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Panoramic radiology and the detection of carotid atherosclerosis

By Dr. Allan G. Farman

The most common manifestations of atherosclerosis are coronary artery disease, peripheral vascular disease and cerebrovascular accidents - *stroke*.[1] In the USA, 731,000 suffer a stroke each year with 165,000 not surviving.[2] There are approximately 4 million stroke survivors. Lifelong disabilities such as loss of mobility, aphasia, and depression often afflict survivors.[3] Estimated healthcare costs related to acute and chronic management of strokes are $40 billion annually. Atheroma-related formations of thrombi and emboli in the carotid artery is the most frequent cause of stroke.[4] Early detection of carotid atherosclerosis has the potential to save lives and reduce medical expenditures.

Since 1981, Friedlander and his colleagues have actively promoted panoramic radiology as an aid in detecting patients at risk of stroke.[5] Calcified atherosclerotic lesions at the carotid bifurcation can be seen in the lower corners of the panoramic radiograph adjacent to the cervical spine and hyoid bone (Fig. 1-3). Such atheroma may appear as a nodular radiopaque mass or as double radio-opaque vertical lines within the neck. These calcifications are found at the level of the lower margin of the third and the entirety of the fourth cervical vertebra, about 1.5 to 2.5 cm inferior-posterior to the angle of the mandible.[6] Similar calcifications are found in the coronary arteries of individuals having ischemic heart disease.[10]

Atherosclerosis is not the only cause of soft-tissue calcifications seen anterior to the cervical vertebrae in panoramic radiographs (Fig. 4). Care needs to be applied to differentiate carotid calcifications from calcified triticeous or thyroid cartilages, calcified lymph nodes and non-carotid phleboliths.[8] For this reason, it is important to have an Anterior-Posterior (AP) radiograph of the neck made using soft tissue exposure settings. Calcifications within the carotid arteries will appear lateral to the spine, whereas calcifications in the thyroid gland, thyroid cartilage, triticeous cartilage or epiglottis will be in the midline, superimposed over the spine. Other calcifications that can be superimposed over the same part of the panoramic film include phleboliths (sclerosing hemangiomata), and calcified acne or lymph nodes. The stylohyoid and stylomandibular ligaments are situated posterior rather than inferior to the mandibular ramus – and therefore should be readily differentiated.

Associations

Factors predisposing carotid atherosclerosis include advancing age, male gender, systolic

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hypertension, hypercholesterolaemia, cigarette smoking, diabetes mellitus, physical inactivity, obesity, hemostatic factors, and coronary artery disease. [1,3] Patients with diabetes mellitus, those who have received radiation therapy for head and neck cancer, and patients having obstructive sleep apnea have a greater prevalence of calcified carotid atheromas visible on panoramic radiographs than do healthy, age-matched persons. Friedlander and Maeder (2000) examined the panoramic radiographs of men aged 55 to 81 years who were receiving insulin to treat type 2 diabetes mellitus, and compared these to radiographs from age-matched nondiabetic controls.[9] The incidence of detected carotid atheroma approximated 20% among the diabetics compared to 4% for controls.

Friedlander *et al.* (1998) studied the detection by panoramic radiography of radiation-induced accelerated atherosclerosis in patients with osteoradio-necrosis.[10] The prevalence for carotid calcifications in patients who had received on averaged a dose of 60 Gy radiation therapy to the carotid bifurcation was 28%. The prevalence was 5% in a matched sample of non-irradiated patients. The difference was statistically highly significant ($p = 0.001$). Chen *et al.* (2001) found the prevalence of calcified carotid atheroma in panoramic radiographs for head and neck cancer patients prior to irradiation to be 7% giving further support to irradiation promoting carotid artery atherosclerosis.[11]

Friedlander *et al.* (1999) studied the prevalence of carotid atheroma in male patients with obstructive sleep apnea.[12] Detectable carotid atheroma was found in 22 % of the study subjects compared to 4% in age and gender matched controls.

Management

While atherosclerosis-related maladies are perhaps the most prevalent cause of life-threatening human disease, there is still not a thorough understanding of its causes. Associations are known, and where these can be changed, the progression of atheroma can be halted and even reversed. Such associations include hypertension, excessive dietary intake of unsaturated fats, obesity, lack of physical activity, diabetes mellitus, and tobacco habits.

