Original Study

# COMPARISON OF PANORAMIC AND RECONSTRUCTED PANORAMIC THROUGH CBCT AND CROSS-SECTIONAL CBCT IMAGING MODALITY IN MEASUREMENT OF THE FOLLICLE SIZE OF IMPACTED MANDIBULAR THIRD MOLAR

*Sharifishoshtari S,[1] Razavi M,[2] Afzoon A,[3] Rohani A[4]*

*1. Assistant Professor, Department of Oral and Maxillofacial Radiology, School of Dental Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.*
*2. Assistant Professor, Department of Oral and Maxillofacial Radiology, School of Dental Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.*
*3. Dental Student, Student Research Committee Center, School of Dental Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.*
*4. Dental Student, Student Research Committee Center, School of Dental Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.*

**ABSTRACT**

**Aim:** The aim of the present study was to compare the diagnostic accuracy of conventional panoramic radiographs and CBCT panoramic reconstructions measurement of the follicular size of impacted mandibular third molar teeth using cross sectional CBCT.

**Materials & Method:** A total of 144 Impacted mandibular third molars images (Panoramic and CBCT reconstructed panoramic and cross sectional CBCT) were retrieved from archive of oral and maxillofacial department, School of Dental Medicine, Ahvaz Jundishapur University of Medical Sciences. The measurement included the maximum width and distance between the mesial and distal anatomical contact points of follicle mandibular third molars impaction and the most distant from CEJ to border of radiopaque follicle. Data were analyzed using McNemar's test, Kappa test, and SPSS ver.19.

**Results:** Mesiodistal view analysis showed a significant difference between panoramic and Cross-sectional CBCT radiographs (p=0.001). As well as, a significant difference was found between conventional panoramic images and reconstructed panoramic images (p=0.003).

Cervico-occlusal view analysis showed a significant difference between panoramic and Cross-sectional CBCT radiographs (p=0.001). As well as, a significant difference was found between conventional panoramic images and reconstructed panoramic images (p=0.003).

Inter-observer and intra-observer cofficiency were at excellent range (by using MC namar and kappa test).

**Conclusion:** The use of CBCTs rather than panoramic imaging for the assessment of follicular size has a potential diagnostic accuracy and may influence the aftermath of treatment.

**Key words:** Dignostic accuracy, Panoramic, Cross sectional CBCT, CBCT panoramic reconstruction.

## Introduction

An impacted tooth is one that fails to flare up into the dental arch within the expected developmental space. The most common reason for impaction of third mandibular molars teeth is insufficient development of the retromolar space and medially angulation of tooth bud during the initial stages of calcification.[1,2] The teeth remain trapped (or, impacted) below the soft tissue of the gingivae and will not expose except with surgical extraction or bone resorption.[3,4]

The unerupted teeth can be characterized as impacted when the root formation is complete but retained in unerupted position. Impacted teeth are commonly associated with an arch length deficiency. The impacted teeth are more frequent in mandibular and maxillary third molar followed by the maxillary canines, and mandibular premolars.[1]

Third molars are the last teeth to erupt and due to insufficient space they remain impacted. In impacted teeth the follicular cyst remains within alveolar ridge. In most cases, the dental follicle size remains intact, however the dental follicle associated with the impacted third molar has the potential to experience cystic degeneration and produce dentigerous cyst and odontogenic keratocyst. The routine follow-up can diagnose symptoms; the cysts being reached to large size.[1] Normal follicular space is 3-4 mm, a dentigerous cyst can be predictable when the space is more than 5 mm.[5]

Proper imaging system is essential for accurately diagnosing of impacted teeth. Panoramic radiography is frequently used in routine examinations of impacted teeth.[1] Panoramic radiography is a technique for imaging of facial structure including both maxillary and mandibular dental arch and their supporting structures.[6]

Panoramic images are clinically used for diagnosis of problems requiring broad coverage of the jaws including evaluation of trauma (maxillofacial fractures), location of third molars, expansive dental or osseous disease, identified or suspected large lesions, tooth growth (particularly in the mixed dentition), retained teeth or root tips (in edentulous patients), temporomandibular joint (TMJ), and progressive anomalies.[7] The most limitation of panoramic radiography is low resolution, Ghost images, image distortion; moreover the image does not display the precise location of the object from the buccolingual dimension.[8] The panoramic radiograph provides a good general overview of the oral structures and determine the need for other radiographic technique. Additionally, panoramic images are also convenient for patients who do not tolerate intraoral radiography.[9]

