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THE PREVALENCE OF CAROTID ARTERY CALCIFICATION DETECTED FROM THE PANORAMIC RADIOGRAPHS OF A SAMPLE OF THE EGYPTIAN POPULATION: A RETROSPECTIVE STUDY

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ABSTRACT

Background: According to the World Health Organization, 17.9 million people die due to cardiovascular disease (CVD) each year. Carotid artery calcification (CAC) is considered one of the main predisposing factors to the problem[3]. Panoramic radiography is a useful screening tool for patients with CAC. The **aim** of this study was to assess the prevalence of CACs in the Egyptian community, correlate it with age and sex and determine their shape distribution**.**

Methods: involved 512 panoramic scans (256 males and 256 females). They were then divided into 3 groups according to age; Group I: 18-34 years, Group II: 35-55 years, and Group III: >55 years.

Results: showed a prevalence of 23.05 %, with a non-statistically significant higher percentage in females (56%). Group II has proven a significant higher percentage of prevalence in both males and females. The unilateral CAC has shown a statistically significant higher percentage than bilateral CAC in males. While in females, the higher percentage of unilateral CACs hasn't been statistically significant. Finally, a higher statistically significant percentage of single shaped CACs has been recorded among the examined sample in this study.

Conclusion: The prevalence of CACs among Egyptian population is comparable to other nationalities. Gender doesn't play a crucial role in CAC prevalence. The right unilateral single shaped CAC predominance requires extra attention to avoid any missed data that could affect the patient. CACs detection is of a major importance to prevent cardiovascular complications.

KEYWORDS: Carotid artery calcification, panoramic radiographs, Egyptian population

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INTRODUCTION

Atherosclerosis is a chronic inflammatory disease of the arterial vasculature[1]. It has been a serious cause of death worldwide[2]. According to the World Health Organization,17.9 million people die due to cardiovascular disease (CVD) each year[2]. Atheromatous plaques, in the walls of the carotid arteries, are considered one of the main predisposing factors to the problem[3].

Atheromatous plaques usually aggregate in the bifurcation of the common carotid artery. Pathologically, they are made of a collection of calcific deposits of calcium, necrotic cores, fatty substances, macrophages, leukocytes, lipids and fibrous connective tissue in the intimal wall of arteries, eventually resulting in stenosis that restricts blood flow and causes tissue death [1,4]. The sensitive positioning of carotid arteries draws attention to the importance of early detection of any calcific deposit that may hinder blood streaming to the brain. This will save the patient's life, and also protect against severe mental and/or physical disability if the patient survived the cerebrovascular accident [5].

The prevalence of calcific atherosclerosis among the Egyptian population has been discovered long ago in the autopsy examination of ancient Egyptian mummies. Where multiple autopsy studies dating as far back as 1852, revealed calcific deposits in the arterial walls. Surprisingly, this is consistent with current computed tomographic findings of the Egyptians nowadays [6]. It is believed that genetic predisposition to a certain disease can be evident in a population, however, the environmental role non-electively interferes in speeding up or slowing down the process [2]. Also factors like aging, gender, and pulse pressure will inevitably contribute to the incidence and severity of the disease [3].

Since the environmental circumstances are not getting better in developing countries, where nearly 80% of the disease burden exist, it is important to identify the high-risk groups to help improve the disease outcome [7]. In Egypt, being a developing country, it is mandatory to rely on the most simple, cheap and convenient methods of identifying patients at high risk of developing atherosclerosis.

Panoramic radiography is considered a useful screening tool for patients with carotid artery calcification (CAC) and hence at high risk for developing atherosclerosis [1]. There has been increased awareness in radiologic investigation as a non-invasive way to trace them. CACs may appear unilaterally or bilaterally [1]. They may appear as one or more nodular, vessel-outlining, or irregular scattered opacities beneath and behind the angle of the mandible at the level of the C3 and C4 vertebrae [8].

The gold standard imaging for diagnosing CACs are Doppler ultrasonography and computed tomography angiography [9]. In 1981, Friedlander and Lande were the first to detect them on a panoramic radiograph [10]. Since then, multiple research projects have studied the prevalence of CACs in panoramic radiographs in different populations and their relation to cardiovascular events [11].

The purpose of the present study is to determine the prevalence of radiopacities suggestive of CACs on panoramic radiographs and correlate it with age and gender in a sample of the Egyptian population. Also, identify the different shapes of carotid artery calcification and determine the percentage of each category.

