Coronary Artery Disease or Hiatal Hernia? Computed Tomography Coronary Angiography as a discriminating diagnostic tool in patients with chest pain.

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Purpose

BACKGROUND

In recent years, with the increasingly high performance of Multidetector Computed Tomography (MDCT) in terms of both spatial and temporal resolution, and the possibility to synchronize images acquisition to the ECG, the use of MDCT in the evaluation of coronary artery disease (CAD) has spread.

Patients with low to intermediate cardiovascular risk are the ones that most can benefit from this type of examination considering the high negative predictive value of computed tomography coronary angiography (CTCA -> 90% for equipment with at least 64 detector layers). In fact, if the result of CTCA is negative, patients do not have to undergo more invasive investigations such as coronary angiography. On the other hand patients with a high probability of disease usually should not be subject to CTCA examination and should instead directly undergo coronary angiography, an exam which currently has mainly therapeutic purpose with the possibility of angioplasty and stent placement.

CTCA is a panoramic examination allowing to identify not only cardiac but also extra-cardiac causes of chest pain.

Among the extra-cardiac causes of chest pain, the ones that mostly enter the differential diagnosis with cardiac chest pain are gastro-esophageal reflux and hiatal hernia. The evaluation of gastric mucosa herniation in the chest cavity with MDCT is possible. Therefore CT becomes a useful tool in discriminating the nature of chest pain, particularly atypical chest pain and particularly in patients not at high risk of CAD.

The possibility to exclude coronary artery disease and to suggest a cause of extra-cardiac chest pain in the same examination could help the physicians to correctly handle patients (e.g. the absence of CAD in presence of hiatal hernia could explain the episodes of angina-like chest pain and refer the patient to a gastroenterological evaluation instead of a cardiological one).

The purpose of this study was to evaluate the prevalence of hiatal hernia as a possible cause of chest pain in symptomatic patients undergoing computed tomography coronary angiography and correlate it with the type of chest pain and the degree of CAD.
Methods and Materials

PATIENTS

We prospectively selected, among all the patients who underwent CTCA in our University Hospital between July 2010 and December 2012, the ones presenting with chest pain. Patients with known coronary artery disease have been excluded so that the study population consisted of 59 patients. For each patient a form with data about age, sex, cardiovascular risk factors and type of chest pain was filled in.

IMAGES PROTOCOL AND DATA ACQUISITION

All CTCA examinations have been performed on 64-MDCT (LightSpeedVCT, General Electric, Milwaukee, Wis., USA) with the following parameters.

Parameters of acquisition:

<table>
<thead>
<tr>
<th>Detector configuration</th>
<th>64 x 0.6 mm</th>
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<tbody>
<tr>
<td>Acquisition thickness</td>
<td>0.625 mm</td>
</tr>
<tr>
<td>Reconstruction interval</td>
<td>0.4 mm</td>
</tr>
<tr>
<td>Tube voltage</td>
<td>80-120 kV</td>
</tr>
<tr>
<td>Tube current</td>
<td>200-700 mAs</td>
</tr>
<tr>
<td>FOV</td>
<td>#25 cm</td>
</tr>
</tbody>
</table>

The angiographic study was preceded by a scout scan and a non-contrast scan (with prospective ECG triggering) for Calcium Score evaluation. The acquisition has been conducted cranio-caudally from the carina to the diaphragm with patient in supine decubitus.

For the angiographic study a bolus of high concentrated contrast medium (Iomeprol 400 mg/l/ml, 85 ml) was administered in an antecubital vein with an injection rate of about 5 ml/sec, followed by a bolus of 50 ml of saline solution at the same injection rate. The scan
delay was determined using the bolus tracking technique positioning a region of interest with a threshold of 150 Hounsfield Unit on the descending aorta.

Oral metoprolol (50-100 mg) was administered about one hour before the examination to all the patients with a heart rate > 65 bpm (beats per minute) and no contraindications. Sublingual nitrates were administered just before the examination to all the patients (in the absence of contraindications).

Images were reconstructed during the tele-diastolic phase (60-80% of the RR interval) with a standard filter.

A reconstruction with enlarged FOV (32 cm) was performed after the acquisition for the evaluation of lung parenchyma and other structures included in the acquisition volume.

IMAGES EVALUATION

Images were evaluated on a dedicated workstation (ADW 4.4, General Electric, Milwaukee, Wis., USA). Evaluation of coronary arteries was based on the classification in segments of the American Heart Association.

In order to evaluate native coronary arteries axial images, Maximum Intensity Projection (MIP) images (fig 1), Multiplanar Reformat (MPR) images, Curved Planar Reformat (CPR) images (fig 2) along the centerline (fig 3) of each vessel and, if necessary, Volume Rendering (VR) images (fig 4) were used.

It was considered coronary atherosclerosis the presence of calcified, non-calcified or mixed plaques in at least one coronary segment. We defined significant disease the presence of at least one stenosis > 50% of the coronary lumen (fig 5) and the absence of significant disease both the absence of any plaque or the presence of one or more plaques determining stenosis #50% (fig 6).

Images obtained by CTCA were evaluated by a board certified radiologist expert in cardiac imaging. All the other possible cardiac non-atherosclerotic diseases identified along with extra-cardiac findings (evaluated using also large FOV and if necessary lung parenchyma window) were reported.

