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Diagnostic tools in the assessment of an impacted canine caused by an odontoma

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Abstract

Background: *The odontoma is frequently the cause of dental inclusion through a mechanism of spatial competition.The aim of the present work is to propose a diagnostic procedure in the evaluation of an impacted canine caused by an odontoma.*
This diagnostic procedure has been applied to a clinical case: the inclusion of an upper canine, caused by an oversized Compound Odontoma.
Methods: *The first diagnostic tool is the clinical evaluation.The patient, 22 years old, showed persistence in the arch of the deciduous element 5.3; the inclusion of the permanent element 1.3 was suspected. The second step is the X-ray examination. The OrthoPanTomography (OPT), performed as radiographic analysis of 1st level; highlighted the inclusion of the element 1.3 and an area of multifocal radiopacity in contiguity to his crown and allowed to identify the probable cause of inclusion of canine: an oversized Compound Odontoma. The prognostic evaluation, according to the technique of Ericson and Kurol performed on OPT, allowed to define numerically the position of the impacted canine and oriented toward a single surgical act: removal of the impacted canine and the odontoma. A Cone-Beam Computer Tomography (CBCT) of the upper jaw, performed as examination of 2nd level, and 3D reconstruction showed the presence of nine radiopaque denticular structures of various sizes, allowed to analyze in detail the involved anatomical region and directed the clinician towards palatal surgical approach.Finally, an histological examination should be performed.*
Results: *As result of this diagnostic process, a single surgical act was performed: removal of the deciduous canine, the impacted canine and the odontoma. The surgical act confirmed the excellent correspondence between the 3D digital reconstruction of the maxillary region and the real anatomical structure. The surgical findings of the odontoma confirmed all that was radiographically highlighted: 9 denticular structures with variable size and shape. The postoperative CBCT confirmed the total removal of the lesion. Histological examination confirmed the diagnostic hypothesis: denticles surrounded by fibrous tissue with structure similar to the follicular sac.*
Conclusions: *The 3D reconstruction provides more realistic and friendly images, useful both in dentist-patient communication both in the choice of the therapeutic approach.*

Keywords: *Tooth impaction or Tooth inclusion; Compound Odontoma; Complex Odontoma; OrthoPanTomography (OPT); Cone-Beam Computer Tomography (CBCT); 3D reconstruction.*

Introduction

The dental eruption is normally a physiological process, that occurs through predetermined odontogenic stages.
An obstacle to the eruptive process can lead to different degrees of dysodontiasis: from tooth malposition to partial or total tooth inclusion [1].
In order of frequency inclusions involve: the lower third molar, the upper third molar, the maxillary canine, the lower premolar, the upper premolar, the lower canine, the maxillary central incisor, the upper lateral incisor [2].
Some noxae contribute to the failure of tooth eruption: particularly they are distinguished in local causes and systemic causes [3].

The local causes include: ankylosis, odontomas or supernumerary teeth, caries of deciduous teeth, early extraction of deciduous teeth, malpositions and eruptive noxae, direct or indirect traumas, space problems, oral specific diseases.
The systemic causes include: endocrine alterations, specific infectious diseases, genetic malformative syndromes.

The purpose of the present paper is to describe a diagnostic procedure in the evaluation of the impacted canine caused by an odontoma.

Materials and Methods

The first diagnostic tool is the clinical evaluation. The patient, 22 years old, showed persistence in the arch of the deciduous element 5.3.
There were no other signs or symptoms such as swelling, suppuration, pain, expansion of the alveolar bone or dental dislocation.Adjacent dental elements were vital and normally conformed.
Suspecting the inclusion of the permanent element 1.3, the OrthoPanTomography (OPT) was prescribed, as radiographic analysis of 1st level **(Figure 1).**

The OPT highlighted the inclusion of the element 1.3 and an area of multifocal radiopacity in contiguity to his crown and to the apical portion of the root of the element 5.3. The OPT showed the lesion, sized 0,8x1,0 cm, as well-defined, bounded by a osteosclerotic rib circumscribing a ray-transparent area, in which radiopaque multiple denticular structures were highlighted.
The Orthopanoramic is however a fundamental exam to get an overview, but does not provide reliable data to determine the exact position of the impacted canine.

