The Efficacy of CBCT for Diagnosis and Treatment of Oral and Maxillofacial Disorders: A Systematic Review

H. Shaabaninejad 1, A. Akbari Sari 2*, MR. Mobinizadeh 3, S. Rafiei 4, A. Mehrabi Sari 5, Y. Safi 6

1Research Center for Health Services Management, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran
2Associate Professor, Department of Health Management and Economics, School of Public Health and Knowledge Utilization Research Center, Tehran University of Medical Sciences, Tehran, Iran
3PhD Candidate of Health Service Management, Department of Health Services Management, School of Management and Economics, Science and Research Branch, Islamic Azad University. Tehran, Iran
4PhD student in Health Care Management, Department of Management and Health Economics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
5DDS and Technical officer of Health Technology Assessment, Standardization and Tariff Office, Deputy of Curative Affairs, MOHME. Tehran, Iran
6Assistant Professor, Department of Oral and Maxillofacial Radiology, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Abstract

**Background and Aim:** Cone Beam Computed Tomography (CBCT) has the ability to accomplish rapid volumetric image acquisition by its cone-shaped beam. The aim of this study was to evaluate the safety and efficacy of this imaging modality.

**Materials and Methods:** A standard systematic review was performed. Medline (December 2012) and The Cochrane Library (Issue 3 2012) were searched to identify evidence about the performance (sensitivity, specificity and safety) of CBCT compared with other standard diagnostic methods. The results of the included studies were analyzed using a qualitative method.

**Results:** Thirty-one articles were included in the study; the majority of them were diagnostic studies with a small sample size (n<10). There was limited evidence about the effectiveness of this technology and the available evidence was scattered and sometimes controversial. At present, CBCT technology has greatly advanced and its image quality in terms of resolution is higher than that of MDCT. However, its contrast resolution is still lower than that of MDCT. Therefore, MDCT is preferred for soft tissue imaging. For evaluation of hard tissue in the maxillofacial region, a more clear image with higher resolution can be obtained by CBCT.

**Conclusion:** CBCT technology is now commonly used in developed countries for obtaining detailed information regarding the oral and maxillofacial region and can greatly help clinicians in diagnosis and treatment of maxillofacial disorders.

**Key Words:** CBCT, Imaging, Cone beam computed tomography, Dentistry

Introduction

In the recent years, medical technology has witnessed great advancements in diagnosis and treatment of diseases. Adequate use of these technologies can greatly help diagnosis and treatment of diseases [1]. On the other hand, unlimited and uncontrolled use of these technologies may lead to an induced demand by the service providers and indiscriminate use. This problem is growing in many developed and developing countries leading to a
significant increase in costs. Thus, in many countries, systematic assessment of health technology is done before allowing import and usage of new technologies [2]. CBCT was introduced in 1990 and has recently been used in radiotherapy and ENT as well. Compared with the conventional CT, CBCT scanners use flat panel technology to enable 3D CT volumetric scanning of the head and neck. Thus, images are not captured as slices. Instead, it shows the entire volume of object with its cone-shaped beam. By rotation of the beam around the object and imaging at different angulations, the respective area is displayed and observed from different directions. Due to the advanced image reconstruction algorithms, 3D images have high resolution and contrast for bone and hard tissue assessment.

Its rapid rotation and low radiation dose produces high quality diagnostic data [3]. At present, demand for using this technology in Iran has increased. Thus, this systematic review was conducted upon request of the Health Technology Assessment Department of the Ministry of Health to evaluate the efficacy of CBCT for diagnosis and treatment of oral and maxillofacial diseases.

