

# DIAGNOSTIC AGREEMENT BETWEEN PANORAMIC RADIOGRAPHS AND COLOR DOPPLER IMAGES OF CAROTID ATHEROMA

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Received: September 26, 2007 - Modification: March 13, 2008 - Accepted: August 13, 2008

## ABSTRACT

The aim of this study was to investigate the agreement between diagnoses of calcified atheroma seen on panoramic radiographs and color Doppler images. Our interest stems from the fact that panoramic images can show the presence of atheroma regardless of the level of obstruction detected by color Doppler images. Panoramic and color Doppler images of 16 patients obtained from the archives of the Health Department of the city of Valença, RJ, Brazil, were analyzed in this study. Both sides of each patient were observed on the images, with a total of 32 analyzed cervical regions. The level of agreement between diagnoses was analyzed using the Kappa statistics. There was a high level of agreement, with a Kappa value of 0.78. In conclusion, panoramic radiographs can help detecting calcifications in the cervical region of patients susceptible to vascular diseases predisposing to myocardial infarction and cerebrovascular accidents. If properly trained and informed, dentists can refer their patients to a physician for a cardiovascular evaluation in order to receive proper and timely medical treatment.

**Key words:** Radiography, panoramic. Carotid artery, external. Carotid artery diseases. Calcinoses.

## INTRODUCTION

Increased blood pressure, high serum levels of cholesterol or carbohydrates, and other factors may lead to endothelial damage and consequent atherogenesis<sup>6</sup>. The presence of carotid atheroma is associated with the severity of coronary artery disease (CAD) and cerebrovascular accident (CVA) or cerebral infarction.

Among the different methods to diagnose atherosclerotic diseases, angiography is considered the gold standard. However, because it is an invasive method, complications may occur<sup>5,24,25</sup>. Therefore, color Doppler imaging, also called laser Doppler fluxometry or duplex scan, has been increasingly used to diagnose atheroma because it is a fast, accurate and painless method of diagnosis. Color Doppler can be considered as a gold standard because the results obtained with this imaging method are similar to those obtained with angiography, with the advantage that color Doppler is a noninvasive method<sup>7,15,16,19,23</sup>.

Panoramic radiographs, used as a complementary

examination resource by dentists, can often show the presence of carotid atheroma<sup>2,22</sup>. Most studies found in dental literature report that calcifications between the 2nd, 3rd and 4th vertebrae first seen on panoramic radiographs are further confirmed as atheroma by color Doppler<sup>3,8,10,20</sup>.

Studies have investigated the possibility of identifying carotid artery calcifications on panoramic radiographs, on many occasions especially in asymptomatic cases. Therefore, patients can be referred to a cardiologist or a neurologist for further investigation<sup>9,12</sup>.

The use of panoramic images to assess carotid atheroma is important because they often show the presence of calcifications. Panoramic radiographs are easy to take and have a low cost compared to other imaging methods. In addition, a complete radiographic examination of the both arches can be carried out with only one x-ray exposure and a relatively lower radiation dose<sup>2,21</sup>.

Our interest stems from the fact that panoramic radiographs can show the presence of carotid calcification regardless of the degree of obstruction. Therefore, the purpose

of this study was to investigate the agreement between diagnoses of calcified atheroma seen on panoramic radiographs and color Doppler images.

## MATERIAL AND METHODS

### Material

This research was independently reviewed and approved by the Research Ethics Committee of the Medical School of Valença, Rio de Janeiro, RJ, Brazil.

Color Doppler and panoramic images of 16 patients obtained from the archives of the Health Department of the city of Valença, Brazil, were analyzed in this study. Both sides of each patient were observed on the images, with a total of 32 analyzed cervical regions.

The criteria for selecting the images considered the date of the examinations and were selected radiographic and color Doppler images taken on the same day and interpreted by

different radiologists who were responsible for the clinics accredited by the Health Department of the city of Valença, RJ, Brazil.

