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Application of Computed tomography in jaw lesions: A comprehensive review

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ABSTRACT:

Radiology is an essential aid to the diagnosis, treatment planning and monitoring of oral diseases. Advances in imaging technology have revolutionized our ability to study image and understand pathology on a macroscopic level. Digital radiology is the next step in the evolution of radiology, its features like significant reduction in radiation exposure, the ability to digitally manipulate the captured image to produce a more diagnostic image, reduction in time between exposure and image interpretation, and digital documentation of patient's records make it a valuable diagnostic aid in hands of a clinician. New diagnostic modalities, like computed tomography has revolutionized dental diagnosis by multi planar reconstructions and allowing virtually any view to be selected, making three dimensional imaging possible by a few clicks on the computer. Hence; we aim to summarize some of the important aspects of role of Computed tomography in jaw lesions.

Key words: Jaw, computed tomography, radiology.

Introduction

Diagnosing maxillofacial lesions poses a great challenge to all clinicians because of the diversity of the lesions and pathologies manifested in this region. Further, the complex anatomical pattern of the skull and jaw bones, many a times necessitates a three dimensional visualization.[1,2]

Computed tomography (CT) is a type of cross-sectional tomographic imaging in which all unwanted planes or layers of a body are completely eliminated using mathematical

techniques. The goal of CT is to detect radiation that has passed through a body at multiple angles, and with the aid of a computer, to reconstruct a cross section of absorption values for that body section. The computer is used to store the data (x-ray transmission values) and reconstruct an image from this data. CT employs a highly collimated X- ray beam that is differentially absorbed by various tissues within the body. The photons that pass through the patient are collected by CT detectors, which show a differential rate of intensity on a Gray scale depending on the degree of absorption along the narrow X-ray beam. The CT scanner's X-ray beam is rotated over many different steps so as to get differential absorption patterns across various rays through a single slab of a patient's body. By mathematical analysis, one is then able to obtain an absorption value for each point within a CT slice. This technique was known as computerized axial tomography. Soon CT had revolutionized the diagnosis of diseases and demand for CT scanners rose rapidly through the world.[3, 4]

Computed tomography is not only a valuable tool in the field of maxillofacial radiology but also a time saving, indispensable and painless investigation in the evaluation of various pathologies and infections of jaws. The speed of MDCT permits CT examination of patients who, would otherwise not tolerate it (such as critical or elderly patients).[5]

However, being a fairly recent technology, we (oral and maxillofacial radiologists) have not gained enough expertise in the interpretation of this fascinating imaging modality. The purpose of this library dissertation is to provide an overview of imaging principles underlying CT technology and in particular focus on the emerging role of CT imaging in dentistry and interpretation of CT images.

Computed tomography

Computed tomography, a cornerstone to the diagnosis and disease monitoring, is influencing every aspect of patient care, treatment planning and by providing real time and superior imaging of the pathologies on a macroscopic level. Interest in computed tomography from all fields of dentistry is unprecedented because it has created a revolution in maxillofacial imaging.[6- 10]

Computerised tomography has revolutionized the field of imaging science of the maxillofacial region and has touched various fields of dentistry including Endodontics, Oral and Maxillofacial Surgery, Prosthodontics, Periodontics, Orthodontics, Pedodontics and Forensic dentistry. CT can be used to identify pathologic processes, display trauma and assess the paranasal sinuses, the bony components of the temperomandibular joint, sites for pre-surgical implant planning.[11- 12]

USE OF CT IN DENTISTRY FOR BONY PATHOLOGIES

CT is currently recognized as an important diagnostic tool for various pathologies of bone and has become widely available. The morphologic findings on CT images are important for the evaluation of jaw pathologies. In such patients 2-D radiography can’t determine the exact extent and nature of lesion whereas 3-D (CT scan) radiography helps in evaluating the exact extent and nature of lesion in all the three dimensions and relation with surrounding structures. Although the radiation dose is much higher in CT, it’s obvious advantages in assessing the contours of the lesion, its contents and extension into the soft tissues, makes it preferable for diagnosis.[10- 13]

