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How did this Newsletter get started?

By Dr. Allan G. Farman

During the Chicago Midwinter meeting earlier this year, I was asked by representatives from Panoramic Corporation if I could recommend a good general textbook on panoramic radiography. Apparently there is a great deal of interest within the dental profession in obtaining clinically relevant information on how to achieve the maximum diagnostic yield from the panoramic radiograph. On my personal library shelf, I have several texts on panoramic radiography published by such eminent sources as Manson-Hing, Langlais and Chomenko; however, when I looked at the dates of publication inside the front covers of these books, I was disappointed to find that the latest revision was made more than a decade ago. A thorough search of the World Wide Web, including "Bestbookbuys.com" showed that I was not mistaken in thinking that there is no available text based upon modern panoramic technology. No easy-to-access, up-to-date resource on panoramic radiography exists in the English language at this time.

It is for this reason that I agreed to edit a newsletter on panoramic radiography that would be distributed as a service to the dental profession. My agreement is contingent upon editorial independence, strict avoidance of commercial content, and a focus on the interpretation of panoramic radiographs in general rather than radiographs made using a machine from one particular vendor. Each issue will contain three to five-and-a-half pages of content, mostly devoted to one topic in each case. There will also be selected clinically relevant abstracts from the scientific literature. The final half-to-one page will be a user's technical guide in which Panoramic Corporation staff provide useful tips and other information specific to the Panoramic Corporation PC-1000. Again, there will be no comparisons made between brands. The intent of this Newsletter is to be a resource for the dental profession rather than an advertisement. You may wish to collect successive Newsletters in a ring binder as a reference.

Getting the most out of panoramic radiographic interpretation.

Quality assurance

As with any other radiographic method, optimum interpretable diagnostic images can only be achieved with careful quality assurance in patient positioning, in selecting appropriate exposure parameters and during processing. While panoramic radiography is easy to perform well provided all the manufacturer's instructions are followed, it is equally easy to perform badly. Most errors are due to incorrect patient positioning, leading to excessive and sometimes disproportionate distortion. A correctly positioned patient's panoramic radiograph generally shows symmetry of the size of the mandibular rami and condyles, and the dental segments are "in focus" with a gentle downward convexity of the maxillary archs. Provided the patient bit correctly on the biteblock, the anterior

"You can sequence your evaluation in many ways; however, it is very important to develop a consistent approach that ensures that all diagnostic information in the radiograph is indeed read."

structures are portrayed in the midline and the apices of the mandibular incisor teeth should be in full "focus." Provided that the tongue is kept up in the roof of the mouth during exposure, the roots of the maxillary teeth are clearly demonstrated. It is less expensive in time and materials - and in radiation to the patient - to perfect your panoramic technique, than to make unnecessary repeat exposures. And the diagnostic yield from an excellent panoramic radiograph is far superior to one made under less rigorous quality controls.

Image projection geometry

To gain the maximum amount of diagnostic information from a dental panoramic radiograph (pantomograph), it is necessary to understand that panoramic radiographs are "flattened out" schemes of a curved image layer. Think of the plan view of the head (Fig. 1). The panoramic radiograph provides a plan of one side, then the midline, then the other side of the face and jaws. Imagine the panoramic film wrapped around the outside of the face. The actual panoramic film seems large in comparison with the 3M human phantom (Fig. 2). This is because the actual image from most panoramic systems is enlarged by about 20 %. Figures 3 and 4 show a printed panoramic image reduced to life size superimposed on the phantom. These graphically explain the association between the panoramic radiograph and the represented structures. In reality the image is formed section by section behind the secondary slit. Figure 5 illustrates this process by putting the same printed panoramic image in place of the film cassette. The relative movement of the x-ray source and the "camera" during exposure creates the effect of "wrapping the film about the patient's face" (Fig. 6).

