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Panoramic Radiography:A review

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Running title: Intraoral radiography

Clinical Significance: The Panoramic Radiographic image allows maximum diagnostic detail and information that a radiographic equipment and technique can allow.

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ABSTRACT

A diagnosis is never complete without sufficient investigations. The significance of the intraoral radiograph in dentistry is well documented in literature. However, it has limitations in unveiling the entiremaxilla-mandibular structures in a single try. Panoramic Radiography has more or less, overcome the limitations of Intraoral Radiography, by displaying the complete maxilla-mandibular structures, condyles, parts of the maxillary sinus and nasal complexeson a single film.

Aims and objectives: The article lays stress on the basic principles, indications, merits and demerits, associated with the production, processing and interpretation of the Panoramic Radiographs, and also the errors that occur within them; thereby, allowing the practitioner to understand the position at which the error occurred, in the image creation process.

Materials and Methods: By using specific keywords, electronic search of scientific papers was carried out on the entire PubMed database, with custom range of 5 years. The electronic search yielded five papers; based on inclusion and exclusion criteria which were specifically predetermined for which the review was done. By pooling the extracted data from selected papers, the reviewed data was synthesized.

Results: The Panoramic Radiography, though beingmore advantageous than the Intraoral Radiography, it has its limitations in terms ofcost effeciency and intricate detailing, which needs to be adhered to, while taking a radiograph. It cannot be a substitute for the intra-oral radiography for routine cases.

Conclusion: While the fundamental basic standards of radiography apply both to the Panoramic and Intraoral imaging, essential differences exist, between the two methods. Acknowledgment of these distinctions can help the practitioner in reliably delivering images of adequate diagnostic quality.

Key words: Orthopantomogram; Panoramic Radiograph; errors in panoramic radiography; Intraoral Radiograph.

INTRODUCTION

We are in the era of Advanced Imaging Modalities, where advanced machines such as the Computed Tomography (CT), MRI (Magnetic Resonance Imaging) and CBCTC (Cone Beam Computed Tomography) have replaced the conventional radiographic machines, including the panoramic radiogram.Though not as advantageous as the afore-mentioned machines, the Panoramic Radiogram, has its own significance.'Orthopantomogram,' (OPG)wasthe earlier used terminology for this machine, and the prefix 'ortho' means'to correct' or 'straighten', so the term was apt for this instrument. Subsequently,the term 'OPG' has become synonymous with Panoramic Radiography.[1]

Panoramic radiographs, has the advantage of displayingthe arches, upper and lower, and its allied structures, in the same radiograph,due to which it isconvenient. It also reduces thenecessity of taking unnecessary, multiple periapical and bitewing radiographs, and therefore minimizesthe added exposure to radiation.An ideal Panoramic Radiograph has a 'U' shaped mandible, and the inner side margin presenting the condyles, equidistant from center, and 1/3rdof the way down from the upper edge of the image. An upward bending 'smile line' depicts the occlusal plane. The entire maxillary and mandibular anterior teeth with its roots are clearly visible with negligible distortion. Both sides of the midline show equal magnification.[1]

Panoramic Radiography works on the principles of tomography and slit radiography.[1]In the older generation machines, sectioned view was achieved by moving the source and film at the same time in inverse directions; whereas in the recent machines, image of a larger areais obtained by utilizing a slit beam in a curved zone. Focal trough (FT) (an area that is three-dimensional, within which, accurate reproduction of structures, can be obtained on a panoramic radiograph), the central point of panoramic radiography varies from machine to machine, and is selective for every machine in thickness and framework. Since it is a delicate procedure,the tomographic system with a slim FT,the patient's positioning becomes vital and the rules must be carefully followed. Major errors,in relation to this methodology are common, and therefore, knowledge and ways to avoid mistakes, are required.

