

SOMAYYEH AZIMI^{1, A, C–F}, HAMID SARLAK^{2, B–D, F}, MARYAM TOFANGCHIHA^{3, A, C, F}

Determining the Prevalence of Carotid Artery Calcification and Associations with Medical History Using Dental Panoramic Radiographs

Ocena występowania zwapnień tętnicy szyjnej i wybranych danych z wywiadu medycznego na podstawie obrazowania pantomograficznego

¹ Honorary Research Fellow, University of Western Australia, Perth, Australia

² Department of Pediatric Dentistry, Tehran University of Medical Sciences, Tehran, Iran

³ Associate Professor, Department of Maxillofacial Radiology, Qazvin University of Medical Sciences, Qazvin, Iran

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of article

Abstract

Background. Early detection of carotid artery calcification on panoramic radiographs may play an important role in the prevention of cardiovascular disease.

Objectives. This study assessed the prevalence of carotid artery calcification (CAC) on digital panoramic radiographs (PRs) of Iranian population, as well as associations with medical history, age and gender.

Material and Methods. A total of 4,847 patients that attended dental radiology clinics were included in this study. After filling out the questionnaires, which included demographic information, history of cigarette smoking, and history of systemic disease related to CAC (hypertension, hyperlipidemia, diabetes mellitus, cardiovascular diseases, renal diseases), dental panoramic view radiographs were taken. The presence of CAC on all radiographs was determined by a maxillofacial radiologist and a senior dental student (trained by a maxillofacial radiologist) on the intervertebral space of C3–C4. Chi-square tests and Kruskal-Wallis tests was used to detect any significant statistical differences.

Results. CAC was observed on 373 PRs (7.7%). There was a significant difference in prevalence of CAC on PRs between patients without and with systemic disease, and smoking ($p < 0.05$).

Conclusions. Dentists need to refer patients for an evaluation, if nodular and linear opacity on the intervertebral space of C3–C4 on PRs were observed, especially in patients with a history of systemic disease (*Dent. Med. Probl.* 2016, 53, 1, 29–33).

Key words: systemic disease, carotid artery calcification, panoramic radiograph.

Słowa kluczowe: choroba ogólna, zwapnienie tętnicy szyjnej, zdjęcie pantomograficzne.

Atherosclerosis, a progressive inflammatory disease of the arteries, can cause coronary artery disease, peripheral vascular disease and lead to stroke [1]. Atherosclerosis, in many countries, is among the most prevalent diseases with a high mortality rate [1]. Cerebrovascular accidents are a not an uncommon cause of death in developed countries such as America and Japan, but are common in developing countries such as Iran [2–4]. One of the most common sites of the occurrence of

atherosclerosis is the carotid artery bifurcation [1]. In most cases of carotid artery calcification, the patient remains asymptomatic and, therefore, the incidental finding on dental panoramic radiographs can be of substantial health value to patients, by triggering early intervention to prevent cerebrovascular accidents [5]. Friedlander et al. [6, 7] brought to the world's attention that carotid artery calcifications could be diagnosed from a dental panoramic radiograph. Common features of

carotid artery calcification on panoramic radiographs include one or more radio opaque nodules or vertical lines in the lower posterior mandibular angle, approximately with 45° angle relative to it, in the vicinity of the greater horn of the hyoid bone and the third and fourth cervical vertebrae (C3–C4) [8]. Since this original finding, the prevalence of carotid artery calcification has been measured in some communities [5, 8–13]. Typical of these findings, Brand et al. [9] reported the prevalence on panoramic radiographs of just fewer than 10% in a Dutch Oral and Maxillofacial Surgery Department.

Given the widespread use of panoramic radiographs in dental treatment, and the very high rates of cardio-vascular disease in the Iranian population, we hypothesized that the prevalence of carotid artery calcification in panoramic radiographs from Iranian dental patients would be very high. The current study examined a cross-section of patients in Qazvin, Iran to test the hypothesis, and at the same time to examine if there was any association between carotid artery calcification and age, sex and medical history.

Material and Methods

In this descriptive-analytical study, all patients (older than 35 years) who attended the dental radiography clinic and were in need of a panoramic view radiograph, during 2012 and 2013, were included in the study. Overall, a total of 4847 digital panoramic radiographs of dental patients were evaluated.

After gaining consent, a standardized questionnaire including demographic data and the history of carotid artery calcification (CAC) associated disease (hyperlipidemia, hypertension, renal diseases, diabetes mellitus, cardiovascular disease, smoking) was completed by each patient. In addition the medical records of each patient were checked for history of risk factors (as listed above).