Interpreting a normal panoramic radiograph

A normal panoramic radiograph contains a substantial amount of information. Figure 7 is the PC-1000 (Panoramic Corporation, Fort Wayne, Indiana) panoramic radiograph of a 12-year male patient. Fifty distinct soft tissues, bony and dental landmarks have been labeled on this radiograph. When was the last time that you consciously and thoroughly inspected all of the structures that are demonstrated? As you probably are making the radiograph with the intent of dental diagnosis at the forefront, the dental arches should be left to last in your systematic evaluation of the image. You can sequence your evaluation in many ways; however, it is very important to develop a consistent approach that ensures that all diagnostic information in the radiograph is indeed read. To see all of the subtle variations in contrast, it is imperative that (1) a view box be used (preferably having a variable light intensity), (2) any extraneous light from the view box be blocked out, and (3) the diagnostic evaluation is performed under subdued ambient lighting away from distractions. It is suggested that you review all panoramic radiographs made in a given day when all patients have left the practice. It will be surprising how much can be gained from such a second look when the atmosphere is likely to be more relaxed!

I approach reading the radiograph roughly in the numerical sequence shown in Figure 7; namely starting with the bony landmarks from the midline of the upper jaw and nasal cavity, then working back in the maxilla and zygomatic complex on each side. The soft tissue shadows of the tongue and soft palate are incorporated at this stage. This is followed by evaluation of the cervical spine

Fig.1. A panoramic radiograph simultaneously presents views from both sides of the patients face as well as providing a frontal perspective.

Fig. 2. You can best understand the relative position of structures shown in a panoramic radiograph if you imagine the film to be bent around the patients face.

Fig. 3. The lateral and more posterior structures are projected to each side of the panoramic radiograph.

Fig. 4. The anterior structures are shown in the midline of the standard panoramic projection.

Fig. 5. The panoramic image is formed sequentially from information passing through the machine's secondary slit. The film moves past the secondary slit at the appropriate rate necessary to minimize mechanical distortion.

Fig. 6. The panoramic latent image is created as the film cassette moves past the secondary slit. The production of the latent image is simulated using the print of a panoramic radiograph.

Fig. 8. Annotated lateral view of phantom.

Fig. 9. Annotated anterior view of phantom.

