2D and 3D Imaging for Morphological Assessment of Maxillofacial Cyst and Tumors: A Case Series

Imagen 3D para la Evaluación Morfológica de Quistes y Tumores Maxilofaciales: Serie de Casos

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SUMMARY: The use and importance of cone beam computed tomography (CBCT) in the diagnostic, treatment and long term follow up of odontogenic tumours, as well as one reconstruction and dental implants rehabilitation is reported. This clinical series shows diagnosis of odontogenic tumors using selected and used CBCT for initial diagnosis, morphological characterization, and follow up for 5 to 10 years. The CBCTs showed the size and form of the tumor and the follow up showed a satisfactory remodelling of bone and the success in the rehabilitation with dental implants. No signs of recurrence were observed. The conventional radiographies, Fan Beam CT, Cone Beam CT and Magnetic Resonance Imaging (MRI) are discussed in the use for follow up of odontogenic tumors. It is concluded that CBCT is an efficient tool for diagnosis, follow up and assessment of the morphology and size of the tumor in order to achieve the best treatment plan, returning the functional conditions to the patients.

KEY WORDS: Odontogenic tumors; Conservative treatment; 3D; Cone Beam Computed Tomography.

INTRODUCTION

The odontogenic tumors constitute a heterogeneous group of lesions with diverse clinical and histopathological characteristics. The biological behavior of these lesions include hamartomatous proliferations, non-aggressive benign tumors, aggressive, and malignant tumors (Buchner *et al*., 2006). Some authors show that these lesions comprise almost 3% of all lesions of the jaws (Bianco *et al*., 2020) and might cause bone expansion and destruction, eventually resulting in facial deformity (Moraes *et al*., 2014).

Clinical study and imaging are complementary for diagnosis and treatment. Dental and panoramic radiographies are frequently used in an initial assessment, however these analysis show limited data and could lead to erroneous conclusions (Rioux-Forker *et al*., 2019). Some lesions present similar clinical, morphological and radiographic characteristics (Araujo *et al*., 2016; Barrett *et al*., 2017; Meng *et al*., 2019) and more advanced imaging diagnosis techniques such as the Fan Beam Computed Tomography (FBCT), Cone Beam Computed Tomography (CBCT), Magnetic Resonance Imaging (MRI) and Ultrasonography are necessary to obtain morphological characterization and prognosis related to soft and hard tissue (Rioux-Forker *et al*.).

Treatment included radical or conservative approach and many therapeutic modalities are presented in the scientific literature (Menon, 2015). Some cysts and tumors show significant recurrence rates, which often result in more aggressive treatments with increased morbidity, such as the large bone resections with safety margins (Chrcanovic & Gomez, 2017; Au *et al*., 2019).Conservative techniques like decompression and marsupialization can result in reduction of the size of the lesions, minimizing risks of sequelae associated to large resections. Less invasive adjuvant techniques as peripheral ostectomy, application of Carnoy's solution and cryotherapy are used in order to diminish recurrence rates (Leung *et al*., 2016; de Souza Cruz *et al*., 2016; Al-Moraissi *et al*., 2017).

Cone Beam Computed Tomography (CBCT) has been introduced in the early 2000 and created a new paradigm for the assessment of maxillary and mandibular bone in Office

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(Guttenberg, 2008). CBCT shows major relevance in the follow up of conservative treatments of cysts and tumors of the jaws because it provides a detailed evaluation in the size of the lesions as well as the recurrences (Gamba *et al.*, 2016).

The aim of this research is to show the role of CBCT images in the follow up of clinical conditions related to odontogenic tumors treated by some strategies in different stages, during decompression, after bone reconstruction and rehabilitation with dental implants.

RESULTS

Case 1: Multicystic Ameloblastoma. A 24 year- old female patient showing a slight swelling in the anterior region of the mandible, related to teeth 31 to 34. In the 2D panoramic radiography it was possible to observe the presence of a radiolucent multilocular image, with bubble soap aspect, similar to the radiographic features of a multicystic ameloblastoma. In a CBCT, it was possible to notice the bulging of the buccal and lingual cortical bone as a result of the expansion of the lesion (Figs. 1A and 1B). In the histopathology the presence of islands of epithelium was observed, as well as the enamel organ epithelium in a mature stroma of fibrous connective tissue, which confirmed the

hypotheses of multicystic ameloblastoma.