Materials and Methods

In this systematic review, first articles published in the following databases from 1990 to October 2012 were searched:

1. Cochrane library (HTA Database, DARE reviews, NHS EEDs, Central)
2. Medline, UK HTA Website
3. BMJ Clinical Evidence
4. TRIP
5. Google Scholar

“CBCT” (key word) was searched in the aforementioned databases. Appropriate search strategy was applied for each database. In the first step, 98 articles were found. In the next step, a systematic review was found published in 2012. The references of the searched articles were also evaluated; which helped us find another 25 articles. Title and abstract of these articles (124) were thoroughly reviewed. Considering the objectives of our study, irrelevant studies were excluded; full texts of the remaining 63 articles were retrieved and studied; 31 articles were chosen based on the inclusion and exclusion criteria as follows:

1. Study population: Study had to be performed on human or phantom. The study had to be experimental and sample size over 10 subjects. Human studies had to be conducted on patients.
2. Intervention: Studies using CBCT for diagnosis or treatment of disease
3. Studies with and without a control group entered the study. Diagnostic and therapeutic studies comparing CBCT with a control group were included.
4. Outcome: In diagnostic studies, one inclusion criterion was comparison of CBCT with a similar imaging technique. Articles containing information on application of CBCT, its safety, accuracy, positive and negative predictive values, change in the course of treatment and change in patient status (increasing the Quality Adjusted Life Years: QALYs and Disability Adjusted Life Years: DALY) were included.
5. Study design: Diagnostic, experimental (interventional) and systematic reviews were chosen. In order to assess the quality of articles, the available standard lists (Center for Review and Dissemination: CRD 2009) were used. Articles included in our study were assessed by one researcher in terms of adherence to the criteria and reviewed by another researcher. If disagreement existed between the two, opinion of a third party was sought. All three were oral and maxillofacial radiologists. Considering the significant heterogeneity among the articles, a meta-analysis was not feasible and data were analyzed using meta-synthesis.

Table 1. List of articles chosen for the study

<table>
<thead>
<tr>
<th>Number</th>
<th>Article</th>
<th>Authors</th>
<th>Publication year</th>
<th>Country</th>
<th>Study design</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diagnostic accuracy of cone beam computed tomography scans compared with intraoral image modalities for detection of caries lesions [4]</td>
<td>Hailer-Neto et al,</td>
<td>2007</td>
<td>Brazil</td>
<td>Comparative</td>
</tr>
<tr>
<td>2</td>
<td>Value of two cone-beam computed tomography systems from an orthodontic point of view [5]</td>
<td>Korbmacher et al,</td>
<td>2007</td>
<td>Germany</td>
<td>Comparative</td>
</tr>
</tbody>
</table>
3. Effect of object location on the density measurement and Hounsfield conversion in a New Tom 3G cone beam computed tomography unit [6]
   Shaabaninejad et al., 2008 Canada Technical

4. Accuracy of linear measurement provided by cone beam computed tomography to assess bone quantity in the posterior maxilla: a human cadaver study [7]
   Lagravère et al, 2008 France Technical

5. Cone-beam computed tomography in assessment of periodontal ligament space: in vitro study on artificial tooth model [8]
   Özmeric et al, 2008 Turkey Technical

6. Cone beam CT and conventional tomography for the detection of morphological temporomandibular joint changes [9]
   Hintze et al, 2006 Denmark Comparative

7. In vitro cone beam computed tomography imaging of periodontal bone [10]
   Mol et al, 2007 USA Comparative

   Mah et al, 2003 USA Technical

9. Radiation exposure during midfacial imaging using 4-and 16-slice computed tomography, cone beam computed tomography systems and conventional radiography [12]
   Schulze et al, 2004 Germany Comparative

10. Image quality vs. radiation dose of four cone beam computed tomography scanners [13]
    Loubele et al, 2007 Belgium Comparative

11. Beam hardening artefacts occur in dental implant scans with the New Tom® cone beam CT but not with the dental 4-row multi detector CT [14]
    Draenert et al, 2006 Germany Comparative

    Scarfe et al, 2006 USA Technical

    Draenert et al, 2008 Germany Technical

    Lagravere et al, 2006 Canada Technical

15. Diagnostic criteria for the detection of mandibular osteomyelitis using cone-beam computed tomography [18]
    Schulze et al, 2006 Germany Technical

    Ludlow et al, 2006 USA Comparative

17. Analysis of the accuracy of linear measurements obtained by cone beam computed tomography (CBCT-New Tom) [20]
    Lascala et al, 2004 Brazil Technical