Cone beam computed tomography (CBCT) is one of the most advanced technique in maxillofacial imaging.[10] CBCT has been introduced in dentistry as 3D imaging modality and replacement for 2D imaging modalities. CBCT images are obtained through a rotating gantry to which an X-ray source and detector are fixed. A cone-shaped source of ionizing radiation is directed through the middle of the area of interest onto an area X-ray detector on the opposite side of the patient. The X-ray source and detector rotate around a fixed fulcrum within the region of interest (ROI). CBCT can be used to evaluate orthodontic treatment, determine the exact relative position between the mandibular third molar and the inferior alveolar nerve (IAN), prepare 3D images of high resolution dental arches, determine the precise dimensions of the implant, to detect cysts or maxillofacial tumors, and detection of fractures and dental cracks that are not readily visible in radiography.[11-13]

Other advantages of the CBCT device are its lower cost, smaller size and smaller radiation dose, high speed and more accurate analysis, high-contrast resolution due to the small size and geometry of its isotropic voxels, and interactive display modes such as mutiplanar reconstruction that are applicable to maxillofacial imaging.[16,17] However, the drawbacks of CBCT imaging are poor tissues and soft-tissue lesions contrast, higher doses than two-dimensional imaging, and visual artifacts.[18-20] Therefore, CBCT is considered as accurate and the gold standard for panoramic images.[21]

The aim of the present study was to compare the diagnostic accuracy of conventional panoramic radiographs and CBCT panoramic reconstructions measurement of the follicular size of impacted mandibular third molar teeth using cross sectional CBCT.

**Materials & Method**

The present in vitro study was conducted in 2017-2018. A total of 144 Impacted mandibular third molars images (Panoramic and CBCT reconstructed panoramic and cross sectional CBCT) were retrieved from archive of oral and maxillofacial department, School of Dental Medicine, Ahvaz Jundishapur University of Medical Sciences. The radiographs were related to the patient who had impacted tooth in the one or both sides of the mandible. The Panoramic radiographs were obtained using Soredex Cranex D Panoramic X-ray machine (Soredex, Finland) and CBCT images were taken by New Tom VGI (QR SRL Co., Verona, Italy). The CBCT device's exposure condition was 110KVP and 27.07 MAS and The panoramic device's exposure condition was 68 KVP and 12.5 MA and 15 S. The radiographs were observed by two oral and maxillofacial radiologists at the same condition and at the interval time of two weeks. Accuracy of measurements made by CBCT panoramic reconstruc¬tions, conventional panoramic radiographs and cross-sectional CBCT images were compared using digital caliper from Imaging software, Digora for Windows (DfW version 2.7, Soredex, Tuusula, Finland) and NNT software (Version 3.0, QR, Italy). The measurement included the maximum width and distance between the mesial and distal anatomical contact points of follicle mandibular third molars impaction and the most distant from CEJ to border of radiopaque follicle. The data were recorded in the predetermined data sheet. Inter-observer and intra-observer agreement were analyzed, and the agreement percentages were calculated. Data were analyzed using McNemar's test, Kappa test, t-test, and SPSS version 19.

**Results**

The results of the present study showed that the mean ratio of the mandibular third molars impaction follicle's diameter to the mesiodistal width in panoramic view was 16.64mm (SD=1.96), reconstructed panoramic view was 12.90mm (SD=0.87), and in Cross-sectional CBCT was 12.43 (SD=0.84).The mean ratio of the mandibular third molars impaction follicle's diameter to the cervico-occlusal width in panoramic view was 10.87mm (SD=2.27), reconstructed panoramic view was 7.76 mm (SD=1.18), and in Cross-sectional CBCT was 7.47 (SD=1.14). [Table 1]

| Groups | Number | Mean | SD |
|---|---|---|---|
| Panoramic view (mesiodistal diameter) | 144 | 16.64 | 1.96 |
| Reconstructed panoramic view (mesiodistal diameter) | 144 | 12.90 | 0.87 |
| Cross-sectional CBCT (mesiodistal diameter) | 144 | 12.43 | 0.84 |
| Panoramic view (cervico-occlusal diameter) | 144 | 10.87 | 2.27 |
| Reconstructed panoramic view (cervico-occlusal diameter) | 144 | 7.76 | 1.18 |
| Cross-sectional CBCT (cervico-occlusal diameter) | 144 | 7.47 | 1.14 |

*Table 1: Descriptive and inferential statistics of studied groups*

Mesiodistal view analysis showed a significant difference between panoramic and Cross-sectional CBCT radiographs ($p$=0.001). there was no significant difference between reconstructed panoramic radiographs and CBCT images ($p$=0.235). As well as, a significant difference was found between conventional panoramic images and reconstructed panoramic images ($p$=0.003).

