

Original Article

Association of Coronary Artery Calcification with Aortic Calcification Detected on Thoracoabdominal Computed Tomography

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Abstract

Background : Mural calcification in arteries is a strong predictor of atherosclerosis. Hence, Coronary Artery Calcification (CAC) is a reflector of coronary artery disease which carries significant morbidity & mortality. In the era of modern medicine with multiple indications of Computed Tomography (CT) of thorax & abdomen, detection of aortic calcification (AoC), hence a reflector of atherosclerosis is seen frequently in routine studies. Hence, in this study we made an attempt to determine its association of AoC with CAC.

Material and Methods : This is a retrospective study performed on 797 patients fulfilling the inclusion & exclusion criteria following approval from Institutional Review Board. The patients were above 30 years with aortic (AoC) or coronary artery calcification on CT thorax and/or CT abdomen performed on 128-slice CT scanner. Patients with history of revascularization procedures & stent/grafts were excluded.

Results : In our study, males outnumbered females (62% versus 38%). AoC was commonest in 6th decade with mean age of 61.55±9.67 years. AoC has a significant association with CAC, 47/78 – 60% AoC patients had CAC. Though AoC in any part of aorta revealed statistically significant association with CAC but calcification in arch of aorta had the least association.

Conclusion : The results of our study on Indian population suggest a significant association of CAC and AoC, signifying active screening & intervention in patients detected with AoC detected on routine CT thorax & abdomen for other indications.

Key words : Aortic Calcification, Coronary Artery Calcification, Atherosclerosis.

Mural calcification whether in coronary arteries or aorta is a strong predictor of subclinical atherosclerosis¹. Both Coronary Artery Calcification (CAC) and Aortic Calcifications (AoC) especially thoracic AoC have been linked to significant cardiovascular morbidity & mortality, but CAC is a direct predictor of coronary artery disease^{1,2}. In the era of modern medicine with multiple scans on Multislice Computed Tomography (CT) of thorax & abdomen, detection of CAC & AoC is common especially the latter. Due to the above facts, we planned to conduct this study with the following Aims & Objectives.

AIMS AND OBJECTIVES

Aim : To determine the association of CAC with AoC.

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Editor's Comment :

Coronary artery calcification is the surrogate marker of coronary artery disease & atherosclerosis and has been used to predict the future risk of acute cardiovascular events. But coronary artery calcification calculation requires dedicated software with ECG-gated CT-Based protocol. However, routine CT thorax & abdomen are a common day-to-day examinations which may show calcification in the aortic wall representing atherosclerosis. Hence, the association of aortic calcification with coronary artery calcification may yield insights into coronary artery disease during routine CT thorax and abdominal imaging

Objectives of the Study :

- (1) To determine the association of CAC with thoracic AoC.
- (2) To determine the association of CAC with abdominal AoC.
- (3) To determine the association of CAC with thoracic & abdominal AoC.

MATERIAL AND METHODS

This retrospective study included CT scans of 797

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patients performed in our institution. The data was collected following approval of Institutional Review Board (IRB). The CT scans were included in our study using the following strict criteria:

Inclusion criteria :

- Patients above age 30 years.
- Patient having AoC or CAC on CT thorax and/or CT abdomen.

Exclusion criteria :

- Patients with history of revascularization procedures in coronary arteries and aorta including stent/grafts.

OBSERVATIONS AND RESULTS

Table 1 shows that the majority of patients in our study were in 6th decade followed by 7th & 5th decades with small number in 4th decade. Also, males outnumbered females in our study with M:F ratio of 1.6:1.

Table 2 shows presence of aortic calcification in more than 72% of our study population. A significant number ie, 65.5% (379 of 579) of those with aortic calcification had both thoracic & abdominal aortic calcifications followed by those with calcification in arch of aorta (24.6% - 137 of 579). Fewer number of patients had calcifications only in abdominal aorta or descending thoracic aorta.