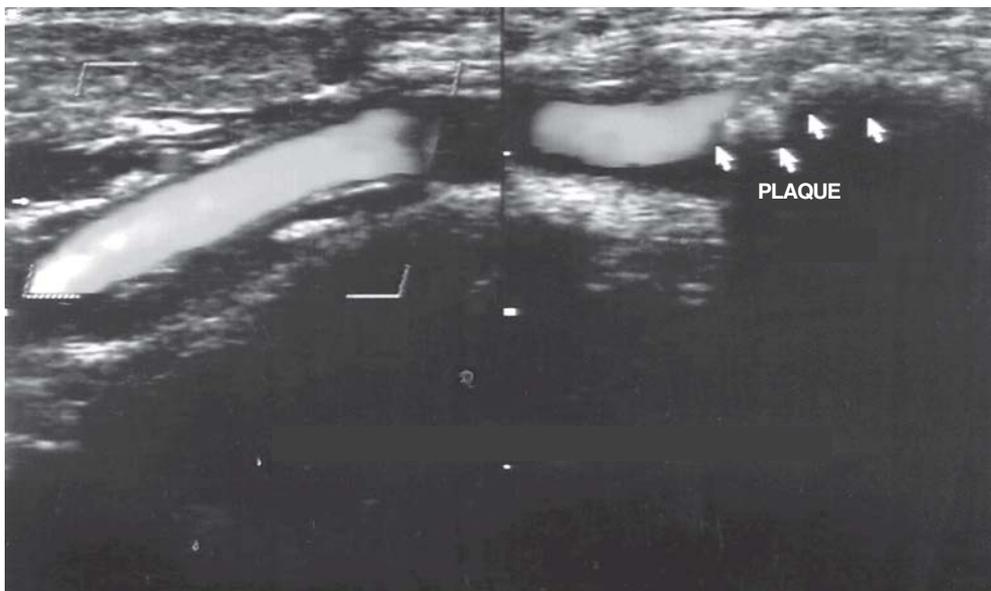
### Methods

The panoramic radiographs were analyzed by a dental radiologist with 20 years of experience. The radiographic findings of calcifications in the cervical region (Figure 1) were compared to the results of color Doppler ultrasonography (Figure 2). Both sides of each patient were examined.

After analyzing the panoramic images, it was verified whether a positive or negative diagnosis of calcification was made and the results were compared to those obtained from the color Doppler ultrasound images, which were analyzed by the same ultrasound medical specialist.



**FIGURE 1-** Panoramic radiography shows a calcification in the cervical region on the right side

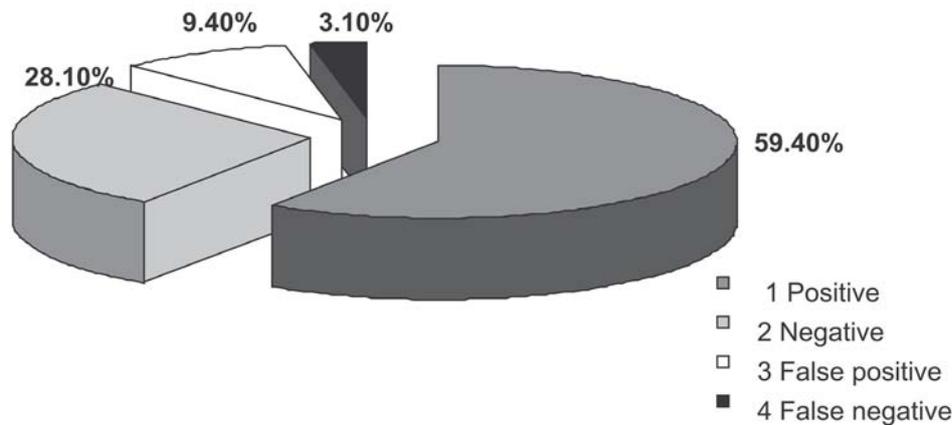


**FIGURE 2-** Carotid stenosis in the left internal carotid artery by color Doppler images

## RESULTS

Figure 3 shows the comparison between the diagnoses of unilateral and/or bilateral carotid artery calcifications after analysis of panoramic radiographs and color Doppler images.

The results were distributed into two groups, subdivided into two subgroups: 1. *Agreement between diagnoses*, which included all cases with similar diagnoses after examination of both panoramic and color Doppler images; 2. *Disagreement between diagnoses*, which included all cases with different diagnoses after examination of both panoramic and color Doppler images.



