

The Prevalence of Carotid Artery Calcification on the Panoramic Radiographs in Cappadocia Region Population

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ABSTRACT

Objectives: The aim of this study is to determine retrospectively the presence of carotid artery calcifications (CACs) detected on panoramic radiographs (PRs) in a group of Turkish population. Further, the relationships between CACs and gender, life style, and medical history were evaluated.

Methods: During the years 2004 to 2006, a random sample of 1282 PRs was collected from patients older than 40 years who were being treated by the School of Dentistry, Erciyes University. Of these 1282 PRs, 750 PRs were included in this study. Medical data was collected from the archival records of the dental school.

Results: About 38 (5.06%) CACs were found on the PRs of 12 (4.5%) males and 26 (5.4%) females. The CAC prevalence was not significantly different between the males and females ($P=0.583$). These calcifications were unilateral in 26 (68.4%) and bilateral in 12 (31.6%) subjects. Of those in the positive group, there were 12 subjects (31.58%) with hyperlipidemia, 12 subjects (31.58%) with hypertension, 7 subjects (18.4%) with diabetes mellitus, 6 subjects (15.8%) with cardiovascular disease, and 6 subjects (15.8%) with smoking history.

Conclusions: This study has the highest CACs prevalence in comparison to the other studies. Therefore, dentists caring for subjects with dental problems should carefully evaluate their PRs for the evidence of CACs, and refer them for medical evaluation as indicated. So, incidental findings could provide life-saving information. (Eur J Dent 2007;1:132-138)

Key words: Panoramic radiograph; Carotid artery calcification; Atherosclerosis, Risk factors

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INTRODUCTION

Atherosclerosis, a progressive inflammatory disorder, may lead to peripheral artery disease, coronary artery disease or stroke. The prevalence of atherosclerosis associated with mortality, and morbidity is very high in developed countries.^{1,2} In western societies, it is the underlying reason of about approximately 50% of all deaths. Specifically, cerebrovascular accident or stroke is the third etiology of death in USA today, preceded only by cardiovascular disease and cancer.^{1,3,4} Over 750,000 new or recurrent strokes occur in the United States annually. In this country, the atherosclerosis is believed to account for about approximately 50% of all embolic strokes and causes to billions of dollars in direct and indirect costs annually.⁵⁻⁷ Not only in the USA, but also in other countries, atherosclerosis and its more dramatic consequences—strokes and heart attacks—represent an important health problem. Although the rate of stroke death has decreased over the past decades in Spain, it is still the second reason of death in men and the first in women.⁸ In Turkey, stroke or cerebrovascular accident is the third etiology of death, preceded only by cardiovascular disease and cancer.⁹

The majority (approximately 80%)¹⁰ of these strokes are ischemic and due to atherosclerotic disease in the region of the carotid bifurcation.¹¹ It was showed that Caucasian men are at greater risk for the stroke from atherosclerotic plaques that arise from carotid arteries.¹² The presence of carotid artery calcifications (CACs) on standard panoramic radiographs (PRs) was first showed by Friedlander and Lande.¹³ They suggested that these radiographs were able to play an important role in the early diagnosis of CACs, which could result in more serious heart disease and cerebrovascular accident.¹⁴ Therefore, PRs may help us as a diagnostic tool for detecting CACs and the early diagnosis could potentially decrease the morbidity and mortality for subjects with CACs.

Recently, a number of studies have revealed the detection of CACs on PRs in many populations,¹²⁻²³ but, there is no enough study regarding this topic in Turkish population. There is only one report about CACs detected by PRs in normal population in Turkey.²⁴ The aim of the present study is to determine retrospectively the presence of CACs detected on

PRs in a group of Turkish population living in Cappadocia region. Further, the relationship between CACs and gender, life style, and medical history was evaluated. According to our knowledge, this is the first study done in Cappadocia region and investigating the risk factors related to CAC in the Turkish population.

MATERIALS AND METHODS

The study is based on 1282 PRs retrieved from the archival records. All the PRs were taken between 2004 to 2006 at the Erciyes University Faculty of Dentistry, Department of Oral Diagnosis and Radiology. The patients with or without dental problems were older than 40 years and treated with this clinic. These PRs were taken as screening films before treatment. Seven hundred and fifty (n=750) of these radiographs were of good image quality. PRs that were excluded because of the subject's movements during the exposure or did not include C3 and C4 were eliminated (n= 532).