Table 3 shows that aortic calcification noted in our study population was either circumferential or spotty with significant number ie, 42.5% (246 of 579) had only spotty AoC while majority, 279 of 579 had both

Table 1 — Age and Gender Distribution in our Study

	Characteristic	Frequency (n)	Percentage (%)
Age Group	30-40	33	4.1
	40-50	229	28.7
	50-60	280	35.1
	>60	255	32.0
Gender	Female	302	37.9
	Male	495	62.1

Table 2 — Distribution of Aortic Calcification in our Study

	Characteristic	Frequency (n)	Percentage (%)
Aortic Calcification	Absent	218	27.4
	Present	579	72.6
Aortic Segment involved	Only AOA	137	17.2
	Only DSN Aorta	18	2.3
	Only ASN Aorta	0	0.0
	Only ABD	45	5.6
	TH & ABD	379	47.6
	No Calcification seen	218	27.4

Table 3 — Distribution of Types of Aortic Calcification & Stenosis in our Study

	Characteristic	Frequency (n)	Percentage (%)
	No Calcification seen	218	27.4
	Only CMF	54	6.8
	CMF & SPT	279	35.0
	Only SPT	246	30.9
Stenosis	Absent	506	63.5
	Present	291	36.5

spotty & circumferential calcification with fewer number ie, 54 of 579 showing only circumferential calcification. Half of the study population ie, 291 of 579 had some degree of aortic stenosis associated with mural calcification.

Table 4 shows that a significant number of patients ie, 44.7% in our study were detected with coronary artery calcification.

Table 5 shows that a significant number of patients with coronary artery calcification ie, 337 of 356 revealed aortic calcification while only 19 of 356 patients with CAC did not reveal AoC. However, a significant number, ie, 244 of 581 patients with AoC did not reveal signs of CAC. Statistical evaluation of the above data was significant with p value less than 0.001.

Table 6 shows the association of CAC with AoC in different parts of aorta. From the table, it is evident that CAC is strongly associated with AoC, both in

Table 4 — Distribution of Coronary Artery Calcification in our Study

CAC	Frequency (n)	Percentage (%)
Absent	441	55.3
Present	356	44.7

Table 5 — Distribution of Coronary Artery Calcification in our Study

Aortic Calcification	CAC		Total	p value
	Present	Absent		
Absent	19	197	216	< 0.001
Present	337	244	581	
Total	356	441	797	

Table 6 — Association of CAC with AoC in our Study

Aortic Segment involved (AOA/Thoracic/Abdominal)	CAC		Total	p value
	Present	Absent		
No Calcification seen	21	197	218	< 0.001
Only AOA	47	90	137	
Only DSN Aorta	5	13	18	0.018
Only ASN Aorta	0	0	0	NA
Only ABD	15	30	45	< 0.001
TH & ABD	268	111	379	< 0.001
Total	356	441	797	

thoracic and abdominal aorta. Though the association of CAC with isolated descending thoracic aortic calcification was statistically significant but the p value was higher being 0.018. No patient with isolated ascending aorta calcification was noted in our study group.

Table 7 shows that irrespective of the type of AoC, circumferential or spotty, CAC was significantly associated with it with p-value of less than 0.001.

Table 8 shows the sensitivity, specificity, Positive Predictive Value (PPV) and negative predictive value of AoC in predicting CAC. It is evident from the table that though the sensitivity of arch of aorta calcification in predicting CAC detecting is higher than any other part of aorta, but presence of both thoracic & abdominal aorta is 92.7% sensitive in predicting CAC. In contrast, the specificity is highest with descending thoracic aorta being 93.8%. Though the highest PPV of 70.7% was achieved with combined thoracic & abdominal AoC but the NPV of all parts of aorta is equal & higher ie, 90.4%. The overall accuracy of AoC for predicting CAC was with descending (DSN) AoC being 85.6% followed by abdominal AoC being 80.6% (Fig 1).

DISCUSSION

Though both coronary artery calcification as well as aortic calcification are independently associated with similar cardiovascular factors risk factors, their pathophysiology differs with differences in strength of association¹⁻³. CAC & AoC are also associated with major cardiovascular events^{1,4,5}. AoC has been described as a highly specific predictor of severe coronary atherosclerosis in the general population⁶.