**FIGURE 3-** Positive, negative, false-positive and false-negative diagnosis

## DISCUSSION

Differential diagnosis of the structures that constitute the carotid region is extremely important. It is necessary to have extensive knowledge of all anatomical structures that may produce radiographic images similar to carotid atheroma, such as the hyoid bone, the epiglottis, calcified stylomandibular and stylohyoid ligaments, and the triticeal cartilage, as well as pathological processes such as sialoliths, phleboliths, and calcified lymph nodes. The radiologists responsible for the analysis of the images must be able to identify anatomical structures and pathological calcifications in soft tissues in the head and neck region, discerning their location<sup>1,3,11-13,18</sup>.

Previous studies have demonstrated that panoramic radiographs of patients undergoing dental treatment can often reveal the presence of carotid atheroma, later confirmed by color Doppler ultrasonography<sup>2,8,12,14</sup>.

Carotid artery calcifications may lead to cerebrovascular accidents (CVA), the third major cause of death in Australia and the USA<sup>1</sup>. CVA may also affect a person's functional ability, and the physical and psychological rehabilitation is difficult and expensive<sup>17</sup>. It is therefore important that panoramic radiographs are used to help establishing an early detection and prevention cerebrovascular or coronary artery diseases an early diagnosis of carotid artery calcifications. The dentist can help save lives with a radiograph taken for dental care purposes<sup>2</sup>.

Some authors<sup>23</sup> do not indicate the use of panoramic radiographs to detect carotid artery calcifications arguing that this type of method of diagnosis has low sensitivity (31.1%). In the present study, it was not our intention to indicate panoramic radiography as the exam of choice for detecting calcification in the carotid artery. Instead, we intended to demonstrate that panoramic radiography is an important adjuvant for enabling patient general evaluation by the dentist, who can adequately refer patients to physicians if a suspicion of atheroma or other pathology arises.

The calcification seen on the panoramic radiographic image has been described as a nodular area of radiopacity. Radiographically, we can observe one or various vertical linear

areas of radiopacity, with a long or triangular shape and various sizes. These areas are observed approximately 1.5 to 4.0 cm from the mandibular angle and/or posterior to the mandible and the 2nd, 3rd, and 4th vertebrae, adjacent to the intervertebral space<sup>3,8,9,10,20</sup>.

The vertebral region is not currently investigated by dentists. However, if dentists were previously trained to identify calcifications in the cervical region on panoramic images and confirm the presence of atheroma by means of other imaging methods, they would help reducing the incidence of cerebrovascular or coronary artery diseases<sup>2</sup>. A study investigating the panoramic images of 1,548 neurologically asymptomatic patients aged 50 or older showed the presence of carotid atheroma in 65 patients, later confirmed by color Doppler<sup>14</sup>. The study showed that early or advanced stages of atherosclerotic disease can be identified through careful analysis of panoramic radiographs by dentists.

There is a report in the literature of an asymptomatic patient whose panoramic radiograph showed calcifications in the carotid region, and color Doppler later showed over 90% bilateral stenosis in the external carotid artery of the patient<sup>4</sup>.

The purpose of our study was to assess the relationship between calcifications seen on panoramic images of the cervical region and by the analysis of color Doppler images. A total of 32 regions were bilaterally examined in 16 patients who had undergone panoramic x-ray exposure and color

Doppler ultrasound. Calcifications were seen on both panoramic and color Doppler images of 19 regions (59.4%), which was considered a positive diagnosis. No atheroma was seen on panoramic or color Doppler images of 9 regions (28.1%), which were considered a negative diagnosis. Calcifications were seen on panoramic images but not confirmed by color Doppler in 3 regions (9.4%), which was considered a false-positive diagnosis. This might be related to anatomical structures or pathological calcifications in soft tissues in the head and neck region<sup>1,3,11,12,13,18</sup>. In 1 case (3.1%) color Doppler showed the presence of a calcification that had not been seen on the panoramic image. This was considered a false-negative diagnosis, and might be related to the degree of calcification. We reviewed the related literature and found no reports on the degree of calcification necessary to produce a radiopaque image specific for atheroma.

## CONCLUSION

It may be concluded that panoramic radiographs may help detecting calcifications in the cervical region of patients susceptible to vascular diseases predisposing to myocardial infarction and cerebrovascular accidents and refer these patients to a neurologist or cardiologist. Since the panoramic radiography is a common, non-expense exam, the present study and similar ones might widen the perspectives to a possible interdisciplinary partnership approach where properly trained and informed dentists can advise their patients as to the necessary steps to be taken in order to receive a correct medical treatment.

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