18. Characteristics of a newly developed dentomaxillofacial X-ray cone beam CT scanner (CB Mercuray): system configuration and physical properties [21]
    Araki et al, 2004 Japan Technical

19. Comparison of three radiographic methods for detection of morphological temporomandibular joint changes: panoramic, scanographic and tomographic examination [22]
    Hintze et al, 2009 Denmark Comparative

20. Three-dimensional accuracy of measurement...
<table>
<thead>
<tr>
<th>Number</th>
<th>Author/Publication year</th>
<th>Reason for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Andreas Staveopoulos/2006</td>
<td>Study was conducted on animal model (pig)</td>
</tr>
<tr>
<td>2</td>
<td>Dee Zoo/2009</td>
<td>Only one patient was evaluated</td>
</tr>
<tr>
<td>3</td>
<td>Eggers/2009</td>
<td>Study was done on a plastic skull</td>
</tr>
<tr>
<td>4</td>
<td>AlexiouKe/2009</td>
<td>Study emphasized on NewTom3G,9000 findings and characteristics of this device namely safety, sensitivity, specificity and accuracy were not mentioned</td>
</tr>
<tr>
<td>5</td>
<td>R0, Der, Zel/2008</td>
<td>Study design was not experimental</td>
</tr>
<tr>
<td>6</td>
<td>Liu, Deng-gao/2008</td>
<td>Study emphasized on NewTom3G,9000 findings and characteristics of this device namely safety, sensitivity, specificity and accuracy were not mentioned</td>
</tr>
<tr>
<td>7</td>
<td>King, Keith S/2007</td>
<td>Description of a specific technology in New Tom 9000</td>
</tr>
<tr>
<td>8</td>
<td>LimEugene Y/2007</td>
<td>Introduction of a side technology using New Tom3G</td>
</tr>
<tr>
<td>9</td>
<td>King, Keith S/2006</td>
<td>Study emphasized on NewTom3G,9000 findings and characteristics of this device namely safety, sensitivity, specificity and accuracy were not mentioned</td>
</tr>
<tr>
<td>10</td>
<td>Loube, Meir/2006</td>
<td>Study was done on a jaw plastic model</td>
</tr>
<tr>
<td>11</td>
<td>Ogawa/2007</td>
<td>Study emphasized on NewTom3G,9000 findings and characteristics of this device namely safety, sensitivity, specificity and accuracy were not mentioned</td>
</tr>
<tr>
<td>12</td>
<td>Sirin Y/2010</td>
<td>Study was conducted on an animal model (sheep)</td>
</tr>
<tr>
<td>13</td>
<td>Sirin Y/2010</td>
<td>Study was conducted on an animal model (sheep)</td>
</tr>
<tr>
<td>14</td>
<td>Gracco A/2010</td>
<td>Study was done on healthy individuals</td>
</tr>
<tr>
<td>15</td>
<td>Makris N/2010</td>
<td>Study emphasized on NewTom3G,9000 findings and characteristics of this device</td>
</tr>
</tbody>
</table>

Table 2. List of excluded articles and the reason for their exclusion
Results
A total of 31 articles were divided into two groups: 
1. Review articles, technical notes and reports regarding the setup and operation of CBCT
A total of 11 articles were in this group. A list of articles in this group that were used for preparation of a report and did not compare the diagnostic value is shown in Table 3.