All the PRs were obtained with an Orthopantomography® OP100 (Instrumentarium Corp. Imaging Division, Tuusula, Finland). The PRs were processed according to the manufacturer's recommendations in an automatic film processor. All the PRs were evaluated by the same author (YS). Each radiograph was viewed in subdued ambient light using transmitted light from a standard view box. A radiopaque nodular mass or masses adjacent to the cervical vertebrae at or below the intervertebral space between C3 and C4 were diagnosed as CACs²³ (Figure 1). Patients with either unilateral or bilateral CACs on these radiographs were detected. For the differential diagnosis of CACs, other cervical calcifications such as calcified triticeous cartilage, calcified thyroid cartilage,



Figure 1. Carotid artery calcifications visible on the right and left neck, adjacent to the upper intervertebral space between C3 and C4 (white arrows) as shown on a panoramic radiography.

hyoid bone and submandibular salivary gland sialoliths were excluded according to Carter's study.²⁵ To check the intra-observer variations, all the PRs were reevaluated by the same author after one month.

Medical records of the patients with CACs were analyzed. When the CACs were detected, the medical records were reviewed for the factors related to atherosclerosis including hyperlipidemia, hypertension, renal diseases, diabetes mellitus, cardiovascular disease, smoking etc. Any relationship between CACs and gender, age, and past medical history was evaluated.

The results were analyzed with SPSS 10.0 (Statistical Package for Social Science Inc., Chicago, Illinois, USA). Data were obtained using *chi-square* test for comparing the CAC prevalence between the males and the females. The results were considered to have a significant difference if the significance level was lesser than .05.

RESULTS

The study population consisted of 268 males and 482 females with a mean age of 51.0 ± 8.3 (range: 40-83 years) at the time of PRs taken. Of the 750 individuals, 38 (5.06%) were detected to have CAC on PRs. The thirty eight individuals who had CACs consisted of 12 males (4.5%) and 26 females (5.4%). CACs was not significantly different between the males and females ($P=0.583$). The mean age of these patients at that time was 55.7 ± 8.02 years (men: 58 ± 7.3 , women: 54.6 ± 8.2 years).

Carotid artery calcifications were seemed as a radiopaque mass or masses adjacent to or just upper the intervertebral space between C3 and C4 (Figure 1). These calcifications were unilateral in 26 (68.4%) and bilateral in 12 (31.6%) subjects. Of the 38 patients there were 12 bilateral (six males, six females: Table 1) CACs. Therefore, 50 CACs were detected in the 38 patients. Of the 38 ($n=50$ CACs) patients, 31 (62%) of the CACs were located on the right side and 19 (38%) were located on the left side.

The medical records of 38 patients with CAC were analyzed for the risk factors associated with CAC. Table 1 shows the relationship between medical history and CACs. In 38 patients with CACs, 12 subjects (31.58%) reported hyperlipidemia, 12 subjects (31.58%) reported hypertension, 10 subjects

(26.3%) reported renal disease, 7 subjects (18.4%) reported diabetes mellitus, 6 subjects (15.8 %) reported cardiovascular disease, and 6 subjects (15.8 %) reported smoking, as shown in Table 1.

DISCUSSION

Carotid artery calcification, especially close to carotid bifurcation, can result in important vascular obstruction causing stroke.¹⁶ Several factors for the stroke are stratified into no modifiable and modifiable risk factors. The former are gender, age, ethnicity, and heredity, and the latter are hypertension, diabetes mellitus, hyperlipidemia, obesity, smoking, and carotid atherosclerotic disease.²⁶ Early detection of these risk factors reduces the morbidity and mortality.¹⁶ In 1981, it was suggested that standard PR is a useful tool in detecting patients at risk of stroke, because the CAC may be seen in the standard PR adjacent to the cervical vertebrae at the level of the C3-C4 intervertebral junction.¹³ Such calcification may seem as either a radiopaque vertical line or nodular radiopaque mass inferior to the angle of mandible.¹³ Dentists should be able to diagnose CACs and be able to distinguish them from a myriad of anatomical and pathological lesions which may be seen in the region.^{18,27,28} Verification of CAC must be conducted with cervical spine radiographs, angiography or Doppler ultrasound analysis and imaging.²⁹

PRs are used routinely in the evaluation of patients with dental problems. It is not as useful as Doppler ultrasonography and three dimensional computed tomography for detecting atherosclerotic plaque in the carotid arteries and especially the stenosis of the vessels,³⁰ but it is very cheap and non-invasive method in comparison to other imaging methods. PRs may help us in the early diagnosis and in the evaluation of CACs in patients with or without associated risk factors and decrease the morbidity and mortality due to diseases caused by atherosclerosis.²⁴