CT can be used to identify various pathologies (cystic lesions and tumors) but image reconstruction allows the radiologist to provide a three dimensional image to assist the surgeon in planning the treatment. The ability of the CT, to image low contrast structures can help determine the contents of a pathologic space which can be a cyst, tumor, blood or a solid tumor. CT also helps to identify perforation of cortical bone or invasion into adjacent soft tissues. CT can record regional lymph nodes to assist in staging of malignancies. Process of windowing can be used for delineating further pathologic process.[13- 15]

Cystic lesions in jaws can be of odontogenic and non-odontogenic origin. Common cystic lesions of the jaws include radicular cysts, follicular (dentigerous) cysts and odontogenic keratocyst (Keratocystic odontogenic tumor). These lesions mostly have a cyst like appearance both on radiographs and on CT images. These cystic lesions sometimes show radiographic features similar to that of benign tumors. Most of them are non-invasive though a few may have different degree of destructive potential locally.[16- 18]

Representative odontogenic cysts in the maxilla and mandible are radicular cysts and dentigerous cysts. Therefore, CT images of both types of cysts are demonstrated.

RADICULAR CYSTS, INCLUDING RESIDUAL CYSTS AND PERIAPICAL GRANULOMAS

The radicular cyst is a well-circumscribed radiolucency arising from the apex of the tooth and bounded by a thin rim of cortical bone. On CT imaging, the cyst is shown as a water-dense mass with a well-defined margin. In addition, the cyst is located around the apex of a causative tooth, including it. If the cyst occurs in the maxilla, extension into the maxillary sinus from the maxillary sinus floor may be observed. At the upper border of the lesion, the bone line may be observed. A periapical granuloma and radicular cyst may have identical radiographic appearances, but a radicular cyst sometimes may be differentiated from the granuloma by its size. An apical granuloma is usually smaller than 1 cm in diameter, whereas a radicular cyst may become as large as 10 cm. One type of radicular cyst is a residual cyst that remains after or develops subsequence to extraction of an infected tooth. Therefore, its radiological findings including CT images are similar to those of radicular cysts without the causative teeth.[19- 28]

DENTIGEROUS CYSTS

Dentigerous cysts are the most common type of non-inflammatory odontogenic cyst and the most common cause of a pericoronal radiolucent area associated with an impacted tooth. On CT images they appear as well-defined round or ovoid, corticated, low-attenuating lesions around the crown of unerupted teeth.[22, 24]

KERATOCYSTIC ODONTOGENIC TUMOR (KCEOT)

Keratocystic odontogenic tumor (KCEOT)/ Odontogenic keratocyst is a distinctive form of developmental odonotgenic cyst owing to its specific histopathologic features, an aggressive and infiltrative behavior. KCEOT is most commonly seen in mandible and demonstrates a unilocular, round, oval, scalloped hypoattenuated lesion with smooth corticated borders, while the larger lesions may appear multilocular. Generally a significant expansion may occur in the upper ramus and coronoid process, however the buccal and lingual cortical plates

of the mandible may show slight expansion only. It may or may not be associated with embedded tooth.[22, 24]

TUMORS IN JAWS

Tumors occurring in the maxilla and mandible are divided into benign and malignant types and most tumors are benign. At the same time, tumors occurring in the jaws are odontogenic, such as keratocystic odontogenic tumors (KCOT) and ameloblastomas, and some are non-odontogenic such as osteomas.[22, 26]

Benign tumors of the jaws are slow growing and spread by direct extension. They tend to resemble tissue of origin histologically. A thorough radiographic examination provides information regarding the extent and characteristics of the lesion so that a specific preliminary diagnosis can be made. CT scanning is useful in determining the location, borders, exact size, extent and internal architecture of benign tumors. It also reveals their effects on adjacent structures.[22,26]