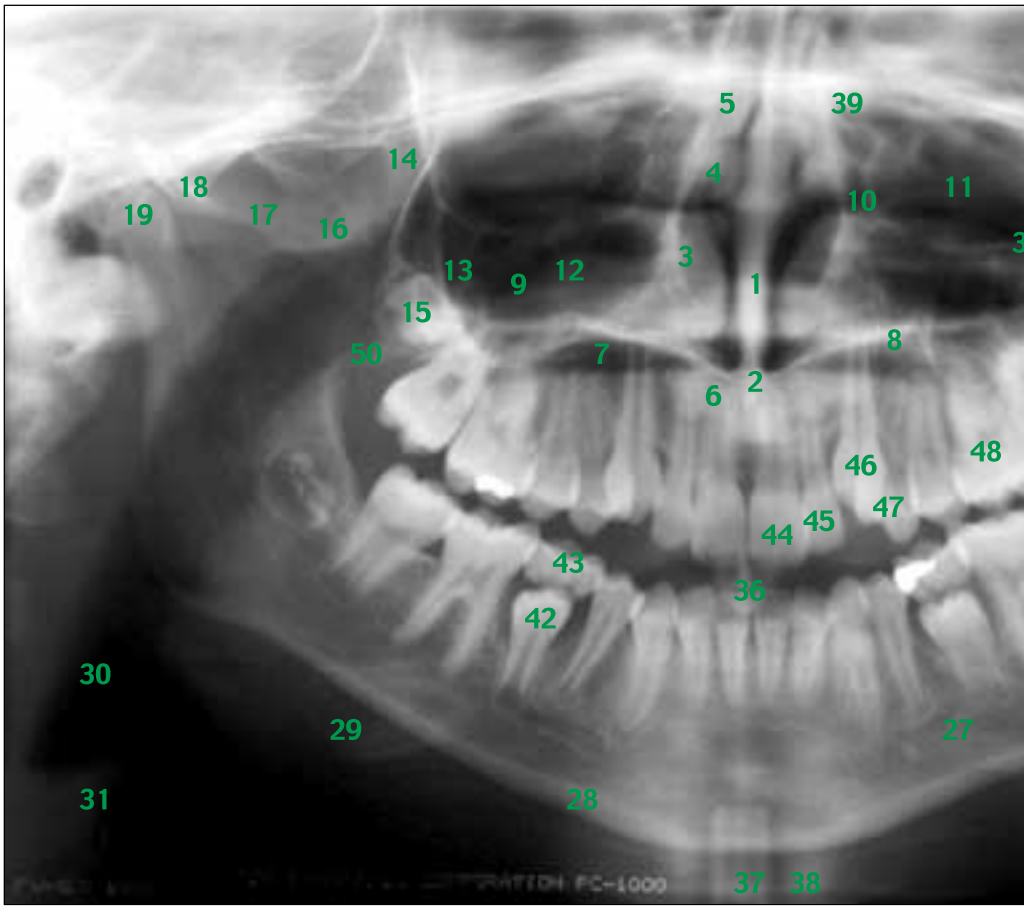

Fig. 7. Annotated panoramic radiograph.

and associated structures. I then evaluate the contents of the mandible starting from the midline and then progressing posteriorly on each side. Any examination would be incomplete without a thorough evaluation of the soft tissues anterior to the spine and inferior to the mandible. [The evaluation of this space will be the main subject of the next issue of this Newsletter.] The last part of the evaluation should be the area of chief complaint and the dental arches.

Anatomical Comparisons

Using the same numerical key as that for the annotated radiograph (Fig. 7), Figures 8 and 9 show the normal anatomical structures viewed from the lateral and frontal facial aspects of a 3M phantom. It should be remembered that the radiograph shows all features within the panoramic image layer whether facial or lingual. It should also be remembered that only the structures that are within the selected image layer will be in "focus." This image layer is generally narrower for the anterior regions than for the posterior segments.

Key To Annotation of Panoramic Image In Figure 7

1. Nasal Septum
2. Anterior Nasal Spine
3. Inferior Turbinate
4. Middle Turbinate
5. Superior Turbinate
6. Soft Tissue Shadow of the Nose
7. Airspace between Soft Tissue Shadow of Upper Border of Tongue & Hard Palate
8. Lateral Wall of Nasal Passage
9. Maxillary Sinus (Antrum)
10. Nasolacrimal Canal Orifice
11. Orbit
12. Infraorbital Canal
13. Zygomatic Process of the Maxilla
14. Pterygomaxillary Fissure
15. Maxillary Tuberosity with Developing Third Permanent Molar Tooth
16. Zygoma
17. Zygomatico-Temporal Structure
18. Articular Eminence of Temporal Bone
19. Mandibular Condyle
20. External Auditory Meatus
21. First Cervical Vertebra (Atlas)
22. Second Cervical Vertibra (Axis)
23. Third Cervical Vertebra
24. Fourth Cervical Vertebra
25. Mandibular Foramen and Lingula
26. Mandibular Canal
27. Mental Foramen
28. Inferior Border of Mandible
29. Hyoid
30. Pharyngeal Airspace
31. Epiglottis
32. Coronoid Process of Mandible
33. Inferior Orbital Rim
34. Mastoid Process
35. Middle Cranial Fossa
36. Biteblock for Patient Positioning During Panoramic Radiography
37. Chin Holder (Cephalostat)
38. Shadow of Cervical Spine
39. Ethmoid Sinus
40. Angle of Mandible
41. Crypt of Developing Mandibular Third Permanent Molar Tooth
42. Developing Mandibular Second Premolar Tooth
43. Primary Second Molar Tooth Showing Physiological Root Resorption
44. Maxillary Permanent Central Incisor Tooth
45. Maxillary Permanent Lateral Incisor Tooth
46. Maxillary Permanent Canine Tooth
47. Maxillary First Premolar Tooth
48. Maxillary Permanent First Molar Tooth
49. Ramus of Mandible
50. Pterygoid Plates

In The Recent Literature:

Periodontal disease: Panoramic radiography is the most frequently used x-ray method for assessment of periodontal disease at dental schools in the UK and Ireland.