<table>
<thead>
<tr>
<th>Article</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Elslande D</td>
<td>2010</td>
<td>Study was done on a plastic model</td>
</tr>
<tr>
<td>Chung RR</td>
<td>2010</td>
<td>Description of a specific technology in NewTom3G</td>
</tr>
<tr>
<td>Stumpel LJ</td>
<td>2010</td>
<td>Observational case report</td>
</tr>
<tr>
<td>Kamburoglu K</td>
<td>2010</td>
<td>Study was done on an autopsy corpse</td>
</tr>
<tr>
<td>Kamburoglu K</td>
<td>2010</td>
<td>Description of a specific technology in NewTom3G</td>
</tr>
<tr>
<td>Christiansen R</td>
<td>2009</td>
<td>Description of a specific technology in NewTom3G</td>
</tr>
<tr>
<td>Lagravere MO</td>
<td>2009</td>
<td>Description of a specific technology in NewTom3G</td>
</tr>
<tr>
<td>Hassan B</td>
<td>2009</td>
<td>Study emphasized on NewTom3G,9000 findings and characteristics of this device</td>
</tr>
<tr>
<td>Loubele M</td>
<td>2008</td>
<td>Study was done on a phantom</td>
</tr>
<tr>
<td>Lagravere MO</td>
<td>2008</td>
<td>Introduction of a side technology using NewTom3G</td>
</tr>
<tr>
<td>Lagravere MO</td>
<td>2008</td>
<td>Study emphasized on NewTom3G,9000 findings and characteristics of this device</td>
</tr>
<tr>
<td>Van der Zel JM</td>
<td>2008</td>
<td>Description of a specific technology in NewTom3G</td>
</tr>
<tr>
<td>Hainer-Neto F</td>
<td>2008</td>
<td>Study was done on laboratory models</td>
</tr>
</tbody>
</table>

2. Articles comparing different CBCT systems (NewTom9000, NewTom3G, CB Mercuray, i-CAT) with one another and with other imaging modalities
A total of 20 articles were placed in this group and evaluated in 5 major subgroups. Subgroup 1 articles compared different CBCT systems (NewTom3G, NewTom9000, CB Mercuray, i-CAT). Two articles were assigned to this subgroup (4, 5). Subgroup 2 contained articles comparing CBCT with other CT systems; 13 articles were assigned to this subgroup [9, 11, 13, 14, 19, 22-24, 29, 31-34].
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Author</th>
<th>Publication year</th>
<th>Compared modality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diagnostic accuracy of cone beam computed tomography scans compared with intraoral image modalities for detection of caries lesions [4]</td>
<td>Haitter-Neto et al,</td>
<td>2007</td>
<td>Comparison of CBCT and two intraoral receptors namely digital and film sensors</td>
</tr>
<tr>
<td>3</td>
<td>Cone beam CT and conventional tomography for the detection of morphological temporomandibular joint changes [9]</td>
<td>Hintze et al,</td>
<td>2006</td>
<td>Comparison of CBCT (New-Tom3G) with conventional tomography</td>
</tr>
<tr>
<td>5</td>
<td>Radiation exposure during midfacial imaging using 4-and 16-slice computed tomography, cone beam computed tomography systems and conventional radiography [12]</td>
<td>Schulze et al,</td>
<td>2004</td>
<td>Comparison of CBCT with MDCT and conventional radiography</td>
</tr>
<tr>
<td>7</td>
<td>Beam hardening artefacts occur in dental implant scans with the New Tom® cone beam CT but not with the dental 4-row multidetector CT [14]</td>
<td>Draenert et al,</td>
<td>2006</td>
<td>Comparison of CBCT (New-Tom 9000) with MDCT (Philips MX 8000)</td>
</tr>
<tr>
<td>8</td>
<td>Dosimetry of 3 CBCT devices for Oral and Maxillofacial Radiology: CB Mercuray, New Tom 3G and i-CAT [19]</td>
<td>Ludlow et al,</td>
<td>2007</td>
<td>Comparison of three CBCT systems (Mercuray, New-Tom3G and i-CAT) and comparison of CBCT and MDCT</td>
</tr>
<tr>
<td>9</td>
<td>Comparison of three radiographic methods for detection of morphological temporomandibular joint changes: panoramic, scanographic and tomographic examination [22]</td>
<td>Hintze et al,</td>
<td>2007</td>
<td>Comparison of CBCT (New-Tom3G) with conventional tomography</td>
</tr>
<tr>
<td>10</td>
<td>Three-dimensional accuracy of measurements made with software on cone-beam computed tomography images [23]</td>
<td>Lagravere et al,</td>
<td>2006</td>
<td>Comparison of CBCT and CMM</td>
</tr>
<tr>
<td>11</td>
<td>Comparison of image performance between cone-beam computed tomography for dental use and four row multidetector helical CT [24]</td>
<td>Hashimoto et al,</td>
<td>2006</td>
<td>Comparison of CBCT with MDCT</td>
</tr>
<tr>
<td>12</td>
<td>Quantitative measurements obtained by</td>
<td>Kamburoglu et,</td>
<td>2008</td>
<td>Comparison of CBCT with laser</td>
</tr>
</tbody>
</table>

