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Reporting of coronary artery calcification on chest CT studies in breast cancer patients at high risk of cancer therapy related cardiac events

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ABSTRACT

Background: The identification of coronary artery calcification (CAC) detected coincidentally on chest CT exams could assist in cardiovascular risk assessment but may not be reported consistently on clinical studies. Cardiovascular risk factor stratification is important to predict short term cardiac events during cancer therapy and long term cardiac event free survival in cancer patients. We sought to determine the prevalence of CAC and clinical reporting rates in a cohort of cancer patients at high risk of cancer therapy related cardiac events.
Methods: 408 Breast cancer patients who were referred to a cardiac oncology clinic were screened. Inclusion criteria included having had a CT chest and the absence of known coronary disease. Among those screened 263 patients were included in the study.
Results: CAC was identified in 70 patients (26%). CAC was reported in 18% of studies. The reporting rates of CAC increased with the extent of coronary calcification ($p < 0.01$) and increased during the period of the study ($p < 0.05$).
Conclusions: CAC was commonly detected on chest CT studies in this observational study of breast cancer patients at high risk of cardiac oncology events. The presence of CAC was often not reported clinically but reporting rates have increased over time. Recent SCCT/STR guidelines recommend reporting the presence of CAC on routine chest CT scans in recognition of the importance of CAC as a predictor of cardiovascular events. Reporting of CAC on chest CTs may help to further risk stratify breast cancer patients and improve cardiovascular outcomes in this vulnerable population.

1. Introduction

Coronary Arterial calcification (CAC) denotes the presence of atherosclerosis and is a powerful predictor of cardiovascular events [1,2]. CAC may be detected co-incidentally on non-gated thoracic computed tomography (CT) studies [3–7]. Chest CT scans are performed in breast cancer patients as part of cancer staging, radiotherapy planning or to investigate clinical conditions that arise during cancer therapy [8]. Until recently there has been no consensus as to how to report arterial calcification on such studies [9]. In light of this, and since the focus of chest CT requests is often to look for non-cardiovascular findings, the presence of CAC may be under reported [9–11].

In breast cancer patients detection of atherosclerosis is of particular importance. This reflects the fact that cardiovascular disease is the leading cause of death in early stage breast cancer [12]. It acknowledges that in the past, cardiovascular risks may have been less aggressively managed in cancer patients [13,14]. As a result pre-chemotherapy cardiovascular screening has recently been recommended in three independent cardiac oncology guidelines [15–17]. Cardiac oncology guidelines also recognize that there is an increased cardiotoxicity risk from chemotherapy experienced by breast cancer patients in the presence of co-existing cardiac disease or cardiovascular risks such as hypertension and diabetes [15–17]. Thus, in not reporting CAC, the possibility of detecting an important short-term determinant from cancer therapy or long-term predictor of atherosclerotic events is potentially over looked.

To examine how often non-gated chest CT reports identified CAC in breast cancer patients we sought to study a population in whom CAC reporting might impact short and long term cardiovascular outcomes. We therefore choose to study breast cancer patients from a cardiac oncology clinic. The prevalence of CAC would be expected to higher in this population in comparison to an unselected population of breast cancer

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sufferers since cardiac oncology patients were either at risk or had already experienced cardiac complications.

2. Methods

The study was approved by the local research ethics board.

2.1. Study sample

From 2009 to 2017, a total of 408 consecutive breast cancer patients, who were referred to the cardio-oncology clinic at the Ottawa General Hospital, were included in the study. Of the 408 patients, 269 patients had undergone prior non-ECG gated Chest CT, 263 fulfilled the inclusion criteria (a history of breast cancer, prior non-ECG gated CT chest and no documented coronary artery disease or peripheral vascular disease.)

2.2. Clinical demographics

Patient cardiovascular risk factors, cardiac history and cancer history were obtained from a comprehensive review of the electronic medical records. A history of coronary artery disease was present if patients self-reported these at the cardio- oncology clinic or if evident on the medical chart [14].

2.3. Image acquisition

CT scans were performed on commercially available multi-detector CTs with methods as previously described [10]. Briefly, images were non-ECG gated thoracic CT scans with or without contrast enhancement as clinically indicated [8,18]. Soft tissue kernel slice-thickness images ranged from 1.0–5.0 mm and were acquired using Aquillon 16-, 64-, 320-detector (Toshiba Canada Medical Systems Limited, Markham, Ontario); Lightspeed Plus 16- and Lightspeed 64-detector (General Electric Healthcare, Mississauga, Ontario,) and Definition Flash dual source 64 × 2-detector Siemens Medical Solutions Canada, Oakville, Ontario). CT exams were initially reported in the clinical setting by a radiologist. All CT studies were subsequently reviewed for the study purposes without additional processing using patient archiving and communication system (PACS) software (McKesson Radiology 12.3, McKesson Canada, Mississauga, Ontario).

