Can Carotid Stenosis Be Predicted By Dental Radiographs?

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Citation

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Abstract

Objective: Panoramic radiography (PR) has been an important component of dental diagnostic radiology for over five decades and is often used as the initial evaluation image that can provide the required insight in determining the pathologies of the jaws. PR can detect calcified plaques in the carotid artery which lies in the focal trough of the PR. The primary aim of the study was to assess the role of PR in detecting the calcified carotid atheromatous plaques on PR in patients with susceptible risk factors. The other aim was to study pathologies that mimic vessel wall calcifications on the PR.Methods: 80 patients with risk factors were subjected to PR and Doppler Ultrasound (DUS), which is considered as the gold standard for detection of vessel wall pathologies. The PR findings were correlated with the observations of the DUS.Results: The prevalence of carotid calcifications on PR was found to be 13.75 %. PR was found to have a high specificity (73.33%) but low sensitivity (31.42%) in detecting vessel wall calcification.Conclusions: PR cannot be used as a screening tool for detecting vessel wall calcifications; nevertheless it should be scanned thoroughly in the area of these calcifications. Furthermore, steps should be taken to create awareness amongst the dental and medical fraternity to identify these calcifications and the entities that resemble them.

INTRODUCTION

Numata and Paatero[1] have taken great strides in the field of maxillofacial imaging by their invention; the Panoramic Radiography (PR). These researchers had little known that their creation could be used to throw light on the small calcifications located in some corner of the curved image slices of the mandibulo-facial tissues, a corner unvisited by the inventors themselves. Arthur Friedlander [2] in 1981 was the first person who had noticed the presence of soft tissue calcifications in the region of the carotid artery on the panoramic radiograph. This gave an additional responsibility to the radiologists, to regularly scrutinize this much ignored area of the panoramic radiograph.

The common carotid arteries ascend within the neck to approximately the midcervical region and bifurcate into the external and internal carotid arteries. The bifurcation i.e. the carotid bulb has an increased tendency to form atheromatous plaques which are recognized as the major contributing source of cerebrovascular embolic and occlusive disease. Such atheromatous plaques often undergo calcification and have been noted on plain radiographs of the skull, facial bones and cervical spine. The bifurcation of the carotid arteries lies in the region of the focal trough of the PR and as the posterior regions of the image layer are wider than the anterior, the heavily calcified plaques can be serendipitously discovered during routine radiographic examinations.[3,4]

While atheromatous plaque may be calcified and imaged on PR the degree of occlusion cannot be ascertained. Doppler Ultrasonography (DUS) remains the “gold standard” in evaluation of carotid artery stenosis.[5-9]

Thus it was thought, worthwhile to study the panoramic radiographs of patients with atherogenic risk factors who would probably reveal such calcifications. An attempt was made to take a step ahead, in not only familiarizing ourselves with such vessel wall calcification on the PR but also to ascertain whether the calcified bodies seen on the PR was indeed a vessel wall calcification by confirming it on Ultrasound. It was the intention of this study to ascertain whether PR can accurately detect vessel wall calcifications in the carotid arteries of patients having high risk for future cerebrovascular events. Furthermore, DUS was used to precisely assess the radiographically visible and invisible stenosis qualitatively as well as quantitatively. Thus an appraisal of these calcified plaques is made on the panoramic radiograph in comparison with Ultrasonography,

the "gold standard" with the following aims and objectives:

1. To determine the prevalence of radiologically detectable vessel wall calcifications.
2. To compare and correlate the vessel wall calcification on PR with USG and to determine the exact location and nature of the calcified body.
3. To confirm the vessel wall calcification on PR with DUS and to rule out other causes of calcifications on PR.

MATERIALS AND METHODS

The study comprised of 80 patients, 55 males and 25 females, above 50 years of age. Patients who were hypertensive and / or diabetic and those who presented with history of cerebrovascular accident (CVA), transient ischaemic attacks (TIA) and Ischemic heart disease (IHD) were selected. Lipid profile, fasting and post prandial blood sugar were assessed.

All the patients selected for the study were informed about the purpose behind the study and their written consent for the radiograph and USG examinations was taken. Each patient was subjected to panoramic radiographic examination with PLANMECA EC PROLINE (Helsinki, Finland) at 66-68 KVp, 10 mAmp for 18 seconds. A 5x12 Kodak film was used for the radiographic examination and was processed manually.