AMELOBLASTOMAS

The common clinical findings of ameloblastomas are painless swelling in the posterior mandible of adults less than 40 years old. Radiologically, the tumor is a well-circumscribed multi-loculated radiolucency bounded by a thin rim of cortical bone with smooth or scalloped margins. On CT images, the tumor is indicated as a soft tissue or water-dense mass with well-defined smooth or scalloped margins. Therefore, it is sometimes very difficult to differentiate between ameloblastomas and KCOT by characteristic radiographic findings.[26,28]

However, ameloblastomas tend to replace the roots of teeth with knife-edge resorption, but KCOT have relatively less resorption if the lesions are contiguous with teeth. In addition, ameloblastomas tend to expand the marked buccolingual cortical bone, but KCOT do not if the lesions are contiguous with cortical bone in the maxilla and mandible. In addition, about 5% of ameloblastomas can transform into malignancy and the mass should be excised appropriately.[28]

OSTEOMAS

Osteoma is a benign tumor composed of mature compact bone or cancellous bone. This tumor is essentially restricted to the craniofacial skeleton and rarely, if ever, is diagnosed in other bones. Kutluhan et al stated that the mandible is the most commonly affected site of the maxillofacial region. Osteoma of the jaws may arise on the surface of the bone, as a polypoid or sessile mass (periosteal osteoma), or it may be located in the medullary bone (endosteal osteoma), as well-circumscribed mass. It shows dense sclerotic matrix which is cortical in origin (buccal cortex). Expansion of buccal cortical plate with no effect on neighbouring structures may be noticed.[29-32]

CENTRAL GIANT CELL GRANULOMA

Central Giant Cell Granuloma (CGCG) accounts for less than 7% of all benign jaw tumours. Central giant cell granuloma (CGCG) is an intra-osseous lesion consisting of cellular fibrosis containing multiple foci of hemorrhage, multinucleated giant cells and trabecules of woven bone. The CT features of central giant cell granuloma include either unilocular or

multilocular hypodense areas with well-defined or ill-defined margins and varying degrees of expansion of the cortical plates. It also shows the evidence of calcification. CT appearance of CGCG may be confused with that of many other jaw lesions like fibrous dysplasia, calcifying epithelial odontogenic tumor and ameloblastoma.[17,19,29]

Malignant tumors which occur in the jaws are of various types such as primary intra-osseous carcinomas, lymphomas, malignant ameloblastomas and metastatic tumors of the jaws. Apart from these malignant tumors oral malignancies also invade the maxilla and mandible and shows erosive changes, hence their evaluation by CT is important.

SQUAMOUS CELL CARCINOMA

Oral malignancies which are histologically diagnosed as squamous cell carcinoma and extended to involve the bone are discussed. Location and size of all these malignancies varied. Most of the cases are located in mandible and CT Findings of these reveales heterogenous matrixes with ill defined margins. Some cases showed mixed lytic and sclerotic density while other had lytic density. A breach in continuity of adjacent structures; resorption of alveolar bone and perforation of lower border of mandible were also seen. Some cases showed lymph node involvement and new bone formation.[28- 33]

Conclusion

CT technology has been widely used in all spheres of dentistry ranging from dental and jaw trauma and infections, quantitative and qualitative osseous evaluation for dental implants, temporomandibular joint osseous pathology, impacted and supernumerary teeth, developmental and congenital jaw deformities, dental endodontic lesions and fractures, malignancies in oral and maxillofacial region, congenital deformaties and oral and maxillofacial pathology.

New techniques are influencing every aspect of patient care and treatment by providing real time and superior imaging but computed tomography will not become redundant in near future, the need of the hour is further development in radiography and new three dimensional diagnostic techniques to walk together for the betterment of the patient. However larger number of clinical trials and evidence based studies are still required for them to be considered as viable and successful diagnostic modalities.

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