

# 3D evaluation of dental impaction using Computed Tomography

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**ABSTRACT:** Dental impaction is the total or partial lack of eruption of a tooth. Their origins include various local causes, such as supernumerary teeth, which represents excess of teeth in regular dental formula. Treatment of impacted teeth requires a combination of oral surgery and/or orthodontic therapy. Although others radiographic techniques are used to diagnose and assessment dental impaction, Dental Computed Tomography (Dental CT) is the main method for accurately localize and to show orientation and morphology of the supernumerary and impacted teeth. These parameters are essential for allowing surgical and orthodontic successful procedures. This paper presents the role of Dental CT with a clinical case of maxillary central incisor impaction.

## 1 INTRODUCTION

Computed Tomography (CT) currently has an important role in the aid of diagnostic and the treatment planning in Dentistry. CT examination, complemented by specific dental software (Dental CT), a series of two-dimensional image data sets can be integrated mathematically to generate panoramic and cross-section images of the patients' jaw. These images enable the internal and external viewing and measurement of anatomical structures in slices. Also, provides the ability to perform tridimensional (3D) reconstructions of the entire region.

Impacted teeth are those prevented from erupting by some physical barrier in their path. Common factors in the etiology of impacted teeth include supernumerary teeth, odontogenic tumors such as odontomas or cysts, alteration in the eruption path or formation of scar tissue due to trauma, premature loss of deciduous teeth, abnormal root angulation or tooth dilaceration (Avinash & Aieshya 2011, Reddy et al. 2011, Suri et al. 2004). Although unerupted teeth can occur in both permanent and deciduous dentition, permanent teeth are much more prone for impacting than deciduous teeth, due to the duration of their odontogenesis (Bodner et al. 2001). The most impacted maxillary tooth is the canine, followed by the central incisor with a prevalence of 0.6 – 0.2 % (Avinash & Aieshya 2011).

Supernumerary teeth are those that are in excess of the regular dental formula. The reported prevalence of supernumerary teeth is 0.1 – 3.8% in Cau-

casian population (Rajab & Hamdan 2002). Supernumerary teeth can grow in any region of the dental arch, but they are most common in the anterior maxilla, being the main cause of impaction of upper incisors (Rajab & Hamdan 2002, Smailiene et al. 2006, Suri et al. 2004).

The treatment of impacted maxillary permanent incisors is challenging due to these teeth importance to facial aesthetics. The regular approach is to eliminate the cause of the maxillary incisor impaction by surgical remove of the supernumerary tooth (Smailiene et al. 2006). This surgical procedure requires a preoperative knowledge of the position and orientation of supernumerary tooth in dental arch. The position and orientation can be accurately obtained by Dental CT program, which also allows 3D reconstructions of the impaction region.

This paper presents the role of Dental CT in a clinical case related with an unerupted maxillary central incisor associated with supernumerary tooth.

## 2 CLINICAL CASE

### 2.1 Case presentation

A 9-year-old male patient presented with a complaint of delayed eruption of the left permanent maxillary central incisor. The patient's medical history indicates good health and no previous systemic disease. There was no history of prior trauma to the teeth or jaws.

## 2.2 Diagnosis and etiology

Intraoral examination revealed absence of the left permanent central incisor in anterior maxilla (Fig. 1). Adequate space for the proper alignment of the unerupted central incisor is visible in Figure 1.

The panoramic conventional radiograph showed the patient's mixed dentition and the two impacted maxillary teeth: the permanent left impacted central incisor and a supernumerary tooth (Fig. 2). The etiology of the permanent central incisor's impaction is attributed to the presence of the supernumerary tooth.

However, the panoramic image didn't establish the real relation between both impacted teeth and between other dental structures, like adjacent teeth and roots. Thus, CT images were requested to show the localization and orientation of the impacted teeth. All CT images were performed in Siemens SOMATOM Esprit equipment with a slice thickness of 1.5 mm.



Figure 1. Intraoral views showing the impacted left permanent central incisor in superior dental arch.