Radiographs were carefully evaluated by both the authors under ideal lighting conditions of the view box, for the presence of nodular, punctate or linear radiopacities in the soft tissues of the neck postero-inferior to the angle of mandible, at the level of the lower margin of the third and the fourth cervical vertebra (C3 & C4). All the patients were then subjected to USG of the carotid arteries and other areas of the neck with a high-resolution B-mode ultrasound Nemio Toshiba system with a frequency 7-9 MHz linear probe. The DUS examination was carried out by senior sonologist.

RESULTS

USG findings of the patients were correlated with clinical history and PR examination. Statistical (Kappa) analysis was done and results were obtained. Out of 80 cases included in the study, 23 cases showed radiographic evidence of calcifications on the PR near the ramus and the vertebra, with 2 of them showing multiple calcifications in the ramus region.

Even if the basic aim of the study was to assess the efficacy of PR in detecting vessel wall calcifications, the actual scrutiny of the radiographic films showed multitude of calcifications of different origins in the area of interest. Perusal of literature suggested that the following conditions can resemble vessel wall calcifications: [10- 13] (1) Triticeous cartilage, (2) Greater cornu of the hyoid bone, (3) Schwall's node, vertebral body or osteophyte of the cervical vertebra, (4) Superior cornu of the calcified thyroid cartilage, (5) Sialolith, phlebolith, tonsillolith or calcified lymph node.

The prevalence of various disease states in 80 patients is mentioned in table 1. After confirmation and correlation of the radiographically evident calcified bodies on the PR with the USG findings, it was found that only 11 of the 23 radiopacities were actual vessel wall calcifications. (Table 2 shows details of patients with calcifications on PR which were confirmed on DUS)

Figure 1

Table 1 showing the prevalence of various diseases in 80 patients.

DISEASE	PREVALENCE
HYPERTENSION	88.75%
DIABETES MELLITUS	51.25 %
ISCHEMIC HEART DISEASE	35%
TRANSIENT ISCHEMIC HEART DISEASE	5 %
HYPERLIPIDEMIA	33.75 %

Figure 2

Table 2 Showing Details Of Carotid Calcifications On OPG & USG

PT NO	OPG FINDINGS (RIGHT)			OPG FINDINGS (LEFT)			USG FINDINGS (mm)		PERCENTAGE STENOSIS
	SHAPE	SITE	TYPE	SHAPE	SITE	TYPE	Calcified plaque-Right	Calcified Plaque-L eft	
1	OV	B H	NOD	X	X	X	5.3 X 2.1	8.9 X 9.8	< 25%
3	OV	B H	NOD	X	X	X	4 X 2	2 X 3	< 25%
4	OV	A H	NOD	X	X	X	3.5 X 3	X	< 25%
5	OV	A H	NOD	IRR	A H	V.LIN	2.4 X 1.4	7 X 2.2	< 25%
6	OV,IRR	AH,ALH	NOD	OV	A H	NOD	MULTIPLE	MULTIPLE	21%-R, 60 %-L
9	IRR	B H	NOD	OV	B H	NOD	7 X 2.2	4	50%-R, 30% -L
10	IRR	A L H	PATCHY	IRR	B H	PATCHY	11.5	17.8	< 25%
15	IRR	A L H	NOD	X	X	X	8 X 3 B	7 X 2	52.7%-R
16	OV	A L H	NOD	X	X	X	1.2 X 1.7	X	< 25%
22	X	X	X	IRR	B H	NOD	X	10 X 3.4	25- 50%-L
23	X	X	X	OV	A L H	V.LIN	X	17X3 4x2	33-50%-R, 32-55%-L

