

Evaluation of Normal Anatomy of the Mandible Using Three Dimensions Computed Tomography and Orthopantomography

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ABSTRACT

The three-dimensional (3D) multi planar reformatted images from conventional cross-sectional computed tomography data have been increasingly used to better demonstrate the anatomy and pathologic conditions of various organ systems. This study was conducted to assess the 3D CT and OPG techniques in demonstrating the anatomy of the mandible including body, ramus, symphysis menti and TMJ, lamina Dura, pulp canal, root of the teeth, mandibular canal, mandibular angle. Samples of twenty Sudanese adult male patients of ages between (20-60years) who were clinically diagnosed as normal, without any fractures, infection, caries, periodontal disease, per apical Pathology, or affected by any bone diseases, were included in this study. 3D facial bone was done for ten of the sample and OPG was done for the other ten. This study was done in Modern Medical Center and Mursi Medical Dental Center in the period from May to August 2010. The machines used were general electric CT/with dual slice (Germany) with: Voltage: 120KV, 140KV, Current four options 60 mA, 80 mA, 100 mA and 160 mA. The orthopantomograph, model OP 5 (Siemens Bens-him, Germany), with the setting were selected typically in the range 70-100 KV and 4-12 mA. The results of this study showed that the OPG technique was the best in demonstrating the root of the teeth (45%), TMJ(10%), Ramus (15%), Lamina Dura (5%), where the 3D CT was the best in demonstrating mandibular angle, and body of the mandible, ramus, smphysis menti for (95%), respectively, and TMJ for (70%). Both techniques failed to demonstrate pulp canal, and mandibular canal, (0%).

المستخلص

تعتبر الصور ثلاثية الابعاد التي اعيد تركيبها من بيانات المقاطع العرضية العادية بالتصوير الطبقي واسعة الانتشار لتوضيح التشريح و الحالات المرضية المختلفة لمختلف اجهزة الجسم. أجريت هذه الدراسة بغرض تقويم تقنية الأشعة المقطعية ثلاثية الابعاد و البانوراما في توضيح الأجزاء التشريحية الطبيعية للفك الأسفل متضمناً الصفحيه الحافيه المعتمه للأشعه، قناة اللب، الحاجز الأنفي، قناة الفك الأسفل، زاوية الفك الأسفل، المفصل الصدغي الفكي، جسم الفك الأسفل، امتداد الفك الأسفل، الإرتفاق الذقني. تم إختيار عينة مكونة من عشرين ذكر سوداني بالغ في مدي العمر بين 20-60 عام تم تشخيصهم على أن الفك الأسفل طبيعي دون كسور او التهابات او امراض باللثة او امراض بالاسنان او عظم الفك لأغراض هذا البحث. اجري لعشره مرضى من العينه فحص بواسطة الأشعه المقطعية ثلاثية الأبعاد والعشره الآخرون أجريت لهم فحوصات عن طريق البانوراما. أجريت الدراسة في المركز الطبي الحديث ومركز مرسى الطبي للأسنان في

الفترة ما بين مايو الي أغسطس 2010 باستخدام مقطعية جنرال الكتريك متعدد المقاطع باستخدام 120-140 كيلو فولت و تيار 60،80،100،160 ملي امبير و جهاز اشعة مقطعية فكية كلي باستخدام 70-100 كيلو فولت و 4-12 ملي امبير .

أوضحت نتائج الدراسة أن تقنية البانوراما هي التقنيه الأفضل لتوضيح جذور الأسنان (45%) و المفصل الصدغي الفكي (10%) و امتداد الفك (15%) و الصفحيه الحافيه المعتمه للأشعه (5%) بينما اوضحت النتائج بان تقنية الأشعه المقطعيه ثلاثية الأبعاد هي الأفضل في توضيح زاوية وجسم وامتداد الفك الأسفل، الإرتفاق الذقني بنسبة (95%) بالتتابع والمفصل الصدغي الفكي بنسبة (70%)، فشلت التقنيتان في توضيح قناة اللب وقناة الفك الأسفل (0%).

KEYWORDS: OPG, mandible, Three Dimensions CT.

INTRODUCTION

It has been shown that cross-sectional imaging (e.g. conventional spiral tomography or spiral CT) offers a better alternative for the precise visualization of anatomical structures in the oral region (1-7).

Nowadays, panoramic radiography is often used in dental practice, because it provides visibility of anatomical structures in pathological changes of the teeth, jaws and temporo-mandibular joints. However, a panoramic radiograph is a two-dimensional (2D) image, lacking information in the bucco-lingual direction and magnifying in both vertical and horizontal directions.