The OPT was used to perform the analysis of Ericson and Kurol[4], that allows to define numerically the position of the impacted canine on the basis of three parameters:

- Angle "α": angle between the long axis of the impacted canine and the inter-incisors midline;
- Distance "d": perpendicular distance to the peak apex of the impacted canine respect to occlusal plane;
- Sector "1" or "2" or "3":
  - "1": vertex of the canine between the inter-incisors midline and the long axis of the central incisor;
  - "2": vertex of the canine between the major axis of the central incisor and that of the lateral;
  - "3": vertex of the canine between the major axis of the lateral incisor and that of the first premolar.

The localization by methodology for sectors serves more for prognostic purpose than diagnostic, in particular:

- The position of mediality of the canine, defined by the position of belonging, is used to assess the suitability of the early extraction of the deciduous canine, in order to facilitate the eruption of the permanent canine in subjects in an evolutionary phase;
- The risk of root resorption of the lateral incisor: it increases by 50%, if the cusp of the canine belongs to Sector 2 and 1 and if the angle α is greater than 25°;
- The lenght of treatment is longer if the canine is in sector 1, shorter if it belongs to the sector 3 respect to 2.

In the present case the impacted canine was in sector 2 and with an angle α of 40°: this allowed to predict a high risk of root resorption of the lateral incisor during operations of disimpaction (considering the value of the angle α) and to predict prolonged treatment times (considering the location of the vertex of the canine to the boundary between sector 1 and 2) **(Figure 2).**

Because the radiographic evidence placed the suspected diagnosis of a Compound Odontoma, a Cone-Beam Computer Tomography (CBCT) of the upper jaw was prescribed, as examination of 2nd level **(Figure 3).**

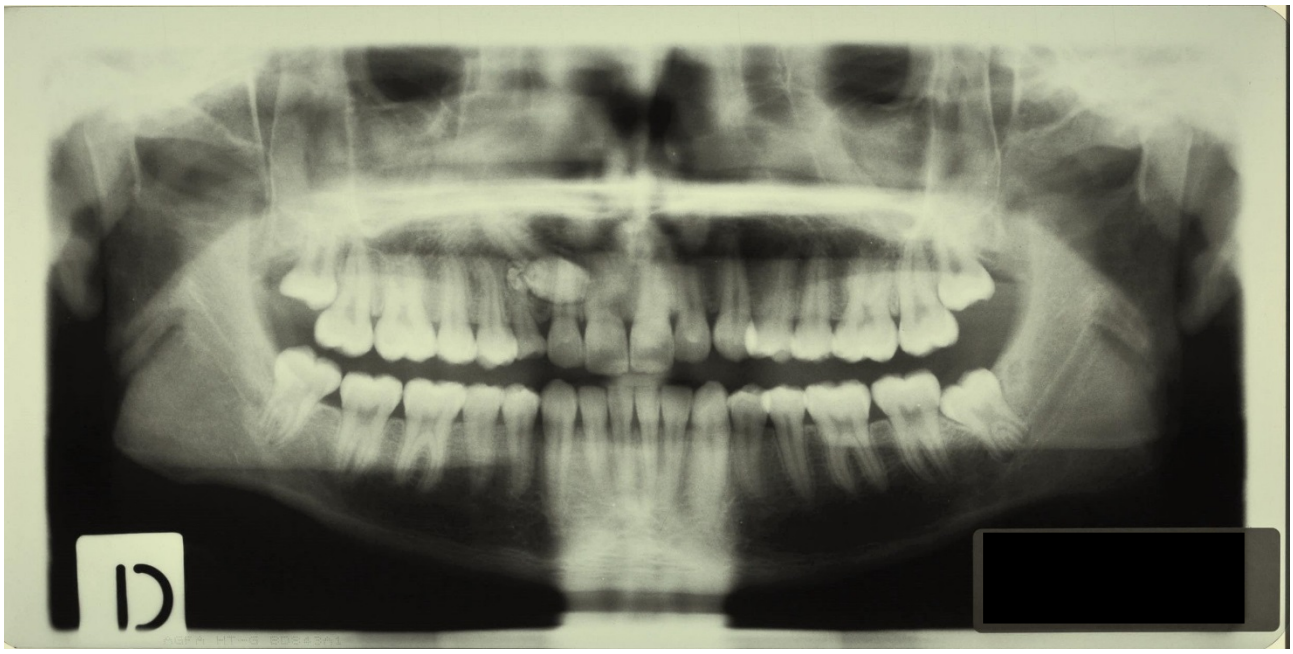

Figure 1. OrthoPanTomography (OPT) clearly shows the inclusion of the element 1.3 and an area of multifocal radiopacity contiguous with his crown and with the apical portion of the root of the element 5.3.