There are only two Turkish reports investigating the CAC prevalence on PRs in normal population and in patients with end-stage renal disease (ESRD).^{24,31} Bayram et al²⁴ evaluated the PRs of 4106 subjects in terms of CAC in the capital of Turkey. Of these patients, 88 patients (2.1%) had CACs. In the current study, our CAC prevalence was higher than this study. This difference may be due to regional, dietary, and lifestyle differences

of the subjects. We also investigated the risk factors for CACs in all the patients. But, Bayram et al²⁴ only evaluated the risk factors in patients with CACs. We think that the availability of both of them

(risk factors and CAC on PRs) may be important for the initial diagnosis and further evaluation of this disorder. In another study, the CAC prevalence on PRs was investigated for the 69 adult patients with

Table 1. The demographic and medical records of the patients with carotid artery calcifications seen on the panoramic radiographs

| Case | Gender | Age | Side | HL | HT | RD | DM | CVD | S | Others |
|-------|--------|-----------|------|-----|-----|-----|-----|-----|-----|-------------------|
| 1 | F | 40 | R | - | HT | RD | - | CVD | - | Gout |
| 2 | F | 42 | R | - | HT | RD | - | - | - | - |
| 3 | F | 44 | R | - | - | RD | - | - | - | Anxiety |
| 4 | F | 45 | R | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 5 | F | 46 | L | - | - | - | - | - | - | Anxiety |
| 6 | F | 47 | R | HL | - | - | - | - | S | - |
| 7 | F | 48 | R | HL | - | RD | - | - | - | - |
| 8 | M | 50 | R | - | - | - | DM | - | - | - |
| 9 | F | 51 | R | - | - | - | - | - | - | - |
| 10 | F | 51 | R | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 11 | F | 52 | R | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 12 | F | 53 | R/L | HL | HT | - | DM | CVD | - | - |
| 13 | F | 53 | L | - | HT | RD | - | - | - | - |
| 14 | F | 53 | R | HL | - | - | - | - | S | - |
| 15 | M | 54 | L | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 16 | M | 54 | R/L | - | - | - | DM | - | - | - |
| 17 | F | 54 | R | - | - | - | - | - | - | - |
| 18 | F | 55 | L | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 19 | M | 55 | R | - | - | - | - | - | - | - |
| 20 | M | 55 | L | HL | - | - | - | - | S | - |
| 21 | M | 55 | R/L | - | - | RD | - | - | - | - |
| 22 | F | 56 | R | - | - | - | - | - | - | Anxiety |
| 23 | M | 57 | R | - | - | - | - | - | - | - |
| 24 | M | 58 | R/L | HL | HT | - | - | CVD | S | - |
| 25 | M | 58 | R/L | - | HT | - | - | - | - | - |
| 26 | F | 58 | R | HL | - | - | - | - | - | Asthma |
| 27 | F | 58 | R/L | HL | HT | - | DM | - | S | - |
| 28 | M | 60 | L | - | - | RD | DM | - | - | - |
| 29 | F | 60 | R | - | HT | RD | - | - | - | - |
| 30 | F | 60 | R | HL | HT | - | - | - | - | - |
| 31 | F | 60 | R/L | HL | - | - | - | - | - | - |
| 32 | M | 62 | R/L | HL | - | RD | - | CVD | S | - |
| 33 | F | 64 | R | - | HT | - | - | - | - | - |
| 34 | F | 64 | L | - | - | - | - | - | - | - |
| 35 | F | 65 | R/L | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 36 | F | 69 | R/L | - | HT | - | DM | CVD | - | Tuber- culosis |
| 37 | F | 72 | R/L | HL | HT | RD | DM | CVD | - | - |
| 38 | M | 79 | R/L | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Total | | Mean=55.7 | | 12 | 12 | 10 | 7 | 6 | 6 | |

HL,Hyperlipidemia; HT, Hypertension; RD, Renal diseases; DM, Diabetes mellitus ; CVD, Cardiovascular disease; S, Smoking; na, not available

renal disease (35 with renal transplant recipients and 34 with ESRD).³¹ It was reported that the CAC prevalence was 15.7% in patients with renal transplant patients and 17.6% in patients with haemodialysis.³¹ This high prevalence was due to ESRD leading to atherosclerosis.

Recently, the literature has been reported several articles on incidental CACs in the carotid bifurcation region detected by PRs in the other populations.¹²⁻²³ Pornprasertsuk-Damrongsri and Thanakun,¹⁶ found a rate of 2.5% in dental school patients showing CAC on the PRs. In the present study, the prevalence of positive findings of CAC on routine dental PRs (5.06%) was higher than the report in Thai population (2.5%). Carter et al³² evaluated the CAC prevalence on PRs in 1175 newly accepted dental school patients in State University, New York. It was showed that the prevalence was 3.6% in this population. In other study, Tamura et al¹⁵ retrospectively investigated the prevalence on 2568 PRs in a Japanese population. The CAC prevalence in this sample was 4.13%. These differences in terms of the CAC prevalence in all the populations might be due to ethnicity, dietary factors, lifestyle, and the other risk factors. There are also many studies evaluating the CAC prevalence in patients with occult metabolic syndrome,³³ treated with therapeutic irradiation,³⁴ dilated cardiomyopathy,³⁵ type 2 diabetes mellitus,³⁶ obstructive sleep apnea³⁷, etc. All these patients had higher CAC prevalence in comparison to normal population. It was due to underlying disorders causing atherosclerosis.