METHODOLOGY

Study Settings and Ethical approval:

The current cross-sectional observational radiological study was approved by the research ethics committee of the Faculty of Dentistry, Cairo University (approval no 29324). The included scans were collected from the archival records of digital panoramic scans available at the Maxillofacial Radiology Department, Faculty of dentistry, Cairo University, Egypt, during the period from July 2023

till June 2024. The scans belonged to patients who already underwent scanning as a part of their dental examination, diagnosis or treatment planning.

Sample size calculation:

The sample size was calculated using the following formula for adequate sample size calculation in the prevalence study: $n=Z^2P(1-P)/d^2$. [12]

Where n is the sample size, Z (=1.96 for α error 0.05 (5%) with two-sided effect), P is expected prevalence (0.0506), and d is precision (0.02 corresponding to effect size).

The result of the calculation was 450 digital panoramic radiographs for the current study.

Inclusion and exclusion Criteria:

All the included panoramic scans were for patients ≥ 18-years-old. All the scans showed the vertebral area clearly and bilaterally till the level of C3 and C4 vertebrae. The included scans didn't show any large pathological lesion or fracture that may affect the visibility of the interpreted area. The scans showing any positioning errors or other imaging artifacts were excluded. Additionally, any scan with missing information regarding the patient's age and sex was excluded.

Outcome variables:

The primary outcome variable was to assess the prevalence of carotid artery calcification in a sample of the Egyptian population and to correlate the incidence with age and sex.

The secondary outcome was to classify the different shapes of carotid artery calcification and determine the percentage of each category.

Radiological Assessment:

Panoramic radiographs were obtained by Planmeca ProMax 2D (Planmeca Helsinki, Finland) with 70 kV, 10 mA & 18 seconds exposure time.

The database of the maxillofacial radiology department was searched, and the scans met the inclusion and exclusion criteria were exported in DICOM image format. 512 panoramic scans (256 males and 256 females) were included. Study subjects were then divided into 3 groups according to age; Group I: 18-34 years, Group II: 35-55 years, and Group III: >55 years.

The scans were assessed by three maxillofacial radiologists with 12+ years of experience, the DICOM files were viewed on personal laptops using MicroDicom image viewer (MicroDicom Ltd, Sofia, Bulgaria). Any discrepancy between the assessors was discussed and cleared to enhance the results reliability.

The presence of any radiopaque nodular mass or masses below angle of the mandible adjacent to the cervical vertebrae at or below the intervertebral space between C3 and C4 was recorded. Additionally, the distribution of the calcifications; whether unilateral or bilateral was noted. Finally, the shape of the calcification was determined in unilateral distribution, and separately in each side if the calcifications were bilaterally present.

For shape determination, the authors had followed Garoff et al.'s classification of CACs as the following: (1) Single CACs or a tight aggregation of multiple calcifications, (2) Scattered CACs with two or more separated calcified nodules, (3) parallel and vertically aligned single or scattered CACs that appear as if they outline the anterior and/or posterior contours of a vessel (Figure 1).[13]

Statistical Analysis:

Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. All data showed parametric distribution (normal). Frequencies and percentages followed by chi-square test were calculated for the data.

Inter-observer reliability coefficient was calculated using (Kappa test) to assess the agreement between the three observers.