**Table 3.** The list of review articles about CBCT

**Table 4.** The list of articles comparing CBCT with other imaging modalities
Table 1

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Articles</th>
<th>Scans Compared</th>
<th>CBCT vs. Other CT Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Micro-computed tomography and confocal laser scanning microscopy [26]</td>
<td>Shaabaninejad et al.</td>
<td>2006</td>
</tr>
<tr>
<td>14</td>
<td>Accuracy of linear measurements using dental cone beam and conventional multislice computed tomography [29]</td>
<td>Simon et al.</td>
<td>2006</td>
</tr>
<tr>
<td>15</td>
<td>Cone-beam computed tomography in assessment of periodontal ligament space: in vitro study on artificial tooth model [8]</td>
<td>Özmeric et al.</td>
<td>2006</td>
</tr>
<tr>
<td>17</td>
<td>A comparative evaluation of cone beam computed tomography (CBCT) and multislice CT (MSCT): Part I. On subjective image quality [31]</td>
<td>Liang et al.</td>
<td>2009</td>
</tr>
<tr>
<td>18</td>
<td>A comparative evaluation of cone beam computed tomography (CBCT) and multislice CT (MSCT). Part II: On 3D model accuracy [32]</td>
<td>Liang et al.</td>
<td>2009</td>
</tr>
<tr>
<td>19</td>
<td>Comparison between effective radiation dose of CBCT and MSCT scanners for dentomaxillofacial applications [33]</td>
<td>Loubele et al.</td>
<td>2009</td>
</tr>
<tr>
<td>20</td>
<td>Radiological diagnosis of periapical bone tissue lesions in endodontics: a systematic review [34]</td>
<td>Petersson et al.</td>
<td>2009</td>
</tr>
</tbody>
</table>

Subgroup 3 compared CBCT with conventional radiography. Three articles fell into this subgroup [8, 10, 12]. Subgroup 4 included articles comparing CBMCT with laser scanning. One article was included in this subgroup [26]. Subgroup 5 included one article comparing CBCT and biopsy [28]. Characteristics of these articles are demonstrated in Table 4. It should be mentioned that the new systems have different features. For example, New Tom VG uses flat panel and provides clearer images than NewTom9000 and New Tom.

