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ORIGINAL ARTICLE

Clinicostatistical study of carotid calcification on panoramic radiographs

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OBJECTIVE: The purpose was to evaluate carotid calcifications on panoramic radiographs, and relate to risk factors for vascular diseases.
METHOD: Between 1997 and 2001, 2568 radiographs were retrospectively collected from new patients at Mie University Hospital whose ages ranged from 50 to 70 years. The mean age of the subjects was 62.2 years (men 61.9 years, women 62.3 years). Medical and social data were collected from case notes, and body weight, height, and age of menopause confirmed by telephone interviews.
RESULT: About 106 carotid calcifications were found on the panoramic radiographs of 26 males and 80 females. The ratio of males to females was 1:3.07. The subjects with carotid calcifications had medical histories that included hypertension (27.6%), obesity (21.1%), hyperlipidemia (14.5%), and cardiovascular diseases (13.2%), all with recognized risk factors for atheromas. Of 76 patients who responded to follow up interviews, two (2.63%) died from cardiovascular stroke during an average follow up of 2.43 years.
CONCLUSIONS: The results show carotid calcifications detected on panoramic radiographs can be used to help predict vascular strokes in patients. In cases where calcified carotid artery atheromas are detected, the dentist or oral and maxillofacial surgeon should refer the patient to a specialized physician.
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Keywords: panoramic radiographs; carotid calcification; atheroma

Friedlander and Lande (1981) first reported that calcified carotid artery atheromas (CCAAs) were diagnosable by means of panoramic radiography. Their later study suggested that panoramic radiographs were able to play a significant role in the diagnosis of CCAAs, which could escalate into more serious cerebrovascular disease and heart disease (Cohen *et al*, 2002). These circulatory diseases would manifest themselves an average of 2.7 years after CCAAs symptoms were diagnosed (Cohen *et al*, 2002).

In Japan, there are a few reports on CCAAs detected by panoramic radiographs. However, for Japanese patients with CCAAs identified on panoramic radiographs, the incidence of carotid artery atheromas and the end-points after long-term follow up periods are not clearly established (Fukuta *et al*, 2003; Ohba *et al*, 2003). Therefore, we retrospectively examined panoramic radiographs obtained from new patients of the Department of Oral and Maxillofacial Surgery at Mie University and studied the incidence of CCAAs and the end-point of those patients who had CCAAs. Further, the relationship between CCAAs and gender, life style, and medical history was evaluated.

Materials and methods

Subjects of this study were new patients at the Department of Oral and Maxillofacial Surgery at Mie University who were between 50 and 70 years old (1221 males, 1347 females, or a ratio of 1:1.03 males to females) during the years 1997–2001.

The radiographs were obtained with a X-600/serial number: CPK J105 (Morita, Kyoto, Japan). Panoramic radiography was performed, according to the manufacturer's recommendations (radiographic film; Konika SR-G, kVp; 60–80 V, 5–10 mA, 10–15 s). A radiopaque nodular mass or masses adjacent to the cervical vertebrae at or below the intervertebral space between C3 and C4 were diagnosed as CCAAs. Three dentists interpreted all radiographs and concurred on a diagnosis of carotid artery atheromas. Radiographs that were distorted because of the subjects' movements during the exposure or did not include C3 and C4 were eliminated. Furthermore, the patients who had a history of radiation treatment to the neck and pharyngeal regions were excluded.

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We reviewed the medical records of the patients with CCAAs. Any relationship between CCAAs and gender, age, past medical history, and obesity was evaluated. A body mass index (BMI) of 25 or more was defined as obesity for this study.

Follow up telephone interviews were conducted with patients who showed CCAAs. The information on body weight, height, and the age of menopause was confirmed. Further, the patients were asked whether they had received treatment for atheromas, experienced a cerebrovascular disease or a myocardial infarction, and whether they received any medical treatment. In cases where the patient had already died, the family answered the questions.

Statistical analysis

Data were analyzed using chi-square test and the results were considered to have a significant difference if the significance level was $<1\%$.

Results

The subject population consisted of 1221 males and 1347 females. About 106 (4.13%) of the 2568 patients had radiopaque nodular masses that were suspected as CCAAs. The 106 individuals who had CCAAs consisted of 26 males (2.13%) and 80 females (5.94%). The gender ratio of male to female was 1:3.07, showing a clinical significance in female patients ($P < 0.01$; Figure 1). The mean age of these patients at that time was 62.2 years (men: 61.9, women: 62.3). There was no significant difference in mean age between men and women.