For each patient a digital panoramic view radiograph was taken with a CRANEX™ D – Soredex (Tuusula, Finland), based on the size of patients, at the same position for all patients. The digital panoramic radiographs (PRs) were evaluated on the medical monitor (EIZO 21 INCH) with (DFW2.5) software. Then, two clinicians, one oral and maxillofacial radiologist, and one trained senior dental student evaluated the PRs independently. A radiopaque nodular mass or masses adjacent to the cervical vertebrae at or below the intervertebral space between C3 and C4 were diagnosed as CACs. Patients with either unilateral or bilateral CACs on these radiographs were de-

tected. Other cervical calcifications such as calcified thyroid cartilage, calcified triticeous cartilage, hyoid bone and submandibular salivary gland sialolithiasis were considered as differential diagnosis and excluded subsequently, considering the different localization and shape on panoramic radiograph [8]. If there was any difference in the diagnosis, another oral and maxillofacial radiologist reviewed the radiographs, and equivocal images were omitted.

The results were analyzed by a statistical specialist. Chi-square tests and Kruskal-Wallis tests was used to detect any significant statistical differences (Statistical package for Social Sciences 19). Significance was set at the 95% level.

The Research Ethics Committee of the Dental Faculty of University of Medical Sciences Qazvin approved this study. This research has been conducted in full accordance with the World Medical Association Declaration of Helsinki.

Results

The sample was evenly split between males ($n = 2415$) and females ($n = 2433$) with an average age of 49.5 ± 14.9 years. Of these patients, 1973 (40.7%) had at least one of the listed risk conditions and CAC were observed on 373 PRs (7.7%), 233 male and 140 female. Nearly 6% had unilateral CAC while 2% had bilateral CAC (Table 1) (Fig. 1).

The chi-square test showed a significant association between the prevalence of CAC on PRs and risk condition prevalence ($p < 0.001$). Similarly, there was a significant difference in the prevalence of CAC between those with a known condition and those without ($P < 0.001$). Using the Kruskal-Wallis test, we concluded there is a significant ($P < 0.001$) association between the age and prevalence of CAC on PRs (Table 2). It was also noted that there was significantly ($P < 0.001$) more CAC found in males than females (Table 3).

Discussion

Carotid artery calcification, especially close to the carotid bifurcation, can result in vascular obstruction causing stroke because of high blood speed and collision in this region. According to the present study, the prevalence of CAC, regardless of the patient's medical history, was 7.7%. This was similar to the studies of Alzoman et al. [14], who reported that 5% of the population studied in Saudi Arabia had calcification of their panoramic view radiographs, Bayer et al. [15] in 2011 reported the prevalence of 4.8% in Germany, Brand et al. [9] in 2009 reported the prevalence of 9.4 % in Dutch,

Table 1. Prevalence of CAC on panoramic radiographs in different clinical history diagnosis groups

Condition	Without CAC		Unilateral CAC		Bilateral CAC	
	Number	Percent	Number	Percent	Number	Percent
Without disease	2777	6.96	79	7.2	18	6
Hyperlipidaemia	423	8.92	26	7.5	7	5.1
Heart and vascular disease	172	8.7	49	2.2	22	1.9
Renal disease	62	6.81	8	5.1	6	9.7
Diabetes Mellitus	108	3.78	27	6.19	3	2.2
Cigarette smokers	614	3.88	63	1.9	18	6.2
Hypertension	318	1.87	31	5.8	16	4.4
Total	4474		283		90	

CAC – carotid artery calcification.

Table 2. Patient's age considering to CAC on panoramic radiographs

Condition	Without CAC		Unilateral CAC		Bilateral CAC	
	Mean	SD	Mean	SD	Mean	SD
Without disease	45.6	15.4	58	10.9	55.7	10.2
Hyperlipidaemia	56.1	9.6	54.3	10.1	46.8	7.1
Heart and vascular disease	61.9	7.7	59.1	9.7	63	8.6
Renal disease	47	15.4	61.5	15.2	42.6	14.1
Diabetes Mellitus	56.4	13.6	59.3	14.3	53.6	17.6
Cigarette smokers	49.8	12.3	45.8	11.6	52.5	13.5
Hypertension	58.4	13.8	54.2	9.4	55.9	11.5

CAC – carotid artery calcification.

Sisman et al. [8] in 2007 showed 5.1% frequency in Cappadocia region, Tamura et al. [16] in 2003 showed 4.1% of samples had CAC.

Discrimination between radiopacities similar to calcified carotid atheroma in panoramic radi-

ography is important. Professionals should pay attention to the risks of misdiagnosis being induced by neighboring anatomic and pathologic radiopacities; especially, calcified triticeous cartilage and the superior horn of a calcified thyroid car-