Unfortunately, atherosclerosis is an insidious disease, often providing few signs and symptoms before life threatening catastrophic failure ensues in the form of a stroke or heart attack. It is for this reason that the dentist's careful evaluation of the panoramic dental radiograph might be instrumental in saving a patient's life. Individuals with panoramic radiographs demonstrating possible carotid artery disease should be followed up using an Anterior-Posterior (AP) head film with exposure settings sufficiently low to show the soft tissues (fig. 5). If calcification is confirmed to be in the region of the carotid arteries on the AP view, the patient should be referred to a physician for confirmation of carotid atherosclerosis. Doppler duplex sonogaphy is a noninvasive method of choice for reevaluation

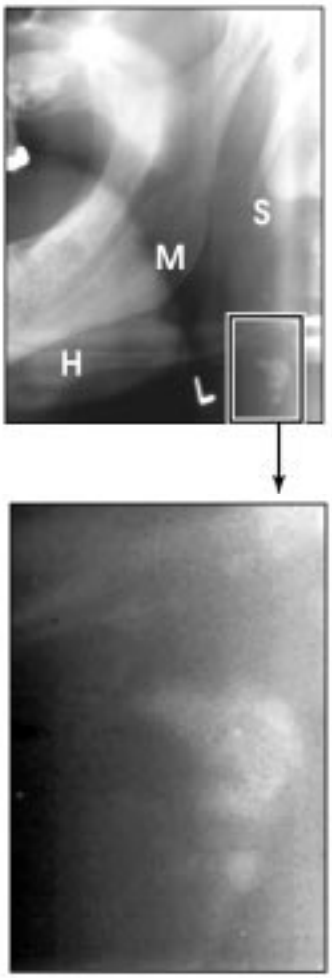

Fig. 1. Case #1: Carotid atherosclerosis occur most frequently at the bifurcation of the common carotid. Initially there is intimal thickening. This is followed by varying degrees of obstruction. The atherosclerotic plaque often calcifies, and it is the calcific deposits that can be seen on panoramic radiography.

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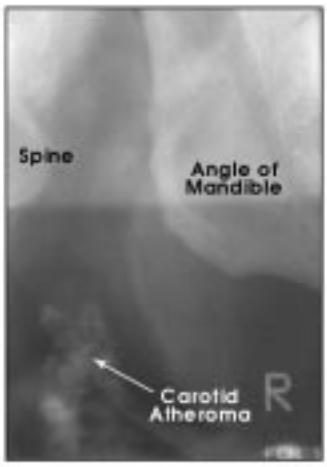

Fig. 2. Case #2: Calcified atheroma of the carotid artery bifurcation. There are extensions into both the internal and the external carotid arteries in this case. (Detail from panoramic radiograph.)

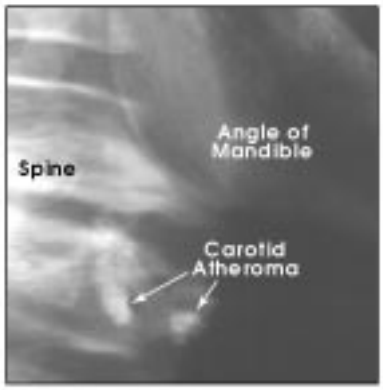

Fig. 3. Case #3: Calcified atheroma of the carotid artery bifurcation. (Detail from panoramic radiograph.)

of such individuals.

Patients with more than 60% blockage of the carotid artery can have the likelihood of stroke reduced by more than half if endarterectomy is performed to surgically remove the plaque.[13,14] Those with less extensive lesions can be treated using a drug regimen such as aspirin (which is an antiplatelet agent) or triflusal to stem atherosclerosis progression and reduce embolus formation.[15,16] Modification in life-style is usually necessary to increase daily exercise, avoid foods high in saturated fats and, where applicable, to be treated for hypertension and/or to cease smoking.[2,17,18]

Cautions

(1) It is possible for a carotid artery to be occluded by atheromatous plaque in the absence of noticeable calcification. While one can question the possibility of carotid disease when finding suspicious calcifications, one should never use the panoramic radiograph as a test for carotid atherosclerosis; you should not give the patient the "all clear" based upon a panoramic radiograph alone. It is the patient's physician, not his or her dentist that should be the final diagnostician.

(2) Different panoramic systems result in nonidentical radiographic images. Some machines are likely to be less able to detect carotid calcification than are others. Factors to consider include the positioning of labels with demographic information and date of exposure, lead indicators of the side – and sometimes their ghost images. Unless one can see the anterior outline of the third and fourth cervical vertebrae to the side of the panoramic image, one is probably missing details of the relevant region. Taking a radiograph with the patient one centimeter anterior and one centimeter superior to the instructions of the manufacturer of the panoramic system would optimize the image for carotid calcification detection – as would underexposure; however, this is not recommended as it is suboptimal for evaluation of the teeth and jaws. The panoramic technique modification described would be best left to follow-up to a regularly performed panoramic radiograph.

(3) Viewing conditions are critical to detecting carotid atheroma using panoramic images. The radiograph should be viewed on a view box with a variable rheostat to adjust the intensity of the transmitted light. The ambient lighting should be subdued. A hot light is also helpful when looking for carotid calcifications.

