Incidental Findings in CT Imaging of Coronary Artery Bypass Grafts – Results from the Canadian Multicentric PATENCY-CORONARY Trial

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CHUM:

Equipment loan by Philips Healthcare and Bayer Canada (CCL).
Background

Heart disease remains the number one cause of hospitalization and death in industrialized countries, as well as imposing a significant economic burden on the health care system.\(^1\)

It has been demonstrated that coronary artery bypass grafting (CABG) surgery improves survival, reduces angina and improves quality of life in patients with severe ischemic heart disease.\(^2\)

Since 1954, operating on a still heart in a bloodless field using cardiopulmonary bypass (CPB) (on-pump) CABG has been the preferred surgical method.\(^3,4,5\)

Background

The technique of operating on a beating heart (off-pump) has been perfected in aim to decrease peri-operative complication associated with on-pump CABG using CPB.

The CORONARY trial the largest clinical trial (N=4752 patients randomly assigned to off- or on-pump CABG) which aims to evaluate short and long term efficiency and safety of off-pump CABG in patients undergoing CABG surgery, as compared to on-pump.¹

Background

PATENCY-Coronary is a multicenter trial of a consecutive subset of patients from the CORONARY trial undergoing graft patency assessment using non-invasive computed tomography angiography (CT) at one-year postoperative follow-up (NCT01414049).

Incidental findings may contribute to a differential diagnosis, be responsible for patient symptoms and/or impact patient management.¹

Aim

In the context of the PATENCY-CORONARY trial, patients undergoing CT graft evaluation were also prospectively assessed for incidental findings (IF).

The aim of this study is to assess the prevalence and clinical significance of cardiac and extra-cardiac IF in patients undergoing MDCT for initial assessment of CABG patency.
Method

Three Canadian institutions are involved in the PATENCY-CORONARY trial from Montreal, Hamilton and Calgary.

Patients reaching 12 to 18-month postoperative follow-up underwent graft patency assessment using CTA.

144 consecutive patients (122 males, 22 females; mean age 69.7 years ± 6.7) recruited between March 2011 and October 2013.
Method – CT Protocol

- **CT scanner specifications:**
  - 256-slice MDCT (Brilliance iCT, Philips Healthcare), 64-slice scanner (Aquilion64, Toshiba Medical Systems, Tochigi, Japan); GE LightSpeed 64 VCT; GE Healthcare, USA)
  - Prospective ECG-gating was prioritized
  - Scanning voltage: 120kV
  - Gantry speed rotation: 270 to 400 ms
  - Slice thickness: 0.5 to 0.625 mm
  - Reconstruction with field-of-View (FOV) of 250 mm in 117 patients, and FOV from 320 to 500 mm in 27 patients, respectively.
  - Sites could use retrospective ECG-gating in case of high HR or BMI.
  - Scan range from the clavicles to the lung bases just caudal to that heart, in order to visualize the heart as well as the internal mammary arteries.
  - Post-treatment platform: Aquarius Intuition, Terarecon (Corelab Montreal).

CRCHUM
Centre de Recherche du Centre Hospitalier de l’Université de Montréal
Method – IF Classification

Incidental Finding:

Unexpected observations of potential clinical significance and unrelated to the main purpose of the PATENCY-CORONARY trial (i.e. graft patency assessment).
Method – IF Classification

Organ involved, anatomical location and type of abnormality were recorded for all IF.

Native coronary artery stenoses were collected as per protocol, but were not considered as IF in this population of patients with coronary artery disease.
# Results

### Patient and Scan Characteristics (n = 144 patients with CABG)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
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<tbody>
<tr>
<td>Men/ Women</td>
<td>122/22</td>
</tr>
<tr>
<td>Age (years) (mean ± SD)</td>
<td>69.7 ± 6.4</td>
</tr>
<tr>
<td>Presence of IF * (n, %)</td>
<td>109 (75.7%)</td>
</tr>
<tr>
<td>BMI (kg/m2) (mean ± SD)</td>
<td>28.0 ± 4.1</td>
</tr>
<tr>
<td>Smoker** (n, %)</td>
<td>105 (72.9%)</td>
</tr>
<tr>
<td>Mean heart rate during scan (bpm) (mean ± SD)</td>
<td>58.4 ± 9.0</td>
</tr>
<tr>
<td>Scan coverage (mm) (mean ± SD)</td>
<td>250.3 ± 28.7</td>
</tr>
<tr>
<td>Effective dose*** (mSv) (mean ± SD)</td>
<td>11.9 ± 7.6</td>
</tr>
<tr>
<td>ECG gating (prospective/retrospective)</td>
<td>134/10</td>
</tr>
</tbody>
</table>

*: IF, incidental findings  
**: current and former smokers were considered as smokers  
***: the effective radiation dose was estimated by the product of the dose-length product and a conversion coefficient for the thorax (k=0.014 mSv*mGy−1*cm−1).
Results – Cardiac Findings

There were 211 IF recorded in 109 patients (75.7%). Among these, 71 (33.6%) were cardiac IF in 52 patients.

