

Mohamed A Jaber\*, Maanas S. Shah and Moosa Abuzayeda

Hamdan Bin Mohamed College of Dental Medicine, MBR University of Medical & Health Sciences, UAE

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**\*Corresponding author:** Dr. Mohamed A Jaber, Department of Oral Surgery, Hamdan Bin Mohamed College of Dental Medicine, MBR University of Medical & Health Sciences, UAE, Tel: (+971) 04 4248630; (+971) 050 5178052; E-mail: mohamed.jaber@hbmcdm.ac.ae

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## Case Report

# Evaluation of Calcified Carotid Artery Atheromas Detected By Panoramic Radiograph among Patients with Type II Diabetes Mellitus

### Abstract

This study was designed to determine the prevalence of Carotid artery calcifications (CACs) of diabetic patients and compare it with normal non-diabetic individuals. Panoramic radiographs of 200 adult patients with type 2 diabetes (90 male and 110 females) (age range 16-79 years; mean age 40.54 years) and 200 controls (age-match, free of systemic diseases) were examined on panoramic radiographs for any unusual radiopacity adjacent to or just below the intervertebral space between C3 and C4. Statistical analysis was carried out using chi-squared and Fisher exact tests. Carotid artery calcifications (CACs) were higher in diabetic patients compared with normal healthy control and the statistical difference between the two groups was significant (Chi-square test = 10.82, P = 0.001). Twenty-five (16 females, 9 males) diabetic patients showed CACs, Mean age of diabetic patients with calcification was 47.11 years. Further analysis of this group showed that 60% of patients with CACs were smokers, 48% had hypertension and 25% were obese. In conclusion, our study shows that in patients with diabetes mellitus CACs can be detected by panoramic radiography and the patients may benefit from a referral to physicians for further evaluation and necessary management.

## Introduction

Diabetes mellitus is currently the fastest growing debilitating disease in the world. The International Diabetes Federation reported that in the United Arab Emirates (UAE) the prevalence of diabetes mellitus estimated to be ~20% such that one out of five people aged 20 to 79 lives with this disease and this has been attributed to the rapid economic development coupled with ageing populations [1]. Type 2 diabetes mellitus is a disorder of abnormal metabolism of carbohydrates, fats and proteins that arises from a combination of resistance to insulin's action and insufficient secretion of additional insulin to compensate for this resistance. Diabetes mellitus associated with metabolic and vascular components that accelerate the development of atherosclerotic lesions at the bifurcation of the common carotid artery and double or triple the risk of ischemic stroke [2-5]. Type 2 diabetes typically appears after age of 40 years and often is associated with the excessive ingestion of a high-caloric diet and reduced physical activity, the combination of which results in central/abdominal obesity.

Previous studies reported that stroke is the second most frequent cause of death worldwide, which frequently associated with permanent disability [6,7]. It has been reported that patients with diabetes are at 1.5 to three times the risk of stroke compared with the general population [8,9], and the associated mortality and morbidity is greater than in those without this underlying condition [10,11]. This is primarily due to the increased atherogenic risk within extracranial and intracranial arteries, attributable to abnormal plasma lipid profiles, hypertension and hyperglycaemia [11].

Type 2 DM may predispose patients to an ischemic stroke, and the majority of these arise in association with the development of atherosclerotic lesions in the region of the carotid bifurcation [12,13].

Hollander et al. [14], reported that individuals diagnosed with carotid artery plaques might experience an increased risk of stroke and cerebral infarction, compared with subjects who do not have carotid plaques. Denudation of the endothelium over the fibrous plaque may lead to exposure of the sub endothelial layer which may result into thrombus formation and partial or complete occlusion of the blood flow [15].

Several researchers have demonstrated the presence of CACs on dental panoramic radiographs, which might be useful indicator to identify asymptomatic dental patients who may benefit from further examination by medical professionals [16-24]. Despite the number of publications about the presence of CACs on the panoramic radiography among various populations, there has been no detailed information about this condition in diabetic patients in UAE. Hence, we evaluated the presence of carotid artery calcifications (CACs) detected on dental panoramic radiographs among a group of diabetic patients attending dental clinics.

## Materials and Methods

A total of 200 diabetic patients (type II) (90 females, 110 males) who visited college of dentistry dental clinics between February 2011 to June 2012 and underwent dental panoramic radiographs for the diagnosis of dental lesions were selected for this study. Age and

gender matched healthy control subjects were identified from the hospital record department and included in the study.

