

Clinical Report

Clinical Significance of Carotid Artery Calcification seen on Panoramic Radiographs

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Abstract: Among patients who visited our hospital with a chief complaint of disorders involving the oromandibular region, with suspected carotid artery calcification based on panoramic radiography, and who underwent computed tomography for a detailed examination of these disorders, there were four patients in whom a definitive diagnosis of carotid artery calcification was made. We herein provide an overview of these cases, along with a brief review of the relevant literature. When imaging findings suggestive of carotid artery calcification are obtained on panoramic radiographs, dentists can request detailed examinations and treatment at specialized medical institutions in the early stage by providing patients with information about the risks of atherosclerotic diseases. Early detection and treatment may reduce the severity or risks of complications and damage caused by atherosclerotic diseases, as well as possibly contributing to improved quality of life. In this study, we evaluated carotid artery calcification visible on panoramic radiographs. However, it seems that further detailed analysis is needed to examine the association between carotid artery calcification and a past history of risk factors for arteriosclerosis.

Key words: Panoramic radiograph, Carotid artery calcifications, CT image, Arteriosclerosis

Introduction

Carotid artery calcification seen on panoramic radiographs is known to be associated with the development of vascular disorders. In particular, arteriosclerosis is a cause of stroke (cerebral infarction, intracranial hemorrhage, and subarachnoid hemorrhage), which is the leading cause of death in the Japanese, and myocardial infarction, which accounts for the majority of sudden death cases in Japan. Having observed that panoramic radiographs taken for dental treatment can indicate the presence or absence of carotid artery calcification, we considered that they might help in preventing the sudden onset of vascular disorders, if dentists could explain the possibility of developing these disorders to patients and urge them to see a doctor.

Among patients who visited Matsumoto Dental University Hospital with a chief complaint of disorders in the oromandibular region, showed signs of carotid artery calcification on panoramic radiography, and underwent computed tomography (CT) for a

detailed examination of the disorders, there were four patients in whom a definitive diagnosis of carotid artery calcification was made. Herein, we provide an overview of these cases, along with a brief literature review concerning the clinical significance of carotid artery calcification.

Materials and Methods

Methods to evaluate carotid artery calcification

The panoramic radiography devices used for imaging of the carotid artery calcification were AZ3000CM (Asahi Roentgen Ind. Co., Ltd., Tokyo, Japan) and a multi-slice CT system, Activion 16 (Toshiba Medical Systems Corporation, Tokyo, Japan), a computerized radiography (CR) system (Konica Minolta, Inc., Tokyo, Japan) was used as an imaging detector. For evaluation of panoramic radiographs and CT images, we used the Digital Imaging and Communications in Medicine (DICOM) data stored in the electric dental records system and a high-resolution medical liquid crystal display, PGL21 (WIDE Corporation, Korea), which was linked with the CR system. In the evaluation of calcified carotid artery lesions on panoramic radiographs, a nodular or irregular opacity independent from the hyoid bone in a region

