**ORIGINAL RESEARCH**

# INCIDENTAL DETECTION OF CORONARY ARTERY CALCIFICATIONS ON NON-CARDIAC THORACIC CT EXAMINATIONS

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## ABSTRACT

**Objective:** Strong relationships have been demonstrated between the presence of occlusive coronary artery disease and coronary artery calcifications detected at autopsy, fluoroscopy, or computed tomography (CT). The aim of our study was to evaluate the frequency of incidental coronary artery calcifications during thoracic CT examinations and to correlate them with cardiac risk factors.

**Materials and Methods:** Thoracic CT scans obtained over a period of 6 months from 113 patients (72 male and 41 female) with a mean age of 62,7 (31-92 years) were retrospectively evaluated. The thoracic scans were performed using standard 9 mm consecutive slices from the apex to the base of the thorax, using a standard thoracic protocol, on a Siemens 16 channel multislice CT scanner. Coronary arteries were evaluated for calcifications.

**Results:** Thirty-seven patients (32.7%) had coronary calcifications.18 patients (15.9%) had one, 9 patients (7.9%) two, 7 patients (6.2%) three, and 3 patients (2.6%) had four vessels with calcifications. The frequency of coronary calcifications was correlated with hypertension, diabetes mellitus, hypercholesterolemia, nicotine abuse, and cardiomegaly. Diabetes mellitus, hypercholesterolemia, cardiomegaly and male gender were significantly associated with coronary calcifications ($p<0.05$).

**Conclusion:** With the advent of multislice faster CT scanners, coronary artery calcifications are more frequently and easily detectable during non-cardiac thoracic CT examinations. This retrospective study showed increased incidence of coronary calcifications in patients with cardiac risk factors. Among these factors diabetes mellitus, hypercholesterolemia, cardiomegaly and male gender were statistically significant.

**Keywords:** Multidetector computed tomography, Heart, Coronary calcification

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# NON-KARDİYAK TORAKS BT İNCELEMELERİNDE RASTLANTISAL OLARAK SAPTANAN KORONER ARTER KALSİFİKASYONLARI

## ÖZET

**Amaç:** Bilgisayarlı tomografi (BT), floroskopi veya otopside saptanan koroner arter kalsifikasyonları ile okluzif koroner arter hastalığı arasında güçlü ilişkiler tanımlanmıştır. Bu çalışmanın amacı, toraks BT incelemeleri esnasında insidental olarak saptanan koroner kalsifikasyonların sıklığını belirlemek ve risk faktörleri ile korele etmekti.

**Gereç ve Yöntem:** Altı ay süresince toraks BT uygulanan ve ortalama yaşları 62,7 (31-92) olan 113 olgu (72 erkek, 41 kadın hasta) retrospektif olarak değerlendirilmiştir. Toraks BT incelemeleri Siemens Somatom Sensation 16 dedektörlü BT cihazında apeksten toraks bazaline dek, 9 mmlik ardışık kesitlerle elde olunmuş ve koroner arterler kalsifikasyonlar açısından değerlendirilmiştir.

**Bulgular:** On sekiz hastada (15.9%) tek damar, 9 hastada (7.9%) çift damar, 7 hastada (6.2%) üç damar ve 3 hastada (2.6%) dört damar kalsifikasyonu olmak üzere toplam 37 hastada (32.7%) koroner kalsifikasyon belirlendi.

Koroner kalsifikasyonların sıklığı hipertansiyon, diabetes mellitus, hiperkolesterolemi, nikotin bağımlılığı ve kardiyomegali ile karşılaştırıldı. Hiperkolesterolemi, kardiyomegali ve erkek cinsiyet ile koroner arter kalsifikasyonları arasında istatistiksel anlamlı farklılık bulundu ($p<0.05$).

**Sonuç:** Daha hızlı, çok dedektörlü BT cihazlarının geliştirilmesiyle, non kardiyak BT incelemeleri esnasında koroner kalsifikasyonlar daha kolay ve sık tespit edilmeye başlandı. Bu retrospektif çalışma kardiyak risk faktörleri olan hastalarda koroner arter kalsifikasyonlarında artmış insidansı gösterdi. Bu faktörler arasında diabetes mellitus, hiperkolesterolemi, kardiyomegali ve erkek cinsiyet istatistiksel anlamlı farklılık bulundu.

**Anahtar Kelimeler:** Multidedektör bilgisayarlı tomografi, Kalp, Koroner kalsifikasyon

## INTRODUCTION

The presence of coronary artery calcification is a significant indicator of atheromatous disease and it may indicate the presence of severe stenosis. While the absence of calcification does not correlate with the absence of coronary artery disease, an incidental finding of calcium has important prognostic implications. Most of the previous work documenting calcification has been observed in patients with a known history of heart disease undergoing further cardiac investigations[1,2].

Early diagnosis of atherosclerosis is therefore highly important in predicting and preventing myocardial infarction. Imaging modalities especially CT scans have been proved to be helpful[1]. The aim of this study was to evaluate the frequency of incidental coronary artery calcifications during thoracic CT examinations, and to correlate this with cardiac risk factors.