Cervico-occlusal view analysis showed a significant difference between panoramic and Cross-sectional CBCT radiographs ($p$=0.001). there was no significant difference between reconstructed panoramic radiographs and CBCT images ($p$=0.235). As well as, a significant difference was found between conventional panoramic images and reconstructed panoramic images ($p$=0.003).

Inter-observer and intra-observer cofficiency were at excellent range (by using MC namar and kappa test).

In the present study, Cross-sectional CBCT imaging was considered as a gold standard and reference for comparison and measurements values of panoramic and panoramic imaging reconstruction. The mean values of deviation in measurements of the vertical dimension was equal to the mean absolute difference of cervico-occlusal diameter in

the studied imaging systems. The mean absolute difference between panoramic images and Cross-sectional CBCT was 3.4mm ($p$=0.001) and between panoramic and reconstructed panoramic images was 3.11mm ($p$=0.003), and this value between reconstructed panoramic images and Cross-sectional CBCT was 0.29mm ($p$=0.235). The mean absolute difference in the mesiodistal view between panoramic images and Cross-sectional CBCT was 4.21mm ($p$=0.001) and between panoramic and reconstructed panoramic images was 3.74mm ($p$=0.003), and this value between reconstructed panoramic images and Cross-sectional CBCT images was 0.47 mm ($p$=0.235).

| Group | Number | Mean difference |
|---|---|---|
| The mean difference between Cross-sectional CBCT and panoramic images from the mesiodistal view | 288* | 4.21 |
| The mean difference between Cross-sectional CBCT and reconstructed panoramic images from the mesiodistal view | 288 | 0.47 |
| The mean difference between panoramic and reconstructed panoramic images from the mesiodistal view | 288 | 3.74 |
| The mean difference between Cross-sectional CBCT and panoramic images from the cervico-occlusal view | 288 | 3.40 |
| The mean difference between Cross-sectional CBCT and reconstructed panoramic images from the cervico-occlusal view | 288 | 0.29 |
| The mean difference between panoramic and reconstructed panoramic images from the cervico-occlusal view | 288 | 3.11 |

*Table 2: Comparison the mean difference of measurement between the studied imaging systems*

**Since in each row of this table, 2 imaging modality were compared, therefore the sample size was multiplied by 2.*

**Discussion**

The mandibular third molar teeth may be irritating and annoying and cause inflammation, infection, abscess formation, pain, swelling, and the formation of a dentigerous cyst, and as result cause potential damage to the lower alveolar nerves. In order to inhibit further development of adverse conditions or disease, prompt impacted teeth removal is recommended. radiographic assessment will help to monitor and detect eruption deviation.[1]

Oral and maxillofacial radiology such as two-dimensional (2D) imaging and three-dimensional (3D) imaging (CT, CBCT) are the most commonly used modalities for detection of impacted teeth development.[22] Panoramic x-ray, is a two-dimensional (2D) radiographic examination initially used to capture the entire mouth in a single image, including the teeth, upper and lower jaws, surrounding structures and tissues.[23]

The limitations of two-dimensional imaging modality lead to tissue overlapping (superimposition).[24] Computed tomography (CT) is emerged as the new gold standard as a result of high contrast and multidimensional features. However, CT image quality can be intensely degraded by artifacts, interfering with the diagnostic accuracy. CBCT imaging technique due to lower radiation dose, small FOV, lower artifact, and more cost-effective is preferred than CT imaging modality.[17]

Panoramic radiography is a complex combination of tomography and scenography, and is highly predisposed to errors due to factors involving the equipment (ghost images, opaque shadow, narrow and blurred image). Moreover, some radiographs may have no diagnostic value as a result of the location of the jaw, position of the patient, and the data processing involved in digitization.[25,26]

The purpose of the present study was to compare the diagnostic accuracy of panoramic radiographs and reconstructed panoramic radiographs through CBCT and cross-sectional CBCT imaging modality in measuring the follicle size of impacted mandibular third molars. A very important reason for choosing this purpose was to understand is there any significant difference between data from measurements performed on both imaging modality? If there is significant difference between these imaging modality, it will be an advantage to not give additional dose to patient and the cost of treatment is reduced.