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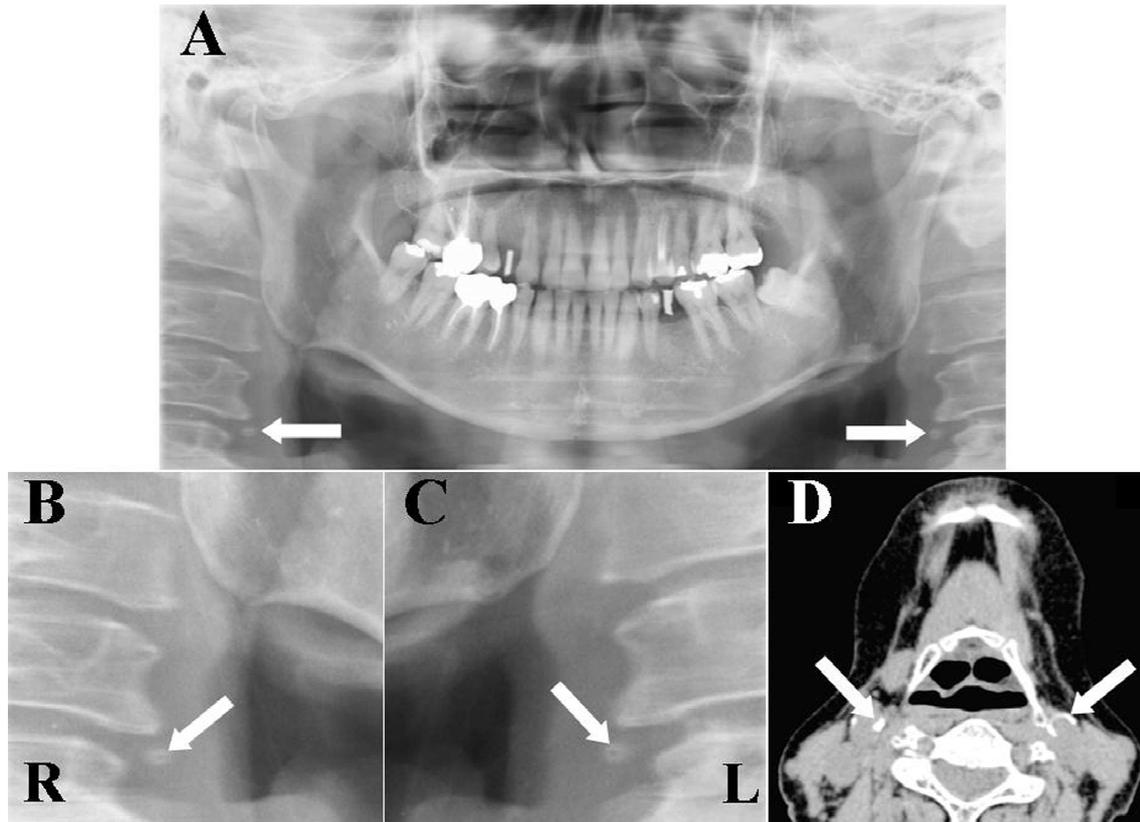


Figure 1. Case 1. A: Rice-grain sized opacities with well-defined margins that suggest carotid artery calcification are observed in an anteroinferior region on both sides of the fourth cervical vertebra. B: An image with partial emphasis on the calcified areas of right side. C: An image with partial emphasis on the calcified areas of left side. D: Calcification is observed in the right carotid artery, and there is also a finding suggestive of calcification in the peripheral part of the left carotid artery.

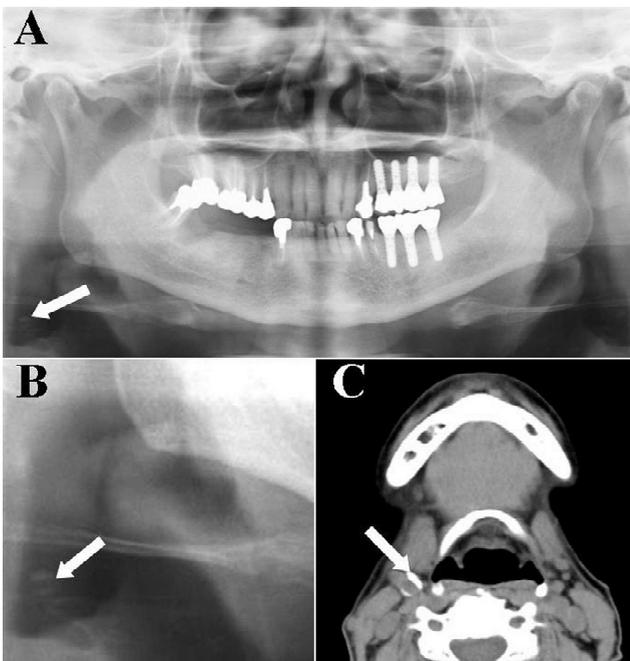


Figure 2. Case 2. A: An opacity with well-defined margins that appeared as carotid artery calcification in front and to the right of the fourth cervical vertebra. B: An image with partial emphasis on the calcified area. C: Calcification is shown in the right carotid artery.