The inclusion criteria include: a diagnosis of type 2 diabetes mellitus, panoramic radiograph visualizing the area 2.5 cm posterior and 2.5 cm inferior to the cortical rim of the midpoint of the mandibular angle and patient's consent for the study. And the excluding criteria included; poor quality radiographs and poor or uncontrolled DM as evidenced by a glycosylated hemoglobin A, or HbA<sub>1c</sub>. According to the generally accepted guidelines in clinical monitoring of diabetic patients, diabetes mellitus is considered to be well controlled if the HbA<sub>1c</sub> levels are below 7.5%, and moderately controlled if the HbA<sub>1c</sub> levels vary between 7.5-8.5%. Values from 6.8 to 10% indicate poor control of the disease (25).

All panoramic radiographs were obtained using a standard dental panoramic radiographic system (a Planmeca 2002 EC Proline multitomographic X-ray unit (Planmeca Co., Helsinki, Finland). Exposed panoramic radiographs were processed according to the manufacturer's recommendations. They were obtained with a constant 12mA, 80kV and 18s exposure through 2.5mm Al filtration. Regular Kodak Lanex (Eastman Kodak Co, Rochester, NY) intensifying screens (15x30 cm cassette) and Kodak T Mat G films (Eastman Kodak Co, Rochester, NY). Films were developed in an automatic film processor (Velopex, Extra-X, Medivance Instruments Ltd, London, UK) with standard solutions as recommended by the manufacturer. The total time of processing was 4 minutes at 27°C.

A panoramic radiographs were examined for the presence of unilateral or bilateral, radiopaque masses of the neck at the level of the intervertebral space between C3 and C4.

Patient's records were reviewed for factors related to both diabetes and atherosclerosis. Specifically noted were hypertension as determined by self-report of physician-diagnosed hypertension; current use of an antihypertension medication; or a systolic blood pressure of more than 150 millimeters of mercury or a diastolic blood pressure of more than 90 mm Hg or both and body mass index (BMI). BMI calculated as weight in kilograms divided by the square of the height in meters, with patients categorized as normal (BMI, 18.5–24.9), overweight (BMI, 25–30) or obese (BMI 30); and smoking history. Ethical clearance for the study was obtained from the Ethical Committee for Research of the College of Dentistry, Ajman University, UAE.

Statistical procedures were carried out using SPSS program version 11. Chi-squared or Fissure exact test were used to compare between the two groups and the results were considered significant when  $p < 0.05$ .

### Results

200 diabetic patients (90 male and 110 females) age range 16-79 years; mean age ( $40.54 \pm 3.7$  years) and 200 non-diabetic healthy subjects have completed the study. The mean age of diabetic patients was not significantly different than the mean ( $\pm$ SD) age of  $40.52 \pm 2.8$  years (range 17–78) for the control group.

Thirty one (7.75%) CACs were detected in the panoramic radiograph of the study subjects (Figures 1,2). CACs was higher in diabetic patients 12.5% (25/200) compared with normal healthy

control 3.0% (6/200) and the statistical difference between the two groups was significant (Chi-square = 10.82,  $P = 0.001$ ).

Table 1 presents general comparisons between the two groups. The twenty-five diabetic patients (16 females and 9 males) had a mean ( $\pm$  standard deviation) age of  $47.11 \pm 4.7$  years (range 26–65 years). Further analysis of this group showed that 60% of patients with CACs were smokers, 48% had hypertension and 25% were obese.

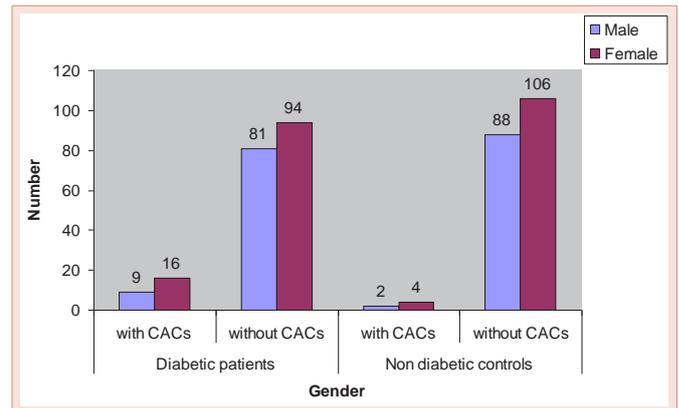


Figure 1: Distribution of carotid artery calcifications (CACs) according to gender.



Figure 2: Unilateral carotid calcification.

Table 1: Characteristics of the 31 patients with carotid artery calcifications.

Characteristics	Diabetic group (25 patients)	Control (6 patients)	P value <sup>#</sup>
Age in years (mean $\pm$ S.D)	47.11 $\pm$ 4.7	45.21 $\pm$ 5.3	>0.05
Gender	Male	2 (33.3%)	0.002
	Female	4 (66.7%)	0.95
Duration of Diabetes (months)	Range		
	Mean	60-240 months (150 months)	
Prevalence of smoking	15 (60.0%)	4 (66.7%)	0.57
Hypertension	12 (48.0%)	3 (50.0%)	0.62
Obesity Body Mass Index (BMI)	Mean $\pm$ S.D	27.5 $\pm$ 3.2	0.61
		6 (25.0%)	1 (2.8%)
Site of occurrence	Unilateral	4 (66.7%)	0.51
	Bilateral	2 (33.3%)	0.38
	21 (84.0%)	4 (66.7%)	

<sup>#</sup>Unilateral occurrence (19/25 76% on the right and 6/25 24.0% were on the left side)

<sup>#</sup>P value for chi-square test, t-test or Fisher's exact test.



