A Radiographic technique for differentiating enamel and dentin in odontogenic tumors

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Abstract

Tumors derived from odontogenic tissues constitute an unusually diverse group of lesions. This multiformity reflects the complex nature of development of dental structures. There occurs a wide range of radiographic manifestations which may result from the fact that the jaw bones contain dental components of ectodermal and mesodermal origin - enamel, dentin, cementum, and pulp tissues(1).Radiographs are foremost and the most important diagnostic techniques. In histopathologic techniques like decalcified sections, calcified structures such as enamel which are highly mineralized may be lost and thus only their empty spaces may remain. Computed Tomography (CT) provides very good spatial resolution i.e. the ability to distinguish between two separate structures that are very close together. Through this case report we highlight the use of CT technique along with a colour contrast software which uses in its principle, methods to quantify & qualitate the density to distinguish between enamel and dentin to provide an accurate diagnosis.

INTRODUCTION

Odontogenic tumors and tumor like lesions of the jaw bones demonstrate a wide spectrum of radiographic manifestations. Specific anatomic location, periphery and shape of lesion and its internal structure all together aid in giving preliminary diagnosis . Odontogenic tumors are frequently associated with calcifications which may range from small foci to large solid amorphous masses. The calcifications could also be characteristic for a particular disease with respect to the association with each other & the arrangement (2).Calcifying odontogenic tumors constitute lesions ranging from non-neoplastic tissue proliferations to neoplasms both benign and malignant. Calcifying Odontogenic tumors with calcified tissue include the following : Ameloblastic Fibrodentinoma, Ameloblastic Fibro-odontoma, Odontome, Odontoameloblastoma, Calcifying Epithelial Odontogenic Tumor, Adenomatoid Odontogenic Tumor(3).

Studies on CT features of jaw bone diseases have given a new dimension when compared to conventional methods .CT scanners create digital imaging by measuring the transmission of an x-ray beam through tissue as the x-ray tube rotates around the patient(4). The CT image is a digital image, reconstructed by computer, which mathematically manipulates the transmission data obtained from multiple projections. The CT image is recorded and displayed as a matrix of individual blocks called voxels (volume elements). Each square of the image matrix is pixel. For image display, each pixel is assigned a CT number representing density. This number is proportional to the degree to which the material within the voxel has attenuated the x-ray beam. CT numbers, also known as Hounsfield units may range from -1000 to +1000, each constituting a different level of density.

CT scans completely eliminates the superimposition of images of the structures outside the area of interest. Inherent high-contrast resolution of CT enhances differences between tissues that differ in physical density by less than 1% such that they can be distinguished.

In this context, a panel of CT features have been supplemented with a color contrast software (Dentascan),which could enhance the precision in distinguishing the varying mineralized tissue seen in odontogenic lesions. This scale of relative densities is based on air (-1000), water (0) and dense bone (+1000)(2).Enamel and dentin have specific values which are >1500 H.U. and 1000-1500 H.U. respectively. The Hounsfield Unit values of the cyst contents are similar to those of water(5).

CT visualization could be enhanced by using specialized software named Siemens 64-slice Computed Tomography Scanner with Dentascan. This software is based on the principle of thresholding i.e. for any given or feeded value a color contrast could be provided to enhance and demarcate that particular mass having a specified density from the rest of the structure.

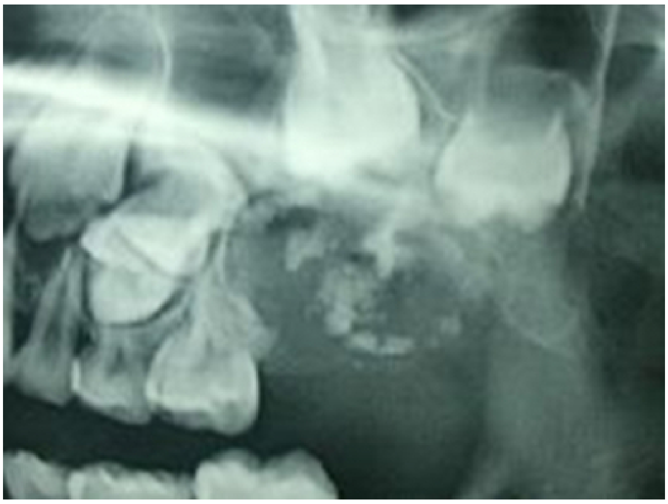
The present article uses a case report for technical illustration and use.

