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The importance of cone-beam computed tomography in the diagnosis and orthodontic planning of impacted canine

A importância da tomografia computada com cone-feixe no diagnóstico e planejamento ortodôntico de caninos impactos

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ABSTRACT

Until recently, conventional radiographic methods were the only images used to help the planning of cases of patients with impacted teeth. However, they are two-dimensional images and provided limited information about the location and positioning of the impacted tooth, as well as its relationship with adjacent structures, leading to diagnosis error and mistakes in the orthodontic treatment plan. The advent of cone-beam computed tomography in dentistry allowed the tridimensional visualization of anatomical structures. The aim of this study was to perform a literature review to evaluate the impact of cone-beam computed tomography in the diagnosis and planning of orthodontic treatment of cases with superior canines impacted, seeking to highlight if the access to the tomography images can modify the planning of the case. A search on the PubMed, Scielo and Bireme databases was performed using the descriptors: "Cone-Beam Computed Tomography", "Tooth, Impacted" and "Orthodontics", selecting literature review articles, clinical cases and comparative studies both in English and Portuguese literature. It was verified that the images obtained by the cone-beam computed tomography scan provide more reliable information regarding the location of the canine, as well as in the identification of root resorption in the adjacent teeth. This information is important for a more accurate diagnosis, which may lead to a change in the initial orthodontic treatment plan, which justifies the indication of cone-beam computed tomography as an auxiliary diagnostic tool in cases with impacted canine, even using higher doses of radiation when compared to two-dimensional images.

Key-words: Cone-Beam Computed Tomography. Impacted Tooth. Orthodontics.

Até recentemente, os métodos radiográficos convencionais eram as únicas imagens utilizadas para auxiliar no planejamento de casos de pacientes com dentes impactados. No entanto, são imagens bidimensionais e forneceram informações limitadas sobre a localização e posicionamento do dente impactado, bem como sua relação com estruturas adjacentes, levando a erros de diagnóstico e erros no plano de tratamento ortodôntico. O advento da tomografia computadorizada de feixe cônico na odontologia permitiu a visualização tridimensional de estruturas anatômicas. O objetivo deste estudo foi realizar uma revisão da literatura para avaliar o impacto da tomografia computadorizada de feixe cônico no diagnóstico e planejamento do tratamento ortodôntico de casos com caninos superiores impactados, buscando destacar se o acesso às imagens tomográficas pode modificar o planejamento do caso. Foi realizada uma pesquisa nas bases de dados PubMed, Scielo e Bireme, utilizando os descritores: "Tomografia Computadorizada de

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Feixe Cônico", "Dente, Impacto" e "Ortodontia", selecionando artigos de revisão de literatura, casos clínicos e estudos comparativos na literatura em inglês e em português . Verificou-se que as imagens obtidas pela tomografia computadorizada de feixe cônico fornecem informações mais confiáveis quanto à localização do canino, bem como na identificação de reabsorção radicular nos dentes adjacentes. Essas informações são importantes para um diagnóstico mais preciso, que pode levar a uma alteração no plano inicial de tratamento ortodôntico, o que justifica a indicação da tomografia computadorizada de feixe cônico como uma ferramenta auxiliar de diagnóstico em casos com caninos afetados, mesmo com doses mais altas de radiação. quando comparado com imagens bidimensionais.

Palavras-chave: Tomografia Computadorizada de Feixe Cônico. Dente impactado. Ortodontia.

1 INTRODUCTION

The superior canines are responsible for establishing a dynamically balanced occlusion, being essential for the function and stability of the occlusion; in addition, they play an important role in facial aesthetics and harmony (MANZI ET AL., 2011; WRIEDT ET AL., 2012; ALQUERBAN ET AL., 2014; MIRESMAEILI ET AL., 2015).