The Focal trough/imaging plane(an area that is three-dimensional, within which, accurate reproduction of structures can be obtained on a panoramic radiograph)isa narrow region of sharp focus, stated by the

machine'smanufacturer, to produce the optimum image. The size of the focal trough/ image plane is very vital for obtaining a successful image and it is adjustable for each age of patient. It is preset in the present day machines.[2]

Professionals, who prescribe panoramic radiographs, need to know about radiation doses, risks to patients, past exposure history etc., to minimize the unwanted complications. Being a routinely prescribed radiograph, it is mandatory that they should know the indications, errors, and artefacts related to it. Accessibility to a technique, does not mandate its misuse.[1]

An ideal panoramic machine,relies upon factors such as

- the scanning geometry
- source to film distance
- the rapidity of transport
- size of focal spot
- the width of the incident X ray beam
- class of receptor utilized
- beam angle projected between teeth to avoid overlap; particularly in the premolar region
- sufficient width in the anterior region to accommodate the anteriors
- obtain satisfactory sharpness and dimensional accuracy at the central plane of focal troughand
- economically viable.

Examples of Panoramic machines include:

- Planmeca;
- GendexOrthoralix 8500 DDE;
- Samsung RayScan Expert 2D Digital Pan;
- SoredexCranex 2.5
- Panoramic X-ray dental;
- DentXPanoura 18S Panoramic System

The above machines have differences regarding:

- Number of rotations
- Size & shape of focal trough and
- Type of film transport mechanism

Intraoral periapical and bitewing radiographs are better aids for caries detection, assessment of periapical pathology and the detection of periodontal lesions where furcation is involved.

Indications of Panoramic Radiographs (OPG)

- Assessment of temporomandibular joint disorders
- Evaluation of growth and development of children and juveniles
- Estimation of adult dentition or partially edentulous patients
- Evaluation of facial trauma
- To analyze the mixed dentition or evaluate third molars
- To evaluate implants
- To study craniofacial anomalies
- To assess the pre and post treatment of periodontal diseases
- In patients with severe gag reflexes and trismus

Manipulation of the instrument

Technique for the correct positioning of the patient and the instrument

To get a decent quality radiograph, consideration should be given to the right positioning of the patient and ideal processing of the radiograph. Any deviation from the right technique can prompt second-rateimages, which may compromise on the right diagnosis. Essential arrangement is similar to that of an IOPA or Bitewing technique, with additional modifications for alignment of the midsagittal plane, occlusal plane and antero-posterior plane that is represented by guide lights. The tongue should touch the palate to avoid airspace shadow overlapping on the periapices of maxillary teeth in the resultant radiograph, and the lips should be kept closed.

There are 'Positioning guides' such as light or plastic guides that are present, to position the patient, along three major planes:

- Antero-posterior (should not be too far forward or back)
- Vertical (alatragus, Frankfort plane, or cantho-meatal lines aligned by lights)
- Midsagittal alignment (to avoid patient twisting or rotation aligned by light)

Patient Positioning Requirements

The alignment of the head, in panoramic radiography,is similar to that used in periapical or bitewing radiographs i.e., the midsagittal plane vertical to the floor and occlusal plane parallel to the floor,withadditional adjustment in the three planes achieved by the guidelights. Additionally the tongue and lip positioning is also important as patient has to stay motionless for about 15-17 seconds.

Steps in taking radiographs:

1. Load cassette in case of conventional machines. Currently, digital machines are predominantly used.

2. Set exposure factors.

3. Have patient remove jewelry.

4. Leadapron should be placed on the patient.

4. Have patient bite on a bite rod correctly, so that patient's arches are sufficiently in the FT.

5. Adjust the chin tilt, to get a sufficiently acceptable smile line therefore avoiding condyles or chin being cut off from the radiograph.

6. Position the side guides to avoid tilting of the head.

7. Have the patient stand up straight to avoid shoulder coming in between, and obstructing the rotation.

8. Have the patient swallow, place tongue on the roof of the mouth (to avoid the airspace between the tongue and palate obscuring the roots of maxillary teeth) and hold still.