Tugnait A, Clerehugh DV, Hirschmann PN. Survey of radiographic practices for periodontal disease in UK and Irish dental teaching hospitals. Dentomaxillofac Radiol 2000 Nov;29(6):376-81. [from the Department of Periodontology, Leeds Dental Institute, Leeds, UK.]

The objective of this paper was to assess current radiographic practices for the management of patients with periodontal disease. All dental teaching programs in the UK and Ireland were sent a questionnaire on radiographic equipment and radiograph selection currently used for assessment of patients with destructive periodontal diseases. Opinions were recorded for advantages and disadvantages of the most frequently used radiographic views. A 100% response rate was achieved. All programs used panoramic and specific periapical radiographs as one of their radiographic regimes for patients with periodontal disease. Of the respondents, 53% most frequently made panoramic and selected periapical radiographs, 24% made full mouth periapical radiographic series most often, and 18% took a panoramic radiograph alone. In conclusion, more than 70% of dental teaching programs in the UK and Ireland make panoramic radiographs, with or without selected periapicals, to assess periodontal status.

Edentulous ridge assessment: Laboratory data suggests that serial panoramic radiographs are suitable for assessing the progression of maxillary ridge resorption.

Kreisler M, Schulze R, Schalldach F, d'Hoedt B, Behneke A, Behneke N. A new method for the radiological investigation of residual ridge resorption in the maxilla. Dentomaxillofac Radiol 2000 Nov;29(6):368-75. [from the Department of Oral Surgery, Johannes Gutenberg-University Mainz, Germany.]

The authors present a new method for assessing residual ridge resorption in the edentulous maxilla. Defined experimental and reference areas in the maxilla were drawn on transparent film laid over a panoramic radiograph and digitized. Bone areas were measured with an integrated planimetry program and expressed as a ratio. The effect of positioning errors on reliability of the method was investigated using dry skulls. The correlation between the change in ratio and actual bone loss was examined by progressively reducing the height of an artificial residual ridge on one skull. The coefficient of variation for the absolute ratio in different head positions was < 0.05 and its correlation coefficient of the change in the ratio and the degree of resorption was $r2 \geq 98.3\%$ ($p = 0.0001$). Comparison of the experimental area with the reference area on serial panoramic radiographs appears suitable for the assessment of residual ridge resorption in the maxilla.

Osteoporosis: Panoramic radiographic evidence of thinning of the mandibular cortex corresponds to a history of osteoporotic fractures in patients older than 60 years.

Bollen AM, Taguchi A, Hujoel PP, Hollender LG. Case-control study on self-reported osteoporotic fractures and mandibular cortical bone. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000 Oct;90(4):518-24. [from Department of Orthodontics, University of Washington, Seattle, USA.]

The purpose of this case-control study was to determine whether the radiographic appearance of the mandibular cortical bone in elderly, noninstitutionalized patients correlated with the history of osteoporotic fractures. Patients older than 60 years, and who had a panoramic radiograph were invited to be interviewed regarding their fracture history and risk factors for osteoporosis. The study population comprised 93 individuals reporting osteoporotic fractures (fractures occurring after minor impact). Controls ($n = 394$) were individuals reporting traumatic fractures ($n = 105$) or no fractures ($n = 289$). Blinded to case-control status, the investigators evaluated the mandibular cortex on a panoramic radiograph and classified them as normal (even and sharp endosteal margin), moderately eroded (evidence of lacunar resorption or endosteal cortical residues), or severely eroded (unequivocal porosity). In addition, cortical thickness was measured below the mental foramen. After adjustment for potentially confounding factors, the odds ratio for an osteoporotic fracture associated with moderately eroded and severely eroded mandibular cortices was 2.0 (95% Cortical Index 1.2 to 3.3) and 8.0 (95% Cortical Index 2.0 to 28.9), respectively. After adjusting for all potentially confounding factors, it was determined that the cortex was 0.54 mm (or 12%) thinner in subjects with an osteoporotic fracture compared with controls (95% CI, 0.25 to 0.84 mm). Patients with a history of osteoporotic fractures tend to have increased resorption and thinning of the mandibular lower cortex that can be measured from panoramic radiographs.