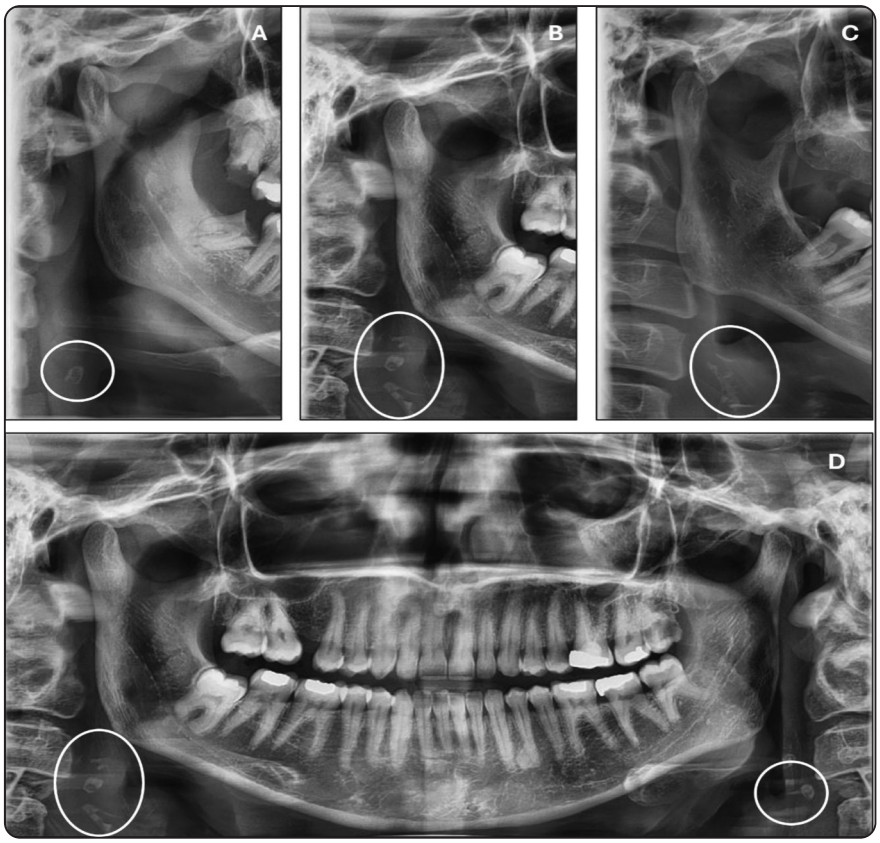

Fig. (1): Different Shapes of CAC. A: Single B: Scattered C: Parallel D: Scattered on right side and single on left side

One-way ANOVA followed by Tukey post hoc test was used to compare between more than two groups in non-related samples The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 22 for Windows.

RESULTS

Results of the current study showed the following:

Inter-observers' reliability:

Almost perfect agreement was found regarding the interobserver reliability between the 3 observers using (Kappa test).

Prevalence of CAC:

From the total sample of the current study, a percentage of 23.05% (118 patient out of 512 patient) showed CAC either bilaterally or unilaterally. Within the recorded 118 patients, 66 patients were females (56%), and 52 patients were males (44%). This confirms that between either sex, there is no statistically significant difference regarding the incidence.

Incidence in relation to sex & age distribution: (Table 1, Figure 2 (A))

In both sexes, the middle age group (35-55 years) showed the highest percentage of incidence (56.06% in females and 61.54% in males) with statistically significant difference between this age group and the other age groups. The lowest percentage of incidence in both sexes was among the youngest age group (18-34 years) with a percentage of (10.61% in females and 15.38% in males) with statistically significant difference between this group and the other age groups. While no statistically significant difference in the incidence was found between both sexes within the same age group.

TABLE (1) Age percentage of patients with CACs in both sexes

Sex/Age	18-34 Y	35-55 Y	>55 Y	*p-value***
Female	10.61%	56.06%	33.33%	<0.001*
Male	15.38%	61.54%	23.08%	<0.001*
Total	12.71%	58.47%	28.81%	<0.001*

Statistically significant **p-value: probability level which is significant at P ≤ 0.05

Unilateral/bilateral distribution of CACs: (Table 2)

In female patients, the unilateral CACs distribution was found non-significantly higher than the bilateral distribution (53.03% and 46.97% respectively). On the other side, in male patients, the unilateral CACs distribution was found significantly higher than the bilateral distribution (67.31% and 32.69% respectively). While in the total patients' sample, the unilateral CAC distribution was found significantly higher than the bilateral distribution (59.32% and 40.68% respectively). Additionally, in the total patients' sample, the right-side unilateral CACs distribution was found significantly higher than the left side unilateral distribution (65.71% and 34.29% respectively) with a p-value of 0.004*.

TABLE (2) Unilateral/bilateral distribution of CACs

Sex	Unilateral/ Bilateral	Percentage	*p-value***
Female	Unilateral	53.03%	0.62
	Bilateral	46.97%	
Male	Unilateral	67.31%	0.01*
	Bilateral	32.69%	
Total	Unilateral	59.32%	0.04*
	Bilateral	40.68%	

Statistically significant

****p-value: probability level which is significant at P ≤ 0.05***

Shapes classification of CACs: (Figure 2 (B))

The highest recorded shape was the single CAC (53%) followed by scattered (37%), while the least recorded was the parallel CAC (10%). A statistically significant difference was found between the different shapes of CAC with p-value of <0.001*.