9. Expose the film.

10. Process the film, if manual, or take printout if digital. If digital, mild adjustments could be done for clarity purposes before taking printouts.

For view specific structures, alterations in positions can be done.

- To view maxillary sinus or condyle the chin may be tipped down slightly.
- To have a view of the area below mandible in case of large lesions the chin may be tipped slightly.
- Special chin rests can be used for large and small mandibles.
- Edentulous patientsmay need special anterior guiding apparatus instead of bite block.

Assessment: Once the image is received,it has to be properly evaluated. The main technical criterion for acceptance of a Panoramic Radiograph isthat, it should adequately show all of the structures of the maxillofacial region.

Evaluation of Accuracy

- Mandible should be U-shaped.
- Condyles must be sufficiently visible.
- Occlusal planes must exhibit a slight curve or "smile line" upwards.Minimal upward curve of teeth-smile line.
- Equal magnification on both sides of the midline.
- Palate and ghost images of palate must be above the apices of the maxillary teeth and below lower part of the maxillary sinus.
- Pulp canal and roots of the maxillary and mandibular anterior teeth must be clearly visible with minimal distortion-not too narrow or too wide.

- No tooth size discrepancy on right or left side.
- Overlapping of premolars due to inherent x-ray beam projection in this region.

Magnification: The images in most panoramic radiographs are enlarged by about 20 %. The magnification factor both in vertical and horizontal planes are given by the manufacturer. This knowledge is helpful during implant placement.

Advantages of Panoramic Radiography

Advantages for Panoramic Radiography are as follows: (**Box 1)**

Box 1: Advantages of Panoramic Radiography

- Soft tissue outline is seen
- Gives a panoramic view of both arches
- Relationship between teeth, arches and condyle can be compared
- Can be used for patient with limited mouth opening
- Condylar evaluation
- Trauma analysis as newer machines allow lying down position also unlike old ones
- Periodontal assessment, large lesions, growth and development, multiple impactions, systemic diseases

Disadvantages ofPanoramic Radiographyare shown below (**Box 2**)

Box 2: Disadvantages of Panoramic Radiography

- Panoramic radiographs provide important additional diagnostic information only when selection criteria are followed.
- Intra oral radiographs are the best in resolution, but panoramic radiographs also can provide a fair resolution image.
- Panoramic imagingneeds machine and patient preparation before taking the radiograph.
- Panoramic radiographs may not be the best and may sometimes present, negligible but acceptable errors. Errors are integral feature of panoramic radiographs, and a study showed 1-5 errors in 95% of the

cases [3]but when major or critical errors occur, it may lead to wrong diagnosis. Documentation of errors, and their reasons, can avoid repeats.

- It should have adequate exposure as shown by no burnouts or increased density, especially in the maxilla, where the periapices of the teeth may not be visible due to space between the tongue and the palate caused by the tongue not touching the palate. Overlapping of proximal contacts especially in the premolar region usually makes the panoramic radiograph, less reliable than intraoral radiographs for detection of small caries and subtle periodontal bony defects in this region.

The practitioner must be conscious of common errors and should be able to correct them.

Errors in panoramic radiography (Box 1), (Box 2), (Box 3) and (Box 4)

A panoramic radiograph is considered having a critical error, if it does not display any of the following:

- Condyle of the TMJ
- Mandibular/maxillary anterior region
- Mandibular ramus

Errors may be due to

- Patient Preparation
- Machine Preparation
- Patient positioning
- Errors in exposure
- Errors in processing

Box 2:Technique and patient preparation errors

Technique errors:

- Inappropriate selection of exposure parameters (over/under exposure) - dark or light radiograph as the case may be.
- Incorrect handling of port-film cassette or image receptor - artefacts

Patient preparation errors:

- Jewelry not removed - aretefacts and ghost images
- Improperly placed radiological protection apron - unwanted radiodensities in crucial areas
- Patient did not bite into the groove of the bite rod correctly - widening or narrowing especially in the anterior region.[4]

Box 3:Postioning and Projection Errors

Chin: too high - condyles spread out, smile line straight; maxilary anteriors unclear. Hard palate superimposed on teeth. Condyle at the edge of the film: mandible broad and flat too low: smile line too much curved.Mandibular incisors not clear.Mandible narrow and V – shaped.