Relationship between CCAAs and locations

Of the 106 patients, 80.2% of the CCAAs were located in the left side and 32.1% were located in the right side. Bilateral CCAAs were found in 12.3% (seven males, six females; Figure 2). For the 26 male patients, 88.5% were located in the left side and 38.5% were located in the right side. For the 80 female patients, 77.5% were located in the left side and 30.0% were located in the right side. The incidence rates of CCAAs in the left side were significantly higher than the rates in the right side for both male and female patients. There were no significant differences between the males and females in the location of carotid artery atheromas.

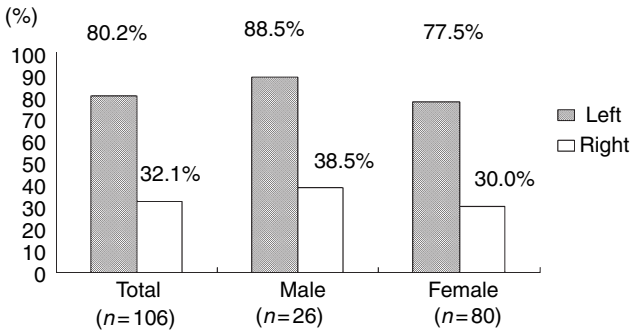

Figure 2 Location of calcified carotid artery atheromas (CCAAs), classified by the total patients, male, and female. The darker column represents the left location and the lighter column represents the right location. Bilateral CCAAs were counted redundantly

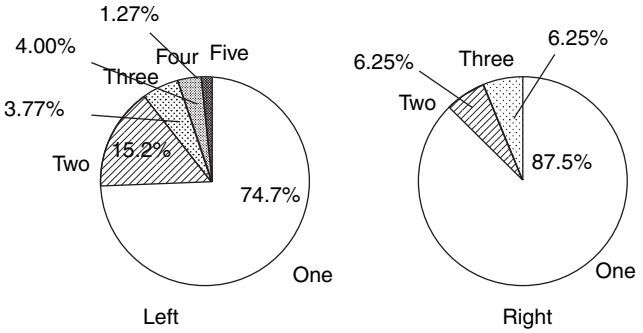

Figure 3 The pie chart indicates the number of calcified carotid artery atheromas (CCAAs) per patient and its corresponding ratio to the total CCAAs

Number of radiopaque nodular masses

Comparing the number of radiopaque nodular masses in terms of the location, one to five masses were distributed on the left side and one to three masses were distributed on the right side. The patients with one radiopaque nodular mass on the left side or on the right side accounted for 74.7% and 87.5%, respectively (Figure 3). The size analysis of CCAAs was eliminated because the magnification on panoramic radiographs differed in individual cases.

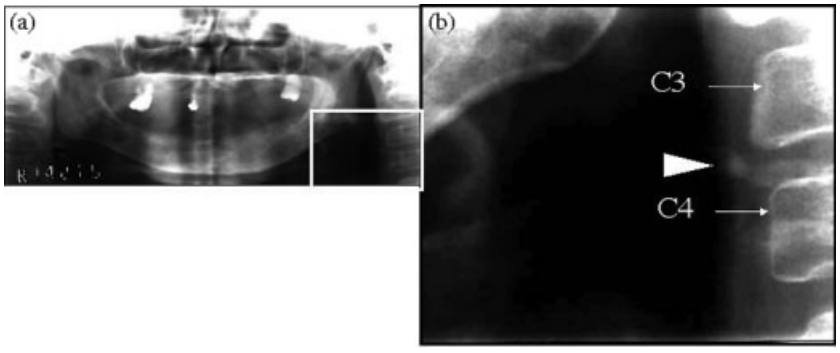

Figure 1 (a) A panoramic radiograph with a nodular calcified carotid atheroma visible on the left side of the neck, adjacent to the intervertebral space between C3 and C4. (b) Enlarged image of the white-framed region of (a). The arrow indicates a nodular calcified carotid atheroma. C3, third cervical vertebra; C4, fourth cervical vertebra

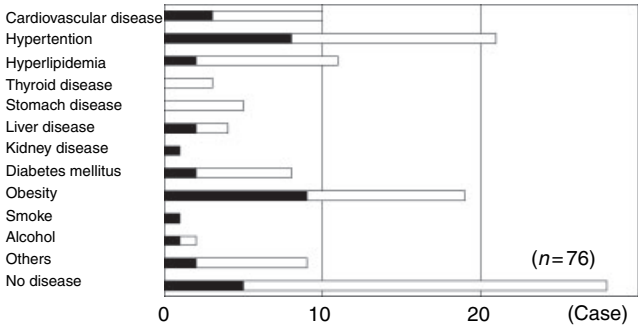

Figure 4 The bar chart indicates the relationship of medical history and lifestyles to CCAAs. The subjects were 76 patients who answered the follow-up oral examination by telephone. The darker part of the column represents male patients and the lighter part of the column represents female patients

Relationship between CCAAs and medical past history
Figure 4 shows the relationship of medical history and life styles to CCAAs. Cardiovascular diseases were found to be common in the patients with carotid artery atheromas: 10 patients (13.2%) had cardiovascular diseases. About 21 patients (27.6%) had hypertension, and 11 patients (14.5%) had hyperlipidemia. Diabetes mellitus, gastrointestinal diseases, and liver diseases were found in decreasing order. About 12 patients (15.8%) were obese. Three patients (3.9%) were smokers, and four (5.3%) were heavy drinkers.