The mandible has a curved body, the halves of which join in the midline at the symphysis menti, and two posterior ascending rami, each with a superior coronoid process (anteriorly) and condylar process (posteriorly, ending in the condyle of the temporo mandibular joint (TMJ)). The body and ramus meet at the angle. The inferior alveolar canal extends from the mandibular foramen on the medial aspect of the ramus to the mental foramen on the

buccal surface of the body, opposite the second premolar. The tooth-bearing body of

the mandible, and the maxilla, consist of alveolar bone, which supports the dentition, and basal bone. Bone has sparse trabeculae and together these factors can result in artefactual lucency in the distal body, which should not be mistaken for a lytic lesion⁽¹⁾.

Dentine, which makes up the bulk of the tooth, is covered by an enamel cap on the crown and by a layer of cementum on the root. The enamel is very dense and is readily distinguishable from dentine whereas cementum has similar density to dentine and is not radiographically visible separate from the dentine. The radiolucent pulp chamber in the crown is continuous with the root canal. A thin radiolucent periodontal ligament space separates the root from the dense bone making up the lamina dura⁽¹⁾.

Nevertheless, the fact that panoramic imaging is widely used for evaluation of the jaws, justifies the interest in determining the visibility of anatomical structures on these films. Number of radiologic technique had been applied to demonstrate different anatomical structures, the, Oblique lateral demonstrates large areas of mandible, is the

projection that produces an image of both jaws and their respective dentitions on a single extra oral film ⁽⁸⁾.

Computed tomography provides sectional images of facial bone, orbits, mandible and TMJ in axial, sagittal and coronal planes. The information obtained from the original axial scan can be manipulated by the computer to reconstruct the three dimensions CT (3D) ⁽⁹⁾.

MATERIAL and METHODS

Patients:

Twenty Sudanese adult male patients with ages between (20-60years) were selected in this study, ten patients referred to the dental clinic for OPG examination, to detect the impacted lower wisdom teeth. The radiographs that were clinically diagnosed as normal mandible; without any fractures, infection, caries, periodontal disease, per apical pathology, or affected by any bone diseases were selected.

Another ten patients were selected from CT department examined for 3D facial bone diagnosed as normal patients.

Equipments:

The machines used were (general electric GE CT/with dual slice - Germany) with the following features, Voltage: two options 120KV, 140KV. Current: four options 60mA, 80mA, 100 mA and 160mA.

The machine of Pan Tomography consists of tube, cassette-carriage and patient support. The generator is a single-pulse generator provides a sufficient output. The x.ray tube was of small effective focal area. Panoramic radiographs were obtained with an orthopantomograph model OP 5 (Siemens. Bens-him, Germany) with setting selected, typically in the range 70-100 KV and 4-12 mA.

CT technique

The patients were positioned on the CT examination table, lying flat on their back and head rested on the head holder. Straps and pillow were used to help in maintaining the correct position ⁽¹⁰⁾. The 3D images were obtained from the CT axial projection using analytical software. When performing the CT examination, a large amount of data is produced, the volume data set is transmitted to the computer where all CT examinations are analyzed using three-dimensional rendering software, the three-dimensional data set analysis uses several types of reconstruction algorithms and is considered part of the CT examination. Rapid scrolling of the axial image is carried out as the first step of the reviewing process; different planes were selected of examination and apply the selected reconstruction algorithm.

OPG Technique

Panoramic equipment is based upon simultaneous rotation movement of the tube head and film cassette carriage in equal but opposite directions around the patient head which remains stationary. The patients were in erect position and were placed accurately within the machines using the various head positioning devices and light beam marker positioning guides. Patients were instructed not to move throughout the exposure ⁽¹¹⁾.

RESULTS

Table (1) lists the results which were obtained from evaluating the radiographs by two radiologists. The evaluation was for lamina dura, pulp canal, root, mandible canal, mandibular angle, TMJ, body of mandible, ramus of mandible, and symphysis mentioned in OPG and 3D CT techniques.

The evaluation was taken from the films diagnosed by two radiologists, the total number was twenty, and the excellent

appearance was given according to normal density (radio-frequency or radio-opacity in the OPG radiographs and the clarity of the anatomical structures in the rotated views in the 3D CT images.

Figures (1) and (2) show examples of radiographs for some patients.

Table (1): the results of the excellent appearance of different anatomical structure done by the radiologists in percentages (%).