Despite the significant importance of the presence of the canine tooth included in the dental arch, 1 to 3% of the maxillary canines tend to remain included, being frequently found in the clinical practice of orthodontics (ERICSON, KUROL, 1987; RICHARDSON, RUSSEL, 2000; COOKE, WANG, 2006). The occurrence of inclusion is, in most cases, unilateral (MAAHS, BERTHOLD, 2004; JAWAD ET AL., 2016), being more frequently found in women (BJERKLIN, ERICSON, 2006; ALQUERBAN ET AL., 2011; ALQUERBAN ET AL 2014, CHAUSHU ET AL., 2015;UKAR ET AL., 2017; and the canines are most often positioned by the palatine in relation to the adjacent incisors (RICHARDSON, RUSSEL, 2000; BJERKLIN, ERICSON, 2006; WRIEDT ET AL., 2012; ALQERBAN ET AL., 2013; CHAUSHU ET AL., 2015; UCAR ET AL., 2017).

Until recently, conventional radiographic methods, such as panoramic, periapical, occlusal, and lateral radiographs, were the only imaging tests used to aid in the planning of cases of included teeth. However, since these are two-dimensional examinations, these tests provide limited information with regard to the location and positioning of the included tooth, as well as its relationship with adjacent structures, providing diagnostic defects and on the orthodontic treatment plan (MARTINS ET AL., 2009; HANEY ET

AL., 2010; ALQERBAN ET AL., 2011; MANZI ET AL., 2011; ALQERBAN ET AL., 2014; UCAR ET AL., 2017).

The advent of the TCFC in dentistry allowed the visualization and highly detailed three-dimensional evaluation of the anatomical structures, becoming an auxiliary resource for cases of included teeth, since it makes the diagnosis and consequent planning of the orthodontic movement safer and more precise, optimizing the and in the literature on the use of the term. (MARTINS ET AL., 2009; MANZI ET AL., 2011; HODGES ET AL., 2013; ALQERBAN ET AL., 2014; JAWAD ET AL., 2016; UCAR ET AL., 2017).

Although producing higher doses of radiation when compared to two-dimensional imaging, the CBCT test produces a lower dose of radiation as compared to the medical CT scan (JAWAD ET AL., 2016; UCAR ET AL., 2017); thus justifying the use of CBCT. In this way, it respects the ALARA (as low as reasonably achievable) principle, which always seeks to use the lowest radiation dose possible, producing good quality images for diagnosis (AMERICAN ACADEMY OF ORAL AND MAXILLOFACIAL RADIOLOGY, 2013; MÜLLER ET AL. , 2013, ALQERBAN ET AL., 2014).

The objective of this study was to perform a literature review to evaluate the impact of CBCT and orthodontic treatment planning of cases that present superior canines, trying to evaluate if there is a difference between the orthodontic treatment plan elaborated based only on conventional orthodontic documentation and that that besides the traditional documentation, the orthodontist also had access to the additional information obtained through a CBCT examination.

2 METHODOLOGY

A descriptive literature review study was carried out that addresses the use of two types of imaging tests, CBCT versus two - dimensional radiographs, in the orthodontic planning of upper canines included.

A research was done the PubMed, Scielo and Bireme databases, using the descriptors: "Cone-Beam Computed Tomography", "Tooth, Impacted" and "Orthodontics", selecting literature review articles, clinical cases, meta-analysis and comparative studies in English and Portuguese literature. The selection of scientific articles published in the last 10 years was made; classic articles and books widely accepted by the scientific community were also used.