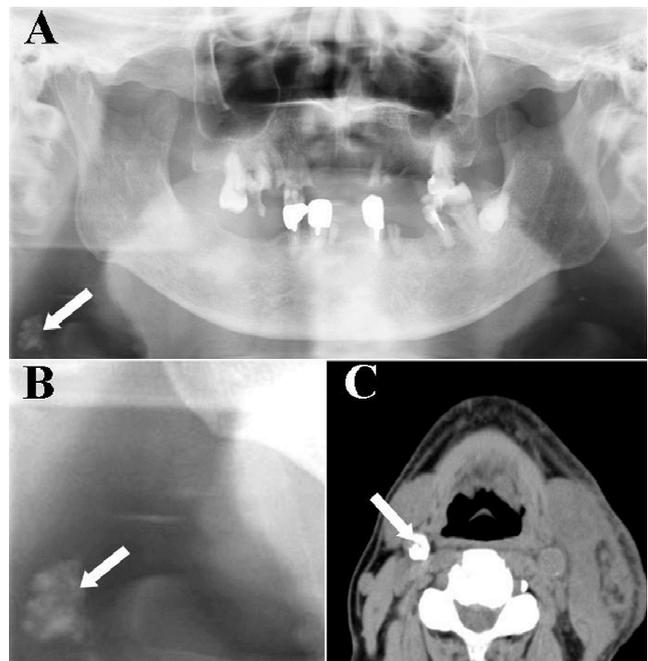


Figure 3. Case 3. A: An irregular opacity with heterogeneous density is shown in front of the fourth cervical vertebra. B: An image with partial emphasis on the calcified area. C: Marked irregular calcification is shown in the right carotid artery.

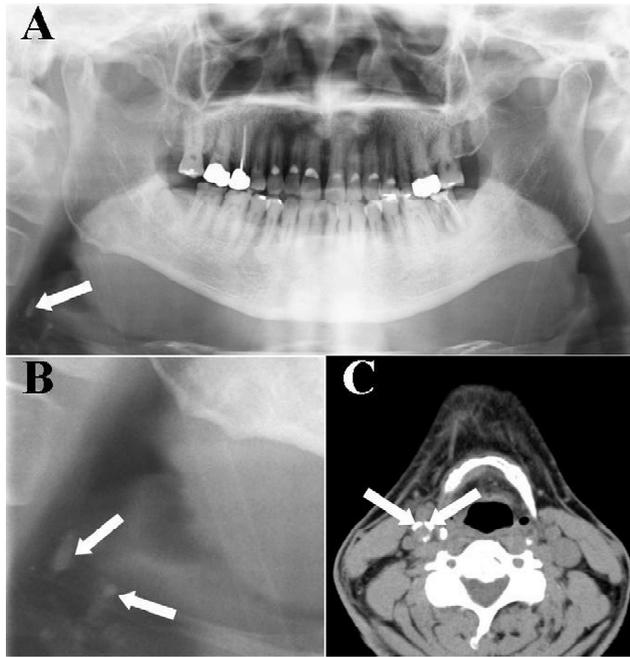


Figure 4. Case 4. A: Scattered nodular opacities with well-defined margins are shown at the back of the right greater horn of the hyoid bone and in front of the fourth cervical vertebra. B: An image with partial emphasis on the calcified areas. C: Plaques associated with calcification are depicted on the internal wall of the right carotid artery.

anterior to the third and fourth cervical vertebrae, or posteroinferior to the angle of the mandible by approximately 45°, was diagnosed as carotid artery calcification, according to the proposal by Friedlander¹⁾, while the transverse sectional view of soft and hard tissues was evaluated on CT images. The images were evaluated by two attending dentists qualified by the Japanese Society for Oral and Maxillofacial Radiology.