Figure 3

Table 3 Showing Details Of Entities Mimicking Carotid Calcifications On OPG

PT NO	OPG FINDINGS (RIGHT)			OPG FINDINGS (LEFT)			USG	
	SHAPE	SITE	TYPE	SHAPE	SITE	TYPE	FINDINGS	
2	LIN	B H	V. LIN	LIN	B H	V.LIN	X	Calcified thyroid
7	X	X	X	OV	A H	NOD	X	Not localised on USG
8	OV	A H	NOD	IRR	A H	NOD	X	Vertebral body
11	OV	A L H	NOD	OV	B H	NOD	X	Triticeous cartilage
12	OV	A L H	NOD	X	X	X	X	Hyoid Comu
13	OV	B H	NOD	OV	B H	NOD	X	Triticeous cartilage
14	OV,IRR	B H	NOD,V.LIN	OV, IRR	B H	NOD,V.LIN	X	Triticeous cartilage
17	OV	RAMUS	PATCHY	OV(ghost)	RAMUS	PATCHY	X	Not localised on USG
18	IRR	B H	V. LIN	OV	B H	NOD	X	Triticeous cartilage
19	OV	B H	NOD	OV	B H	NOD	X	Triticeous cartilage
20	OV	A L H	NOD	OV	B H	NOD	X	Triticeous cartilage
21	OV (ghost)	AH,RAMUS	NOD	OV	AH,RAMUS	NOD	Parotid calcification	Parotid calcification

Abbreviations: OV- Ovoid, IRR- Irregular, NOD- Nodular, BH-Below Hyoid, AH- Above hyoid, ALH- At the level hyoid, V.LIN- Verticolinear , LIN- Linear.

Careful history, inspection and palpation allowed us to rule out the pathological radiopacities such as sialoliths, phleboliths and calcified lymph nodes. An attempt was also made to trace these remaining radiographically evident radiopacities in the adjacent soft tissues of the cervical areas with DUS. These were then classified after studying their morphology and location as triticeous cartilage, greater cornu of the hyoid bone, vertebral osteophyte, calcified thyroid cartilage and dystrophic calcification in the parotid gland. It was also observed that 2 of the radiopaque bodies were located in the ramus region on each side. These bodies had their ghost shadows on the contralateral side. 2 of these radiopacities, in the concerned region could not be localised by the USG (Table 3 gives details of entities that resemble carotid calcifications on the PR).