CASE REPORT

A 7yr. old male child reported to the OPD of ITS-CDSR with the chief complaint of non erupting teeth. On examination, a whitish firm, ovoid lesion was seen in the left maxillary alveolus in relation to unerupted 25, 26 and 27 extending from 26 to tuberosity of left maxilla. Orthopantomograph revealed a radiolucent area with the specks of radiopacity. 26 was pushed into the maxillary sinus (Fig.1).

Figure 1

Figure 1- Orthopentomograph showing a unilocular radiolucency with the flecks of radio-opacities.



Multiple radiodense foci are scattered within the lesion(Fig.2).

Figure 2

Figure 2 - Multiple dense foci are scattered within the lesion.

CT Scan showed a well defined corticated hypodense lesion in the left posterior maxilla in relation to 65 & 26(Fig.3

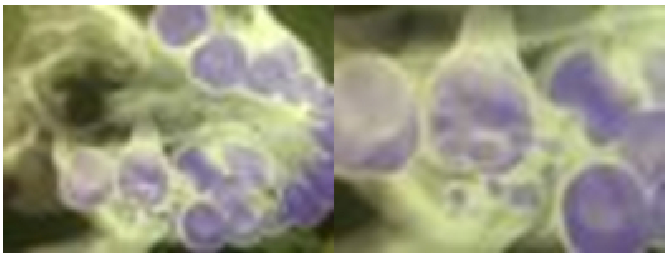
Figure 3

Figure 3 - A well defined corticated hypodense lesion in the left posterior maxilla in relation to 65& 26 .

The attenuation values for the radiodense foci were compatible with dentin (1000 H.U-1500 H.U) and enamel (> 1500 H.U) (Fig.4&5)

Figure 4

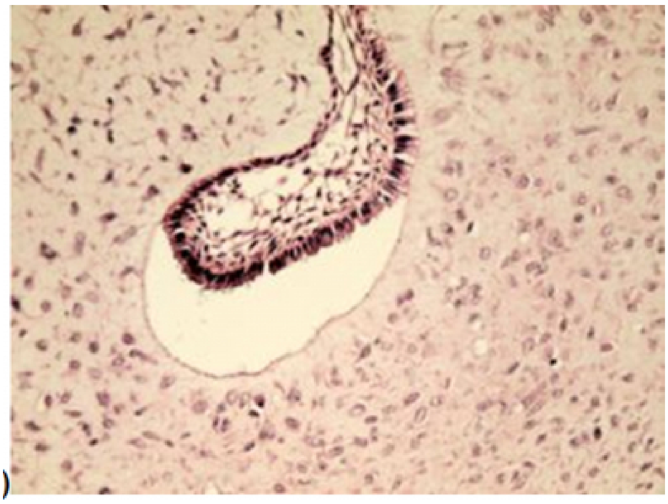
Figure 4 & Figure 5 - The attenuation values for the radiodense foci were compatible with dentin (1000 H.U-1500 H.U) and enamel (> 1500 H.U).



Histopathologically, odontogenic epithelium arranged in follicle with the peripheral ameloblast like & central stellate reticulum like cells

Figure 5

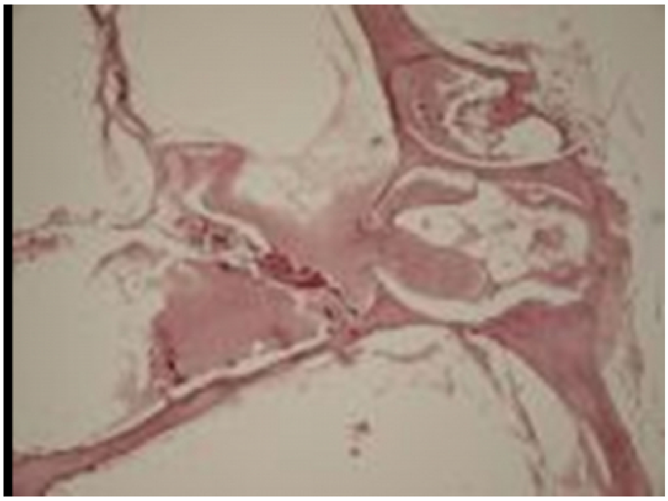
Figure 6 – H & E (40x) section showing odontogenic epithelium consisting of ameloblast & stellate reticulum like cells arranged in strands and islands in primitive ectomesenchymal tissue.