Chin not on chin rest: top of the sinus and the condyles cut off.Possibility of a distortion; overlapping and lack of sharpness of anterior teeth.

Soft Tissue Projection Errors:

Tongue drop: Shadow over maxillary teeth apices.

Lips not closed:increased radiolucency over the maxillary anterior region

Hard Tissue Projection Errors:

Patient Movement: double imaging or loss of segments; dent in the lower border of the mandible

Head:

Biting far front:anteriors not clear,

Biting far behind: spine shadow,anterior teeth blurry and wide, ghosting of mandible and spine, condyles close to edge of film.

Head turned to one side,

Gross asymmetry between two sides,

Uneven blurring throughout the arch; nasal structures not clear.

Head tilted

Condyles at different levels; nasal structures distorted. [4]

Box 4: Errors in panoramic radiography-Ghost Images

- Formed when object is between source & center of rotation
- Has same general shape of original
- Does not produce a mirror image
- Appears: On the opposite side of original In a higher position than original
- Magnified and not sharp more in vertical plane than horizontal.[4]

Images of Panoramic Radiographs depicting the changes due to technique errors and patientposition errors(Figures 1 to 6)

Figure 1: Steep smile line

Figure 2: Spine shadow

Figure 3: Tongue not touching palate
Periapices of palatal roots obscured

Figure 4: Reverse smile line
Chin tilted up

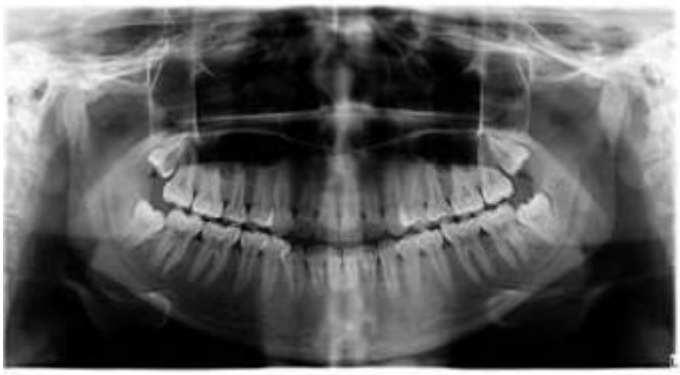

Figure 5: Dark image- exposure parameters not Adjusted

Figure 6: Spine on either side of ramus - Patient slumped

Discriminative use and analysis of radiographs are necessary for evaluation in various conditions, eg. Linear and angular measurements for mandibular asymmetry analysis, measurements of bone width for implant placement, and for performing cephalometric analysis.

For implant placement: Overestimation or underestimation can be a problem especially for implant placement. There may be differences in the vertical and horizontal magnifications and vertical magnification may be more stable as compared to horizontal.[4]

In spite of many disadvantages and errors, panoramic radiography is gaining popularity due to its advantages. [5]The machine is becoming more affordable and easy to procure. In today's digital age, capturing and storing panoramic radiographs is a reliableprocedure and that if available, together with practice management software, helps in obtaining the patient's image together with his file at a later date when required.[2]

CONCLUSION

Panoramic Radiography is an intricate procedure requiring machine and patient readiness, prior to patient positioning and subsequent exposure. Each Panoramic Radiograph should therefore be carefully taken, by fulfilling specific criteria. When the principles for radiographic techniques are abided by; the panoramic radiographexhibits all the essential diagnostic datas. The knowledge of the errors occurring in these radiographs and the information to rectify them would go a long way in constructive usage of this cost effective and sensitive radiographic technique.

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