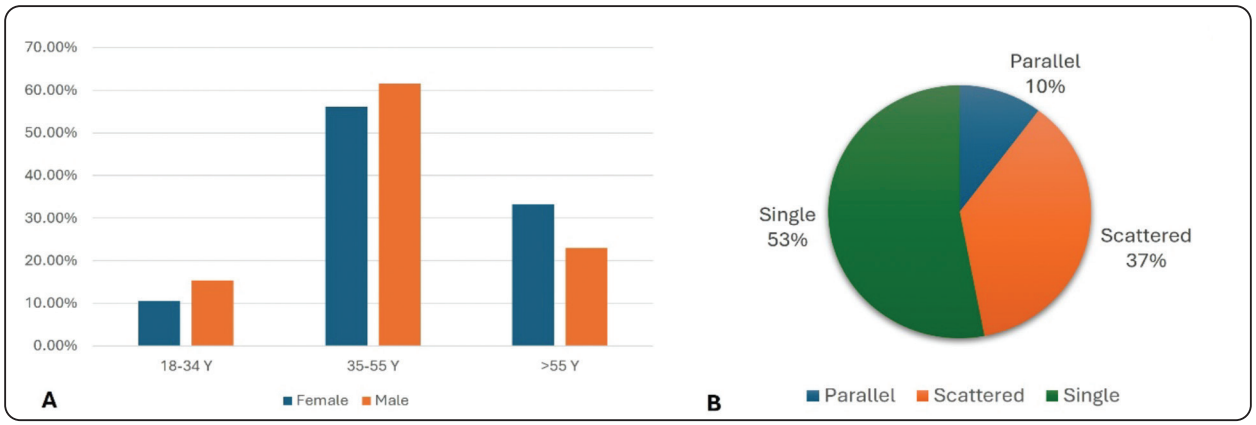

Fig. (2) (A) Age Distribution of patients with CACs in both sexes. (B) Shape classification of patients with CACs

DISCUSSION

Atherosclerotic CVDs are a group of diseases that can have serious complications. These diseases include ischemic cerebrovascular disorders (stroke), and coronary artery diseases as myocardial infarction and angina. Panoramic radiography is a simple and useful aid in identifying patients at the high risk of developing cerebrovascular disease. This is due to the ease of CAC visibility on panoramic radiographs. In order to preserve the patients' health, early identification and care of CVDs are crucial, which is why this study aimed to determine the prevalence of CACs in the Egyptian community, correlate the incidence with age and sex while also, classifying and determining the percentages of different shapes of CAC [14&15].

In the current study, CAC prevalence has been 23.05 % among the selected sample, with a non-statistically significant higher percentage in females (56%). The middle age group (35-55 years) has proven a significant higher percentage of prevalence in both males and females, compared to other age groups. Moreover, the unilateral CACs has shown a statistically significant higher percentage than bi-lateral CAC in males. While in females, the higher percentage of unilateral CACs hasn't been statistically significant. Finally, a higher statistically significant percentage of single shaped CACs has been recorded among the examined sample in this study.

In 2024, *Altindag* [14] examined 1200 panoramic images of the Turkish population in order to screen the prevalence of CAC. The sample included both males and females. The recorded percentage of prevalence was 20.92%, which is considered a comparable result to the percentage of prevalence in the present study (23.05%). This indicates the similarity of incidence of CACs in both Egyptian and Turkish populations.

However, the same Turkish study recorded no significant difference between the different age groups, in contrast to the current Egyptian study, where middle age group has shown the higher risk to possible cardiovascular complications. This difference could be explained by the different health habits adopted by the middle-aged individuals in Egypt and Turkey [14].

On the other hand, a recent study by Shah et al [16] examined a total of 500 panoramic radiograph for soft tissue calcifications. Their results revealed that female patients over 40 years showed higher prevalence of CAC. This comes in line with the current study findings, which have indicated the higher possibility of CACs in middle-aged individuals.

In 2018, Nasseh and Aoun [17] investigated 500 panoramic radiographs as a sample of Lebanese population. The recorded incidence of CAC was 6.8%, which is significantly lower than the recorded percentage in the present study, despite the resemblance of the total sample size. This discrepancy could be explained by the nationality difference plus the surrounding environment influence, or most importantly the time gap between both researches. Where the higher prevalence percentage in the current study could be quite an indication for the increase of cardiovascular problems across the world due to the uprising levels of un-healthy habits and consuming lifestyles.