## MATERIAL AND METHOD

Thoracic CT scans obtained over a period of 6 months from 113 patients (72 male and 41 female) with a mean age of 62,7 (31-92 years) were retrospectively evaluated. The exclusion criteria were existing implanted coronary stents, a history of previous bypass surgery, or non-diagnostic scans with poor resolutions. The thoracic scans were performed using standard 9 mm consecutive slices from the apex to the base of the thorax, using a standard thoracic protocol, on a Siemens 16 channel multislice CT scanner. A standard tissue window was used (WL: 50, WW: 500) for the assessment of slices.

The coronary arteries were evaluated for calcifications. The number and location of coronary calcifications were noted for each patient. The investigated cardiac risk factors were gender, hypertension, diabetes mellitus, hypercholesterolemia, and nicotine abuse. The diagnosis of cardiomegaly was achieved with the calculation of transverse heart ratio (>0,5) on plain thoracic x-rays.

Medical records were reviewed and the data related to age, sex, smoking history, risk factors for vascular disease, and general medical condition were noted in a standardized form. Evidence of previous cardiac disease was determined on the basis of electrocardiographic evidence of arrhytmias, ischemia or previous myocardial infarction. Prior infarctions were documented by evaluation of enzyme levels, history of

treatment for angina or congestive heart failure, and findings of any available studies of cardiac function such as cardiac echocardiography, exercise thallium myocardial perfusion imaging and exercise tolerance testing.

**Image interpretation**

CT scans were transferred to an independent Workstation (Leonardo console, software version 2.0; Siemens) for postprocessing, and the 3D multiplanar reconstruction (MPR) images were reconstructed in the coronal and sagittal planes in addition to the axial source slices. The left anterior descending (LAD), circumflex and right coronary arteries (RCA) were evaluated for presence of calcifications by two radiologists on the basis of the knowledge of the CT anatomy of the coronary arteries in consensus. The readers were experienced in reading images of the coronary anatomy. The presence of coronary calcifications was evaluated with a contiguous-slice method. A calcified lesion was defined as a hyperdense area inside the artery with a Hounsfield unit (HU) of greater than 90 and that measured 0.5 $mm^2$ or larger.

**Statistical Analysis**

All statistical analysis were performed using Statistical Package for Social Sciences (SPSS) for Windows 10.0. The number of calcifications, locations, and the risk factors of the patients were reported as the mean ± standard deviation. Student's t test was performed to compare the subgroups with and without calcifications. A p value of less than 0.05 was considered to indicate a statistically significant difference.

**RESULTS**

A total of 113 thoracic CT scans were reviewed. The scans were performed with various clinical indications. The most common indication was for identification of primary or secondary lung carcinomas, followed by airway disease evaluation.

Thirty-seven patients (32.7%) had coronary calcifications. Of the 37, 18 patients (15.9%) had one, 9 patients (7.9%) had two, 7 patients (6.2%) had three, and 3 patients (2.6%) had four vessel calcifications (left main coronary, circumflex, LAD and RCA).

The incidence of calcifications were significantly higher in males ($p<0.05$), as well as in patients with diabetes mellitus (12.3%), hypercholesterolemia (16.8%) and cardiomegaly (20.3%) ($p<0.05$). Although nicotine abuse, and hypertension are associated with increased risk of calcification, these were not statistically significant. (Table-I).

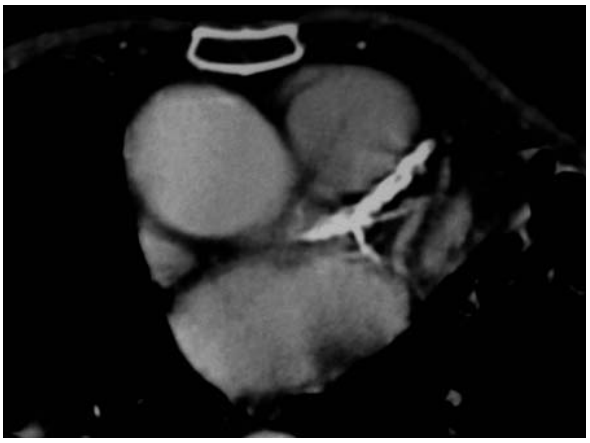

**Figure 1:** Axial thorax CT image at the level of heart demonstrates left main coronary and circumflex artery calcifications.

**Figure 2:** Coronal 3D MPR CT image of the thorax at the level of heart demonstrates left main, anterior descending and circumflex coronary artery calcifications.