The medical and past histories of the patients were searched in the dental records, interview forms, and dentistry articles that were stored in the electric dental records system of Matsumoto Dental University Hospital.

This research was conducted with the approval of Matsumoto Dental University Institutional Review Board (approval number: 0152) and the consent of each patients after an explanation of the intent of the research.

Results

Case 1 was a 58-year-old man who was referred for dental implant therapy to this university hospital by a neighborhood dental clinic and visited in August 2011. He had undergone radical surgery for maxillary sinusitis 10 years earlier. He had no history of hypertension, diabetes mellitus, or dyslipidemia. For dental implant therapy, panoramic radiography and CT were performed. The panoramic radiograph showed rice-grain sized opacities with well-defined margins in an anteroinferior region on both sides of the fourth cervical vertebra, suggesting carotid artery calcification

(Fig. 1 A, B). On the CT images, calcification was observed in the right carotid artery, and there was also a finding suggestive of calcification in the peripheral part of the left carotid artery (Fig. 1 C).

Case 2 was a 74-year-old woman who visited this university hospital in August 2010, and whose chief complaint was swelling of the buccal gingiva of the right mandibular second molar. She was currently under treatment with oral medication for hypertension and hyperlipidemia. Dental implant therapy was planned because she also requested it, and panoramic radiography and CT were performed for detailed examination of the inside of the mandible. The panoramic radiograph showed an opacity with well-defined margins that appeared as carotid artery calcification in front and to the right of the fourth cervical vertebra (Fig. 2 A, B). The CT images confirmed calcification in the right carotid artery (Fig. 2 C).

Case 3 was a 75-year-old man who was referred to this university hospital for detailed examination and treatment of painless swelling of the palate and visited in May 2008. The patient had a history of infiltrative tuberculosis of the left hilum at the age of 17 years. At the age of 65 years, he was found to have hypertension, for which he was currently taking oral medication. For detailed examination of the palate, panoramic radiography and CT were performed. The panoramic radiograph revealed an irregular opacity with heterogeneous density in front of the fourth cervical vertebra (Fig. 3 A, B). The CT images showed marked irregular calcification in the right carotid artery (Fig. 3 C). Because marked calcification of the carotid artery was observed, we consulted a neurosurgical hospital for a detailed examination of the site. Three-dimensional CT angiography and ultrasonography depicted plaques associated with carotid artery calcification.

Case 4 was a 67-year-old man who visited this university hospital in October 2011 with chief complaints of pain in the left mandibular molar region and marked buccal swelling. He had a history of hypertension and diabetes mellitus, for which he was currently taking oral medication. As there was suspicion of cellulitis caused by the periapical lesion of the left mandibular second molar, panoramic radiography and CT were performed. The panoramic radiograph revealed scattered nodular opacities with well-defined margins at the back of the right greater horn of the hyoid bone and in front of the fourth cervical vertebra (Fig. 4 A, B). The CT images depicted plaques associated with calcification on the internal wall of the right carotid artery (Fig. 4 C).

Discussion

Sclerotic lesions of the carotid artery are known to occur at the bifurcation of the common carotid artery. This bifurcation occurs at a level between the fourth and fifth cervical vertebrae in 48.1% of individuals, between the third and fourth cervical vertebrae in 34.2 %, and between the third and fifth cervical vertebrae in 82.3 %¹⁾. Carotid artery calcification seen on