Under general anesthesia, extraction of teeth 31, 32, 33, 34, 41 and 45 associated to the lesion, followed by a segmental conservative resection was performed. After resection, a peripheral ostectomy with a round bur was performed in the cortical lingual bone region. The area was reconstructed at the same time with autogenous bone blocks harvested from the retromolar region which were fixed with screws, associated to particulated bone graft and platelet concentrate.

After 6 months, a healthy bone tissue could be observed, with signs of bone remodeling (Fig. 1C). Four osseointegrated implants were installed in the area, and a fixed prosthesis after 4 months was installed. The patient was followed up during 5 years and didn`t show any recurrence.

Case 2: Unicystic Ameloblastoma. A 33-year-old male patient showed pain in the right side of the mandible, close to 48, clinically related to pericoronitis; however, at the CBCT presented an unicystic, well defined, hipodense osteolytic lesion in the right mandibular ramus suggesting the diagnosis of odontogenic keratocyst or unicystic ameloblastoma (Figs. 2A, 2B and 2C). Impairment of the mandibular ramus and root resorption of the 48 was also noted . In the initial surgical time the dental extraction of 48
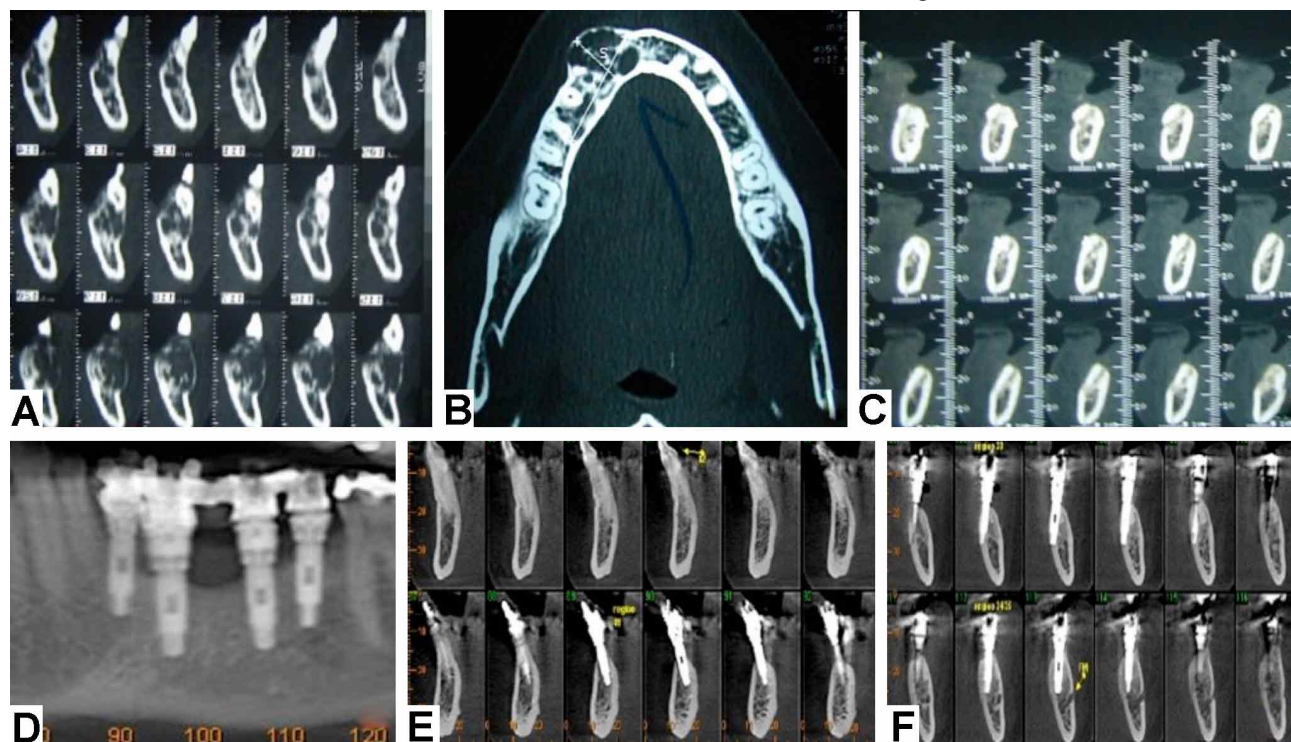