**Figure 3:** Bilateral carotid calcifications.

The evaluation of the CACs occurrence revealed that twenty-five (25/31 80.6%) of the CACs were unilateral (Figure 2) and six were bilateral (Figure 3) in distribution.

## Discussion

Ischemic cerebrovascular disease is a leading cause of mortality in UAE and other countries. Therefore, factors associated with this disease are important to identify. In this study carotid artery calcification was higher in diabetic patients compared with non-diabetic healthy individuals, a similar findings were reported by Friedlander and Maeder [21], who reported that 20.4% of the panoramic radiographs of diabetics patients had atheromas whereas those of the control groups only 4.0% demonstrated atheromas, furthermore, previously published studies demonstrated that patients with type 2 diabetes treated with insulin had a high prevalence of CAC visible on panoramic radiographs [22,26]. And those diabetic patients controlling their type 2 diabetes with diet alone or with a hypoglycemic agent had slightly lower prevalence of CAC on their panoramic radiographs than did those treated by diet and insulin [22].

Atherosclerosis, a progressive inflammatory disease, may lead to stroke, coronary artery disease, or peripheral artery disease and is a frequent cause of morbidity in patients with diabetes [27]. It tends to accumulate within the bifurcation of the common, external and internal carotid arteries, and it produces symptoms as plaque forms on the irregular surface and embolises to the brain [16]. Atherosclerosis of the cervical carotid artery bifurcation is a major cause of stroke and transient ischemic attack; it provides a site at which progression of atherosclerosis can be monitored reproducibly and noninvasively [28,29]. Various risk factors were reported to contribute to its initiation and progression such as; diabetes mellitus, arterial hypertension and inadequate diet and eating habits. Other new risk factors such as periodontitis, chronic renal disease and menopause have been suggested as being favorable to its development [21]. On panoramic radiographs, these calcifications appear as heterogeneous radiopacities near the hyoid bone at the level of the C3 and C4 intervertebral space [16,21].

Atheromas composed of lipids and fibrous tissue, which are deposited on the arterial walls and become calcified, making it feasible to identify them in panoramic radiographic screening, a widely used diagnostic tool in routine dental practice [30-38]. However, The diagnosis of atheromas in panoramic radiographs may

not be so simple, as various other entities may be present in the same region, therefore the dental practitioners ought to be familiar with the differential diagnosis of the images of carotid artery atheromas in panoramic radiography which includes number of anatomic structures in the cervical and adjacent regions, such as: the hyoid bone, styloid process, triticeal cartilages, thyroid cartilage, epiglottis, calcifications in the stylohyoid and stylomandibular ligaments, tonsillooliths, phlebolites, calcified lymphnodes and anterior tubercle of the atlas vertebra [39-41].

Previous reports indicated that CACs might not always be noticed on the panoramic radiograph because not all atherosclerotic lesions are calcified, thus an expert's opinion is needed for accurate radiographic interpretation [16,40]. The use of panoramic radiography to detect carotid artery calcifications could also have led to potential error. Panoramic radiography has been found in multiple studies to be helpful in the diagnosis of CAC but can lead to miscategorization of the degree of calcifications, especially if not performed and evaluated properly or if the plaques causing calcifications are not adequately calcified.

To our knowledge, the present study is the first report describing the prevalence of CACs on panoramic radiographs of patients with type 2 diabetes in UAE. We determined a higher prevalence of calcification in the area of the carotid artery of patients with diabetes than those of matched control patients (12.5% vs. 3.0%). Some studies reported that CAC were also seen in non-diabetic control group and also among general dental outpatients [37,38].

Panoramic radiography is widely used as a diagnostic tool for all health disciplines concerned with the oral and maxillofacial region. However, it has some limitations when used in screening for carotid calcification [42], thus other diagnostic modalities such as ultrasound, MRI and angiography might be required to confirm presence and extent of vascular calcification [43-46]. Randoux et al. [47], reported that Multiple Detector CT angiography is a robust technique for assessing calcification and can potentially depict and allow quantification of load in the carotid arteries in a manner similar to coronary artery scoring, while being highly accurate for measuring luminal stenosis.

In conclusion, our study shows that in patients with diabetes mellitus CACs can be detected by panoramic radiography and the patients may benefit from a referral to physicians for further evaluation and necessary management.

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