panoramic radiographs was reported by Friedlander²⁾ to appear as nodular or irregular opacities in a region anterior to the third and fourth cervical vertebrae, and posteroinferior to the angle of the mandible. The criteria for cerebral atherosclerosis developed by a research group of the Japanese Society of Cardiovascular Disease Prevention under a grant from the Ministry of Health, Labour and Welfare include a relatively clear criterion, defining it as a lesion that can be confirmed by plain cervical radiography to be calcification of the arterial wall at the bifurcation of the common carotid artery³⁻⁵⁾. In all of the four cases in the present study, the panoramic radiographs showed carotid artery calcification as nodular opacities independent from the hyoid bone in the region anterior to the fourth cervical vertebra and posteroinferior to the angle of the mandible; in addition, the definitive diagnosis of carotid artery calcification was obtained by CT scan. Thus, the calcified lesions of the neck seen on the panoramic radiographs seem to have indicated carotid artery calcification on the basis of the morphology and location of the opacities. However, because the shadows of the cervical vertebrae were not sufficiently depicted on the panoramic radiographs in Cases 2 and 4, we were not able to fully appreciate the positional relationship between the opacities and the cervical vertebrae. In order to use panoramic radiography for screening to determine the presence or absence of carotid artery calcification, it is important to pay sufficient attention to the positioning of the head and neck for panoramic radiography. At the same time, because the currently used positioning of the head and neck causes variations in the positions of the cervical vertebrae, studies on radiographic techniques also seemed to be needed.

Regarding the incidence of carotid artery calcification, Friedlander et al. reported that carotid artery calcification was observed in six of 134 outpatients aged 65 years or older (mean age, 68.2 years; incidence, 4.5 %)²⁾, and that, in another study of 304 outpatients aged 55 years or older without any past morbidity, carotid artery calcification was observed in 10 outpatients (approximately 3 %)⁶⁾. In a clinical study conducted in 1195 patients with carotid artery calcification by Sato et al.⁷⁾, findings suggestive of carotid artery calcification were detected on panoramic radiographs in 48 patients (4.0 %), who were 50 years or older with a mean age of 70.3 years. Sato et al.⁷⁾ reported that carotid artery calcification was frequently detected in patients in their 60s and 70s, and that the incidence, according to sex and age, was the highest in women in their 80s (42.9 %), followed by men in their 70s (16.4 %), and men in their 60s (13.9 %). Imataka et al.⁴⁾ reported that carotid artery calcification was observed in 10.2 % (100 of 983 patients), while the incidence according to age group was reported as follows: carotid artery calcification was not observed in any patients in their 40s; it occurred in only a few patients in their 50s; whereas the incidence in patients aged 60 years or older, which was markedly higher, was 22.2 % (80 of 361 men) and 73.9 % (15 of 190 women). Although the number

of cases that we have reported above is small, the age of the four patients ranged from 57 to 75 years and averaged 68.5 years, which is nearly consistent with the age group reported by other researchers. However, we consider that patient distribution by age group needs to be closely analyzed through accumulation of cases in the future.

The known risk factors for stroke include hypertension, heart disease, diabetes mellitus, and hyperlipidemia, and many patients with carotid artery calcification have a past history of these diseases³⁾. While there is a report that the incidence of carotid artery calcification was two to three times higher in patients aged 50 years or older with such a past history than in those without⁷⁾, other reports indicate that the incidence is high in women one year or more after menopause and in elderly individuals who have a past history of type II diabetes mellitus^{8,9)}. Moreover, there is also a report that the rate of complication with stroke was high in patients with carotid artery calcification⁴⁾. Regarding the past histories of the four patients in the present study, Case 1 did not have any past history of hypertension, diabetes mellitus, or dyslipidemia, nor was there anything notable in the family history. The patient in Case 2 was currently being treated with oral medication for hypertension and hyperlipidemia. In Case 3, the patient had been diagnosed as having hypertension and was currently receiving oral medication. The patient in Case 4 was currently receiving oral medication for hypertension and diabetes mellitus. Despite the small number of cases in our report, it seemed that past histories of hypertension, diabetes mellitus, hyperlipidemia, etc., might be associated with carotid artery calcification. When findings suggestive of carotid artery calcification are observed on panoramic radiographs, it is important to interview patients regarding their past history, general condition, medication use, etc., even in general dental practice.