2A. Comparison of CBCT with other CTs

Liang et al, in their study used a high-resolution laser scanner as the gold standard for comparison of the accuracy of the 3D model obtained by CBCT and multi-slice computed tomography (MSCT) and reported that the mean deviation from the gold standard was 0.137 mm for MSCT, 0.282 for CBCT, 0.225 for i-CAT, 0.165 for Acuittomo, 0.386 for New Tom and 0.206 for Scanora and Galileos [32]. Liang et al, also reported that Acuittomo was superior to MSCT and other CBCT systems in displaying anatomical landmarks; whereas MSCT is superior to other CBCT systems in reducing image noise [31]. Loubele et al. compared the efficacy of CBCT and MSCT and the following results were obtained: the effective dose was in the range of 13-82 µSv for CBCT and 474-1160 µSv for MSCT. These rates were lower than those of Acuittomo and higher than those of i-CAT [33]. Suomalainen et al. compared the accuracy of linear measurements obtained using CBCT and MSCT and reported that the mean measurement error was 4.7% for CBCT and 8.8% for MSCT in a dry mandible. This rate was 6.6% for CBCT and 5.4% for MSCT for mandible immersed in sucrose solution [30]. Mah et al. compared the absorbed dose of tissues by New Tom 9000 and other CTs and found that the effective dose for maxillofacial imaging with New Tom 9000 was 50.3 μSv; which was significantly less than that of conventional CTs [11]. Draenert et al. compared imaging artefacts of New Tom and MDCT and reported that scans with NewTom9000 showed stronger artefacts than MDCT [14]. Lagravere et al. compared the accuracy of linear measurements made on CBCT and coordinate measuring machine (CMM) and reported that t-test found no significant differ-
ence in linear and angular measurements between the CMM and New Tom 3G and the difference in this respect was less than 1 mm and 1 degree, respectively [23]. Ludlow et al. in dosimetry of 3 CBCT devices reported the calculated dose (in mSv, E1990, E2005) to be (45, 59) for New Tom 3G, (135, 193) for i-CAT and (477, 558) for CB Mercuray. These values were 4 to 42 times greater than the panoramic examination doses (6.3 mSv, 13.3 mSv) [19]. Hashimoto et al. compared the image performance between CBCT and four-row multi-detector helical computed tomography (MDCT). MDCT images were used as the standard. CBCT images were evaluated using a 5-level scale. Assessment of imaging performance revealed that CBCT images had higher quality than MDCT images and that CBCT is a useful imaging modality in dentistry [24]. Loubelle et al. in another study on image quality and radiation dose of 4 different CBCT systems (i-CAT, NewTom3G, CB Mercuray, Accuitomo) reported that the most favorable radiation dose versus image quality belonged to i-CAT. The lowest image quality belonged to Mercuray. The highest radiation dose belonged to Mercuray and Somatom Sensation and the lowest belonged to Accuitomo 3D [13]. In another study done by Hintze et al. image accuracy of CBCT and conventional CT was compared and the results found no significant differences between the two systems for detection of skeletal changes. Sensitivity and specificity of CBCT were compared for detection of flattening, defects and osteophytes. In the sagittal (lateral) dimension, the mean sensitivity value was 0.14 for CBCT and 0.13 for conventional CTs. In the cross-sectional dimension, the mean sensitivity was 0.3 for CBCT and 0.2 for conventional CTs. The mean specificity in the sagittal (lateral) dimension was 0.92 for CBCT and 0.97 for conventional CTs. This value for the cross-sectional dimension was 0.93 in CBCT and 0.94 in conventional CTs. In other words, the mean sensitivity for various changes was usually low and varied from 0.11 for flattening in conventional CTs to 0.4 for defects on cross-sectional CBCT images. The mean specificity was high for various changes ranging from 0.87 for CBCT cross-sectional views of the flattening to 0.99 for CT images of osteophytes [22]. Schulze et al. compared the radiation exposure of CBCT and conventional CTs and found that multislice CT had higher exposure values than CBCT and thus, CBCT is safer than multislice CT systems [12]. Hintze et al. failed to find a significant difference for detection of skeletal changes in condyle and articular bone between two CBCT systems namely NewTom3G and conventional tomography [9]. Petersson et al. in their systematic review in 2012 concluded that evidence regarding the equal diagnostic accuracy of the digital intraoral radiography and the conventional film technique is insufficient. The same goes for CBCT. They failed to draw any conclusion about the accuracy of radiological examination for detection of periapical bone tissue changes or condition of tooth pulp [34].

2B. Comparison of different CBCT systems

Haiter-Neto et al. compared NewTom3G and Accuitomo CBCT systems and reported that NewTom3G had lower diagnostic accuracy for detection of caries than intraoral imaging system and Accuitomo [4]. It should be noted that NewTom3G was among the first products of this company and the newer systems have higher image quality; particularly the latest product New Tom VG that uses flat panel technology and has a very high image resolution. Korbmacher et al. compared NewTom9000 and Mobile Arcadis 3D CBCT systems and conventional radiography in terms of image quality for orthodontic purposes and concluded that CBCT systems are superior to conventional radiography in this respect [5].

2C. Comparison of CBCT with conventional radiography

Özmeric et al. compared CBCT (NewTom9000) and conventional radiography (RG) in terms of image quality and showed that CBCT had a lower quality than RG [8]. Mol et al. compared CBCT (NewTom9000) and conventional radiography in terms of quantitative and diagnostic information and found that NewTom9000 was superior to RG in this respect (10). Schulze et al. compared CBCT with MDCT and RG in terms of radiation exposure and showed that MDCT, CBCT and RG had the highest radiation exposure in a decreasing order [12].