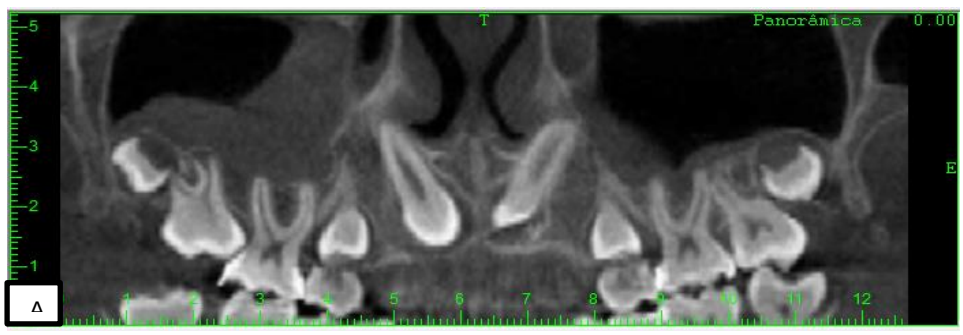
The exclusion criteria used to select the articles were: references that addressed impaction of other dental elements that were not superior canines, reports of cases with multiple dental impactions and studies carried out on syndromic or fissured patients.

3 LITERATURE REVIEW

The etiology of canine impactions is of multifactorial origin, involving general and local factors. (BISHARA, 1992; MANZI et al., 2011). As general factors, heredity, endocrine disorders and syndromes with craniofacial malformations stand out. As local factors, lack of dental arch space, disturbance of permanent eruption, incorrect germ positioning, ankylosis, permanent lateral incisor agenesis, prolonged retention or premature loss of deciduous tooth, cleft palate, presence of cysts, tumors or supernumerary in the region. However, according to several authors, (JACOBY, 1983; CAPPELLETTE ET AL., 2008; ALQERBAN ET AL., 2011; MANZI ET AL., 2011; JUNG ET AL., 2012), the most important local factor for the inclusion of the superior canines is the long and tortuous eruption path that this tooth presents, causing this tooth to take twice as long to complete its eruption when compared to the other dental elements (CAPPELLETTE ET AL. , 2008).

The most frequent adverse effect associated with upper canine impaction is the external root resorption of the adjacent upper lateral incisor (BJERKLIN, ERICSON, 2006; ALQERBAN ET AL. 2011; ALQERBAN ET AL. 2014; MIRESMAEILI ET AL., 2015; JAWAD ET AL UCAR ET AL., 2017). **FIGS. 1 and 2.**

Figure 1 - Computed tomography of conical bundle indicated for evaluation of upper canines included. A - Panoramic reconstruction evidencing superior canines in ectopic position; B - Panoramic reconstruction showing external root resorption in the upper incisors due to the presence of impacted canines; C - Axial reconstruction evidencing external root resorption present in teeth 12, 11 and 21.