Fig. 1. A. Initial view of the lesion in paraxial CT scans; B. CT scan/Bulging of cortical bone; C. Paraxxial CT scan from the grafted área after 6 months; D. Follow up CBCT after 5 years (Panoramic Screen); E. Paraxial CT scans from the resected and grafted area with implants after 5 years; F. Paraxial CT scans from the resected and grafted area with implants after 5 years.

was performed as well as the incisional biopsy and the placement of an obturator device for decompression. The histopathology confirmed the unicystic ameloblastoma. The 18-month follow-up was realized using CBCT (Figs. 2D, 2E and 2F), and after that, the total enucleation of the pathology was performed.
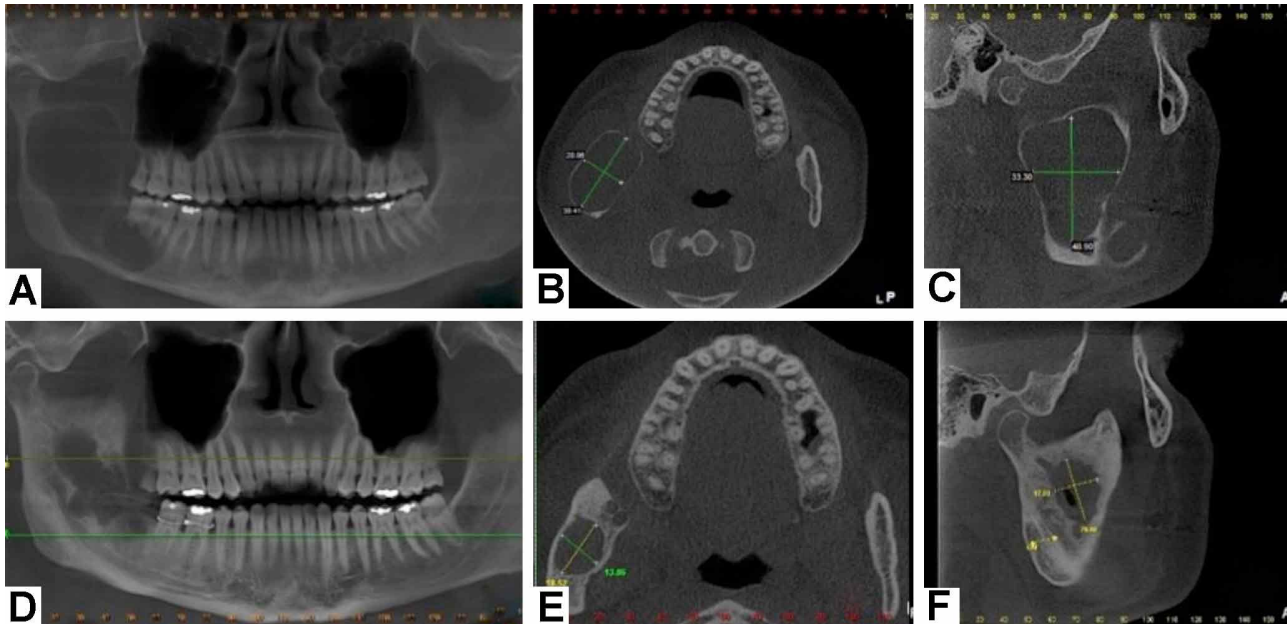