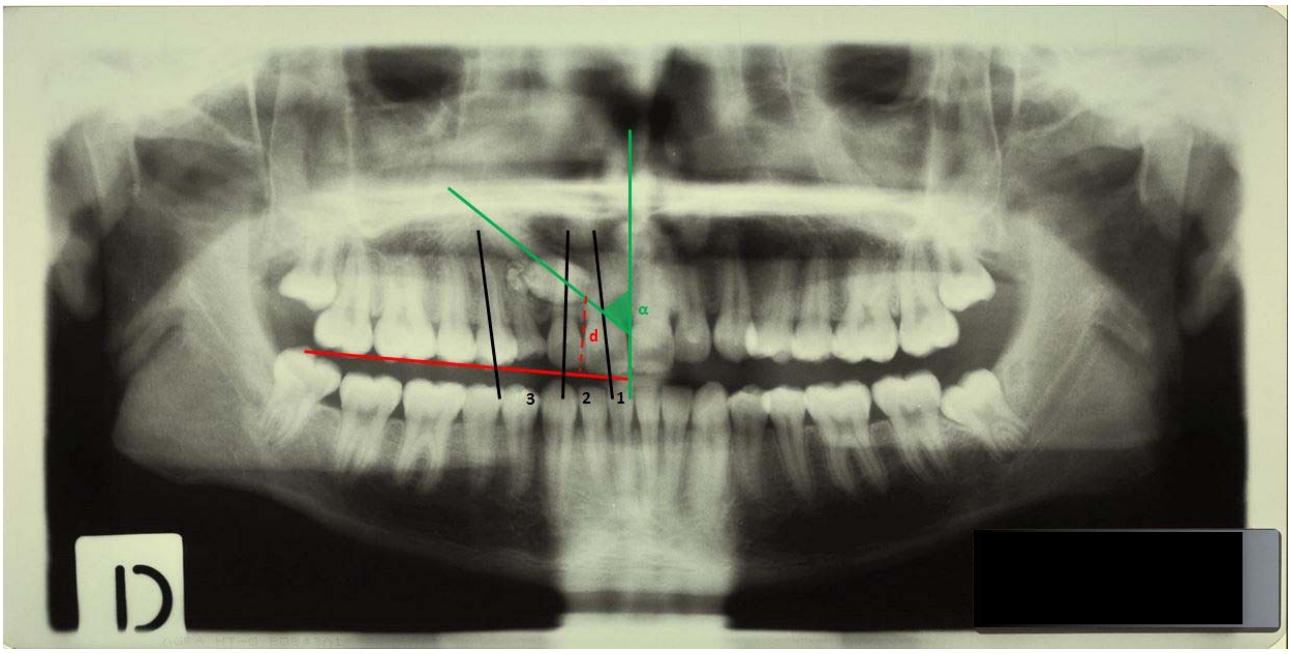

Figure 2. Analysis of Erikson and Kurol on OrthoPanTomography (OPT): Angle α = 43°; Distance d = 17mm; Sector 2 = vertex of the canine between the major axes of central and lateral incisors.

Figure 3. Cone-Beam Computer Tomography (CBCT) of the upper jaw: A- Panorex image showing denticular radiopaque formations; B- Cross Section highlighting the relations between the lesion, the impacted canine and the root of the deciduous canine; C- Cross section showing the lesion highlighted in yellow.

By using the Simplant software (SimPlant 3-D Pro; Materialize, Leuven, Belgium) a 3D reconstruction of the involved anatomical region was performed.

This software allows the import of DICOM (Digital Imaging and COmmunications in Medicine) files, the first standard format for sharing and viewing any kind of medical image. Once imported, images were processed in axial, sagittal, and paraxial sections. The images were real x-ray representations of jaw bones (reproduction scale 1:1) and allowed accurate measurements of anatomical structures.

The " Segmentation" tool of the software has made it possible to exploit the different radiographic density (calculated in H.U. Hounsfield Unit) of the bony and dental structures, to rebuild the anatomical region with masks of different color by an appropriate thresholding of the density value.

CBCT X-ray images and the 3D reconstruction showed the presence of nine radiopaque formations like denticles of various sizes, circumscribed by a ray-transparent rib with uneven contours **(Figure 4).**

The clinical picture was consistent with that of a Compound Odontoma.