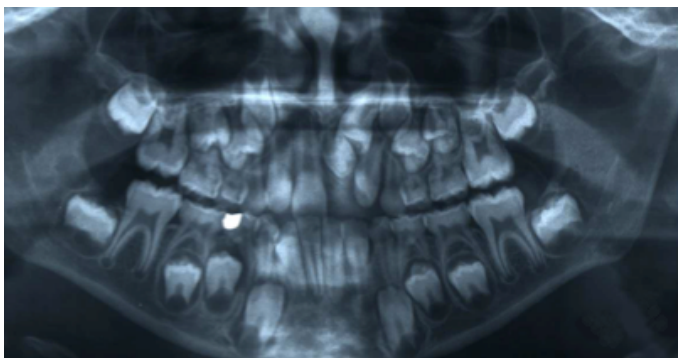


Figure 2. Panoramic conventional radiograph showing a supernumerary tooth associated to the impacted left central incisor.

## 3 RESULTS

### 3.1 Dental CT examination

The successful removable of supernumerary tooth is highly dependent on radiographic examination performed to the patient. Thus, a Dental CT exam was made through axial images to acquire at the time of the scanning procedure. During scanning procedure, the patient was instructed to stay motionless in order to avoid motion artifacts. After data acquisition, Dental CT software was used to define the plane and lo-

cation of the reformatted panoramic and cross-section views. Figure 3 shows topogram and Dental CT evaluation, which was restricted to the patient's maxillary (Figs. 3a, b). The final cross-sectional and panoramic images are defined using transversal (Fig. 3c) and parallel lines (Fig. 3d) overlapped on the arch of the maxilla, respectively. Figures 4 and 5 show the finals cross-sectional (buccolingual) and panoramic images of the patient's premaxilla.

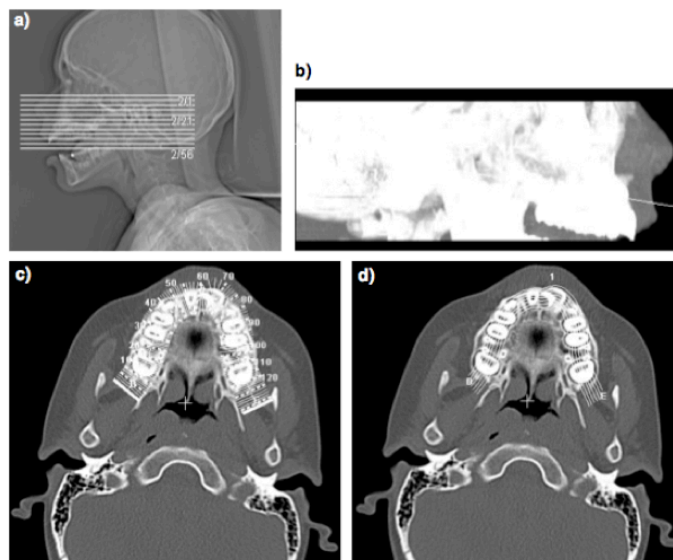


Figure 3. Images obtained in CT exam and Dental CT evaluation. a) Patient's head topogram showing ROI selected (upper jaw); b) Lateral MIP (Maximum Intensity Projection) view of the maxilla. This image has an orientation line in order to choose an image with the best plane (transaxial or oblique) to define reformatted final images; c) Transversal and d) Parallels lines overlapped on the arch of the maxilla in order to generate the cross-sectional and panoramic images, respectively.

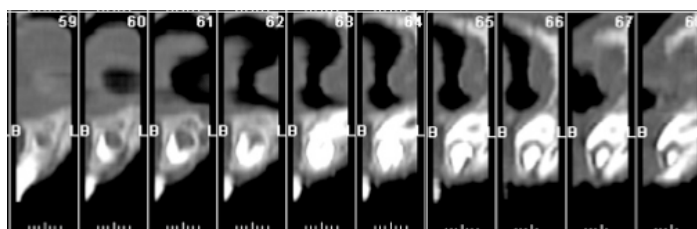


Figure 4. Anterior maxilla cross-sectional images resulting of Dental CT evaluation. These images allow visualization of both impacted teeth and a cyst formation.

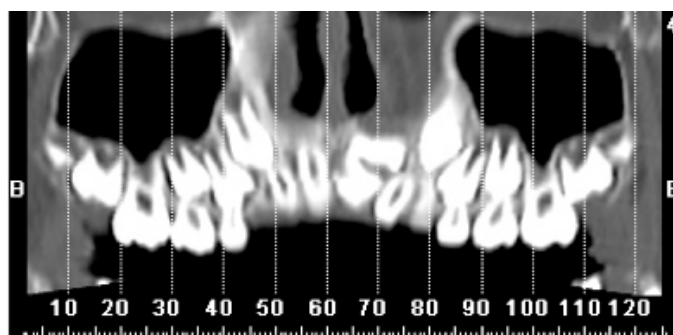


Figure 5. Panoramic image resulting of Dental CT evaluation. The patient's mixed dentition and impacted teeth are clearly shown.