Fig. 2. A. Initial view of the lesion (Panoramic view); B. Paraxial CT scan of the lesion; C. Paraxial CT scan from the grafted area after 6 months; D. Panoramic view (Decompression 18 months); E. Paraxial CT scan (Decompression 18 months); F. Sagital CT scan (Decompression 18 months).
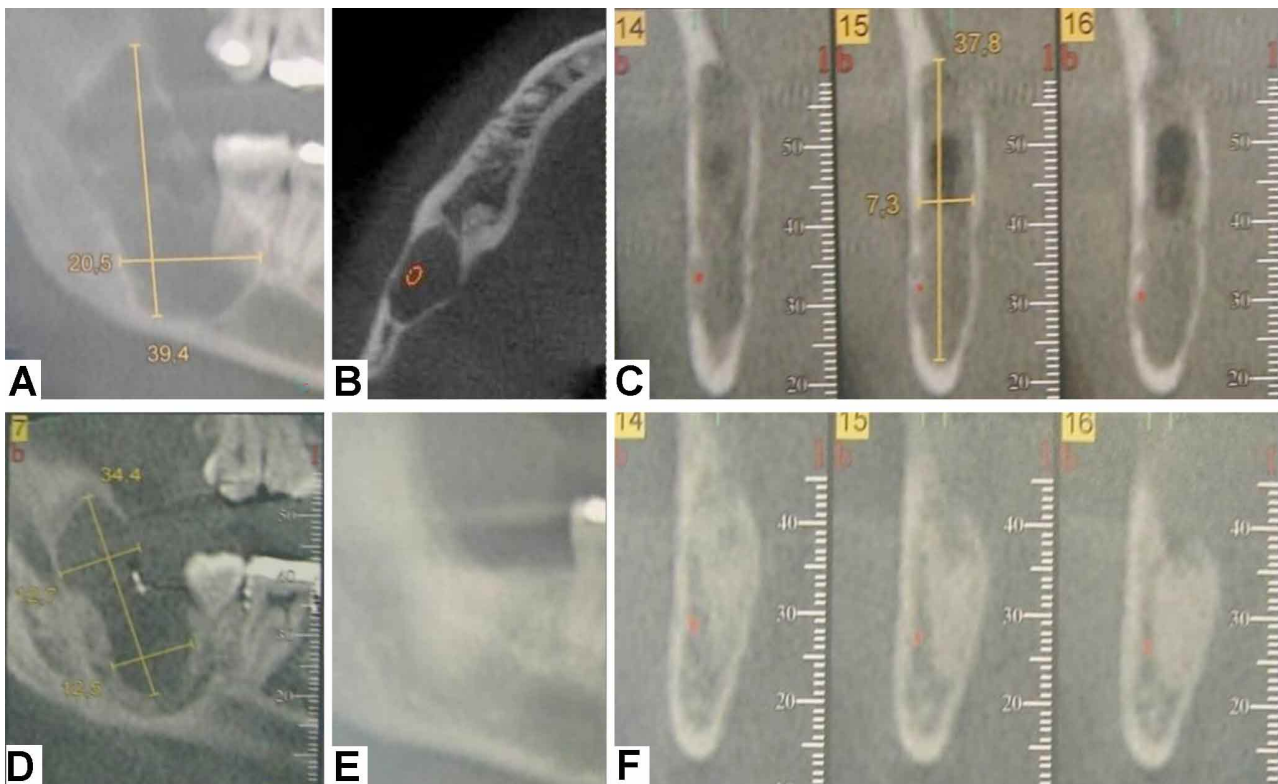

Fig. 3. A. Panoramic view of the lesion; B. CT scan of the lesion; C. Paraxial CT scan of the initial lesion; D. Panoramic view after 12 months of decompression; E Follow up panoramic view of the region 5 years after enucleation and bone reconstruction; F. Paraxial CT scans/Follow up panoramic radiography of the region 5 years after enucleation and bone reconstruction.