The lesion was localized in the sagittal direction between the apexes of the elements 1.2 and 1.4, on the same axis of 5.3 and in contiguity to the mesiobuccal surface of crown of included 1.3. The canine had a palatal overlooking **(Figure 5).**

The deciduous element showed an advanced degree of rizalisis, clinically detectable by a considerable mobility of the itself element.

The canine appeared fully formed and therefore had lost its eruptive potential: in this case there was no chance that the canine could spontaneously erupt, once removed the odontoma, which had caused the inclusion.

The possibility of a surgical-orthodontic recovery of the included tooth was proposed to the patient, but, took note of the refusal to the orthodontic treatment, the radical surgical solution was preferred: extraction of the deciduous canine, extraction of the impacted canine and removal of the odontoma in a single surgical act; a final rehabilitation of implant-prosthetic type was then proposed to the patient.

The 3D reprocessing enabled to correctly identify the location of the lesion, at the center of the alveolar process, and the palatal overlooking of the impacted canine and directed the surgeon to perform a palatal approach both for the extraction of the canine, after odontotomia, both for the enucleation of the odontoma.

Results

The surgical act confirmed the excellent correspondence between the 3D digital reconstruction of the maxillary region and the real anatomical structure.

The surgical findings of the malformation confirmed all that was radiographically highlighted: 9 denticular structures with variable size and shape **(Figure 6).**

The postoperative CBCT confirmed the total removal of the lesion **(Figure 7).**

Histological examination confirmed the diagnostic hypothesis: denticles surrounded by fibrous tissue with structure similar to the follicular sac. The dental tissue, which forms the denticles, included a central core similar to the pulp, surrounded by primary dentine and partially covered by demineralized enamel and primary cement.

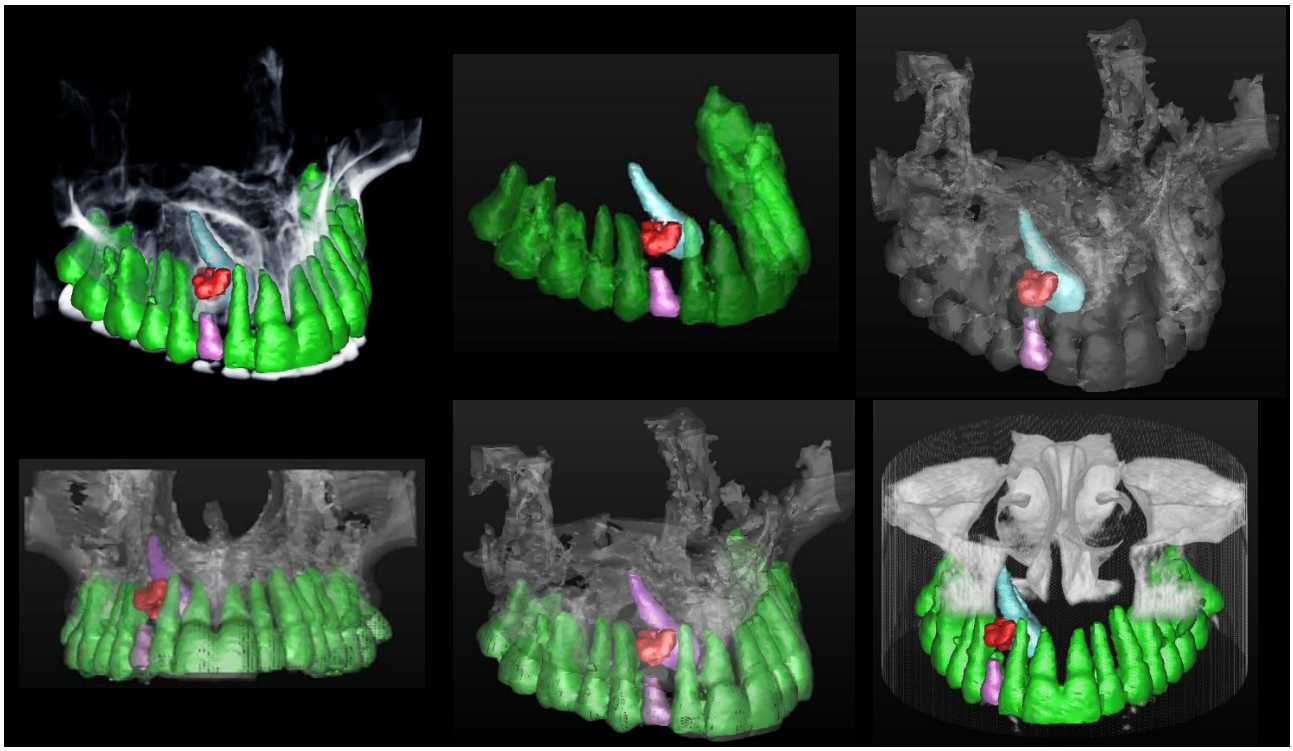

Figure 4. Different perspectives of the 3D reconstruction, showing the relationship of the lesion with the adjacent anatomical structures.