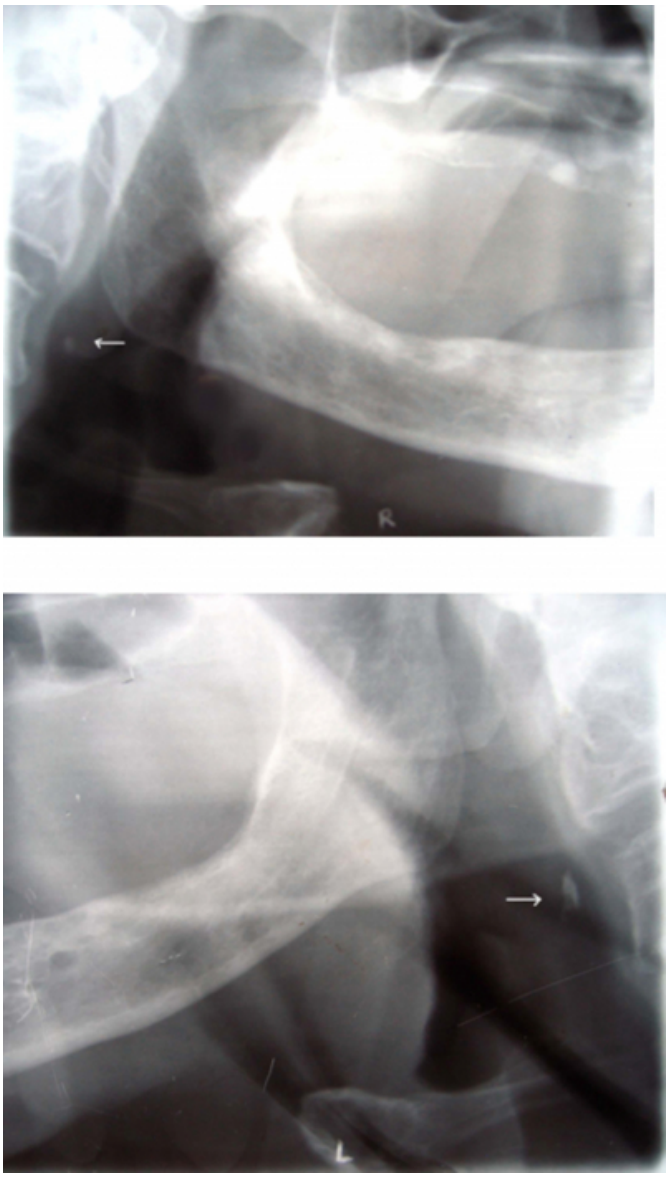
DISCUSSION

Arthur Friedlander et al [2, 10, 12] have described carotid artery calcifications as being discrete radiopaque nodular masses within the soft tissues of the neck at or above the level of the third cervical vertebra or the intervertebral space between C3 and C4. They may also be observed as punctate, linear or irregular non-homogenous radiopacities.[9,14-16] In our study, most of the ultrasonographically proven calcified carotid plaques were nodular in shape, with some of them showing variations in morphology, being linear or patchy and most of them were either at the level of hyoid or below it.

The radiographic detection and USG confirmation of most of these plaques had demonstrated 30-50 % or more than 50 % stenosis and proved to be helpful in the identification of patients with a risk of cerebrovascular event, which is consistent with the findings of various authors. [4, 15, 17] (fig 1A&B - Cropped PR of a patient with bilateral carotid calcification)

Figure 4

Fig 1 A & B: Cropped PR of a patient with bilateral carotid calcification.



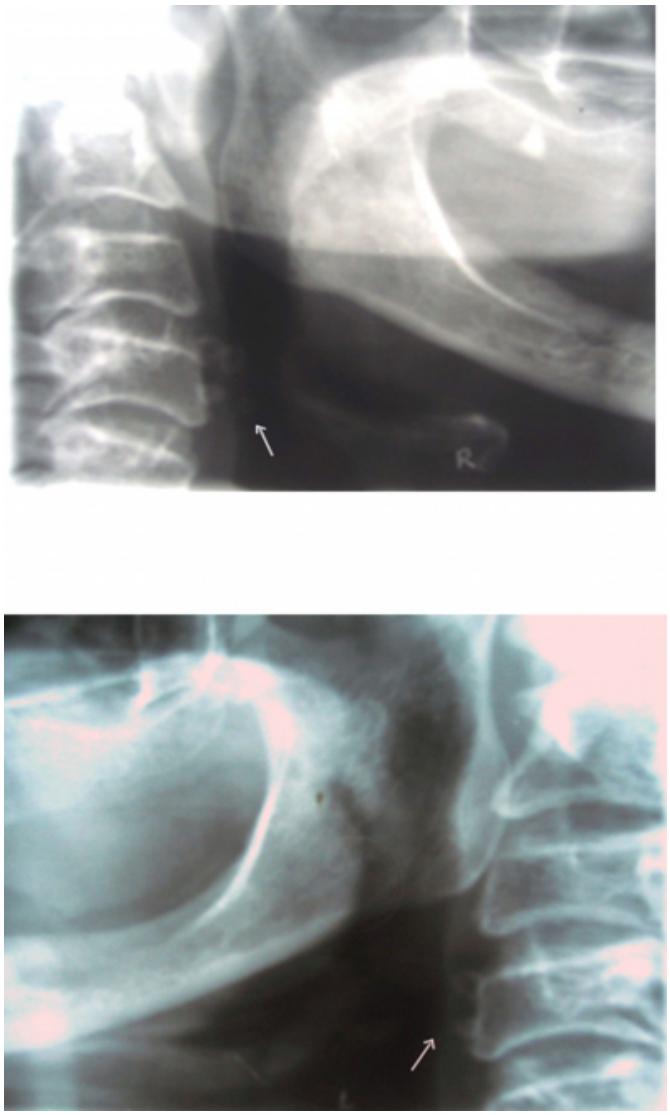
In our study, the most deceptive appearance was that of the triticeous cartilage being 6 out of the remaining 12 cases. Almost all the cases pronounced as triticeous cartilage were well defined, ovoid in shape with a nodular outline. According to various researchers, the triticeous cartilage is the greatest cause of erroneous diagnosis of calcified carotid atheroma since they are located in the same region and their age range also coincides with the mineralization of these cartilages.[7,15,16, 18- 21]

The case of patient no.12 was adjudged as the greater cornu

of the hyoid bone, its position being at the level of the hyoid (ALH) and it being contiguous with the body of the hyoid (fig 3A&B - Cropped PR showing triticeous cartilage, cornu of hyoid) The morphological appearance of this radiopaque body had a remarkable resemblance to the calcified carotid atheroma. Greater cornu of the hyoid bone is the entity most likely to be misinterpreted as calcified carotid atheroma, after the triticeous cartilage.[15, 16, 20]