Case 3: Odontogenic Keratocyst. A 44-year-old male patient showed a CBCT image close to an odontogenic cyst or tumor in the posterior region of the mandible, associated with element 48. It was possible to notice the presence of an osteolytic lesion with a hypodense, radiolucent image, uniloculated in the posterior region of the mandible. (Figs. 3A, 3B and 3C). An incisional biopsy of the capsule was performed for histopathological analysis and an obturator device was installed for decompression; the histopathological analysis showed the odontogenic keratocyst. Treatment outcome was followed up using CBCTs for 12 months, with a significant reduction in the size of the odontogenic keratocyst (Fig. 3D). After 12 months, the patient was admitted for enucleation of the tumor and to fill the remaining gap using biomaterials. The patient was followed up for five years with CT scans and no signs of recurrence were observed. (Figs. 3E and 3F)

Case 4: Adenomatoid Odontogenic Tumor. A 14-year-old male showing swelling in the vestibular region close to 43 and 45. In the panoramic radiography a well-defined radiolucent unicyst area was observed, involving tooth 44 and displacement teeth 43 and 45 (Fig. 4A). Under the hypotheses of dentigerous cyst or adenomatoid odontogenic tumor, surgical plan included a 1st stage for tumor enucleation surgery and bone reconstruction using calcium sulfate (Osteoset, Wright Medical Technology - USA) and organic bovine bone (Organic Genox, Baumer), mixed with platelet concentrates (Fig. 4B); histopathological analysis confirmed the diagnosis of adenomatoid odontogenic tumor; the 2nd stage was to observe the radiographic and development of the facial skeleton (Figs. 4C and 4D); the 3rd stage, at 21 y.o., was for installation of dental implant submitted to immediate loading in the area (after eight years) and prosthetic rehabilitation.
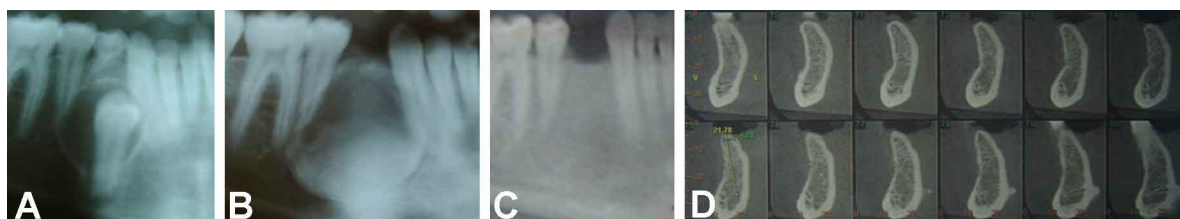

Fig. 4. A.Panoramic radiography of the initial lesion; B. Panoramic radiography in the immediate postoperative period; C. Follow up panoramic view after 8 years; D. Follow up Paraxial CT scans after 8 years.
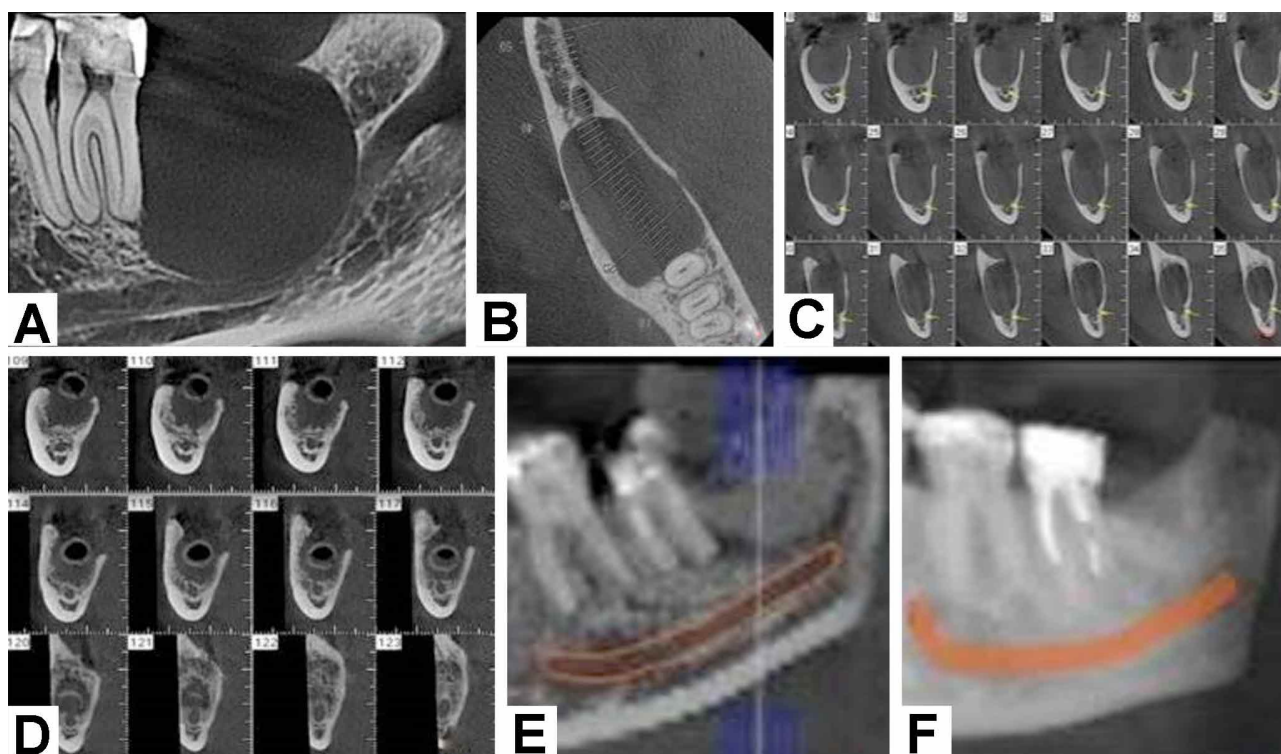