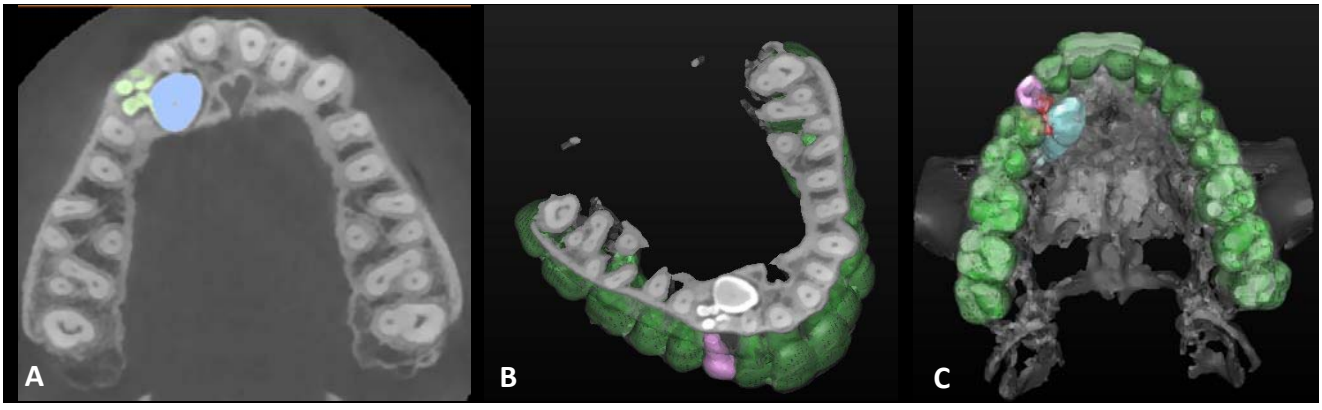

Figure 5. Images highlighting the impacted canine overlooking the palate: A- axial image; B, C- 3D reconstructions.

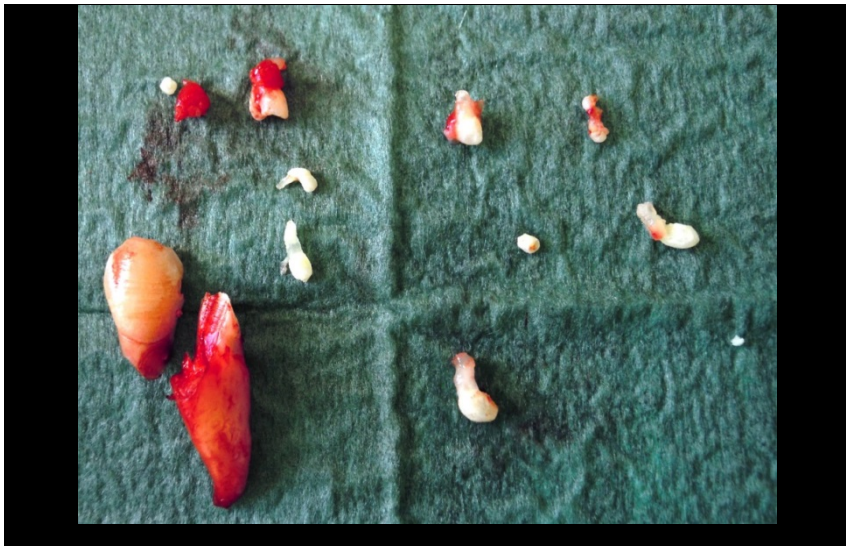

Figure 6. Surgical findings: permanent element 1.3, deciduous element 5.3 and the 9 denticles forming the odontoma.