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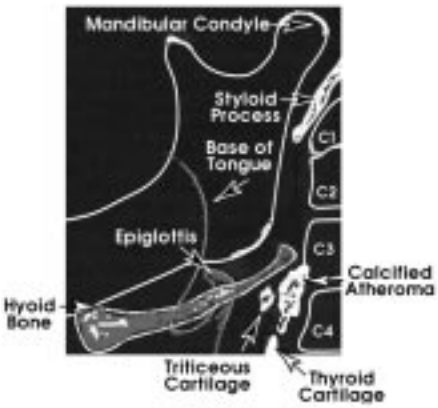

Fig. 4. Care needs to be taken to differentiate between calcified atheroma and other structures in the same vicinity that can also calcify. Such structures include the thyroid cartilage, the thyroid gland, the triticeous cartilage, and the epiglottis.

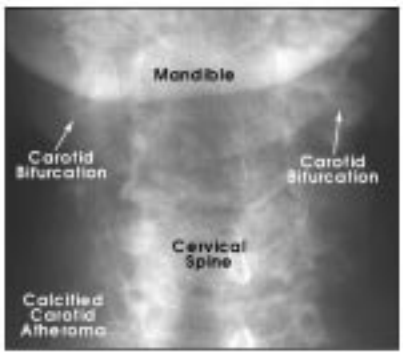

Fig. 5. Anterior-Posterior (AP) neck view made using reduced exposure to highlight the soft tissues. The right common carotid artery is calcified throughout its length (arrows) with calcifications of both internal and external carotid arteries. Calcified atheroma is also noted in the region of the carotid bifurcation on the left side. The AP view is a useful adjunct to rule out calcifications being in midline structures.

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In The Recent Literature:

Mandibular trauma. Panoramic radiographs are equal in sensitivity and specificity to high-quality four-view mandibular series for the detection of fractures.

Guss DA, Clark RF, Peitz T, Taub M. Pantomography vs mandibular series for the detection of mandibular fractures. Acad Emerg Med 2000;7:141-5. (from the Department of Emergency Medicine, UCSD Medical Center, San Diego, CA 92103-8676, USA.)

The two primary radiographic techniques used for the evaluation of mandible injury are the panoramic radiograph (PS) and the standard four-view mandibular series (MS). The hypothesis of this study was that there is no difference in sensitivity or specificity between a panoramic radiograph and a high-quality standard MS for the detection of mandibular fractures. A prospective, blinded study of 54 patients presenting with acute mandibular injury was performed to compare PS to MS. Two board-certified emergency physicians and a single staff radiologist read the series of PS and MS films in a randomized fashion without access to clinical information or identifying patient data. For fractures present, the truth was determined by a neuroradiologist with access to both the panoramic radiographs and the plain film series, as well as pertinent clinical information. Thirty patients had 47 mandibular fractures. The sensitivities for fractures detection for each physician were 0.79, 0.74, and 0.83 with PS and 0.85, 0.77, and 0.89 with MS. There was no significant difference between the two methods ($p > or = 0.51$, $p > or = 1.00$, and $p > or = 0.51$, respectively, McNemar's binomial test) with regard to sensitivity. The specificity for fractures detection for each physician were 0.96, 1.00, and 0.92 for PS and 0.88, 0.92, and 0.96 for MS. Again there was no significant difference between the two methods ($p > 0.625$, $p > 0.50$, and $p = 1.00$, respectively, McNemar's binomial test). It can be concluded that a panoramic radiograph is equal to a high quality four-view mandibular series.

Age determination. The panoramic radiograph is useful for assessment of the dental ages of children and adolescents.

Frucht S, Schnegelsberg C, Schulte-Monting J, Rose E, Jonas I. Dental age in southwest Germany. A radiographic study. J Orofac Orthop 2000;61:318-29. (from the Department of Orthodontics, University of Freiburg, Germany.)

A cross-sectional study was made to assess the biological dental age of healthy children between the chronological ages of 2 and 20 years. 1,003 panoramic radiographs were studied, and all were from children in southwest Germany. The permanent teeth of the left side of the lower jaw were rated, except for the third molars. The development of each tooth was divided into 8 defined stages. Statistical evaluation revealed a correlation between chronological age and biological age for both genders ($r = 0.85$ for girls; $r = 0.89$ for boys). Two gender-specific equations for calculating dental age were devised and a marked sexual dimorphism was found. Girls showed accelerated dental development in comparison with boys.

Prevalence of dental anomalies in Down syndrome patients: Panoramic radiographs can be used successfully for evaluation of the dental condition in special patients such as those having Down syndrome.

Shapira J, Chaushu S, Becker A. Prevalence of tooth transposition, third molar agenesis, and maxillary canine impaction in individuals with Down syndrome. Angle Orthod 2000; 70:290-6. (from the Department of Pediatric Dentistry, Hebrew University-Hadassah Faculty of Dental Medicine, Jerusalem, Israel.)