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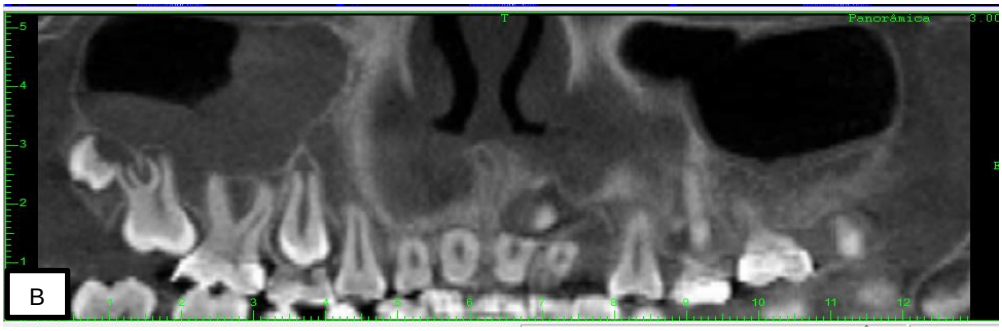
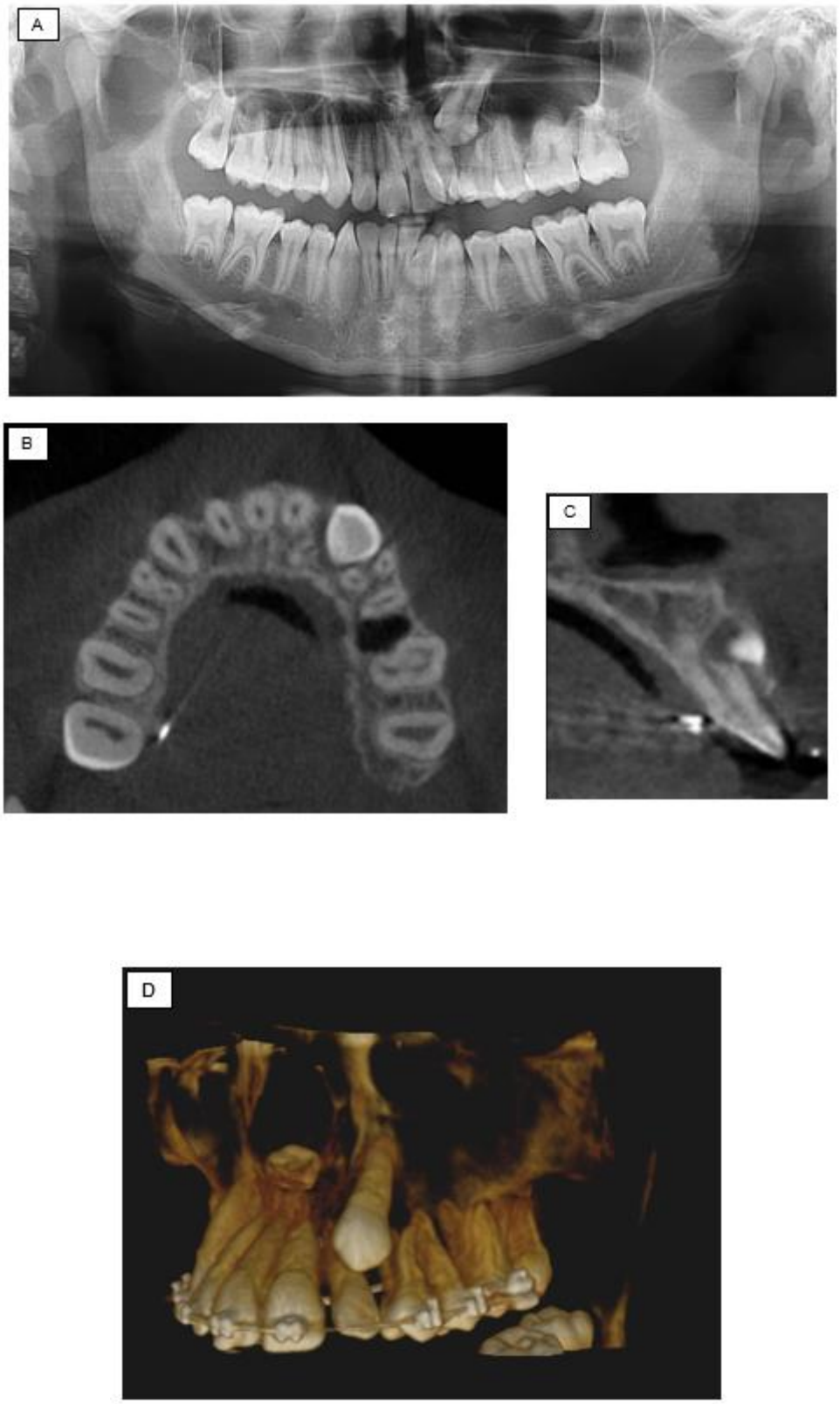


Source: Private Archive

Figure 2. A - Panoramic radiograph showing tooth 23 included and with crown image superimposed on the roots of teeth 22 and 24; B - Axial reconstruction evidencing external root resorption present in tooth 22; C - Reconstruction transverse to the ridge, evidencing the presence of external root resorption on the buccal surface of the tooth 22. D - Three-dimensional reconstruction.



