

Special Edition
"Radiographic Interpretation as a
Teaching Tool for Dental and
Dental Hygiene Students"

Research

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Enhancing Student Radiographic Interpretation Skills through Research

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ABSTRACT

Objective: Detection of abnormalities on a panoramic radiograph is essential to the practicing dentist and dental hygienist. The objective of this study was to evaluate the accuracy of students in detecting calcification of carotid artery atheromas (CCAA) on panoramic radiographs as a component of a research study. Additionally, the objective was to use the results of the student's analysis to determine if there is a correlation between CCAA and certain health risks and demographic features in a Metro-Detroit area patient population as compared to other populations.

Methods: A correlation studies research design was used to conduct a retrospective cohort study of panoramic radiographs of patients of record at Detroit Mercy Dental between 2012 and 2014. In this study, 1,000 radiographs were examined by 4 dental hygiene students for the presence of CCAA.

Results: Fifty-four of 1,000 (5.4%) radiographs revealed CCAA as identified by the dental hygiene students acting as researchers, and subsequently confirmed by 2 radiologists. Forty percent of the 54 patients with confirmed CCAA were smokers, 43% had hypertension, and 17% had heart disease as recorded on the available health history forms.

Conclusions: Two main conclusions were derived from this study. One, it is concluded from this investigation that, as researchers, dental hygiene students are equipped to detect calcifications on panoramic radiographs as evidenced by the high levels of agreement of diagnoses between students and board certified radiologists. Additionally it was concluded that the results of the present study are similar to previously published studies by other investigators regarding the incidence of CCAA identified by radiographic methods.

KEYWORDS: Atheroma; Carotid calcification; Panoramic radiograph; Radiology education; Risk factors.

ABBREVIATIONS: CCAA: Calcification of Carotid Artery Atheromas; IRB: Institutional Review Board.

INTRODUCTION

Knowledge regarding detecting abnormalities on a panoramic radiograph is essential to the practicing dental professional. At Detroit Mercy Dental, dental and dental hygiene students are provided rigorous didactic and clinical training throughout their curriculum to detect such abnormalities in order to provide their patients with an excellent overall health examination. Upon graduation, as part of the scope of practice panoramic radiographs are exposed when indicated depending on the patient situation. While the main focus of a panoramic radiograph is to detect oral hard and soft tissue abnormalities, other anatomical features may be observed by the trained dental professional.^{1,2}

Atherosclerosis or hardening of the arteries is an inflammatory condition of immunological origin³ that may lead to coronary artery disease and stroke, and has been reported to

be an underlying cause of nearly 50% of all deaths in Western countries.⁴ The accumulation of fat, cholesterol and other materials in the walls of the arteries produce atherosclerotic lesions known as atheromas or plaques.^{5,6} Disruption of the endothelial lining over the atheromas can lead to calcification of the lesions. When atheromas become significantly calcified within the carotid artery they may be visualized on a panoramic radiograph as a calcified carotid artery atheroma (CCAA).^{7,8} Indeed, Friedlander and Lande⁹ discussed the identification of calcified atheroma plaques within the carotid artery on panoramic radiographs over 30 years ago. If present, CCAA at the carotid bifurcation is observed in a panoramic radiograph adjacent to the cervical spine and hyoid bone. CCAA appear as nodular radiopaque masses or radiopaque vertical lines inferior and/or posterior to the angle of the mandible.^{10,11}

Factors predisposing a patient to carotid artery atherosclerosis include, among many other factors, age, gender, systolic hypertension, hypercholesterolemia, cigarette smoking of more than 20 packs/year, diabetes mellitus, physical inactivity, obesity and coronary artery disease.¹²⁻¹⁴ Unfortunately a patient may not experience any signs or symptoms alerting them to the presence of CCAA, increasing their chances for life-threatening cardiovascular events including stroke or heart attack. Many studies have confirmed the identification of CCAA on panoramic radiographs in patients with varying health conditions and risk factors.¹⁵⁻¹⁷ This provides evidence that a dental professional's knowledgeable and careful evaluation of the dental panoramic radiograph might play a significant role in detecting CCAA and providing the patient with information critical to their well-being.^{1,2,18,19}

At Detroit Mercy Dental, dental hygiene students are required to complete a research study as a component of the curriculum. One education-focused aim of this report therefore is to evaluate the accuracy of dental hygiene students, in the role of researchers undertaking a retrospective analysis of patient records, in detecting CCAA on panoramic radiographs. A research-focused aim of this study is to determine potential correlations between CCAA and certain health risks and demographic features in a Metro-Detroit area population, and to compare the results to published reports in other populations.

