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Intraoral Periapical (IOPA) Radiographs: A Key Element to Dental Imaging

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ABSTRACT: As far as concerned with technological development in medical domain, the image processing playing an important role in dentistry. Now a days, the impact of dental imaging (DI) in dentistry highlights the crucial role in detection of dental abnormalities. It helps operator to detect and diagnose the disease in proper way. Earlier there was classical (film based) method used to detect caries, bone artifacts, periodontal disease etc., now digital radiography technology is using for clinical observation. DI has some advantages over film based processing method, but again classical method is preferred by operator. There are number of diseases pertinent to teeth are identified and diagnose by means of analyzing 2D and or 3D images. These images captured by means of respective machines. Mouth is an entrance part of energy input to human being and teeth are important elements for processing it. The proper care must be taken for the same. Paper focuses on different imaging techniques, dental clinical applications of digital imaging, advantages and disadvantages dental imaging.

KEYWORDS: Image Processing, Dental Abnormalities, Operator, 2D and or 3D images, Dental Clinical Applications, Dental Imaging

I. INTRODUCTION

Today medical imaging is a fastest growing field in the world. This field is directly related to life so having very much importance in our day today life. People working in this area contributing their valuable work which is directly beneficial for social and human being. The first dental x-rays taken by Dr. Otto Walkhoff in January 1896. He uses own mouth for an exposure of x-rays for 25 min [1] after this experimentation the revolution in dentistry started. In the field of dentistry the most important concern is diagnosis of patient. There are many researchers working with medical imaging and their related areas. DI also a part of medical imaging where researchers and radiologist find more space to enhance the quality and accuracy of technology used for particular clinical applications.

IOPA stands for Intraoral Periapical radiograph. The IOPA (Intraoral periapical radiograph) is the most commonly used radiograph in the practice of endodontics. It is cost effective and can be developed manually. For specific tooth analysis, the periapical radiograph should provide an image of the entire tooth from the crown to the apex, including some or all of adjacent teeth, the surrounding bone, and anatomical structures in the vicinity [2]. Film processing is another task which can enhance the image processing based applications. The operators are more rely on IOPA film based processing techniques rather than other one, because of easiness and radiation doses.

The treatment is directly associated with the degree of certainty in diagnosis. Hence the imaging of teeth plays crucial role here. An image (digital image) is produced by using analog-to-digital conversion. There are three steps in image formation, first the low voltage ranges values in the signal are grouped together as a single value then every sampled signal is assigned a value and stored in the computer and finally the computer organizes the pixels in matrix form as it is an digital image in their proper locations and displays a shade of gray corresponding the number assigned and the image becomes visible on the computer screen [3]. Now a days Digital radiography has become an integral part of dentistry. The dentists are more preferring and relying on digital imaging. There are some advantages over film based like, it does not require film or dark rooms, reduces X-ray doses, and instantly generates images [4]. The dental imaging could be 2- Dimensional or 3-Dimensional. For erupted and non erupted teeth 3-D imaging is desirable. Also in surgical implants the 3-D imaging is most desirable as far as the accuracy is concerned. There are various techniques used for 3D imaging in such as (MRI) Magnetic Resonance imaging, (CT) computer tomography and many more. Dental radiography has been used since the beginning of radiology.

II. RELATED WORK

Literature review shows different aspects and views by authors regarding digital radiography to identify and diagnose dental disease by visualization and digital processing on radiographs. Recently 3D imaging is preferred for correct and clear visualization. Cone beam computed tomography (CBCT) most of dentist preferring for accuracy but its cost limits for general purpose access. Generally dentist prefers 2D technique for IOP and OPG. Image quality plays an important role in assisting dentist's diagnosis ability. As far as concerned with quality of image, film-

based image has some limitation due to chemical processing and image enhancement cannot be done if required because of manual processing. Therefore, digitized film-based image to digital image was required to allow image enhancements in order to improve the interpretability quality of information in the image [5].

In this paper authors says that, digital imaging is more beneficial in oral epidemiology in an effort to overcome some of the limitations of direct clinical assessment. Recent studies have demonstrated successful mitigation of observer bias through the use of digital imaging, with the option to remotely score anonymised images facilitating effective examiner blinding. [6]

Generally the use of direct digital radiography which generates the image are, photostimulable storage phosphor (PSP) sensors (also known simply as “storage phosphor sensors”), solid-state electronic sensors such as charged-coupled devices (CCD) and complementary metal-oxide semiconductor active pixel sensors (CMOS-APS) [5]. However, noise that come from the nature of image acquisition processes degrades image quality in radiographs. Advancement in image processing has leads many researches toward the enhancement of medical images for more accurate medical expert interpretation [7]. Dentists follow the ALARA principle, which stands for “As Low As Reasonably Achievable,” when obtaining radiographs. Because of the low radiation dose associated with dental radiographs, people who have received radiation treatment for head and neck cancer can undergo dental radiography safely [8].