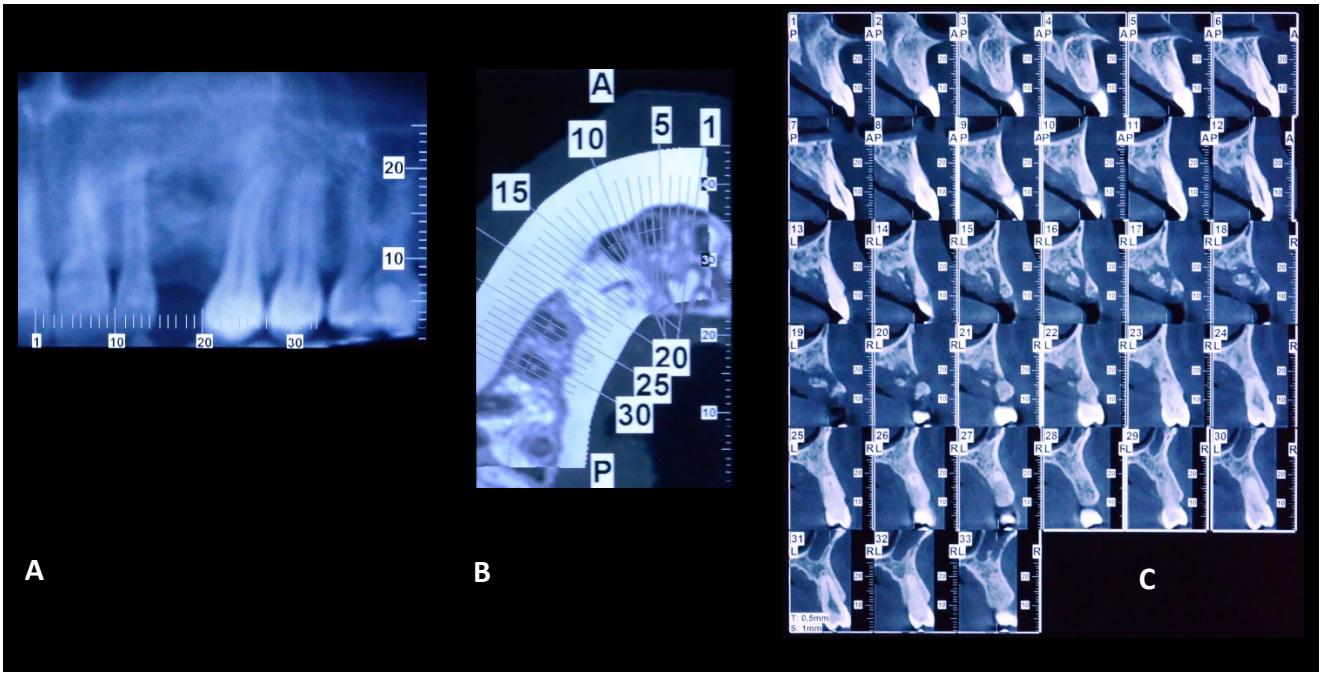

Figure 7. Post-surgery Cone-Beam Computer Tomography (CBCT) confirming the complete removal of the lesion: A- Panorex image; B- ScoutView of reference; C- Cross sections.

Discussion

The upper canine is the tooth that has the longest period of development. The beginning of its formation occurs between 5-6 months of fetal life, while the beginning of calcification occurs around 12 months after the birth.
The point of formation of this tooth is at the side of the piriformis foramen; it is therefore the tooth that has to travel the longest way to arrive in occlusion.
This aspect is reflected in the length of the root that appears to be the greatest of all teeth.
To arrive in the arch from this position the canine has to travel a long and circuitous route and this may explain the high percentage of inclusion of this tooth than others [5].

Very important is the relationship that the crown of the upper canine has with the root of the lateral incisor. Compared to this the crown of the permanent canine lies in a more vestibular plane. The lateral incisor, with the progressive development of its root, ends up creating a kind of obstacle, in the palatal side, to the eruption of the canine, while the root of the deciduous canine is situated in the vestibular direction.

In the period between the full eruption of the incisors and the beginning of the permute in the posterior region it occurs the infraosseous eruptive path of the canine toward his point of emergency. At this stage the canine crown proceeds in close relationship with the distal surface of the root of the lateral incisor.
At this stage of the permute it frequently occurs the situation, defined by Broadbent as that of the "ugly duckling", characterized by the distal inclination of crown of the lateral incisors and due to the close contact between the cusp of the canine and the root of the lateral [6]. Since the emergency in the arch of the canine and until its full eruption, it occurs the progressive closure of eventual diastemas, present mesially to the lateral incisors, with normalization of the axis of the same.