MATERIALS AND METHODS

A correlation studies research design was used to conduct a retrospective cohort study using patients of record at Detroit Mercy Dental. Institutional Review Board (IRB) approval was obtained from the University of Detroit Mercy Institutional Review Board by the principal investigator (Protocol#1415-04). The investigation consisted of an examination of 1,000 electronic panoramic radiographs exposed between 2012 and 2014 on patients of record at the Detroit Mercy Dental Oral and Maxillofacial Radiology Imaging Center, Detroit, MI, USA.

The radiographs were chosen randomly and analyzed, together as a group, by 4 dental hygiene students mentored by a Faculty member (KO-M) from the Department of Biomedical and Diagnostic Sciences. The students were in the 2nd year of a two-year dental hygiene program. Analysis was done in a dark room setting with all extraneous light blocked and utilizing a high quality monitor.

The dental hygiene students characterized each of the radiographs as to the presence or absence of CCAA. Criteria used for this determination was based on information that had been provided in the classroom, and included the appearance of radiopaque masses by C4/C5 vertebrae.^{10,11} Following student analysis, 2 board-certified oral and maxillofacial radiologists at Detroit Mercy Dental examined the same set of radiographs in the same environment. The radiologists were blinded to the patients demographic and health data as well as to the decisions of the students regarding the presence or absence of CCAA. The presence or non-presence of CCAA on panoramic radiographs was determined by the radiologists using a high quality monitor viewed under the same conditions in a darkroom setting with all extraneous light blocked (Weber's law).

For radiographs with CCAA initially suggested by the students and then confirmed by the radiologists, electronic health records were examined and the following patient data was collected: gender, age, race, smoking status, presence/absence of hypertension, and presence/absence of heart disease. Once the health data was matched to the panoramic radiograph data, all links to personal identifiers were broken. Descriptive statistics were used to analyze the results.

RESULTS

This study initially included 1000 radiographs of patients of record at Detroit Mercy Dental. CCAA was positively identified as an irregular, heterogeneous, verticolinear, or circular radiopaque mass inferior to the angle of mandible and adjacent to the cervical vertebrae at the levels of the C3-C4 intervertebral junction. Using these criteria, 54 of the radiographs (5.4%) revealed CCAA as primarily identified by the student researchers and subsequently confirmed by two radiologists. There was a nearly 100% level of agreement between the dental hygiene students and the radiologists regarding the presence of CCAA.

Descriptive statistics of the subpopulation of the radiographs identified with CCAA are shown in Table 1. Of the 54 patients, 34 (63%) were males and 20 (37%) females. The mean age of the male patients was 58 with a range of 50 to 90 years of age. The mean age of the female patients was 59 with a range of 47 to 90 years of age. Nineteen (35%) of the patients identified as white and 35 (65%) as African American. Of the 54 patients demonstrating CCAA, 22 (40%) were smokers, 23 (43%) had hypertension, and 9 (17%) had heart disease as indicated on the health records (Table 2).

Total sample=54	
Gender:	
Male (%)	34 (63%)
Female (%)	20 (37%)
Mean Age:	
Male	58
Female	59
Age Range:	
Male	50-90
Female	47-90
Race:	
White (%)	19 (35%)
African American (%)	35 (65%)

Table 1: Characteristics of the study population.

Gender	Race	Comorbidity	Number Patients
Female	White	Smoking	2
Female	White	Hypertension	3
Female	White	Heart Disease	1
Male	White	Smoking	6
Male	White	Hypertension	6
Male	White	Heart Disease	1
Female	African American	Smoking	8
Female	African American	Hypertension	5
Female	African American	Heart Disease	1
Male	African American	Smoking	6
Male	African American	Hypertension	9
Male	African American	Heart Disease	6

Table 2: Comorbidity status in patients with CCAA.