On panoramic radiographs, opacities that need to be differentiated from carotid artery calcification include submandibular sialolith, cervical lymph node calcification, tonsillar calculus, phlebolith, and stylohyoid ligament calcification¹⁰⁻¹²⁾. Submandibular sialolith appears as an opacity overlapping the body of the mandible, in the case of an intraductal sialolith, or as an opacity with well-defined margins in a region anteroinferior to the angle of mandible, in the case of an intraglandular sialolith. Cervical lymph node calcification appears as a heterogeneous opacity with irregular margins, and tuberculous lymph node calcification appears as multiple opacities of different sizes on both sides of the neck. Tonsillar calculus appears as a nodular opacity that overlaps the mandibular ramus. Phlebolith appears as multiple opacities that are found in combination with cavernous hemangioma. Stylohyoid ligament calcification appears as an elongated projecting, segmental, or nodular opacity. It is assumed that carotid artery calcification can be relatively easily differentiated from those showing opacities in the neck on the

basis of anatomical location, morphological features, or clinical findings.

When carotid artery calcification is observed on panoramic radiographs, atherosclerotic diseases are not always suspected. Because there is no apparent subjective symptom of carotid artery calcification or atherosclerotic disease, early detection of arteriosclerosis is difficult. Thus, patients with these diseases may be unlikely to visit a specialized medical institution in the early stage. In the four cases reported here, after CT was performed as a preoperative test for dental implant surgery or detailed examination of stomatognathic diseases, carotid artery calcification was diagnosed accidentally. However, in the dental field, it is difficult to perform CT in all cases that show carotid artery calcification on panoramic radiographs. At some dental university hospitals, ultrasonography of the carotid arteries is performed. The observation areas for ultrasonography of the carotid arteries are observable areas among the common carotid artery, bulbous, bifurcation, internal carotid artery, and vertebral artery, while the external carotid artery, subclavian artery, and their branches may also be observed if needed. When intima-media thickness or plaques are evaluated, the essential observation areas are the common carotid artery, bulbous, and internal carotid artery¹³⁾. Examination by specialists in the medical department or tests appropriately performed by certified ultrasound technicians are important.

Although carotid artery calcification seen on panoramic radiographs does not always lead to a diagnosis of the presence or absence of atherosclerotic diseases, panoramic radiography allows the observation of teeth, entire jaws, and calcification of soft tissue on a single radiograph. In Japan, there are 59,059 panoramic radiographic devices, and the number of annual imaging cases is reported to be 123.36 million¹⁴⁾. Moreover, panoramic radiography is considered to be most frequently performed in people aged 50 to 59 years¹⁴⁾. Because this age group corresponds to that of people with risk factors for arteriosclerosis (hypertension, heart diseases, diabetes mellitus, and hyperlipidemia), panoramic radiographs could be used for screening of patients with a tendency to develop stroke. It seems highly likely that carotid artery calcification might also be detected on panoramic radiographs of patients who have no previously identified risk factors for arteriosclerosis⁵⁾.

When imaging findings suggestive of carotid artery calcification are obtained on panoramic radiographs taken in general dental practice, dentists can promote detailed examination and treatment at specialized medical institutions in the early stage by providing patients with information about the risks of atherosclerotic diseases. Early detection and treatment may allow a reduction in the severity or risks of complications and damage caused by atherosclerotic diseases and may also contribute to improved quality of life. In this study, we evaluated carotid artery

calcification seen on the panoramic radiographs of four patients. However, it seems that further detailed analysis is needed to examine the association between patients with carotid artery calcification seen on panoramic radiographs and a past history of risk factors for future arteriosclerosis. Studies of the processing of images exhibiting carotid artery calcification and the development of computerized support systems are also needed.

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