Anomalies in the size, morphology and number of teeth are among the many inherited disorders that have been reported in individuals having Down syndrome. By contrast, third molar agenesis and tooth transposition have been largely ignored and the prevalence of canine impaction had not been reported previously. The intent of this study was to quantify the occurrence of such anomalies in a group of individuals with Down syndrome, using standardized records, which included a clinical examination, dental casts, and a panoramic radiograph. A high prevalence of third molar agenesis (74% of individuals older than 14 years), canine impaction (15%), and maxillary canine/first premolar transposition (15%), was found in comparison to published findings from other populations. The anomalies should not be seen as separate, independent entities, but as associated phenomena. Perhaps the maxillary canine/first premolar transpositions represent a pheno-typic expression of this trisomy.

Locating unerupted teeth. The negative beam angulation of a panoramic radiograph can be combined with the different vertical angulation of an occlusal radiograph for achieving parallax.

Jacobs SG. Radiographic localization of unerupted mandibular anterior teeth. Am J

Orthod Dentofacial Orthop 2000;118:432-8. (from the Dental Health Services Victoria, Australia.)

The parallax method using two radiographs taken with different beam angulations is a method commonly used to locate unerupted teeth. Most often this method is described using a pair of intraoral radiographs. The author instead recommends the use of a panoramic radiograph and an occlusal radiograph. This combination involves a vertical x-ray tube shift. Case reports are presented that demonstrate the proposed combination can accurately locate unerupted mandibular anterior teeth. A deceptive appearance of the labiolingual position of the unerupted tooth can be produced if solely depending on an occlusal radiograph. Increasing the vertical angle of the tube for the occlusal radiograph makes the tube shift effect easier to discern when comparing the relative positions of dental structures depicted in the occlusal radiograph to their relative positions in a panoramic radiograph.

Stylohyoid ligament calcification: Panoramic radiography is useful in evaluating calcification of the stylohyoid ligament. Calcification progresses with increasing age, especially up to age 20 years.
Krennmair G, Lenglinger F, Lugmayr H. Variants of ossification of the stylohyoid chain. Rofo Fortschr Geb Rontgenstr Neuen Bildgeb Verfahr 2001;173(3):200-4. (from the University Clinic for Oral and Maxillofacial Surgery, University of Vienna, Austria.)

Age-related differences in the incidence, length and topographic location of ossifications in the stylohyoid chain were examined. Panoramic radiographs of 380 patients were sorted according to the patient's age group (up to 20-years of age, 21-40 years, 41-60 years, and older than 60 years). 718 stylohyoid chains were clearly demonstrated and, of these, 221 (30.8%) showed elongation of the styloid process or ossification of the stylohyoid ligament. With increasing age, there was an increase in the incidence and length of stylohyoidal ossifications ($p < 0.01$). A linear correlation between the length of the stylohyoidal ossifications and age was found only in the youngest age group (up to 20 years; $p < 0.01$). In this age group, calcifications were most commonly restricted to the superior stylohyoidal segment. With increasing age, the middle and inferior stylohyoid segments were more frequently ossified. In conclusion, stylohyoidal ossifications evidenced age-related differences in incidence, length and topography.

Frequently Asked Questions About Film Reimbursement:

Q: Is it true insurance will pay for panoramic films every 3 to 5 years?

A: This may or may not be factual, depending on the individual case. As with all radiographs taken, dental or medical, there must be a clinical justification for taking the film. This justification must be noted in the patient file, and in some circumstances, on the insurance forms. The frequency and number of films taken is not determined by the insurance, but by the clinical necessity. There is only liability for payment when the dentist puts on the hat of Radiologist and determines that there is, or is not, suspected pathology and subsequently enters those findings in the patient record as a separate dated and signed report, or, even better, as part of the treatment record for that day's visit. If there is no documentation of radiographic findings, there is no liability for payment.

Q: How many films are included in D0210 — Intraoral — complete series (including bitewings)?

A: Whatever number of films the dentist needs to complete the radiographic assessment of this patient according to the needs of the patient and the professional judgement of the doctor. The same holds true for D0330 panoramic film plus "necessary" bitewings and any "necessary" periapicals to complete the assessment and render a diagnosis worthy of a D0150 comprehensive oral evaluation. When submitting a panoramic film plus bitewings in lieu of D0210 — complete series, third party payors will most likely reimburse at 80 to 85% of D0210, including any necessary periapicals.

NOTE: *Questions on insurance and reimbursement are very difficult as each represents a unique situation. We have enlisted the aid of experts in the field and the above information has been excerpted with permission from DENTAL INSURANCE TODAY, a newsletter published by Atlanta Dental Consultants. For more information on this newsletter contact Atlanta Dental Consultants at 404-252-7808.*

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