Figure 5

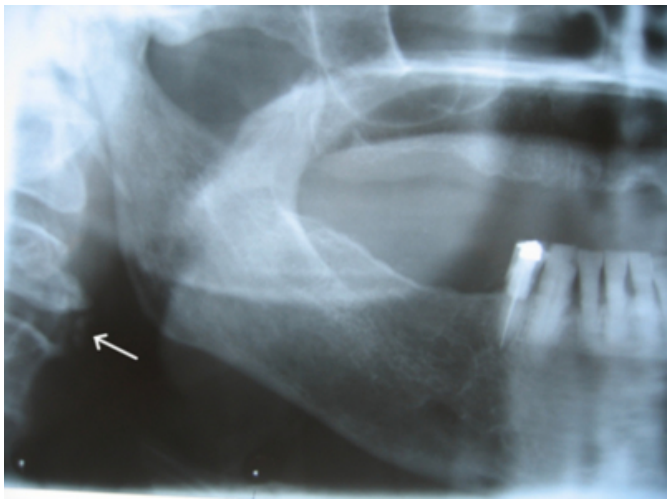
Fig 3 A & B : Cropped PR showing triteceous cartilage and cornu of hyoid.



One of the patient, presented with 2 parallel lines extending below the hyoid with a linear orientation. This was adjudged as the calcified thyroid cartilage. Another interesting finding which was analogous to the calcified plaque in our study was the vertebral osteophyte (Schwall's node) of the third cervical vertebra. It appeared as ovoid, irregular and in proximity with the 3 rd cervical vertebra (fig 4- PR of a patient showing vertebral osteophyte/ Schwall's node)

Figure 6

Fig 4 : Cropped PR showing vertebral osteophyte/Schwall's node.



Exploration of the adjacent soft tissues in case no. 21 failed to show a calcific plaque in the vessel wall, however, it showed ultrasonographic evidence of areas of dystrophic calcification in the right parotid gland. In the remaining 2 cases, the exact nature of origin of calcification could not be ascertained despite USG study and were presumed to be soft tissue calcification in the area of interest.

In our study the prevalence of calcified carotid artery atheromas in patients with risk factors was found to be 13.75 %. Overall percentage of prevalence in various studies was found to be ranging from 2-37 %[4, 6, 12, 22-28]. Thus it indicates that while observing radiographs of patients with history of risk factors, one should be vigilant and look for radiopacities at the corners of the PR.

In our study, PR had a low sensitivity of (31. 42 %) and a high specificity of (73.33 %) in detecting vessel calcification. The fact that conventional radiography does not have the advantage of contrast enhancement can be one of the reasons for a low sensitivity. Kappa statistics was applied to ascertain the level of agreement of between the PR and the USG in detecting a calcified plaque. In our study, this was found to be very low (k= 0.05).

Even if 23 calcified bodies were detected on PR, only 11 were confirmed as vessel wall calcification on the DUS. On the other hand, USG showed other vessel wall changes such as intimo-medial thickening, fibro-fatty plaque and calcified plaque and the amount of occlusion. Therefore it appears that though PR cannot rule out vessel wall pathologies but it

still has some potential to identify vessel wall calcification.

CONCLUSIONS

In conclusion, we would like to emphasize that the PR is not proposed as a screening tool for carotid artery disease. Nevertheless, it is advisable that the PR be scanned thoroughly and an attempt should be made to identify these calcifications, as they may be of great clinical significance. Also, the entities that resemble these calcifications should be studied properly to avoid false positive results. Moreover, digital imaging with enhancement of brightness and contrast has an advantage over conventional radiography in studying these lesions.

General dental practitioners are able to identify most of the dental pathologies on the panoramic radiograph, but do not give importance to inspect the cervical regions. Even those who are trained to identify these calcifications find it difficult and are not confident enough to differentially diagnose vessel wall calcification. Thus, awareness programs should be encouraged not only amongst the dental as well as medical fraternity about the potential of panoramic radiography to recognize vessel wall calcifications and differentiate them from the myriad of calcifications occurring in these areas.

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