End-points
Of the 106 phone interviews, there were 76 responses by either the patients or their family. The average follow up period for the 76 patients was 2.43 years. There were no patients who received medical treatment for cardiovascular attack or disease. Three patients had end-points of death. Of the three deaths, two women (2.63%) died from cerebrovascular disease and acute heart failure. The follow up periods for the two were 3.45 and 2.41 years. The third death was from a malignant disease.

Discussion

In America, stroke by cerebral thrombosis is the third most common cause of death and every year 550 000 Americans are struck down by cerebrovascular diseases originating in the occlusion of the carotid artery. More than 160 of 100 000 Americans will suffer from a stroke. Even if the first stroke does not lead to death, one-third of the survivors suffer from physical impairments, a small percentage of them need nursing care, and approximately 50% of them die of a recurrence of stroke within 5 years (Doherty *et al*, 1997). In Japan, cardiac disease and cerebrovascular disease are the second and third most common cause of death after malignant neoplasm, implying early detection and treatment of CCAAs is quite important (White Paper of Ministry of Health and Welfare of Japan, 2002). CCAAs are considered to be important because they can develop into cerebral infarction because of stenosis, blockage, and thrombus formation in the arteries that are perfusing vital organs. In the USA, some studies have reported that CCAAs on the panoramic radiographs were powerful markers that made it easier to detect cerebrovascular disease and stroke (Carter *et al*, 1998; Friedlander and Friedlander, 1999; Friedlander and Altoman, 2001; Cohen *et al*, 2002; Ohba *et al*, 2003; Sung *et al*, 2004). Carter (2002) reported that attention must be paid to distinguish CCAAs from other diseases such as sialolithiasis and phleboliths or other radiopacities in this area such as the hyoid bone, styloid process, cricoid cartilage, arytenoid cartilage, epiglottis, calcified stylomandibular ligament, stylohyoid ligament, and triticeous cartilage. Of them, triticeous cartilage adjacent to the fourth cervical vertebra is the most difficult to distinguish from CCAAs. The observation of the triticeous cartilage being mistaken as a CCAA is well taken as is the occasional phlebolith and other normal anatomical structures that can make identification of the CCAAs difficult. According to his study, CCAAs were projected irregularly and heterogeneously as a radiopaque nodular mass or masses overlapped with soft tissue just below the intervertebral space between C3 and C4 and located more to the side of the triticeous cartilage (Carter, 2002). Recent study indicates that Doppler sonographic examination is useful in distinguishing CCAAs from other radiopaque masses (Ravon *et al*, 2003). Radiopaque nodular mass or masses adjacent to the fourth cervical vertebra were eliminated from this study because of the difficulty in differentiating CCAAs from triticeous cartilage.

There is no report comparing the incidence of CCAAs of male patients with female patients. In our study, CCAAs were detected by means of panoramic radiography in 4.13% of the subjects (106 of 2568 subjects, with an average age of 62.2 years). Of the 106 subjects, 26 were male and 80 were female. The incidence rate of CCAAs among females (5.94%) is approximately three times higher than the rate among males (2.13%). The result of women having a significantly higher incidence of CCAAs suggests a relationship between the decline of estrogen levels in the blood and CCAAs. The decline of estrogen levels in the blood of postmenopausal women is considered to be a factor for CCAAs. Friedlander and Altoman (2001) reported that estrogen decreases low-density lipoprotein (LDL) catabolism in the blood and that increased LDL cholesterol levels in blood were associated with hepatic lipase activity, causing vessel walls to harden and thicken () but this is not a comparable population with our study group. The subjects in this study were between 50 and 70 years old, and all of the female patients who answered the follow up examination were postmenopausal women.

Generally, CCAAs are formed at the branch point of artery vessels where turbulent flow is increased (Friedlander and Altoman, 2001). The results showed that CCAAs were more commonly located on the left side rather than the right side. However, Friedlander and Altoman (2001) reported more CCAAs were located on the right side and Ohba *et al* (2003)

reported more on the left side. Further research on the location of CCAAs will be needed. Carter *et al* (1998) reported that CCAAs raised the blood flow of the internal carotid artery about 5.5 times (430 cm s^{-1}) greater than normal, posing a risk of a severe narrowing of the arteries.