### 3.2 3D Reconstruction

In order to assist in accurate localization and orientation of the impacted teeth and for allowing 3D assessment of these teeth and their relationship to others teeth and structures in the dental arch, a 3D Surface Shade Display (SSD) reconstruction was made. The SSD reconstruction allows reconstruction of the surfaces of volumes. These volumes consist of voxels whose gray-scales are in a range defined by two limit values, an upper and a lower gray-scale limit. This method is especially suitable for displaying bone structures or blood vessels filled with contrast medium. The final 3D SSD reconstruction is shown in Figure 6.

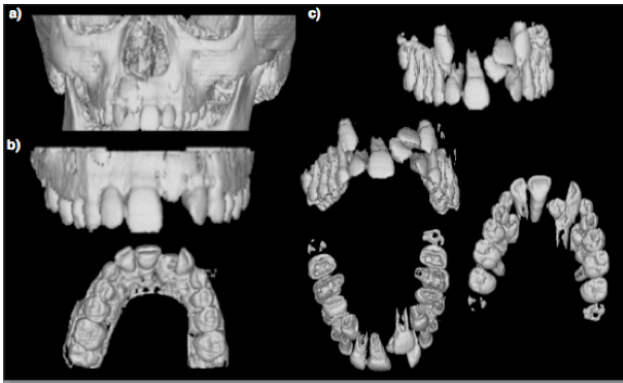


Figure 6. 3D SSD reconstruction of the patient's upper jaw, showing spatial relationship of the impacted central incisor and supernumerary tooth. a) Entire volume reconstruction; b) Upper jaw reconstruction; c) Anterior, superior and inferior view of the teeth reconstruction.

## 4 DISCUSSION

Impacted teeth are not a rare abnormality in dental arch. These teeth remain embedded in the jawbone due to some obstacle in their eruption path. One of the most causes of impaction is the presence of supernumerary teeth. They are most common in the anterior maxilla, resulting on impaction. Rajab & Hamdan (2002) studied 152 cases of supernumerary teeth: 90 % occurred in the premaxilla, of which 92.8 % were in the central incisor region. After treatment, 73.5 % of the cases were impacted.

In this paper was presented a clinical case diagnosed with an unerupted central incisor in premaxilla due to the presence of a supernumerary tooth in the same region.

The treatment approach of impacted teeth requires cooperation of dental specialties, such oral surgery and/or orthodontics (Avinash & Aieshya 2011). When a supernumerary tooth prevents the eruption of a permanent tooth, the treatment can vary between the removal of the both impacted teeth, the removal of the supernumerary tooth leading to spontaneous eruption of the permanent tooth or the removal of the supernumerary tooth and exposure and

traction of the permanent tooth into proper position (Akhare & Daga 2011, Mason et al. 2000). In the permanent dentition, removal of the physical obstruction from the path of eruption is recommended (Suri et al. 2004).

The patient's treatment approach included surgical removal of supernumerary tooth and conservation of the permanent maxillary left central incisor. By extraction of the supernumerary tooth, it is expected that leads to spontaneous eruption of the impacted central incisor.

However, in some instances, eliminating the cause of impaction by removing supernumerary tooth, would not lead to spontaneous eruption of the impacted tooth. Thus, it would be necessary a second surgical exposure of the unerupted tooth in order to perform orthodontic therapy by applying directional traction (Smailiene et al. 2006). Spontaneous eruption of the impacted maxillary tooth has obviously an advantage over orthodontic treatment. Smailiene (2006) found that spontaneous eruption of impacted maxillary incisors occurs in 54 % to 76 % of cases when supernumerary tooth was removed and there was enough space in the dental arch.

Several factors influence the time needed by an impacted tooth to erupt following removal of the supernumerary tooth, such as initial location and inclination of impacted tooth, the space available in the dental arch and the stage of root development (Avinash & Aieshya 2011, Rajab & Hamdan 2002, Smailiene et al. 2006). The spontaneous eruption of impacted maxillary incisors may take up to 3 years and sometimes orthodontic treatment is necessary to achieve adequate alignment of the erupted tooth in the dental arch (Rajab & Hamdan 2002, Smailiene et al. 2006).