In the present study, of the 38 patients with CAC, 12 (4.5%) were males and 26 (5.4%) were females. As in our study, in Pornprasertsuk-Damrongsri and Thanakun¹⁶ and Carter et al's³² studies, the CAC prevalence was not different between male and female population. Tamura et al¹⁵ and Bayram et al²⁴ revealed that the CAC incidence in female patients was approximately three times higher than the incidence in males. We suggest that all these different CAC prevalences in female and male populations are probably due to the sample of the studies.

Commonly, CACs are formed at the bifurcation point of the vessels where turbulent flow is increased.²² In the majority of the reports in normal populations,^{15,16,32} the CACs were unilateral and located on the left side rather than the right side.

In the current study, the most of the CACs were unilateral, but generally located on the right side. In another study, Ohbe et al²³ investigated the CAC prevalence in the patients older than 80 years. It was found that the most of the CACs were located on the right side as in our study. They showed that CACs on the left side are less detected than those on the right side on PRs. However, we think that these different CAC localizations in the reports may be related to the sample of the studies.

As for diseases and life style factors associated with CACs, hyperlipidemia, hypertension, cardiovascular diseases, smoking, obesity, renal disease,³¹ diabetes mellitus,³⁶ obstructive sleep apnea syndrome,³⁷ and periodontitis¹⁵ were reported. In the present study, in 38 patients with CACs, 12 subjects (31.58%) reported hyperlipidemia, 12 subjects (31.58%) reported hypertension, 7 subjects (18.4%) reported diabetes mellitus, and 6 subjects (15.8 %) reported smoking. Pornprasertsuk-Damrongsri et al¹⁶ investigated the archival records of 34 CAC patients for the risk factors. It was found that all the patients with CAC were associated with hypertension (52.9%), diabetes mellitus (29.4%), hyperlipidemia (14.7%), smoking (2.9%), and other risk factors such as renal disease, cardiovascular disease, etc.¹⁶ Their findings were consistent with a previous study in terms of hypertension (77.8%) and diabetes mellitus (22.2%) reported by Lewis et al¹⁷ Carter and colleagues found that obesity (45.2%) was most strongly related to the occurrence of CAC.³² We think that this relationship may be related to obesity associated co-morbidities including hypertension, hyperlipidemia, diabetes mellitus etc. rather than the disease. Cohen et al¹⁴ revealed 1879 male patients over age 55 having standard PRs with 71 (3.8%) showing CACs. In their study, 53.5% of those patients with CACs had a history of hypertension, 36.6% had hyperlipidemia, 22.5% had diabetes mellitus, and 54.9% were smokers.¹⁴ Their morbidity rates were higher than the rates of our study as in Tamura et al's¹⁵ report. These may be due to smaller selected age groups of the both studies in comparison to Cohen et al's¹⁴ report. However, we think that all these differences in terms of risk factors may be due to ethnicity, dietary factors, lifestyle, and regional differences.

CONCLUSIONS

As a result, CACs found as incidental findings on standard PRs may be important markers for future coronary artery disease, strokes and death.¹⁴ PR should be carefully examined in the area of the carotid artery in not only patients with systemic disease such as diabetes, renal disease etc., but also asymptomatic patients.³¹ The CACs in the present study were detected by standard PR in 5.06% of the patients with dental problems. Most of the CACs were detected on the right side. The CAC incidence in female patients is approximately two times higher than the rate in male patients in our sample. In the current study, 31.58% of our patients with CACs had a history of hyperlipidemia, 31.58% had hypertension, 18.4% had diabetes mellitus, and 15.8% had smoking as consistent with the other previous reports. Therefore, any patient with CACs should be evaluated in terms of risk factors for atherosclerosis. According to our knowledge, this study has the highest CACs prevalence in comparison to the other studies. Also, this is the first study done in Cappadocia region and investigating the risk factors related to CAC in the Turkish population. In conclusion, we believe that dentists caring for subjects with dental problems should carefully evaluate their PRs for the evidence of CACs, and refer them for medical evaluation as indicated. So, incidental findings could provide life-saving information.

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