Despite the previous discrepancy, the Lebanese study recorded higher percentage of incidence in the right side compared to the left side which agrees with the current study results. Therefore, these findings could be used as a foundation for the need to double examine the right side of panoramic images to avoid missing CACs [17].

Additionally, in 2023, the accuracy of panoramic images in detecting CACs was evaluated and compared to cone beam computed tomography (CBCT) in a study by Most et al [18]. They pointed out that panoramic images had an accuracy of 90.6%, a sensitivity of 67.5% and a specificity of 99.5% compared to CBCT. Hence, panoramic imaging as a

reliable method for diagnosing CAC was concluded. Same study also recorded an incidence percentage of 27.8% among German population with no statistical difference between age groups. Moreover, they claimed a strong correlation between a history of heart disease and cardiovascular risk factors with the incidence of CACs.

Kadyan et al [19] also attempted to evaluate the prevalence of CACs on CBCT images and a percentage of 34.7% was recorded among 500 radiographic images as a study sample from the United States. They mentioned that there was no statistical difference between genders. While, the notable higher incidence could be owing to the difference in the radiographic modality used for assessment (2-dimensional images versus 3-dimensional images). Also, the difference in nationality and population could be contributing factors [19].

Another study by Bladh et al [20] in 2024, examined the prevalence of CACs in Swedish population using ultrasound as the reference standard for assessment with no possibility of confusion by the superimposition of shadows that may be present in panoramic imaging. A comparable sample size of 414 patients from both genders was obtained. The resulted percentage of incidence was 30%, which was comparable but a bit higher than the current study. This could indicate the higher accuracy of Kadyan et al [19] examination in detecting CACs using CBCT in case of unclear panoramic results. In accordance with the present study, both American and Swedish results showed no statistical difference between both sexes.

Additionally, Bladh et al highlighted the correlation between the pre-existing medical conditions like hypertension, CVDs and diabetes and the prevalence of CACs. Thus, showing that CACs can be an indication of an existing undiagnosed medical conditions or an identification of individuals at high risk of developing hypertension and CVDs [20].

Likewise, the link between detected CACs and cerebrovascular accident, coronary artery disease, and poor oral health was evaluated. Where, CACs patients recorded a high prevalence of hypertension, hyperlipidemia, diabetes mellitus, cerebrovascular accident, and coronary artery disease. Unfortunately, only 41.7% of these patients received a medical consultation after CAC detection on panorama. This draws the attention to the need for increasing awareness to the importance of medical follow up after CACs detection. Therefore, it is crucial for dentists to refer these patients for further evaluation [21].

Another study researching CACs with a larger sample size of 4000 patients, revealed an incidence of 21.68%, with a higher percentage of unilateral cases than bilateral ones. Also, a higher incidence in female patients was recorded. These findings come in alliance with the present study results despite the difference in the sample size. Which supports that the current study sample could be considered representative and descriptive [22].

To further highlight the importance of detecting CACs, Liu et al [15] presented a case of a Chinese female patient with nasopharyngeal cancer who underwent several radiotherapy sessions. On panoramic follow-up, CAC was detected unilaterally as a nodular radiopaque mass. This observation was highly valuable due to the compromised medical status of the patient and hence, the medical team advised with close observation for any cardiovascular complications. So, based on the current study findings and observations from the Chinese case, females are showing higher percentage of CACs incidence even with no statistically significant difference. Which may call for a closer observation for CACs and possible complications in females.

Regarding the shape of the calcifications, the current study has recorded a higher percentage for single CACs in comparison to scattered and parallel ones. This finding could explain the possible difficulty of detecting CACs by general

practitioners. As single shaped CAC could be more readily missed than scattered or parallel CACs.

In 2018, Garoff et al [23] recorded that the Swedish population had a different shape distribution of CACs. As they reported higher percentage of parallel CACs than single or scattered ones. This finding was further strengthened by another recent study on the Swedish population with a larger sample size. Both studies agreed that the parallel CAC had a higher prevalence [20]. This highlights the importance of carrying out more researches on different nationalities, to spot the differences in shape and other different incidence influencing factors. As unfortunately, in the available literature, there aren't enough data on the prevalence of CACs shape distribution in different populations.