In the present study, Cross-sectional CBCT imaging was considered as a gold standard and reference for comparison and measurements values of panoramic and reconstructed panoramic images. The mean values of deviation in measurements of the vertical dimension was equal to the mean absolute difference of cervico-occlusal diameter in the studied imaging systems. The mean absolute difference between panoramic images and Cross-sectional CBCT was significant ($p$=0.001) and between panoramic and reconstructed panoramic images was significant ($p$=0.003), and this value between reconstructed panoramic images and Cross-sectional CBCT was not significant ($p$=0.235). The mean absolute difference in the mesiodistal view between panoramic images and Cross-sectional CBCT was significant ($p$=0.001) and between panoramic and reconstructed panoramic images was significant ($p$=0.003), and this value between reconstructed panoramic images and Cross-sectional CBCT images was not significant ($p$=0.235).

Very few studies have been conducted in line with the present study, whose main goals are somewhat different, but in terms of the variables being measured (imaging precision), they have some conceptual similarities with the present study.

Abdinian *et al*., 2018 compared the accuracy of special imaging techniques available in dental settings, including panoramic radiography, CBCT, and intraoral

ultrasonography (US), in detection of different foreign bodies(FBs). The results of the study showed that CBCT was more accurate in detection of FBs than panoramic radiography and intraoral US. Finally, they concluded that CBCT was the most accurate detection modality for all locations and compositions of foreign bodys, except for the wooden materials.[27] Their conclusion (the superiority of CBCT compare with OPG) was in line with our study.

Markic *et al*., 2015 compared the different imaging procedures (CBCT, CT, MRI, OPG, and lateral cephalometry (LC) for assessing the mandibular height [ramus height (RH)] and condylar process (CondProc) length. The results of the study showed that all imaging procedures displayed nearly equal results when used to measure the CondProc and RH, which inconsistent with the results of the present study.[24] The difference between two studies could be explained due to very small sample size of Markic *et al*.'s study. Also, they measure another component of maxillofacial area.

Flores *et al*., 2014 in a study examined the accuracy and reliability of tooth length measurements obtained from conventional panoramic radiographs and CBCT panoramic reconstructions to that of a digital caliper (gold standard). The results of the study revealed that tooth measurements obtained from conventional panoramic radiographs were on average 6.3 mm (SD = 2.0 mm) ($p<0.05$) longer than actual anatomical lengths (overestimation) and this difference was significant, while tooth measurements from CBCT panoramic reconstructions were an average of 1.7 mm (SD = 1.2 mm) ($p>0.05$) shorter than actual anatomical lengths (underestimation) and this difference was not significant.[28]

The results of Flores *et al*.' study and the present study werein agreement with each other regarding the panoramic imaging compared to gold standard.

Similarly, some other studies confirmed the diagnostic accuracy of CBCT measurement compared to actual anatomical lengths and considering it as the gold standard.[27,29]

Computed tomography (CT) has become the gold standard for measurement of bone morphology, but the radiation doses of CTs may be associated with increased cancer risk and must be inhibited in children.[30]

The panoramic radiograph is sensitive to operator. The most common errors in panoramic radiography followed by patient positioning. Malposition the patient's dental arches results in variation in both vertical and horizontal magnification, producing angular distortion of the image. Therefore, some studies recommended that the clinical assessment of panoramic radiography should be approached with extreme caution with an understanding of the inherent image distortions.[26]

The benefit of CBCT reconstructions over conventional panoramic is the ability to accurately change the volumes through the imaging software with the purpose of standardize the anatomical planes of image, therefore decreasing the error hosted by variable patient position. Obviously, the reconstructed images from pseudo-panoramic CBCT offer a potential advantage for maxillofacial imaging. Additionally, CBCT-based panoramic images allows clinicians for the accurate assessment specially where the superimposition of anatomic structures impedes the detection of small structural density changes.[31]

**Conclusion**

The use of CBCTs rather than panoramic imaging for the assessment of follicular size has a potential diagnostic accuracy and may influence the aftermath of treatment. Additionally, CBCT reconstructed panoramic radiographs due to elimination of anatomic superimposition and displaying exact localization of the retained tooth are recommended.

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**Corresponding Author**

**Dr. Sanaz Sharifishoshtari,**
Assistant Professor,
Department of Oral & Maxillofacial Radiology,
School of Dental Medicine,
Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.
Email Id: - alirohani172@gmail.com