Source: Private Archive

External root resorption on the vestibular and palatine surfaces are extremely difficult to visualize only with two-dimensional radiographs, making the CBCT superior to conventional radiographs in evaluating the presence of external root resorption in the incisors adjacent to the included canines and consequently being important for the elaboration of a treatment plan. (BJERKLIN, ERICSON, 2006; JAWAD ET AL., 2016; UCAR ET AL., 2017). **Fig. 3**

Figure 3 - Image exams for evaluation of included canine. A - Periapical radiography evidencing the presence of right upper canine included and in the process of orthodontic traction. In this image we can not fully evaluate the root of the incisors due to the overlap of the canine crown image. B - Reconstruction transverse to the ridge in region 11, evidencing the presence of external root resorption on the buccal surface. C - Reconstruction transverse to the ridge in region 12, showing intimate contact of the crown of the 13 with the vestibular surface of the root of 12, but without presence of root resorption.

Source: Private Archive

According to the guidelines developed by the American Academy of Oral and Maxillofacial Radiology containing clinical recommendations regarding the use of TCF in orthodontics, examination should only be requested when the benefit to the patient is greater than the potential risk of a higher dose of radiation, that is, when the CT scan has the potential to provide information that is not demonstrated on conventional radiographic examinations, and the additional information that is desired has the potential to significantly alter the diagnosis and treatment plan or facilitate / optimize the performance of treatment (AMERICAN ACADEMY OF ORAL AND MAXILLOFACIAL RADIOLOGY, 2013).