2.4. Coronary artery calcification (CAC)

CAC was identified and quantified using visual ordinal scoring system as previously described [3,19]. Briefly calcium in the left main, left anterior descending artery, left circumflex and right coronary arteries was categorized as absent (0) or present. If present the degree of calcification (1–3, or) was classified as mild (1) if <1/3 of the length of the entire artery contained calcification (CAC = 1), moderate if 1/3–2/3 (CAC = 2) and severe if >2/3 of the artery showed calcification (CAC = 3). The final score was the sum of the individual artery scores from 0 to 12. Patients were divided into 4 subgroups based on their final scores: 0, 1–3, 4–5 and 6–12. These scores have been reported to correspond to Agatston scores of 0, 1–100, 101–400 and >400 as previously described [19].

2.5. Thoracic arterial calcification

Non coronary arterial calcification (NCC) in the aorta, brachiocephalic, subclavian, or carotid arteries was classified as present or absent.

2.6. CT imaging reports

Reports from the CT chest studies were obtained from the patient's electronic medical records. The time and date of study in terms of standard working hours (7 am–7 pm) and on call hours (7 pm–7 am) were recorded. For the purposes of the study weekday and weekend work times were not treated differently. The interpreting radiologist was classified as cardiac or non-cardiac based on their individual training and clinical practice during working hours.

2.7. Statistical analysis

Associations between the clinical reporting of non-coronary arterial calcification or CAC and a) the extent of coronary calcification, b) time of CT study (working versus on call hours), c) year of CT study, d) reading radiologists (cardiac versus non cardiac) were assessed as categorical and ordinal variables as appropriate using Chi Squared tests. The year of CT study was divided into 4 groups for this analysis. The groups were divide into quartiles by total number of CT scans performed (2002–2009 (65 studies), 2009–2011 (66 scans), 2011–2013 (66 scans) and 2013–2016 (66 scans). Linearity between the frequency of CAC or NCC reporting and the extent of CAC or year of CT study were assessed using Pearson's Chi Square test. Data were analyzed using IBM SPSS 24 statistics for Windows (Armonk, NY: IBM Corp). Statistical significance was defined as $p < 0.05$.

3. Results

3.1. Demographics

A total of 263 of 408 breast cancer patients at the cardiac oncology clinic met the inclusion criteria (Table 1). The majority of our sample were female (98.5%) and the median age was 60 years old. The most common indication for chest CT was cancer staging (87.5%) followed by investigation for pulmonary pathology (including pneumonia, chronic obstructive lung disease) (5.3%) and chest pains (3.4%). Reasons for referral to the cardiac oncology clinic were reduced left ventricular ejection fraction (51.3%), arrhythmia (11.4%), dyspnea (5.7%), and chest pain (7.6%) (Table 1). 75.7% of patients had received anthracycline containing chemotherapy regimens and 64.6% of patients received trastuzumab.

3.2. Coronary artery calcification

CAC was identified in 70 patients (26.2%) patients (Table 2). The most common artery to be involved was the LAD (22.9%) followed by the RCA(15.6%), LCx(14.3%) and LM(10.3%). The distribution of

Table 1
Patient's characteristics.

Patient's characteristics, $n = 263$		
Category		Frequency (%)
Gender	Female	259 (98.5)
Age (mean ± SD)		59.5 ± 11.6
Cardiovascular risk factors	Hypertension	95 (36.1)
	Diabetes	38 (14.4)
	Smoking	105 (39.9)
	Obesity	71 (27.0)
	Family history of coronary disease	34 (12.9)
	Peripheral vascular disease	11 (4.2)
	Dyslipidemia	74 (28.1)
Cardiac oncology referral	Low ejection fraction	135 (51.3)
	Palpitations/arrhythmia	20 (7.6)
	Chest pain	20 (7.6)
	Dyspnea	15 (5.7)
	Atrial fibrillation	10 (3.8)
	Other	63 (24.0)
Reason for chest CT	Cancer staging	230 (87.5)
	Pulmonary pathology	14 (5.3)
	Chest pain	9 (3.4)
	Pre-operative assessment	10 (3.8)