The above considerations demonstrate the complexity of the mechanisms of eruption and explain how the canine, last to erupt, can easily run into “incidents along the way”.
Among the local causes that contribute to the failure of the canine eruption, there are odontomas and super-numerary teeth.
These factors act as a mechanical obstacle interposed along the normal eruptive way [7].

The odontoma is frequently the cause of dental inclusion by acting through a mechanism of spatial competition. Odontomas are the most common odontogenic tumors and are considered as the result of a defect in development of the tooth and of the adjacent structures [8].
They consist of mature and calcified dental tissues such as enamel, dentin, cement and pulp tissue, present in variable quantities.
Normally their growth is slow and asymptomatic. As with other dental items, once completed the process of calcification, the odontomas finish their development; this process is defined as "self-limiting" growth.

It was shown that the odontoma has a slow evolutionary character with a peripheral plastic component, which slowly and progressively tends to increase the space available to these tissues, in order to depose their organic matrix and to mineralize the mineralizable component.
Even if the growth is self-limiting, the lesion may recur, in the event that it was not effected a complete removal still in the early stage in which the soft tissue is predominant.
The classification of odontomas, used by most authors, is that of the World Health Organization (WHO), which distinguishes odontomas in Complex and Compound [9].
The Complex Odontoma is a malformation in which there are all types of dental tissues, each readily identifiable, but distributed in a disorderly manner. The frequency of the Complex Odontoma varies between 5% and 30% and the majority of cases are diagnosed before the age of 30 years. The Complex Odontoma shows no gender preference, while it is found a preference of location: in most cases the posterior region of the mandible is affected. Radiographically, the lesion appears as a solitary mass of calcified material, more or less amorphous, surrounded by a thin ray-transparent ring; histologically the degree of morphological differentiation varies from lesion to lesion.

The Compound Odontoma is a malformation, in which are represented all the dental tissues in a more orderly manner than the previous form, so that looks like a set of more dental structures. Most of these structures, from the morphological point of view, does not resemble the teeth of normal dentition, but in each of them the enamel, the dentin, the cement and the pulp are distributed and recognizable as in natural teeth.
The frequency of the Compound Odontoma varies from 9% to 37% and it is diagnosed more frequently before the second decade of life. There is no gender preference and the anterior region of the maxilla is the most common site.

Radiographically it appears as a radiopaque mass of small and multiple calcified structures, similar to a deformed tooth, surrounded by a narrow ray-transparent zone. The typical pathognomonic appearance is that of "a crumb of bread”. Histologically various denticles are surrounded by a fibrous capsule [10].

Ultimately the distinction between Complex and Compound Odontoma is arbitrary, based solely on the preponderance of the organization of tissues in individual dental sketches rather than on absolute differences.

The radiographic identification can be difficult if the odontoma is in the developing and the calcification process is not yet completed.

The certainty of the diagnosis of odontoma derives exclusively by histological examination of the tissue surgically removed, which must be sent to the anatomo-pathologist, to exclude any doubt about the tumoral nature of the lesion.

In the present case, the development of a Compound Odontoma along the eruptive way of the upper canine had determined its inclusion.

The association between impacted teeth and odontoma is very frequent. MacDonald [11], about 39 cases of odontomas analyzed in the Chinese population, reports an association equivalent to 2/3. Tormizawa et al. refer a delay of eruption in 87% of cases of odontoma, while Da Silva et al. [12] encounter the association with impacted teeth in 58% of patients with maxillary central incisor interested in 19.4%.

The initial diagnosis is usually clinical. The most common signs of the presence of an odontoma are: missing teeth, persistent deciduous teeth, swelling. Other less common symptoms are: suppuration, pain, expansion of the alveolar bone and dental dislocation. Even more rare are aplasia, malformation and loss of vitality of the adjacent teeth [13].

The radiographic diagnosis can be made with a simple OrthoPanTomography (OPT) eventually associated with intraoral periapical radiographs or occlusal radiographs.

The main problem with such conventional radiographic examinations is the reproduction of two-dimensional images with consequent superimposition of anatomical structures.

As previously described, the OrthoPanTomography (OPT) is however a fundamental exam to get an overview, but does not provide reliable data to determine the exact position of the impacted canine. For this reason the OPT must be used to perform the analysis of Ericson and Kurol [4], that allows to define numerically the position of the impacted canine on the basis of three parameters (angle α, distance D, sector 1 or 2 or 3); as illustrated above the localization by methodology for sectors has more prognostic significance that diagnostic.