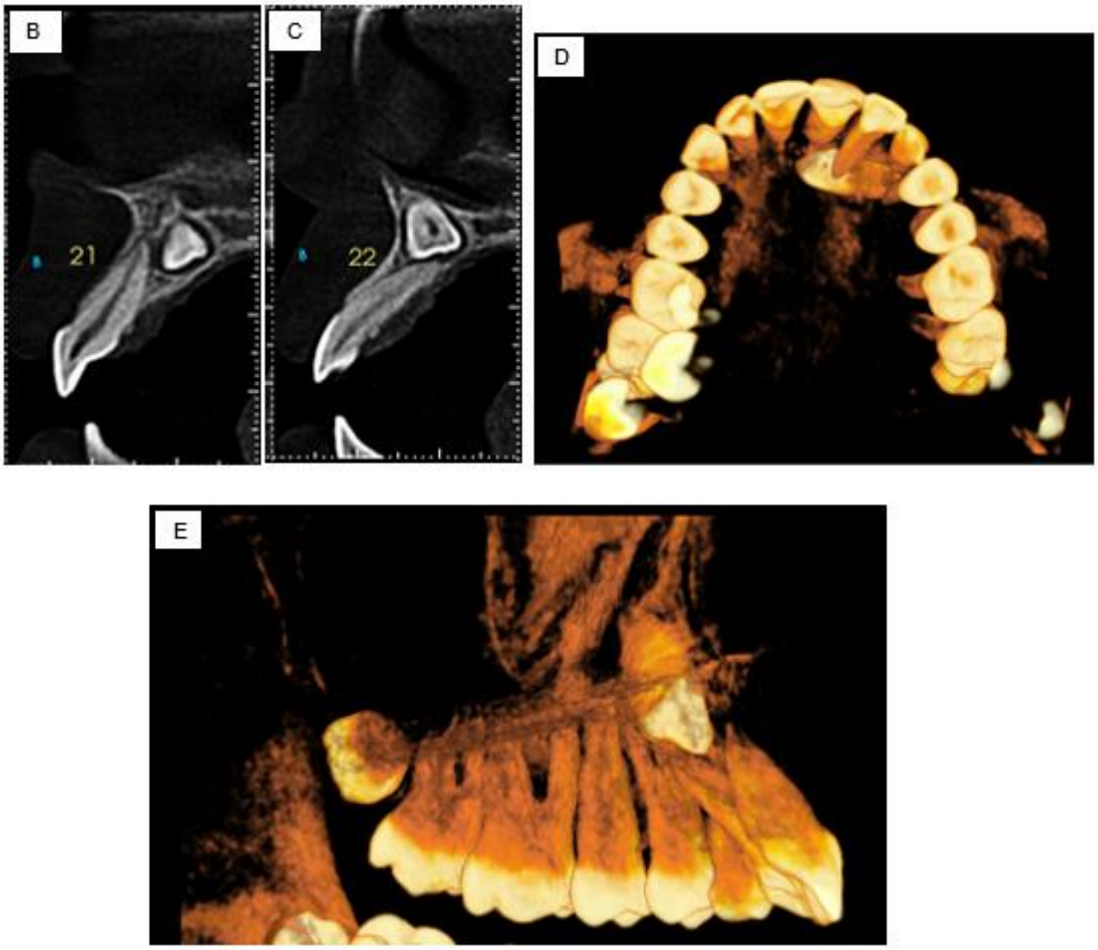
4 DISCUSSION

Several studies have shown that CBCT has been able to provide more reliable information than two-dimensional imaging methods with regard to the precise location of the included tooth, as well as inclination, angulation, crown height relative to the occlusal plane, crown, root length, as well as the visualization of the canine root dilaceration even (BODNER ET AL., 2001; ALQERBAN ET AL., 2011; BOTTICELLI ET AL., 2011; ALQERBAN ET AL., 2013 ; Alqerban et al., 2014)

Fig.4. The importance of this information is due to the fact that the correct localization of the canines included is essential to establish the treatment plan, since it assists in the surgical access and in the direction of the orthodontic forces to be applied during the traction (HANEY ET AL., 2010 WRIEDT ET AL., 2012).

Figure 4: Differences in the location of canines included between panoramic radiography and conical beam tomography. A - Panoramic radiography evidencing the presence of a

tooth 23 included, but without showing the correct relation between the included canine and the adjacent incisors; B - Reconstruction transverse to the ridge showing that the crown of the canine is palatine in relation to tooth 21; C - Reconstruction transverse to the collar showing that the crown of the canine is vestibular in relation to tooth 22; D, E - Three-dimensional reconstruction.



Source: Private Archive

According to Bjerklin and Ericson (2006) in 50% of the patients who present with canines, some degree of external root resorption in the adjacent incisors is found. For Jung et al. (2012) this percentage was 30%, while for Wriedt it was 38%. In the study by Hadler-Olsen et al. (2015) it was verified that 11% of the central incisors and 67.6% of the adjacent lateral ectopic canines presented some degree of resorption, whereas that percentage was 0% and 36.2% in the group that presented a canine in normal eruption. In the study by Jawad et al. (2016), it was verified that 45% of lateral incisors adjacent to canines included had external root resorption. Ucar et al. (2017) found a statistically significant decrease in the lateral volume of the lateral incisors adjacent to canines

included, when compared with lateral incisors of the same patient and the opposite side that did not present the canine. Therefore, it is important to know the extent of this resorption before orthodontic treatment is initiated.

Bjerklin and Ericson (2006) concluded that the amount of external root resorption detected on a CT scan was approximately 50% greater than that detected on conventional radiographs. Haney et al. (2010) observed that the imaging modality significantly influenced the identification of this alteration, with 36% of discordance in the detection of external root resorption of adjacent teeth to canines included when compared with images produced by conventional radiographs and images produced by TCFC. Alqerban et al. (2011) also found significant differences in the detection of the presence and severity of external root resorption in the lateral incisors, as well as Botticelli et al. (2011) and Alqerban et al. (2013), which showed that external root resorption of the lateral incisors was detected more frequently with CBCT images than with panoramic images; however, in the study by Alqerban et al. (2014), although the presence of root resorption in the lateral and central or premolar incisors were more detected in the CBCT, when compared to conventional records, this difference was not statistically significant.