Fig. 5. A. Panoramic view of the initial lesion; B. Paraxial CT scan of the initial lesion; C. Transversal CT scans of the initial lesion; D. Transversal CT scans of the lesion after 12 months of decompression; E. CBCT after enucleation and grafting (Panoramic view); F.CBCT panoramic view (Follow up of 2 years).

Case 5: Residual Cyst. A 52-year-old female presented a radiolucent area in the posterior region of the left mandible causing slight bone expansion of the vestibular cortical bone and disrupting the upper cortical of the mandibular canal (Figs. 5A, 5B and 5C). Histopathological analysis was performed (confirming the diagnosis of inflamatory residual cyst) and an obturator device was used for decompression. After 12 months a significant reduction in the size of the cyst was observed with new bone neoformation (Fig. 5D). Enucleation was performed and the remaining bone defect was treated with biomaterials (Lyophilized Bovine Bone - Bioss® Geistlich Wolhusen) (Fig. 5E).In 2 years follow up no recurrence was observed (Fig. 5F).

DISCUSSION

This research shows different clinical cases performing conservative treatments for odontogenic tumors using CBCT for the follow up. 3D image allows the analysis of morphological characteristics of the lesions such as structural condition and extension, presence of teeth, expansion or perforation of corticals bone, proximity to anatomical landmarks, presence of recurrences, among other information necessary to define the initial diagnosis that guided the treatment and follow up (Kheir *et al*., 2013; Gamba *et al*.; Parmar *et al*., 2016; Milman *et al*., 2016; Meng *et al*.).

Stoelinga *et al*. (2012) recommend not performing preoperative incisional biopsies in cases of unilocular lesions observed radiographically. In these cases, enucleation of the lesion and subsequent histopathological analysis are recommended. In this sense, other authors contraindicate the decompression technique for lesions in the presence of multiloculated images, mainly related to aggressive tumors with a high recurrence (Effiom *et al*., 2018).

In this context, the Fan Beam Computed Tomography (FBCT) and Cone Beam Computed Tomography (CBCT) techniques show a great value in diagnosis, treatment and follow up of oral and maxillofacial pathologies and their advantages are confirmed in this research (Kheir *et al*.; Gamba *et al*.; Meng *et al*.). FBCT has high contrast resolution, allows the use of agents that reinforce the contrast of images in tissues with greater vascularity such as tumors and offers high quality in the reconstruction of images (Pereira *et al*., 2001). This is an advantage when compared to CBCT, because it allows visualization of the internal contents of the tumor with more details (Meng *et al*.). Apajalahti *et al*. (2015) concluded that the use of FBCT and contrast is better for analysis of mixed cystic content and solid content in cases of ameloblastomas. On the other hand, the use of contrast

could be related to higher doses of radiation and possible allergic reactions and renal dysfunction (Meng *et al*.; Oda *et al*., 2019). Another disadvantage is the finantial costs and the size of the equipment that need a bigger area than CBCT requirements, usually non compatible with dental clinics (Guttenberg; Gamba *et al*.).