**Table I:** Association of cardiac risk factors with coronary calcifications.

| | **The group with coronary calcifications** | **The group without coronary calcifications** | **Statistical difference (p)** |
|---|---|---|---|
| **Gender** | 62,5% male | 37,5% male | $p<0.05$ |
| | 45,7% female | 54,3% female | $p>0.05$ |
| **Nicotine abuse** | 15(13,2%) | 14(12,3%) | $p>0.05$ |
| **Hypertension** | 21(18,3%) | 15 (13,2%) | $p>0.05$ |
| **Diabetes Mellitus** | 14 (12,3%) | 6 (5,3 %) | $p<0.05$ |
| **Hypercholesterolemia** | 19 (16,8%) | 7 (6,1%) | $P<0.05$ |
| **Cardiomegaly** | 23 (20,3%) | 12 (10,6%) | $P<0.05$ |
| **Known cardiac disease** | 13 (11,5%) | 10 (8,8%) | $p>0.05$ |

## DISCUSSION

Autopsy studies have shown that there is a close link between coronary artery calcification and the extent of vascular stenosis with a subsequent risk of myocardial infarction. A variety of imaging modalities have been used for detecting coronary artery calcifications of which, plain chest radiography and fluoroscopy have the lowest sensitivity. CT imaging is superior to fluoroscopy for detecting coronary calcifications[1].

Ultrafast CT has high-resolution contrast, a rapid image acquisition, and allows elimination of the image blurring caused by heart movement. Due to these features, ultrafast CT has a high sensitivity for detecting calcium in the coronary arteries[3]. In different series, the sensitivity and specificity of the examination ranged from 88 to 100% and 43 to 100%, respectively[2,4,5].

Arterial calcification occurs in the intima of the blood vessels, as a part of atherosclerosis. In general population, coronary artery calcification correlates with the atherosclerotic plaque burden and with coronary vessel stenosis, and has consistently been shown to be predictive for future cardiac events[6-9].

Coronary segments with a luminal obstruction greater than 50% are likely to have some calcification that is detectable with electron-beam CT. In a trial, it was shown that, a 0 calcium score had a 100% predictive value in the exclusion of angiographic evidence of obstructive epicardial coronary lesions. The higher the calcium score, the more likely the presence of angiographic obstructive disease[10].

Results of autopsy studies indicate that coronary artery calcification is invariably associated with the presence of atherosclerotic plaques[11]. In a previous study performed with 450 consecutive patients, Callaway et al., found atherosclerotic plaques in 26% of male and 15.6% of female scans. When they limited their sample to those over 40 years for age, the incidence increased to 48% from 41.6% [12].

Coronary calcification is strongly associated with the prognosis. Indeed, the extent of coronary atherosclerosis (total calcium score) is the most powerful predictor of subsequent or recurrent cardiac events. This was true in the former years when calcium was detected with fluoroscopy and conventional CT[13].

Janowitz et al., analyzed the evolution of the amount of calcium in atherosclerotic plaques by ultrafast CT in patients with and without coronary artery disease[3]. Ninety-eight percent of the calcium deposits identified on the initial examination were confirmed in consequent imagings, and there was a significant increase in the calcification volume and in the total calcified area of the atherosclerotic plaque in the evolution. Patients with coronary artery disease have a

large amount of new calcium deposits, which are not found in asymptomatic patients. In patients with no evidence of calcification, both in the first approach and later, the prevalence of ischemic heart disease is extremely low.

In a study searching the presumptive detection of coronary stenosis on the basis of existing calcification by means of CT, higher sensitivities have been found in the calcified arteries (78% for LAD, 63% for the circumflex and 16% for RCA). Specificities were 78%, 80% and 100%, and positive predictive values (PPV) were 88%, 83% and 100%, respectively. The high PPV suggested that significant coronary artery disease was likely to be present when coronary calcification was seen on CT[14]. In a study performed by Shirazi et al., of the total 100 patients (62 males), 69 had coronary artery obstruction (>50% stenosis was detected by angiography). Angiography was normal in the rest. For the diagnosis of coronary artery disease, a spiral CT scan had a sensitivity of 94% and a specificity of 61%. PPV and negative predictive value (NPV) were 84% and 79%, respectively[1].

In their series performed with double-helix CT, Shemesh et al., stated that calcification was significantly more prevalant in patients with obstructive coronary artery disease (>83%) than in patients with normal coronary arteries (27%) or in healthy control subjects (34%, $p<0.1$). The researchers found a high sensitivity (91%), however, the specificity was low (52%) due to calcification in non-obstructive lesions[15]. When CT and angiographic findings were compared, CT was found to have 84% accuracy with PPV and NPVof 89% and 59%, respectively[15].

In contrast, some investigators claim that the technique is useless[16]. Detrano et al., in their series performed with 1196 asymptomatic high-coronary-risk subjects that underwent risk-factor assessment and cardiac CT, showed that CT calcium score did not add significant incremental information to risk factors in clinical screening. The researchers claimed that neither risk-factor assessment nor the calcium detected with CT was an accurate event predictor in high-risk asymptomatic adults[16].

The present study had some limitations. Our sample size was small and a relatively old CT technology was used. Moreover, there was no gold standard angiographic demonstration of stenotic effects of the calcium deposits.

In conclusion, coronary calcifications were easily discernible with CT. Our study showed that calcified deposits were more frequently encountered with increasing age and male gender. In addition, to the increased association of coronary calcification with the male gender, a relationship to diabetes mellitus, hypercholesterolemia and cardiomegaly was detected.

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