Atherosclerosis: Patients evidencing calcifications overlying the carotid region seen on panoramic radiography

should be referred to their physician with a recommendation of formal evaluation for potentially life-threatening atheroma.

Almog DM, Illig KA, Khin M, Green RM. Unrecognized carotid artery stenosis discovered by calcifications on a panoramic radiograph. J Am Dent Assoc 2000 Nov;131(11):1593-7. [From the Eastman Department of Dentistry, University of Rochester, New York, USA.]

Approximately 730,000 strokes occur each year in the United States, costing an estimated $40 billion annually. One-half of all strokes are the result of atherosclerotic plaques found in the carotid artery. Such plaques frequently are heavily calcified and can be identified on a panoramic radiograph by the incidental finding of calcifications overlying the carotid bifurcation. The authors found that a 67-year-old asymptomatic woman had calcium deposits overlying both carotid bifurcation regions on a panoramic radiograph. Subsequent duplex ultrasonic examination indicated bilateral, high-grade carotid arterial stenoses. The patient had critical carotid arterial stenoses associated with significant risk of stroke that had not been identified otherwise. The findings on the panoramic radiograph led to appropriate and potentially life-saving treatment. The patient underwent uneventful bilateral carotid endarterectomy.

Developmental abnormalities: Abnormalities affecting dental treatment planning were found in panoramic radiographs from > 20% of adolescents aged 10-15 years.

Cholitgul W, Drummond BK. Jaw and tooth abnormalities detected on panoramic radiographs in New Zealand children aged 10-15 years. N Z Dent J 2000 Mar;96(423):10-3. [From the Department of Radiology, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand.]

Panoramic radiographs of 1,608 children and adolescents aged 10 to 15 years (797 males and 811 females) were reviewed to determine the prevalence of tooth and jaw abnormalities. Abnormalities were detected on 21% of the radiographs (23% for females and 17% for males); 879 teeth were diagnosed with abnormalities in 331 panoramic radiographs. The more common abnormalities were malpositioned teeth, missing teeth, morphologic anomalies of teeth, and teeth with structural defects such as hypoplasia. Bony abnormalities and growth problems were detected on occasion. These findings demonstrates the value of panoramic radiography in detecting or confirming dental abnormalities, and supports recommendations on the use of panoramic radiography to aid in the assessment of dental development.

Frequently Asked Questions From Our Service Department:

1. **Q: Why are we getting light films?**

   A: Light films can be the result of any one or combination of the following:

   * The intensifying screens could be reversed or turned inside out.
   * The chemicals in the processor could be weak.
   * The temperature in the processor could be low.
   * Developing time could be short
   * Intensifying screens could be worn out.
   * Tubehead is out of alignment

2. **Q: What causes a dark film?**

   A: Dark films can be a result of any one or combination of the following:

   * Light exposure from light leaks in darkroom or daylight loader.
   * Light exposure from too great of safelight bulb wattage.
   * Safelight being mounted closer than 4′ from work surface.
   * Exposure from equipment with operational lights in the darkroom.
   * Processing temperature is set too high.
   * Processing time is set too long.
   * Incorrect type of film for the intensifying screens being used.

3. **Q: How can we eliminate the whiteout in the anterior region of the film?**

   A: The white out in the anterior region is a result of patient positioning: First you want the patient to stand as straight as possible, position the patients feet under the chinrest, this will make sure the neck is straight, next lower the machine so the Frankfort Plane (imaginary line from the middle of the ear opening to the bottom of the eye orbit) is parallel to the ground. This will help stretch the patient's neck enough to allow X-rays to pass between the vertebrae in the neck, allowing radiation to reach the anterior region of the film.

Provided as a professional service by:

Panoramic Corporation Dental Diagnostics and Equipment
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