In the study by Jawad et al. (2016), it was verified that in 63% of the cases that presented external root resorption in the incisors adjacent to the canines included, the presence of this alteration was only confirmed after the CBCT analysis; 36% of the cases with intact roots in the panoramic radiographic image were diagnosed with presence of external root resorption when the CBCT examination was evaluated, which proves that tomographic images have a greater accuracy in the detection of external root resorption when compared to the images two-dimensional.

Oenning et al. (2013) and Jawad et al. (2016) stated that in cases of lack of space for the correct alignment of all teeth, where it will be necessary to perform extraction of some dental element, the presence of extensive external root resorption in a lateral incisor adjacent to the canine can significantly modify the orthodontic treatment plan as it changes the tooth chosen for extraction.

It is known that the choice of the treatment type for canine impaction depends on the location and angulation of the included tooth, the distance from the tooth to the alveolar process, the mid-distal positioning of the canine tip, the presence of root dilaceration, the contact with adjacent teeth and the presence, location and severity of root resorption in adjacent teeth; which have been shown to be statistically different between panoramic and tomographic images in several studies (BODNER et al., 2001;

ALQERBAN ET AL., 2011; BOTTICELLI et al., 2011; 2013; Alderman et al., 2014; Mirsleyeil et al., 2015).

Several studies have observed a change in the orthodontic treatment plan of cases that included canines after access to the tomographic examination. In the study by Bjerklin and Ericson (2006), this change was verified in 43.7% of the sample. Most of the time, the modification in the treatment plan was due to the change in the decision on the need for extraction and on which tooth to be extracted. In the planning performed without tomography, 17.5% of the sample would have one or both lateral incisors removed without need and 10% of the sample that would have the first premolars extracted, after the evaluation of the CT scan, had the treatment plan changed for the absence of extraction or extraction of lateral incisors, canines or second premolars. In the study by Haney et al. (2010), 27% of the teeth that were planned with the traditional radiographs to be left, tractioned or extracted were selected for a different treatment when the evaluators visualized the three-dimensional images.

In addition, if the treatment plan included tooth traction, the selection of the initial traction vector was significantly influenced by CT. Botticelli et al. (2011) also showed divergences between the treatment plans elaborated. The authors verified that there was a greater choice for tooth trapping even when three-dimensional images were evaluated, even results found by Wriedt et al. (2012), who verified a change in the treatment plan of almost 52% of the canines indicated for extraction when only the panoramic radiography was evaluated. Hodges et al. (2013) compared orthodontic planning based on traditional orthodontic documentation with the planning performed with CBCT and verified a change in the treatment plan of 22% of the cases that had some even tooth; being most of the changes related to the mechanics that would be applied to carry out the traction of this tooth.

The evaluation of several studies showed that the set of images obtained by the CBCT provides important additional information when compared to two-dimensional images (BODNER ET AL., 2001; ALQERBAN ET AL., 2011; BOTTICELLI ET AL., 2011; WRIEDT ET AL., ALQERBAN ET AL., 2013, ALQERBAN ET AL., 2014). The initial treatment plan may be altered because of the greater sensitivity of the CBCT in diagnosing the presence and extent of external root resorptions caused by this breakthrough anomaly in adjacent teeth. Often, the teeth chosen for extraction were those affected by root resorption that reached the pulp cavity. This information, therefore, has a strong clinical relevance, which justifies the highest dose of radiation produced by

TCFC (BJERKLIN, ERICSON, 2006; GARIB ET AL., 2007; HOTEY et al., 2010; WRIEDT ET AL., 2012; HODGES ET AL., 2013; UCAR ET AL., 2017).

5 CONCLUSION

After reviewing the literature, it was concluded that, in cases with canine inclusion, the images obtained by means of the CBCT examination are able to provide more reliable information regarding the location of the canine as well as the detection of resorption the adjacent teeth. This information is important for a more accurate diagnosis and may lead to a change in the initial orthodontic treatment plan; which can generate a better treatment result and a more favorable prognosis, justifying the indication of the CBCT, even using higher doses of radiation when compared to two-dimensional tests.

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