As for diseases and life style factors associated with CCAAs, hypertension, hyperlipidemia, diabetes mellitus, smoking, obesity, obstructive sleep apnea syndrome (OSAS), and periodontitis were reported. Cohen *et al* (2002) reported on 1879 male subjects over age 55 having panoramic radiographs with 71 (3.8%) showing CCAAs. In their study, 53.5% of those patients with CCAAs had a history of hypertension, 36.6% had hyperlipidemia, 22.5% had diabetes mellitus, 54.9% had a history of smoking, and 21.1% were obese. Their rates of morbidity were higher than the rates of this study. It could be attributed to the difference in life styles between the USA and Japan. Fukuta *et al* (2003) reported that 29.3% of the patients having cardiovascular diseases also had CCAAs and the incidence rate was 14.7 times as high as that of those who had no cardiovascular diseases. Furthermore, 22.0% of the patients (54 male subjects, mean age 60.4 years) having OSAS also had CCAAs and the prevalence was far greater than age-matched controls (3.7%) (Friedlander and Friedlander, 1999).

Cohen *et al* (2002) reported that 15.4% of the 71 patients had an end-point of death during an average 3.6-year follow up, which is a much higher rate than the 2.3% death rate of our study. This could be attributed to the fact that the average follow up period in this study (2.43 years) was shorter than that of their study (3.6 years), and also that the mean age of the patients in this study (61.9 years) was younger than that in their study (68 years).

In conclusion, the CCAAs in our study were detected by means of panoramic radiography in 4.13% of the subjects (106 of 2568 subjects, with an average age of 62.2 years). Most of the CCAAs were detected in the left side (80.2%). The incidence rate of CCAAs among females is approximately three times higher than the rate among males. CCAAs detected on panoramic radiographs can be used to predict vascular strokes in patients. If dentists find CCAAs on panoramic radiographs, they should explain the risk of stroke to the patients immediately and refer them to a specialized physician for further investigations.

References

Carter LC (2002). Discrimination between calcified triticeous cartilage and calcified carotid atheroma on panoramic radiography. *Oral Surg Oral Med Oral Pathol* **90:** 108–110.

Carter LC, Tsimidis K, Fabiano J (1998). Carotid calcifications on panoramic radiography identify an asymptomatic male patient at risk for stroke. *Oral Surg Oral Med Oral Pathol* **85:** 119–122.

Cohen SN, Friedlander AH, Jolly DA, Date L (2002). Carotid calcification on panoramic radiographs: an important maker for vascular risk. *Oral Surg Oral Med Oral Pathol* **94:** 510–514.

Doherty MC, Baumann DS, Creswell LL *et al* (1997). *The Washington manual of surgery*, 1st edn. Little, Brown and Company: Massachusetts, USA, pp. 315–317.

Friedlander AH, Lande A (1981). Panoramic radiographic identification of carotid arterial plaques. *Oral Surg Oral Med Oral Pathol* **52:** 102–104.

Friedlander AH, Altoman L (2001). Carotid artery atheromas in postmenopausal women. *JADA* **132:** 1130–1136.

Friedlander AH, Friedlander IK (1999). The prevalence of carotid atheromas seen on panoramic radiographs of patients with obstructive sleep apnea and their relation to risk factors for atherosclerosis. *J Oral Maxillofac Surg* **57:** 516–521.

Fukuta Y, Kimura T, Totsuka M (2003). Oral findings of patients with cardiovascular disease: remaining tooth number and panoramic radiographic findings. *Jpn J Oral Diagn/Oral Med* **16:** 15–21.

Ohba T, Takata Y, Ansai T *et al* (2003). Evaluation of calcified carotid artery atheromas detected by panoramic radiograph among 80-years-olds. *Oral Surg Oral Med Oral Pathol* **96:** 647–650.

Ravon NA, Hollender LG, McDonald V, Persson GR (2003). Signs of carotid calcification from dental panoramic radiographs are in agreement with Doppler sonography results. *J Clin Periodontal* **30:** 1084–1090.

Sung EC, Friedlander AH, Kobashigawa JA (2004). The prevalence of calcified carotid atheromas on the panoramic radiographs of patients with dilated cardiomyopathy. *Oral Surg Oral Med Oral Pathol* **97:** 404–407.

White Paper of Ministry of Health and Welfare of Japan (2002). *IV. Analyses by causes of death, abridged life tables for Japan, vital statistics*. http://www.mhlw.go.jp/english/database/db-hw/lifetbo2/4.html