Table 7 — Association of CAC with AoC in our Study

Type of calcification involved (Circumferential/Spotty)	CAC		Total	p value
	Present	Absent		
No Calcification seen	22	198	220	< 0.001
Only CMF	22	32	54	
CMF & SPT	223	54	277	
Only SPT	89	157	246	
Total	356	441	797	

Table 8 — Statistical Association of CAC with AoC in our Study

Test	Only AOA	Only DSN Aorta	Only ABD	TH & ABD
Sensitivity	69.1	19.2	41.7	92.7
Specificity	68.6	93.8	86.8	64.0
PPV	34.3	27.8	33.3	70.7
NPV	90.4	90.4	90.4	90.4
Accuracy	68.7	85.6	80.6	77.9

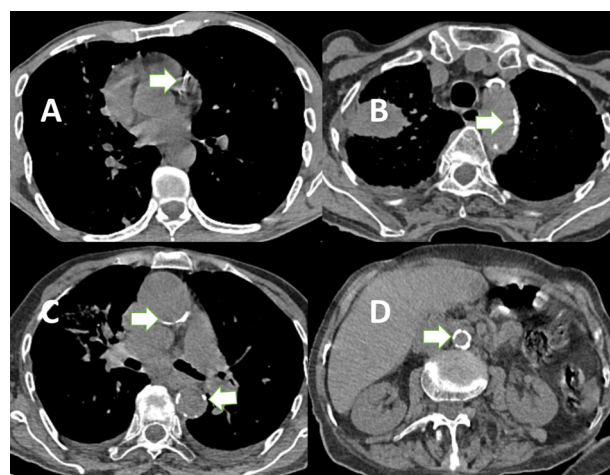


Fig 1(A-D) — Axial Noncontrast Computed Tomography (NCCT) Images of Thorax (A-C) and Abdomen (D) show Coronary Artery Calcification (A), Aortic Arch Calcification (B), Ascending & Descending Thoracic Aorta Calcification (C), & Abdominal Aorta Calcification (D) in different patients (arrows).

The risk of CAC associated with ascending AoC is higher than descending thoracic AoC¹. As AoC occurs earlier and is more prevalent than CAC, some studies have advocated AoC as a better predictor of coronary artery atherosclerosis than CAC^{7,8}. Absence of CAC is associated with excellent cardiovascular prognosis⁹.

Our study showed a statistically significant association between CAC and AoC with sensitivity, specificity & accuracy reaching up to 92.7%, 93.8% & 85.6% respectively. The sensitivity was highest with combined thoracic & abdominal AoC with highest specificity & accuracy with descending thoracic AoC. The association of CAC with AoC is much higher in our study than studies conducted by Bannas P, *et al* & Kalsch H, *et al* showing 70% and 74.0% prevalence of CAC in patients with AoC which was similar to the accuracy of arch of aorta calcification in our study being 68.7%^{9,10}.

In contrast to Kalsch H, *et al* our study has shown descending AoC as a better predictor of CAC¹. Also, abdominal AoC has shown results equivalent to descending AoC for predicting CAC in our study. These results may reflect demographic differences as well as poor representation of descending AoC in our study.

Strengths of Our Study

All the previous studies have included dedicated computed tomography of coronary arteries or electron beam computed tomography with calcium scoring done for cardiac indications. In contrast, our study

has utilized the data from routine CT thorax and abdomen done for variety of clinical indications. Hence, our study is a better predictor of prevalence as well as extends the utility of routine CT examinations for predicting coronary artery disease.

Our study is unique in including the abdominal AoC as a parameter to predict CAC as none of the studies in existing medical literature has done so to the best of our knowledge.

Limitations of the Study

All patients included in our study did not have CT thorax and abdomen. Patients with only CT thorax or CT abdomen were also included in our study.

Though coronary artery calcification is marker of coronary artery disease, our study did not include the degree & length of stenosis and the coronary artery involved.

Our study is a retrospective study.

CONCLUSIONS

AoC is noted in more than two-thirds of patients undergoing routine CT thorax and abdomen while CAC in nearly half of patients undergoing these examinations.

AoC is commonest in arch of aorta followed by abdominal aorta probably due to combination effect of turbulent flow secondary to directional change in blood flow from ascending to descending thoracic aorta as well as atherosclerotic changes.

AoC is commonly spotty but coexistent circumferential calcification is equally seen. AoC associated stenosis is noted in more than one-third of patients.

Statistically strong significant association exists between CAC & AoC including all parts of aorta, strongest with descending thoracic aorta followed by abdominal aorta as it predominantly secondary to atherosclerotic changes in presence of laminar blood flow due to straight course of the aorta in these segments.

Descending thoracic followed by abdominal AoC are strong predictors of CAC in the study.

SUMMARY

Significant association of CAC and AoC exists including thoracic as well as abdominal, signifying

active screening & intervention in patients detected with AoC on routine CT thorax & abdomen for other indications. This will help in predicting as well as reducing the associated morbidity & mortality related to cardiovascular diseases by early detection and management.

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Conflict of Interest : None

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