Varying amounts of osteodentin or dentin like material and occasionally enamel matrix can be identified (Fig.7).

Figure 6

Figure 7 - H & E (40x) showing enamel space, dentin & osteodentin are evident.



Features are suggestive of Ameloblastic Fibro-odontoma.

DISCUSSION

CT has become useful for diagnosing diseases in maxillofacial complex primarily because of its spatial and high contrast resolution and ability to demonstrate small differences in density(5). Both multidetector and cone-beam CT has excellent spatial and high contrast resolution. Dentascan allows the production of panoramic, radial and axial 2D reconstructions. Dentascan scan gives a very good overview of medium to large-sized lesions and also simultaneously demonstrating bone-related lesions. Additional software allows the production of maximum intensity projections and 3D volume rendered images (6). MultiDetector CT has the advantage over ConeBeam CT of demonstrating soft-tissue detail and allowing accurate measurement of attenuation. Soft-tissue visualisation allows detection of dense keratin debris in keratocystic odontogenic tumours and allows distinction between cysts and solid tumours(6) The perception of normal soft tissue densities on a CT scan is subjected to the window settings chosen. Desquamated keratin(100-200 H.U.) creates an increased attenuation area and can therefore be distinguished from calcification(800-1600 H.U.) by the windowing effect(6).

The extent of a lesion's relationship to teeth, root resorption, internal structure, cortical expansion and erosion, the boundary of a lesion and the presence of multiple lesions can all be evaluated with the help of this technique. CT features depend on the amount of hard tissue in the lesion and its arrangement. Periphery of the lesion and structures within it are well appreciated by C T which helps in giving accurate diagnosis (2).

AFO are diagnosed in the patient's first two decades of life, average ages of nine to eleven years. There is a slightly higher incidence of AFO in males, most common site is the posterior mandible(7).AFO is generally an asymptomatic, slow growing tumor, commonly associated with an unerupted tooth(8). Radiographically AFO presents as a well-demarcated radiolucency containing radiopaque areas (9). The CT features depend largely on the amount of hard tissues present in the lesion, with the calcific density in the lesion varying from homogeneous mass like structures to multiple spots or striations (1) .The tumor may cause resorption of the roots of the neighbouring teeth (9). In the present case, a well defined radiolucent area containing various amounts of radio opaque material of irregular size and form was seen. With the advanced diagnostic technique like the one used in this particular case, it is possible to gauge the density of a radio opaque material and can be correlated with the density of the normal dental hard tissues. In the present case, dentascan was performed with Siemens 64-slice CT scanner and the contrast obtained correlated well with the value of enamel(>1500H.U.) and dentin(10000-1500 H.U.).

Jaw bones contain dental component of ectodermal and mesodermal origin,i.e enamel, dentin, cementum and pulpal tissue and hence , present a wide spectrum of radiographic manifestations. Radiographic techniques such as the one applied here i.e. CT along with colour contrast software can be utilized to appreciate the differences between enamel & dentin as enamel is lost in histopathological procedures of decalcified sections. Further same principle can be used to distinguish between complex and compound odontomas. In complex odontomas, the pattern of arrangement of hard tissues like dentin, enamel, and cementum can be studied by assessing the densities of these calcified masses. In contrast, in compound odontomas, more orderly patterns are evident so that the lesion appears to be associated with multiple calcified structures, each reminiscent of a tooth (1) .

This technique can be appreciated in quantifying the density & quality of enamel in certain developmental disturbances such as Amelogenesis Imperfecta. This can also be applied to detect or differentiate between bone & cementum in cemento-ossifying fibroma which is at times is difficult in routine histological examination. Thus, this technique can be used to interpret the varying degrees of mineralization & to know the exact nature of the mineralized component of any lesion which exhibits pathological calcification in the head & neck region.

CONCLUSION

Odontogenic tumors are frequently associated with multiple dense calcifications. These calcification patterns have been extensively investigated with conventional radiography. The interpretation of the calcified material in the present case was done using the new technique of Dentascan with Siemens 64-slice CT scanner which quantified the presence of enamel & dentin having specific values within the calcified masses. This study highlights the significance of diagnostic techniques as an adjunct in diagnosis.

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