Strokes are the second most common cause of death worldwide. It is responsible for 11% of cerebrovascular accident's total deaths. Approximately 60% of all acute strokes are associated with atherosclerotic disease in the common carotid artery including CACs. So, research for alternative automated methods to detect CACs has started, in order to prevent further complications. In 2023 and 2024, studies by Amitay et al [24] and Yoo, S. W. et al. [25] respectively, attempted to use artificial intelligence to detect, classify and segment CAC on panoramic radiographs using deep learning. They concluded the possibility of applying deep learning-based methods in an actual application of automatic screening for CAC in standard panoramic radiographs and that cascaded deep learning network can detect and classify CACs with high accuracy which can help dentists to screen patients at risk of stroke more easily.

Considering the routine usage of panoramic radiographs for the clinical diagnosis and evaluation in today's dental procedures, as well as their ease of usage and low cost compared to other imaging methods, panoramic radiography can be considered an effective diagnostic tool in the detection of the CAC [18&25].

CONCLUSION

The prevalence percentage of CACs among Egyptian population is comparable to other nationalities. While sex doesn't play a crucial role in the prevalence percentage, a right unilateral predominance of CACs requires special attention in radiographic examination with an extra attention for single shaped CAC to avoid any missed data that could affect the patient. CACs detection is of a major importance to prevent cardiovascular complications.

REFERENCES

1. Brar, A., DeColibus, K., Rasner, D.S., Haynes, A.R., Pancratz, F., Oladiran, O., Gbadamosi, S.O. and Owosho, A.A., 2024. Carotid Artery Calcification Detected on Panoramic Radiography Is Significantly Related to Cerebrovascular Accident, Coronary Artery Disease, and Poor Oral Health: A Retrospective Cross-Sectional Study. Dentistry Journal, 12(4), p.99.
2. Fan, J. and Watanabe, T., 2022. Atherosclerosis: Known and unknown. Pathology international, 72(3), pp.151-160.
3. Ahmed, M., McPherson, R., Abruzzo, A., Thomas, S.E. and Gorantla, V.R., 2021. Carotid artery calcification: what we know so far. Cureus, 13(10).
4. Moshfeghi, M., Taheri, J.B., Bahemmat, N., Evazzadeh, M.E. and Hadian, H., 2014. Relationship between carotid artery calcification detected in dental panoramic images and hypertension and myocardial infarction. Iranian Journal of Radiology, 11(3).
5. Nasseh, I. and Aoun, G., 2018. Carotid artery calcification: a digital panoramic-based study. Diseases, 6(1), p.15
6. Thomas, G.S., Wann, L.S., Allam, A.H., Thompson, R.C., Michalik, D.E., Sutherland, M.L., Sutherland, J.D., Lombardi, G.P., Watson, L., Cox, S.L. and Valladolid, C.M., 2014. Why did ancient people have atherosclerosis?: from autopsies to computed tomography to potential causes. Global heart, 9(2), pp.229-237.
7. Reda, A., Bendary, A., Elbahry, A., Farag, E., Mostafa, T., Khamis, H., Wadie, M., Bendary, M., Azeem, B.A. and Salah, R., 2020. Prevalence of atherosclerosis risk factors in Egyptian patients with acute coronary syndrome: final data of the nationwide cross-sectional 'CardioRisk' project. Journal of public health in Africa, 11(2).

8. Janiszewska-Olszowska, J., Jakubowska, A., Gieruszczak, E., Jakubowski, K., Wawrzyniak, P. and Grocholewicz, K., 2022. CAC on panoramic radiographs. International Journal of Environmental Research and Public Health, 19(21), p.14056.

9. Schroder, A.G.D., de Araujo, C.M., Guariza-Filho, O., Flores-Mir, C., de Luca Canto, G. and Porporatti, A.L., 2019. Diagnostic accuracy of panoramic radiography in the detection of calcified carotid artery atheroma: a meta-analysis. Clinical Oral Investigations, 23, pp.2021-2040.

10. Friedlander, A.H. and Lande, A., 1981. Panoramic radiographic identification of carotid arterial plaques. Oral Surgery, Oral Medicine, Oral Pathology, 52(1), pp.102-104.