III. DENTAL IMAGING

Initially film based conventional radiography was using then Radio-visio-graphy (RVG) is introduced as digital radiography. A sensor which is directly connected to computer, it captures and sends to computer system. With the help of software facilities are provided to enhance quality of image. RVG produces 2-D radiographs with excellent quality images to support an operator to analysed dental disease. The primary use is of Radio-visio-graphy (RVG) to supplement the clinical examination by providing insight into the internal structure of teeth and supporting bone to reveal caries, periodontal and periapical diseases, and other osseous conditions [9].

Recently, technology is growing towards 2D to 3D in dental imaging. A novel framework for objective evaluation of automatic dental radiography analysis algorithms has been established under the auspices of the IEEE International Symposium on Biomedical Imaging 2015 Bitewing Radiography Caries Detection Challenge and Cephalometric X-ray Image Analysis Challenge [10]. Recently Cone beam computed tomography (CBCT) is more famous in 3D dental imaging. CBCT provides the quality images of the maxillofacial skeleton, including the teeth and their surrounding tissue. The key advantage of preference of CBCT technology is a lower effective radiation dose than traditional CT scans [11].

A. Types of dental radiographs:

In dentistry, X-rays are divided into two main categories, Intraoral and Extraoral. Intraoral is taken inside the mouth and extraoral X-ray is taken outside of the mouth. Intra oral includes: Bite-wing, Periapical and Occlusal X-rays. Extraoral X-rays are taken from outside the mouth. Comparatively, Intraoral has more advantageous over extraoral hence intraoral are more preferable. The periapical radiograph technique includes;

- Bisecting angle and long cone paralleling technique
- The bite-wing radiograph
- The occlusal radiograph

The occlusal radiographs such as Maxillary anterior, Maxillary lateral and Mandibular anterior occlusal.

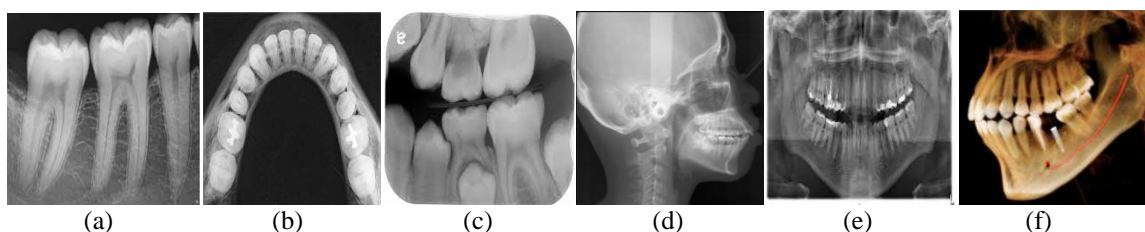


Figure 1: (a) Intraoral Periapical, (b) Occlusal x-rays, (c) Bitewing, (d) Extraoral X-rays, (e) 2D Panoramic, (f) 3D CBCT image

There are number of applications associated with X-rays. Some of them classified in two groups IOPA and OPG where diagnosis is done by digital imaging.

IOPA stands for Intra oral Periapical Radiography. In this a small film is used for a single or two, three teeth. OPG stands for Ortho pantomogram

B. IOPA applications:

- a) Interpretation caries / occlusal caries
 - Interpretation of Incipient occlusal lesions
 - Interpretation of moderate occlusal lesion
 - Interpretation of severe occlusal lesion
- b) Proximal caries
 - Interpretation of incipient of proximal lesion
 - Interpretation of moderate proximal lesion
 - Interpretation of severe proximal lesion
 - Interpretation of advanced proximal lesion
- c) Root surface caries
- d) Assessment of periodontal disease
- e) Interpretation of restorative and base materials

C. OPG applications:

- Evaluation of trauma
- Evaluation of third molars
- Evaluation of extensive disease
- Evaluation of tooth development
- Evaluation of retained teeth
- Evaluation of root tips
- Evaluation of development anomalies

Panoramic radiographs are also useful for patients who do not tolerate intraoral procedures well or those with a large known (or suspected) lesions.

D. Advantages

- a) Easy and fast capturing
- b) Radiation dose reduction
- c) No need of film development by means of chemicals and other artifacts.
- d) Minimum retake
- e) Probability of error occurrences reduces
- f) Can send to remote place
- g) Image enhancement possible easily

E. Disadvantages

Cost of hardware and software.
Machine installation and maintenance

IV. CONCLUSION AND FUTURE WORK

Dental imaging is playing an important role for detection and diagnosis of dental disease. Operators are more relying on radiographs and mostly referring patient to go for x-rays. Recently most of the dentists prefer digital radiography techniques which include 2D as well as 3D techniques. CBCT is recent technology in dentistry to solve critical issues which are quite difficult to analyse by classical and or 2D methods. Hence the image processing plays key role to take part in correct diagnosis. The 2D applications are enlisted in this paper, which are most commonly used. Digital radiography limits the exposure to x-rays repeatedly for same thing.

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BIOGRAPHY

Shaikh Mohammed Aamer received Master degree from Government College of Engineering, Dr. BAMU, University Aurangabad (MS), India. Currently he is doing research work in Medical image processing. He has published many papers in conferences and journals.



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