Magnetic Resonance Imaging (MRI) could be used as an advanced technique for diagnostic widely used for some pathologies, diagnosing and monitoring of various medical conditions in the medical field (Omaskovic *et al*., 2018; Duarte & Xin, 2019; Lerch *et al*., 2020; Rao *et al*., 2021). Kurabayashi *et al*. (2021) claim that the main advantages of magnetic resonance imaging include the excellent contrast of soft tissues without the use of ionizing radiation. The same authors still believe that the use of contrast agents by diffusion is able to show the internal structures of an odontogenic tumors. This idea is confirmed by recent studies (Vanagundi *et al*., 2020). MRI is considered of great value to show differences in tumors with the same clinical behaviour, radiographic and morphological characteristics, being more effective than FBCT and CBCT (Kheir *et al*.).

However, their use is still restricted today and limited to assessments of soft tissue tumors and disorders of the temporomandibular joint (Kurabayashi *et al*.). The finantial cost is another issue to include in this analysis (Gamba *et al*.). Other important disadvantages include the closed architecture of the devices and the time taken to perform the exam superior to CTs (Mendes *et al*., 2020). Some clinical conditions of patients, such as the use of cardiac pacemaker devices, also constitute important contraindications for this exam (Russo *et al*., 2017).

CBCT is growing in use and applications. The finantial cost is estimated to be 3 to 5 times lower than that of the FBCT, the equipment is smaller, being more compatible with dental clinics and quantitatively, the radiation is considerably less compared to the FBCT (Guttenberg; Nasseh & Al-Rawi, 2018). In terms of diagnosis, treatment and monitoring of odontogenic tumors, the CBCT is able to offer information regarding the presence of bone cortical expansions and perforations, presence of bone septa, radiolucency and radiopacity of internal structures, proximity of anatomical structures (Guttenberg; Kheir *et al*.; Gamba *et al*.; Meng *et al*.). In the same direction, others show that the CBCT could be used for three dimensional print and stereolithographic models that help in simulation and planning of reconstructions of bone defects after extensive resections (Cohen *et al*., 2009; Kim *et al*., 2016). As a disadvantage, this technique has a lower contrast resolution than the FBCT, which makes it difficult to differentiate between the various types of tissues (Nasseh & Al-Rawi).

Finally, we can conclude that CBCT is a usefull strategy for diagnosis, follow up and for assessment of tumor's morphology and structure. Other techniques could be used, but CBCT is more cost/effective in the follow up to choose the best surgical technique.

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RESUMEN: Se reporta el uso y la importancia de la tomografía computarizada de haz cónico (CBCT) en el diagnóstico, tratamiento y seguimiento a largo plazo de tumores odontogénicos, tal como en una reconstrucción y rehabilitación de implantes dentales. Esta serie clínica muestra el diagnóstico de tumores odontogénicos utilizando CBCT seleccionados y usados para el diagnóstico inicial, caracterización morfológica y seguimiento durante 5 a 10 años. Los CBCT mostraron el tamaño y la forma del tumor y el seguimiento mostró un remodelamiento óseo satisfactorio y el éxito de la rehabilitación con implantes dentales. No se observaron signos de recurrencia. Las radiografías convencionales, el uso de TAC, TAC de haz cónico y resonancia magnética nuclear (RMN) se consideran para el seguimiento de tumores odontogénicos. Se concluye que CBCT es una herramienta eficaz en el diagnóstico y seguimiento a largo plazo para evaluar la morfología del tumor y de su tamaño, y además, para obtener los mejores resultados en el tratamiento y eventuales condiciones funcionales de los pacientes.

PALABRAS CLAVE: Tumores odontogénicos; Tratamiento conservador; 3D; Tomografia computarizada de haz conico.

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