The extraction of supernumerary tooth is not always the treatment's choice. If they are symptomless and do not appear to be affecting the dentition in any way, it is sometimes best left in place and kept under observation (Rajab & Hamdan 2002).

It is important to determine the best surgical approach causing the least harm to adjacent tooth roots while minimizing trauma to surrounding tissues. Thus, to the surgical removal of the supernumerary tooth it is vital the precise location, position and morphology of both impacted and supernumerary teeth and their relationships to the adjacent dental structures.

Dental CT program was used to obtain this information. Figures 4 and 5 shows cross-sectional and panoramic images of the patient's anterior maxilla, respectively. Both images clearly revealed the presence of a supernumerary tooth adjacent to an unerupted left central incisor and the exact location of the impacted teeth in dental arch.

In addition, Figure 4 revealed a cyst formation associated with the supernumerary tooth, which had not been seen on the panoramic radiograph (Fig. 2)

because overlapping of the two teeth. Cyst formation is a common complication resulting of permanent teeth impaction (Al-Faleh 2009).

Figure 6 shows a 3D reconstruction of patient's upper jaw. Figures 6a and b allows the visualization of the entire maxilla, however it is difficult to see the whole extent of the impacted tooth root and its relationship to adjacent teeth. Therefore, the threshold level of the 3D reconstructed images was adjusted, in order to remove the surrounding bony structures, allowing evaluation of the entire structure of the teeth (Fig. 6c). Figure 6c presents 3D relationship of the two impacted teeth to the adjacent structures. The supernumerary tooth presents an incomplete root formation, while the root formation of the impacted central incisor has already started.

Mason et al. (2000) in his study assessed the maturity of the unerupted incisors by Cvek's classification (Fig. 7). They concluded that more immature teeth (Cvek groups 1, 2, and 3) erupted spontaneously after removal of the supernumerary than mature teeth (Cvek groups 4 and 5). According to Cvek's classification of the maturity of the unerupted incisors, the patient's impacted teeth can be included on group 3 (see Fig. 6c), and therefore, spontaneous eruption of the left maxillary central incisor is expected.



Figure 7. Cvek's classification of maturity of incisors. Group 1 – roots with wide, divergent ends and less than half their final length; Group 2 – roots between one-half and two-thirds their final length; Group 3 – roots two-thirds their final length; Group 4 – teeth with open apical foramina and roots almost full length; Group 5 – teeth with completely formed roots.

Radiographic examination is essential to establish the etiology and for accurate diagnosis and planning of treatment, particularly with regard to the surgical approach. Traditionally, conventional periapical, occlusal and panoramic radiographs are used to determine the location and position of impacted teeth (Akhare & Daga 2011, Kim et al. 2003, Rajab & Hamdan 2002). In these images can occur cases of overlapping, magnification or blurred of dental structures. In severe cases of overlapping of impacted teeth, it may be impossible to determine the accurate location of these teeth relative to surrounding structures. Also, these modalities do not provide sufficiently detailed information concerning the 3D relationship between supernumerary or impacted teeth and adjacent structures. The main drawback of conventional radiographic techniques is that the images are two-dimensional. CT solved these problems, providing accurate information than other imaging methods. This method enables the production of precise 3D images of anatomic structures without over-

lapping and preserving soft tissue detail. Dental CT software program display multiple axial, cross-sectional, and panoramic images of the jaw, which provides the exact location, inclination and morphology of the impacted teeth in the dental arch and its proximity to the vital structures or to the adjacent teeth (Al-Faleh 2009, Kim et al. 2003, Suri et al. 2004). Thus, surgical access and technique choice are facilitated, also reducing the procedure time.

Based on the images obtained by Dental CT, the supernumerary tooth was easily surgically removed. The patient presents proper space to impacted tooth eruption and, therefore spontaneous eruption of the left maxillary central incisor is expected.

## 5 CONCLUSION

Dental CT imaging can accurately localize supernumerary or impacted teeth. It can offer useful information for diagnosis and treatment planning that conventional radiograph are unable to provide. Such additional information includes the exact position of the impacted and supernumerary teeth in relation to adjacent roots or anatomic structures, the 3D relationship between dental structures and the absence of overlapping in the final images.

## 6 ACKNOWLEDGMENTS

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