The Anatomical structure	OPG Excellent appearance (%)	Frequency of OPG Excellent appearance	3D Excellent appearance (%)	Frequency of 3D Excellent appearance
1- lamina Dura	5	1	0	0
2-Pulp canal	0	0	0	0
3-Root of the teeth	45	9	0	0
4-Mandibular canal	0	0	0	0
5-Mandibular angle	25	5	90	9
6-TMJ	10	2	70	7
7-Body Of mandible	0	0	90	9
8-Ramus of mandible	15	3	90	9
9-Symphysis menti	0	0	90	9

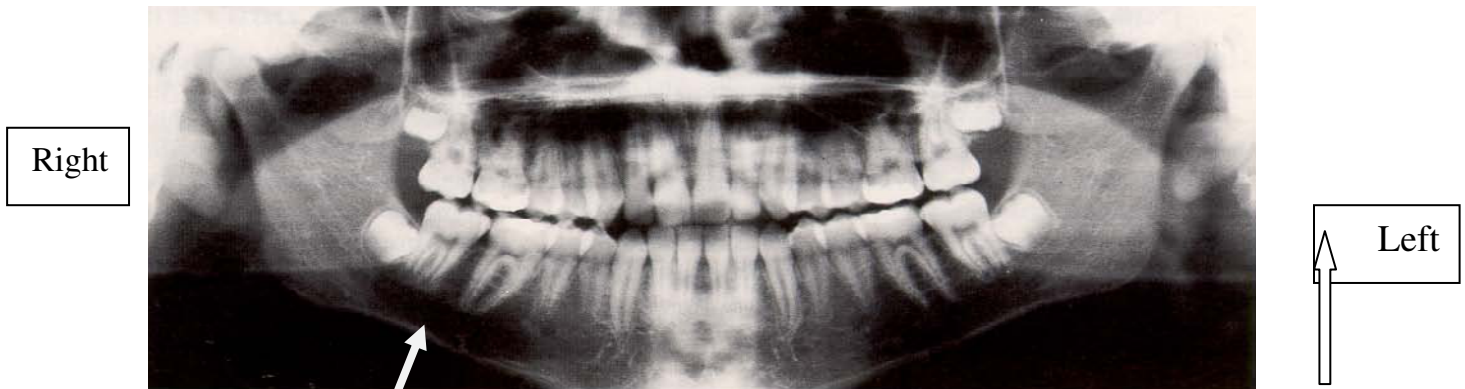


Figure 1: the anatomical structures for a 20 years old male with permanent dentition showing the roots of the teeth (long arrow) and Lamina Dura (short arrow) as demonstrated In OPG technique.(90 KV and 12mA).