Most common cardiac findings:
- Left or right atrial dilatation (or both) (39 patients, total of 48 IF (67.6%))
- Aortic valve calcifications (7 patients, 9.9%).

Other cardiac findings: left ventricular hypertrophy, atrial septal aneurysm, pericardial effusion, left atrial thrombus and fat metaplasia of the left ventricular wall suggestive of a chronic myocardial infarction.
Among 211 IF recorded, 140 (65.7%) were extra-cardiac IF in 87 patients.*

Most common extra-cardiac findings:
- Pulmonary nodules (51 patients; total 54 nodules (38.6%))
- Emphysema (21 patients, 15.0%).

Other extra-cardiac findings:

<table>
<thead>
<tr>
<th>Thoracic aorta dilatation</th>
<th>Subclavian artery stenosis</th>
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<tbody>
<tr>
<td>Abdominal aorta aneurysm</td>
<td>Brachiocephalic artery stenosis</td>
</tr>
<tr>
<td>Pulmonary infiltrates</td>
<td>Enlarged mediastinal lymph nodes</td>
</tr>
<tr>
<td>Main pulmonary artery dilatation</td>
<td>Hiatal hernia</td>
</tr>
<tr>
<td>Thyroid nodules</td>
<td>Adrenal gland adenoma</td>
</tr>
<tr>
<td>Breast abnormalities</td>
<td>Pleural effusion/ thickening</td>
</tr>
<tr>
<td>Hepatic lesions</td>
<td></td>
</tr>
</tbody>
</table>

*Some patients presented both cardiac and extra-cardiac findings.
Results

37 significant IF (17.5 % of all IF, in 34 patients (23.6%)):
- Pulmonary nodules (23 cases, 62.2%) (mean size 6.12 mm ± 2.45)
- Pulmonary infiltrate (1 case, 2.7%)
- Enlarged mediastinal lymph nodes (3 cases, 8.1%)
- Left ventricular hypertrophy (1 case, 2.7%)
- Hepatic lesions (6 cases, 16.2%)
- Thyroid nodule (3 cases, 8.1%)

Imaging follow-up was recommended in 29 cases (78.4% of significant IF): CT (73 %), and ultrasonography (23 %).

8.1% of significant findings required immediate attention (follow-up in < 1 month)

Most common follow-up time frame: 3 - 5.9 months
Results

- Comparison between patients with and without IF:
  - Comparable baseline demographics (p ≥ 0.05).
  - Lower prevalence of congestive heart failure and lower effective radiation dose in people who presented incidental findings (p < 0.05).

- Among patients with vs without lung nodules, proportion of smokers or former smokers were 60.9% (25/41) and 77.6% (80/103) (p = 0.07), respectively.

- Among patients with significant lung nodules vs without the presence of any lung nodules, proportion of smokers or former smokers were 70.0% (16/23) and 76.8% (73/95) (p = 0.65), respectively.
This sub-study from the PATENCY-CORONARY trial shows a high prevalence (75.7%) of IF in patients with CABG on cardiac CT. Most IF were minor (82.5%). Age and comorbidities may explain the high prevalence of IF in comparison to other studies, as well as the longer z-axis coverage used to assess patients with CABG.

Of note, a recent study of patients assessed for transcatheter aortic valve replacement (TAVR) showed a 100% prevalence of IF on CT. As the patients in our study, patients assessed for TAVR also present more comorbidities and are older than most other cardiac CT patients. CT imaging for TAVR also requires an increased z-axis coverage.

The proportion of significant IF was 17.5% in the present study, which is similar to other studies.

Pulmonary nodules were the most frequent significant IF. Among 37 significant IF, 23 were pulmonary nodules, most of which required CT follow-up.

Limitations

No significant association between smoking and significant pulmonary lung nodules was demonstrated, probably due to the relatively small sample size. In no patient was the incidental finding confirmed by histology. A limited FOV was used in most patients. This may have decreased the prevalence of pulmonary nodules detected in our study.  

3. Earls JP. The pros and cons of searching for extracardiac findings at cardiac CT: studies should be reconstructed in the maximum field of view and adequately reviewed to detect pathologic findings. Radiology 2011; 261: 342–346.
Conclusion

CT angiography used for CABG assessment shows a high prevalence of incidental findings, most of which are lung nodules. Extracoronary structures, especially lung parenchyma, should be reviewed in patients undergoing cardiac CT for CABG assessment.