DISCUSSION

Previous studies have demonstrated that panoramic radiographs of middle-aged and older patients may reveal the presence of CCAA. One objective of this investigation was to determine if there is a correlation between the presence of CCAA on panoramic radiographs and certain health risks in a Metro-Detroit area population. Additionally the goal was to compare the results to that of other populations. In total, 5.4% of the radiographs screened by students and radiologists revealed the presence of CCAA. Results from this study of a Detroit population are in general agreement with published reports of 2 to 11% incidence of detectable CCAA on radiographs.^{20,21} As a few examples, a study of middle aged adults in Korea showed that 6.2% revealed the presence of CCAA on panoramic radiographs²² and Ohba et al²³ reported that the prevalence of CCAA in a Japanese population was 5%. Lastly, 2.5% of the radiographs studied in a Thai population showed evidence of CCAA.²¹

Certain groups appear to have higher percentages of detectable CCAA on radiographs, including males, aged individuals, smokers, and patients with hypertension, diabetes, and hypercholesterolemia.^{21,22} The present study agreed with previous observations in that CCAA was detected in individuals with hypertension and in those who smoked, and that males had a greater prevalence of detectable CCAA compared to females. In the present study, males were nearly twice as likely to show CCAA. The results of this study also show that the majority of patients with detected CCAA smoke and are hypertensive. Diagnosis of diabetes and hypercholesterolemia were not a focus of the present study, however analysis of a larger number of radiographs may reveal such disease in the Detroit population. It can be concluded from this study that the incidence of CCAA noted on radiographs is in general agreement with reports of other populations.

CONCLUSION

The objective of this study was to evaluate the accuracy of students in detecting CCAA on panoramic radiographs as a component of a research study. It is concluded from this investigation that dental hygiene students are well equipped to detect calcifications on panoramic radiographs due to the high levels of agreement of diagnosis between students and board certified radiologists.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

- MacDonald D, Chan A, Harris A, Vertinsky T, Farman AG, Scarfe WC. Diagnosis and management of calcified carotid artery atheroma: Dental perspectives. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2012; 114(4): 533-547. doi: [10.1016/j.oooo.2012.06.020](https://doi.org/10.1016/j.oooo.2012.06.020)
- Ertas ET, Sisman Y. Detection of incidental carotid artery calcifications during dental examinations: Panoramic radiography as an important aid in dentistry. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2011; 112: e11-e17. doi: [10.1016/j.tripleo.2011.02.048](https://doi.org/10.1016/j.tripleo.2011.02.048)