Currently the most appropriate radiographic examination is the 3D evaluation by Computed Tomography (CT) Dentascan and Cone Beam Computed Tomography (CBCT), which allows the acquisition of more detailed information on the location of the odontoma and its relationship with adjacent structures [14,15].

The big disadvantage of CT has been for years the high dosage of radiation, to which the patient was forced to undergo. This resulted in a risk-benefit ratio significantly to the disadvantage of the CT.

With the advent of CBCT this risk-benefit ratio has considerably changed in favor of the benefit. In fact, the clarity of the images remains very similar to that of a traditional CT, but the exposure to ionizing radiation has been greatly reduced.

The perfection of the images, the possibility of obtaining stereolithographic models and reduced exposure compared to traditional CT make the CBCT the gold standard for the diagnosis of inclusion of the canine.

The 3D reconstruction of the radiographic images through the use of programs of image processing allows to have an even more friendly vision of the anatomic region under examination [16].

As previously described, in this case the 3D reprocessing enabled to correctly identify the location of the lesion, at the center of the alveolar process, and the palatal overlooking of the impacted canine and directed the surgeon to perform a palatal approach both for the extraction of the canine, after odontotomia, both for the enucleation of the odontoma; the surgical act then confirmed the excellent correspondence between the 3D digital reconstruction of the maxillary region and the real anatomical structure.

Conclusions

The radiographic examination of 1st level, OrthoPanTomography (OPT), allowed to identify the probable cause of inclusion of the canine: an oversized Compound Odontoma. The prognostic evaluation of impacted canine, performed according to the technique of Ericson and Kurol on OPT, directed the clinician to a surgical radical act: removal of the impacted canine and the odontoma.

The radiographic examination of 2nd level, Cone-Beam Computer Tomography (CBCT), allowed to analyze in detail the anatomical region concerned, enabling to evaluate the topographic relations between the odontoma, the permanent canine, the deciduous canine and other dental elements and directed the clinician towards palatal surgical approach.

The 3D reconstruction, performed by Simplant software, provided more realistic and friendly images, useful both in dentist-patient communication both in the choice of the therapeutic approach. Histological examination confirmed the diagnostic hypothesis.

References

1. Santoro F., Maiorana C.: Chirurgia speciale odontostomatologica. Masson, Milano, 1996.
2. Barone A., Bianchi A.E.: Manuale di chirurgia orale. SICOI, Elsevier, 2011.
3. Grover PS., Lorton L.: The incidence of unerupted permanent teeth and related clinical cases. Oral Surg Oral Med Oral Pathol 59:420-425; 1985.
4. Ericson S., Kurol J.: Radiographic examination of ectopically erupting maxillary canines. Am J Orthod Dentofac Orthop 1987; 91: 483-92.
5. Van Der Linden F.P.G.M.: Development of the dentition. Quintessence Publishing Co., 1983: 67.
6. Broadbent B.H.: Ontogenetic development of occlusion. Angle Orthod 1941;11:223-241
7. Morning P, et al. Impacted teeth in relation to odontomas. Int J Oral Surg 1980;9(2):81-91.
8. Paoloni V, et al. Gli odontomi di interesse ortodontico. Mondo Ortodontico 2012; 37 (4):1-8.
9. http://who.int/oral_health/en/
10. Budnick SD: Compound and complex odontomas. Oral Surg Oral Med Oral Path 42:501-506, 1976.
11. MacDonald-jankowski DS. Odontomas in a Chinese population. Dentomaxillofac Radiol 1996; 25 (4): 186-92.
12. DaSilva LF, David L, Ribeiro D, Felino A. Odontomas: a clinicopathologic study in a Portuguese population. Quintessence Int 2009; 40(1): 61-72.
13. De Oliveira BH, Campos V, Marcal S. Compound odontoma—diagnosis and treatment: three case reports. Pediatr Dent 2001; 23(2):151-7.
14. Maverna R, Gracco A. Different diagnostic tools for the localization of impacted maxillary canines: clinical considerations. Prog Orthod 2007;8(1): 28-44
15. Chen Y, Duan P, Meng Y, Chen Y. Three – dimensional spiral computed tomographic imaging: a new approach to the diagnosis and treatment planning of impacted teeth. Am J Orthod Dentofacial Orthop 2006; 130(1):112-6.
16. Di Bari R, Coronelli R, Cicconetti A. Intraosseous vascularization of anterior mandible: a radiographic analysis. J Craniofac Surg. 2014 May;25(3):872-9.