2D. Comparison of CBCT with laser scanning microscopy

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Kamburoglu et al. compared CBCT with laser scanning microscopy and despite the strong correlation between the two, it was shown that CBCT significantly underestimated the diameters and volumes [26].

2E. Comparison of CBCT with biopsy
Simon et al. performed differential diagnosis of periapical lesions using CBCT and biopsy and concluded that CBCT provides an accurate diagnosis compared with biopsy and histology without the need for an invasive surgery or waiting for a year to see the results of non-surgical therapy [28].

Discussion
Numerous studies are available on CBCT and the majority of them have a diagnostic or descriptive design. These studies aimed at assessing the application of CBCT, its diagnostic accuracy and technical properties namely the radiation dose, resolution, contrast and etc. Limited evidence exists regarding the efficacy of CBCT in the course and outcome of treatment and the existing ones are mostly controversial. These factors seem to change over time by the advances in technology. The CBCT system is produced in different designs and the results are different based on the type of system used. However, these differences are mostly insignificant. Studies comparing older CBCT systems with MSCT have shown that the image quality in MSCT is higher than that of CBCT. More recent studies comparing newer CBCT systems with MSCT have reported reverse results. CBCT has some advantages over similar systems namely higher image quality, high speed, easy application, low radiation dose and providing a 3D volumetric image by one time radiation. Based on the available evidence, CBCT has low sensitivity and high specificity. It seems that CBCT can be an accurate, non-invasive and practical technique for estimation of the magnitude of dental and skeletal trauma especially in the oral and maxillofacial region. Considering the various technical characteristics of this technology, it should be used for specific purposes by expert individuals. At present, CBCT has the highest application in dentistry and maxillofacial surgery and is mostly purchased by dentists and maxillofacial surgeons (not radiologists). Considering its technical aspects, it is suggested that CBCT be used by the oral and maxillofacial radiologists. CBCT should not be used as the only imaging modality in poly-trauma patients because the intracranial assessments cannot be done accurately by this technique alone. Based on the available literature, this system is suitable for import and use in Iran. However, number of imported systems, their location of use, indications for use and related tariffs have to be precisely controlled.

Conclusion
CBCT technology is now commonly used in developed countries for obtaining detailed information regarding the oral and maxillofacial region and can greatly help clinicians in diagnosis and treatment of maxillofacial disorders.

Acknowledgement
This research project was approved and financially supported by Tehran University of Medical Sciences in 2009 (code 8792-74-02-88).

References
6- Lagravère M, Carey J, Ben-Zvi M, Packota G, Major P. Effect of object location on the density measurement and Hounsfield conversion in a NewTom 3G cone beam computed tomography
25- Walker L, Enciso R, Mah J. Three-dimensional localization of maxillary canines with cone-beam
Kamburoğlu K, Barenboim S, Artürk T, Kaffe I. Quantitative measurements obtained by micro-
computed tomography and confocal laser scanning microscopy.
27-Stratemann S, Huang J, Maki K, Miller A, Hatcher D. Comparison of cone beam computed
29-Suomalainen A, Vehmas T, Kortesniemi M, Robinson S, Peltola J. Accuracy of linear
measurements using dental cone beam and conventional multislice computed tomography.
30-Pinsky H, Dyda S, Pinsky R, Misch K, Sarment D. Accuracy of three-dimensional measurements
beam computed tomography (CBCT) and multi-
slice CT (MSCT): Part I. On subjective image
32-Liang X, Lambrichts I, Sun Y, Denis K, Hassan
B, Li L, et al. A comparative evaluation of cone
beam computed tomography (CBCT) and multi-
slice CT (MSCT). Part II: On 3D model accuracy.
33-Loubele M, Bogaerts R, Van Dijck E, Pauwels
between effective radiation dose of CBCT and
MSCT scanners for dentomaxillofacial
of periapical bone tissue lesions in endodontics: a
systematic review. Inter Endod J. 2012 Sept; 45
(9):783-801.