3. Taleb S. Inflammation in atherosclerosis. *Arch Cardiovasc Dis.* 2016; 29. doi: [10.1016/j.acvd.2016.04.002](https://doi.org/10.1016/j.acvd.2016.04.002)
4. Lusis AJ. Atherosclerosis. *Nature.* 2000; 407: 233-241. doi: [10.1038/35025203](https://doi.org/10.1038/35025203)
5. Bailey G, Meadows J, Morrison A. Imaging atherosclerotic plaque calcification: Translating biology. *Curr Atheroscler Rep.* 2016; 18(8): 51. doi: [10.1007/s11883-016-0601-6](https://doi.org/10.1007/s11883-016-0601-6)
6. Fisher EA. Regression of atherosclerosis: The journey from the liver to the plaque and back. *Arterioscler Thromb Vasc Biol.* 2016; 36(2): 226-235. doi: [10.1161/ATVBAHA.115.301926](https://doi.org/10.1161/ATVBAHA.115.301926)
7. Kamikawa RS, Pereira MF, Fernandes A, Meurer MI. Study of the localization of radiopacities similar to calcified carotid atheroma by means of panoramic radiography. *Surg Oral Med Oral Pathol Oral Radiol Endod.* 2006; 101(3): 374-378. doi: [10.1016/j.tripleo.2005.03.030](https://doi.org/10.1016/j.tripleo.2005.03.030)
8. Friedlander AH, August M. The role of panoramic radiography in determining an increased risk of cervical atheromas in patients treated with therapeutic irradiation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1998; 85: 339-344. doi: [10.1016/S1079-2104\(98\)90020-8](https://doi.org/10.1016/S1079-2104(98)90020-8)
9. Friedlander AH, Lande A. Panoramic radiographic identification of carotid arterial plaques. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1981; 52: 20-24.
10. Romano-Sousa CM, Krejci L, Medeiros FM, et al. Diagnostic agreement between panoramic radiographs and color Doppler images of carotid atheroma. *J Appl Oral Sci.* 2009; 17: 45-48. doi: [10.1590/S1678-77572009000100009](https://doi.org/10.1590/S1678-77572009000100009)
11. Lewis DA, Brooks SL. Carotid artery calcification in a general dental population: A retrospective study of panoramic radiographs. *Gen Dent.* 1999; 47: 98-103. Web site: <http://europepmc.org/abstract/med/10321159>. Accessed October 21, 2016.
12. Lubin JH, Couper D, Lutsey PL, Yatsuya H. Synergistic and non-synergistic associations for cigarette smoking and non-tobacco risk factors for cardiovascular disease incidence in the atherosclerosis risk Incommunities (ARIC) study. *Nicotine Tob Res.* 2016. doi: [10.1093/ntr/ntw235](https://doi.org/10.1093/ntr/ntw235)
13. Nishizawa A, Suemoto CK, Farias DS, et al. Association between adiposity and systemic atherosclerosis: A protocol of a cross-sectional autopsy study. *Open Heart.* 2016; 3(2): e000433. doi: [10.1136/openhrt-2016-000433](https://doi.org/10.1136/openhrt-2016-000433)
14. Schultheiss UT, Daya N, Grams ME, et al. Thyroid function, reduced kidney function and incident chronic kidney disease in a community-based population: The atherosclerosis risk in communities study. *Nephrol Dial Transplant.* 2016. doi: [10.1093/ndt/gfw301](https://doi.org/10.1093/ndt/gfw301)
15. Guerreiro da Silva Júnior N, Pedreira EN, Tuji FM, Warm-ling LV, Ortega KL. Prevalence of calcified carotid artery atheromas in panoramic radiographs of HIV-positive patients undergoing antiretroviral treatment: A retrospective study. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2014; 117(1): 67-74. doi: [10.1016/j.oooo.2013.08.022](https://doi.org/10.1016/j.oooo.2013.08.022)
16. Chang TI, Tanner JM, Harada ND, Garrett NR, Friedlander AH. Prevalence of calcified carotid artery atheromas on the panoramic images of patients with syndrome Z, coexisting obstructive sleep apnea, and metabolic syndrome. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2012; 113(1): 134-141. doi: [10.1016/j.tripleo.2011.07.039](https://doi.org/10.1016/j.tripleo.2011.07.039)
17. Patil S, Maheshwari S, Khandelwal S, Malhotra R, Desmukh A. Prevalence of calcified carotid artery atheromas on panoramic radiographs of renal stone patients. *Saudi J Kidney Dis Transpl.* 2016; 27(1): 62-66. doi: [10.4103/1319-2442.174074](https://doi.org/10.4103/1319-2442.174074)
18. Friedlander AH, Cohen SN. Panoramic radiographic atheromas portend adverse vascular events. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2007; 103(6): 830-835. doi: [10.1016/j.tripleo.2006.07.016](https://doi.org/10.1016/j.tripleo.2006.07.016)
19. Friedlander AH, Friedlander IK. Identification of stroke prone patients by panoramic dental radiography. *Aust Dent J.* 1998; 43: 51-54. doi: [10.1111/j.1834-7819.1998.tb00153.x](https://doi.org/10.1111/j.1834-7819.1998.tb00153.x)
20. Carter LC. Discrimination between calcified triticeous cartilage and calcified carotid atheroma on panoramic radiography. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2000; 90: 108-110. doi: [10.1067/moe.2000.106297](https://doi.org/10.1067/moe.2000.106297)
21. Pornprasertsuk-Damrongsri S, Thanakun S. Carotid artery calcification detected on panoramic radiographs in a group of Thai population. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2006; 101: 110-115. doi: [10.1016/j.tripleo.2005.04.002](https://doi.org/10.1016/j.tripleo.2005.04.002)
22. Yoon SJ, Yoon W, Kim OS, Lee JS, Kang BC. Diagnostic accuracy of panoramic radiography in the detection of calcified carotid artery. *Dentomaxillofac Radiol.* 2008; 37(2): 104-108. doi: [10.1259/dmfr/86909790](https://doi.org/10.1259/dmfr/86909790)
23. Ohba T, Takata Y, Ansai T, et al. Evaluation of calcified carotid artery atheromas detected by panoramic radiograph among 80-year-olds. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2003; 96: 647-650. doi: [10.1016/j.tripleo.2003.07.001](https://doi.org/10.1016/j.tripleo.2003.07.001)