of management (of discovery) in our study seemed a little late; this can be explained by the inadequacies of the different oral health policies in Morocco, especially screening early in school.

Several studies reported that dental retention was much more common in females than males [5]. In the current study, female inclusion rate was 67%. These findings were in agreement with the results reached by Al-Nimri and Gharaibeh [9] where they reported a female rate of 67%. Similarily, in previous studies, the percentage of female involvement was approximately around 70%, which was in harmony with the present results. In a comparative study carried out by Chaushu et al., [10] about the factors of associated root resorption at the retention of canines, the percentage of female involvement was 83.6%. Anand and Sajnani [8] reported that females were more prone to complications than males. The predominance of dental retention in females could be explained by the fact that female patients were more concerned with their dental aesthetics than males.

The diagnosis of inclusion was made by a clinical assessment targetting specific signs, supplemented by radiological examinations. Thus, in our study, the inclusion of canines was dominated by the reason for consultation in relation to delayed eruption or persistence of deciduous canine teeth. The study showed a diversity of exams undertaken by different practitioners; OPT and profile teleradiography were the basic exams prescribed by orthodontists. The study conducted by Schubert et al., [11] in which baseline Cone Beam Computed Tomography (CBCT), OPT data and treatment times of 30 adolescent non-syndromic/cleft orthodontic patients with a unilaterally palatally impacted upper canine, aligned by fixed orthodontic non-extraction traction treatment (closed eruption), were retrospectively analyzed. In their study, gender and impaction side differences did not significantly affect treatment time or measured eruption path length. Their results seemed to indicate that the severity of canine impaction was not-dependent nor did a preferred side for canine impaction seemed to exist. CBCT and OPT eruption path length and time to canine alignment did not show significant gender, age, or impaction side differences, but CBCT methods made a distinct correlation. However, in our study, only a proportion of the patients benefited from CBCT (8.8%) ; the increased cost associated with using CBCT limited its use. The maxillary canines are the second most frequently impacted teeth after the mandibular 3rd molar, with incidence reports in the literature in the range of 1% to 3.5% in the general population [12]. In our study, 88.2% of the patients had a unilateral canine inclusion and 11.8% had a bilateral inclusion. In contrast, Warford, Grandhi, and Tira reported that the records of 134 patients' documentation and panoramic views with impacted maxillary canine showed that 54.4% of impacted canine were unilateral, while 46.6% were bilateral [13].

Over the years, numerous authors have suggested various parameters for the distinction of canine impaction. Sector location and angulation of the unerupted tooth were analyzed previously as predictors/sectors of canine eruption (sectors 1, 2, 3, 4, see figure1). Angulation method was carried out by Stivaros and Mandall (6), which was performed by drawing a horizontal bicondylar line, then the line corresponding to the major axis of the included tooth was drawn (the angle is mesial) (figure 2). Warford et al., [14] localized the canine according to 4 sectors and measured the angle between the bicondylar line and long axis of canine. They concluded that the probability of canine impaction increased as the angle reduced and the sector increased. The authors confirmed that the angulation method was not clinically significant except for sector 2 where it contributed in prediction. In our study, the level of retention was limited to 2 sectors: low retention or high retention, 70.6% of high retention and 29.4% of low retention. 17.6% of the patients had canine inclusions in sector 1 while sector 2 involved 5.9% of the patients. 20.6% of the patients had canine inclusions in sector 3, although more than half of the patients (52.9%) revealed canine inclusions in sector 4. In previous research carried out on the same population (7), the location was buccal in 43.3% of the cases and generally high (63.3%). In the study group of Chaushu et al., [15], most canines (64.9%) were located close to the midline, mainly in sector 5 (35%) and sector 4 (29.9%). In the

study conducted by Syryńska et al., [13] in patients with unilateral impacted maxillary canine, 60.3% canines were localized in palatal position, 20.6% in vestibular position and 19.2% in axis position. In patients with bilateral impacted maxillary canines, the palatal position of impacted canines was the most frequent.