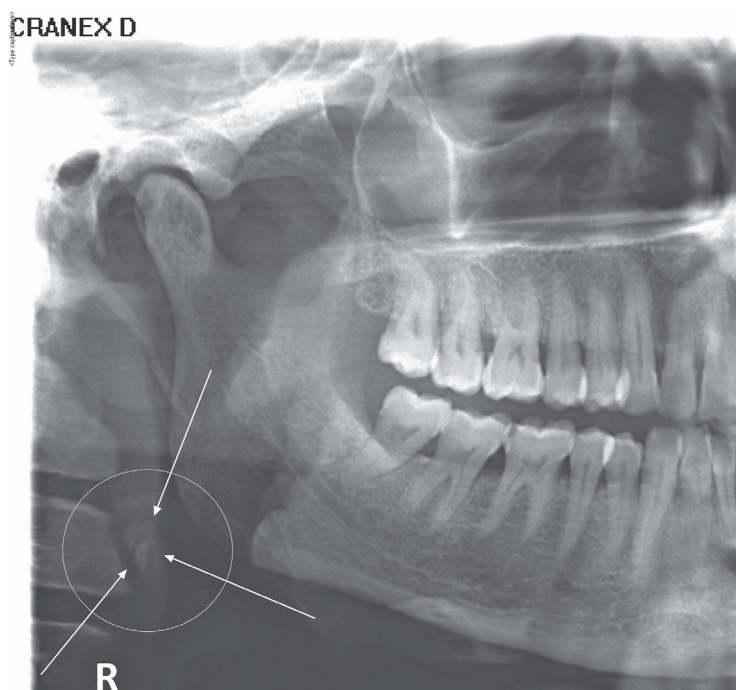
**Fig. 1.** Unilateral carotid artery calcification

Table 3. Prevalence of CAC on panoramic radiographs by sex

Condition	Male		Female		Total	
	Number	Percent	Number	Percent	Number	Percent
Without CAC	2182	8.48	2292	2.51	4474	3.92
Unilateral	177	5.62	106	5.37	283	8.5
Bilateral	56	2.62	34	8.37	90	9.1
Total	2415	8.49	2432	2.5	4847	100

CAC – carotid artery calcification.

tilage. However, CAC appears more laterally than the calcified triticeous cartilage in panoramic radiographs. Triticeous cartilage is usually found adjacent to the superior portion of C4, within the pharyngeal air space. The thyroid cartilage is imaged medial to the C4 and, generally, only the top 2 to 3 mm of that is visible on the inferior border of the panoramic radiograph [17,18]. In the present study we used a digital panoramic device. Although some authors agree that radiograph techniques (conventional or digital) did not impact the results significantly, others argue that digital provide a more appropriate view of the carotid bifurcation, due to an improved image [19].

According to the results of this study, most CACs were unilateral, similar to the studies of Sisman et al. [8] in and Takeshi et al. [3]. But in the studies of Brand et al. [9], Uthman et al. [20] and Kansu et al. [1] most CAC was bilateral.

In Iran in 2014 Moshfeghi et al. [21] investigated the panoramic view of 200 women patients above 50 years of age, suffering from vascular disease, and reported that 11% of patients had carotid artery calcification on their dental panoramic radiographs.

The difference in the prevalence of CACs and presentation of them unilaterally or bilaterally may be because of: the degree of density and the region of carotid artery calcification, differences in race and investigated society, interventional factors like age or gender, misdiagnosis of CAC from similar soft tissue calcifications, different conditions of observing radiographs, radiographs with different qualities, method of preparing different radiographs and inter observer error.

Also in this study, there was a significant association between systemic disease and the prevalence of calcification. These systemic diseases, according to the order of prevalence are cardiovascular disease (29.2%), diabetes (21.7%), renal disease (18.4%), hypertension (12.9%), smoking

(11.7%) and hyperlipidemia (7.2%) ($p=0.00$). The results of studies of Uthman et al. [20], Kugmal et al. [6], Kansou et al. [1] and Tamura et al. [16] are a line with our study. Also, Moshfeghi et al. [21] in Iran concluded that there is a relationship between CAC observations on dental panoramic radiographs and hypertension and MI.

In our study there was a significant association between age and the prevalence of CAC. Results of the study of Almog et al. [22] in 2005 were similar to our study.

In this study the prevalence of CAC, regardless of medical history of the individual, was higher in men than in women, similar to the studies of the Alzoman et al. [14] in 2012 and Brand et al. [9], but different in Tamura et al. [16], Sisman et al. [8] and Bayer [15]. The prevalence of CAC in patients with hypertension, diabetes, renal disease or cardiovascular disease was similar in male and female participants in our study. Although Doppler ultrasonography and CT are more useful in detecting atherosclerotic plaques in the carotid arteries and stenosis of the vessels than dental panoramic radiography, the use of panoramic radiographs is a non-invasive and non-expensive method in comparison to other imaging methods, and they are frequently used for dental treatment and diagnosis. Panoramic radiographs might assist us to detect CACs in patients with or without other risk factors [8].

We used a self-attained questionnaire for evaluating systemic disease that is the limitation of this study. General practitioner examination is recommended for future studies.

The results of this study highlight the important need for dentists to be aware of possible carotid artery calcification presence on PR's, and the need to refer patients to physicians for more evaluation, if the nodular and linear opacity on the intervertebral space of C3–C4 on PRs were observed, especially in patients with a history of systemic disease.

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Address for correspondence:

Maryam Tofangchiha
 Department of Maxillofacial Radiology
 Qazvin University of Medical Sciences
 Qazvin
 Iran
 Tel.: +98 9121825156
 E-mail: mt_tofangchiha@yahoo.com

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