11. Bladh, M., Gustafsson, N., Engström, G., Kennbäck, C., Klinge, B., Nilsson, P.M., Jönsson, D. and Jäghagen, E.L., 2024. Defined shapes of CAC on panoramic radiographs correlate with specific signs of cardiovascular disease on ultrasound examination. Oral surgery, oral medicine, oral pathology and oral radiology, 137(4), pp.408-420.

12. Pourhoseingholi MA, Vahedi M, Rahimzadeh M. Sample size calculation in medical studies. Gastroenterol Hepatol Bed Bench 2013;6(1):14-17).

13. Garoff, M., Ahlqvist, J., Levring Jäghagen, E., Johansson, E., & Wester, P. (2016). Carotid calcification in panoramic radiographs: radiographic appearance and the degree of carotid stenosis. Dento maxillo facial radiology, 45(6), 20160147. https://doi.org/10.1259/dmfr.20160147

14. Altindag, A., 2024. Annals of Medical Research Investigation of calcified atherosclerotic plaques on panoramic radiographs. Annals of Medical Research, 31 (1), 66–70.

15. Liu, S.-Y., Liu, B.-L., and Chiang, C.-P., 2024. Carotid artery calcification detected on the panoramic radiographs. Journal of Dental Sciences, 19, 1906–1908.

16. Shah, N., Patel, P., Sankireddy, S., Gohil, P., Mangukiya, H., and Gadhiya, R., 2024. Prevalence of Soft tissue calcification in panoramic radiograph. Journal of Advanced Medical and Dental Sciences Research, 12 (8), 21276.

17. Nasseh, I. and Aoun, G., 2018. Carotid Artery Calcification : A Digital Panoramic-Based Study. Diseases, 6 (15).

18. Möst, T., Winter, L., Ballheimer, Y.E., Kappler, C., Schmid, M., Adler, W., Weber, M., Kesting, M.R., and Lutz, R., 2023. Prevalence of carotid artery calcification detected by different dental imaging techniques and their relationship with cardiovascular risk factors , age and gender. BMC Oral Health, 23 (949), 1–11.

19. Kadyan, V., Vaddi, A., Nagpal, A., Molina, M.R., Lurie, A.G., and Tadinada, A., 2024. Evaluation of Cone-Beam Computed Tomography Scans to Develop a Staging Method of External Carotid Artery Calcification. Journal of Clinical Medicine, 13 (3189).

20. Bladh, M., Gustafsson, N., Engstrom, G., Kennback, C., Klinge, B., Nilsson, P.M., Jonsson, D., and Jaghagen, E.L., 2024. Defined shapes of CAC on panoramic radiographs correlate with specific signs of cardiovascular disease on ultrasound examination. Oral and Maxillofacial Radiology, 137 (4), 408–420.

21. Brar, A., Decolibus, K., Rasner, D.S., Haynes, A.R., Pancratz, F., Oladiran, O., Gbadamosi, S.O., and Owosho, A.A., 2024. Carotid Artery Calcification Detected on Panoramic Radiography Is Significantly Related to Cerebrovascular Accident , Coronary Artery Disease , and Poor Oral Health : A Retrospective Cross-Sectional Study. Dentistry Journal, 12 (99).

22. Janiszewska-olszowska, J., Jakubowska, A., Gieruszczak, E., Jakubowski, K., Wawrzyniak, P., and Grocholewicz, K., 2022. CAC on Panoramic Radiographs. International Journal of Environmental Research and Public Health, 19 (14056).

23. Garoff, M., Ahlqvist, J., J, E.L., Johansson, E., and Wester, P., 2016. Carotid calcification in panoramic radiographs : radiographic appearance and the degree of carotid stenosis. Dentomaxillofacial Radiology, 45, 1–6.

24. Amitay, M., Id, Z.B., Sudri, S., Drori, C., Wase, T., Abu-el-naaj, I., Ben-ari, M.K., Rieck, M., Avni, Y., Pogozelich, G., Weiss, E., and Mosseri, M., 2023. PLOS DIGITAL HEALTH Deep convolution neural network for screening carotid calcification in dental panoramic radiographs. PLOS Digital Health, 2 (4), e0000081.

25. Yoo, S.W., Yang, S., Kim, J.E., Huh, K.H., Lee, S.S., and Heo, M.S., 2024. CACSNet for automatic robust classification and segmentation of carotid artery calcification on panoramic radiographs using a cascaded deep learning network. Scientific Reports, 14 (13894).