Grande et al., [16] carried out a study on 47 OPT with 59 displaced canines, the mean values for the angle of inclination of the maxillary canines from the occlusal plane were 57.4 degrees. They pointed out that the indication to remove or orthodontically tract maxillary canines should not be based on OPT alone. In contrast, Margot et al., [17] argued that their prediction model based on parameters measured on OPT was a valuable tool to decide between early intervention and regular follow-up of impacted canines.

55.9% of the patients in the present study had a partial transposition while 41.2% had no transposition. The study conducted [18] on the same population showed that the prevalence of tooth transposition was 2%, with the female population heavily affected (64%). Tooth transposition occurred only in the maxillary arch. Of all the teeth, the canines were the most involved in this anomaly.

Sometimes, the retained canines can cause resorption of the adjacent central and lateral incisors. Stivaros et al., [8] found out that 4.1% of their patients whose adjacent incisors were resorbed. Chaushu et al., [10] showed that root resorption was more common in females. Local factors were divided between those related to the impacted canine, position and size of the dental follicle and those related to the lateral, shape and size. According to Kurol [19] 12.5% of the cases studied revealed resorptions. In our study, 17.6% of the patients had resorption of the adjacent central and lateral incisors.

Our study showed that 67.6% of the patients underwent orthodontic treatment without extraction, and 32.4% underwent orthodontic treatment with extraction. In the study conducted by Weintraub et al., [20] the extraction rates ranged from 25% to 85% on a sample of 438 patient whose treatment was completed.

Bonding was performed peroperatively in 94.1% of the patients,, and postponed to a later session for 5.9% of the patients. In 73.5% of the cases, a closed eruption technique was required in which a flap was elevated and an attachment was bonded to the exposed surface of impacted canine, while only 23.5% of the cases required no raised mucoperiosteal flap (open eruption technique). Thus, in a systematic review [21], the authors concluded that there was no difference between the two techniques regarding the periodontal outcomes and aesthetic appearance. The surgical procedure was shorter in the open exposure group and the amount of postoperative pain during the first day was similar between the open and closed surgical exposure patients. However, these conclusions were based on two single trials with high level of evidence, while the rest of the studies presented high risk of bias.

The success rate of the included canines was 76.5%, while the rate of 23.5% was reported as a failure. In a study [8] conducted on 533 Southern Chinese children and adolescents having at least one impacted permanent maxillary canine, the success rate was 70%. The majority of orthodontists reported that their operating protocol was reliable, and if the treatment had to be repeated, they would have followed the same therapeutic approach. The overall treatment time to move an impacted canine back to its place in the dental arch may vary considerably, depending on the complexity of the case; it may range from 6 months to 18 months or even two years. In our study, the average duration of treatment was 26 months, with duration ranging from 18 to 36 months. In a previous study carried out on the same population [7] the mean treatment duration was 11.4 months. Fleming et al., [22] stated that the accurate prediction of treatment duration for orthodontic alignment of palatally impacted maxillary canines was difficult.

The correlations of association between angulation measurement, orthodontists' perceived degree of difficulty and overall treatment duration showed that there was a positive correlation between the orthodontists' perceived degree of difficulty and treatment duration, $p < 0.039$. In contrast, all the other correlation associations were negative, in particular, the association between overall treatment duration and angulation measurement the inclusion of the canine.

Conclusion

The successful treatment plan of impacted maxillary canines requires a good cooperation between different dental specialties, including surgeons and orthodontists. The diagnosis of these inclusions in general is the responsibility of orthodontists who will have decided on the treatment plan by taking into account the patient's needs, the evidence of science and their clinical skills and experience. In the present study, the success rate for placement of canines on the dental arch was 76.5%, and the sector method associated with the angulation method on the OPT could help to orthodontists to assess the prognosis of included canines.

Ethical approval

Ethical clearance was obtained from the Ethics Committee of Casablanca School of Dentistry, at Hassan II University.

Conflict of interest

There are no conflicts of interest to declare by any of the authors of this study.

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