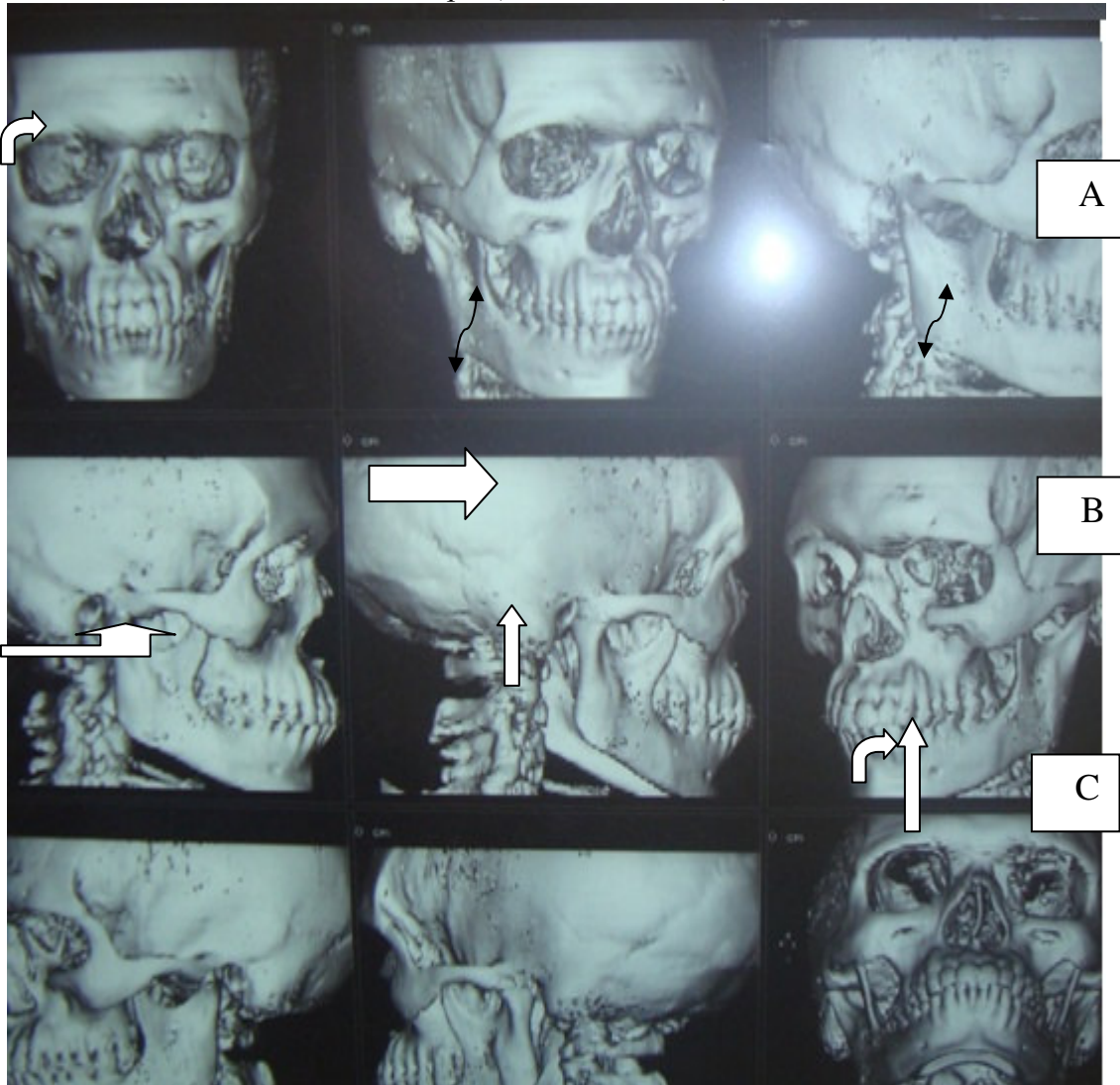


Figure 2: the anatomical structures for a 47 years old male with permanent dentition showing: Nasal septum curved arrow at (A) and (C), and body of the mandible thin arrow at (A), Ramus of the mandible curved arrow, angle of the mandible thin arrow and TMJ thick arrow at (B) the Symphysis menti Straight arrow at(C).140 KV and160 mA.

DISCUSSION

This study conducted to assess the 3D CT and OPG techniques in demonstration the anatomy of the mandible including body, ramus, symphysis menti and TMJ, lamina dura, pulp canal, nasal septum, hard palate, root, mandibular canal, mandibular angle.

The evaluation was from all films diagnosed by two radiologists, the total number was twenty, and the excellent appearance was given according to normal density (radio-lucency or radio-opacity in the OPG radiographs and the clarity of the anatomical structures in the rotated views in the 3D CT images.

Curved structure of the jaws requires a special nomenclature for anatomical relationship: Boeddinghaus, and because in the OPG ,the X-ray tube and film rotate around the head of the patient, at different velocities, resulting in a flat representation of the curved surfaces of the jaws⁽¹¹⁾. Only objects in the image layer remain in focus, other structures appearing blurred and distorted. So the spatial resolution is therefore lower and subtle carious or normal radiolucency or radioopacity and periapical lesions may not be visible and this agree with Lurie⁽¹²⁾, as well as the panoramic radiograph is a two-dimensional (2D) image, lacking information in the bucco-lingual direction and enhance in both vertical and horizontal directions. Therefore the findings of this study, in the OPG technique, showed that the appearance of root of the teeth which is radiolucent and of low attenuated value was found to be excellent in (45%) of the sample and TMJ (10%), Ramus (15%) Lamina Dura (5%) consigned with the above mentioned justifications.

CT studies have the advantage of allowing fairly detailed assessment of the bony structures; where Special software gathers information from the transaxial scan data to display 3D images on a 2D screen (Volume Rendering).

The results of this study showed that the 3D CT is best in demonstrating mandibular angle, and body of the mandible, ramus, smphysis menti for (95%) respectively, and TMJ for (70%) and Nasal Septum (50%). This is because of its ability to present the anatomy in a rotated form as well as it is a result from data collected after the images reconstruction.

Both techniques failed in demonstration of pulp canal, and mandibular canal, (0%), because the pulp canal bounded by high intensity material, so radiation was absorbed by the outer structure (no details), and this can be solved by using perpendicular plain to get the pulp canal image.

CONCLUSIONS

According to the results the main findings of the study were:

The 3DCT has value in demonstrating the angle of mandible, body and ramus of mandible, TMJ, and symphysis menti and nasal septum.

The OPG has value in demonstrating the root of the teeth and lamina Dura.

In all cases both techniques failed in demonstrating the pulp canal and mandibular canal.

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