In a second time, on the same images, the presence of hiatal hernia was evaluated. Axial images and multiplanar reformat images were used to identify the presence and the degree of gastric mucosa herniation in the thoracic cavity, which was recorded as absent, small (fig 7-9) or large (fig 10-12). This evaluation was performed in double blind way by
a radiology resident and board certified radiologist; cases with discordant assessment (n=6/59, 10%) were reviewed in consensus.
Fig. 1: example of maximum intensity projection (MIP) axial image showing cardiac inferior wall with visibility of the crux and its terminal branches (postero-lateral and posterior descending arteries).

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Fig. 2: example of curved planar reformat (CPR) image of a right coronary artery with no significant disease.

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**Fig. 3:** another kind of curved planar reformat (CPR) image showing an anterior descending artery with non-significant stenosis straightened along its centerline.

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Fig. 4: example of a volume rendering (VR) image showing the origin from the aorta of both coronary arteries affected by some calcified plaques.

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Fig. 5: multiplanar reformat (MPR) image showing the section of the middle tract of the anterior descending coronary artery with a significant calcified plaque (arrow).

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Fig. 6: volume rendering (VR) image of the left main, anterior descending and circumflex arteries in a patient with no coronary artery disease.

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**Fig. 7:** axial image showing a small hiatal hernia (arrow) at the level of the esophageal hiatus of the diaphragm.

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**Fig. 8:** MPR coronal view showing a small hiatal hernia (arrow) at the level of the esophageal hiatus of the diaphragm.

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Fig. 9: MPR sagittal view showing a small hiatal hernia (arrow) at the level of the esophageal hiatus of the diaphragm.

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**Fig. 10:** axial image showing a large hiatal hernia (arrow) at the level of the esophageal hiatus of the diaphragm.

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**Fig. 11:** MPR coronal view showing a large hiatal hernia (arrow) at the level of the esophageal hiatus of the diaphragm.

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Fig. 12: MPR sagittal view showing a large hiatal hernia (arrow) at the level of the esophageal hiatus of the diaphragm.

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Results

The study population included 59 patients (34 males; 25 females; mean age 64±13 years old; range 32-93 years), most of them (36/59; 61%) presenting with atypical pain (Table 1).

Table 1. Distribution of coronary artery disease (CAD) detected at computed tomography coronary angiography in the 59 patients presenting with chest pain included in the study population.

<table>
<thead>
<tr>
<th></th>
<th>Typical pain n (%)</th>
<th>Atypical pain n (%)</th>
<th>Total n (%)</th>
</tr>
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<tbody>
<tr>
<td>Significant CAD</td>
<td>6* (26%)</td>
<td>7 (19%)</td>
<td>13 (22%)</td>
</tr>
<tr>
<td>Absent or not-significant CAD</td>
<td>17 (74%)</td>
<td>29 (81%)</td>
<td>46 (78%)</td>
</tr>
<tr>
<td>Total</td>
<td>23 (100%)</td>
<td>36 (100%)</td>
<td>59 (100%)</td>
</tr>
</tbody>
</table>

* 1 patient with typical pain affected by significant coronary artery disease presented also a small hiatal hernia

Almost 80% of the patients considered had no or not-significant CAD but were found to have at least one other cardiac (fig 13,14) or extra-cardiac (fig 15) finding correlated with their chest pain (Table 2). Hiatal hernia resulted to be the most frequent cause of chest pain in this patient group (30.4%).

Table 2. Distribution of extra-cardiac or cardiac non-atherosclerotic diseases at Computed Tomography (CT) in the 46 patients without significant coronary artery disease (CAD).
<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Typical pain n (%)</th>
<th>Atypical pain n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial bridge</td>
<td>4 (8.7%)</td>
<td>3 (6.5%)</td>
<td>7 (15.2%)</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>1 (2.2%)</td>
<td>1 (2.2%)</td>
<td>2 (4.4%)</td>
</tr>
<tr>
<td>Pericarditis</td>
<td>0</td>
<td>1 (2.2%)</td>
<td>1 (2.2%)</td>
</tr>
<tr>
<td>Malignant coronary anomaly</td>
<td>1 (2.2%)</td>
<td>0</td>
<td>1 (2.2%)</td>
</tr>
<tr>
<td>Hiatal hernia</td>
<td>7 (15.2%)</td>
<td>7 (15.2%)</td>
<td>14 (30.4%)</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>0</td>
<td>1 (2.2%)</td>
<td>1 (2.2%)</td>
</tr>
<tr>
<td>No CT abnormalities</td>
<td>5 (10.9%)</td>
<td>17 (36.9%)</td>
<td>22 (47.8%)</td>
</tr>
<tr>
<td>Total</td>
<td>17 (37%)</td>
<td>29 (63%)</td>
<td>46*(100%)</td>
</tr>
</tbody>
</table>

*Two patients, with respectively, typical and atypical pain, had both a small hiatal hernia and a myocardial bridge.
Fig. 13: volume rendering (VR) image showing a malignant coronary anomaly with the right coronary artery originating from the left Valsalva sinus and an interarterial pathway between the aorta and the pulmonary trunk

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**Fig. 14:** maximum intensity projection (MIP) image showing the origin of a malignant right coronary artery from the left Valsalva sinus

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Fig. 15: axial image showing a pneumothorax (asterisk) of the left lung.

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Conclusion

This study, even if in a limited number of patients, shows that the presence of hiatal hernia can be the only cause of chest pain in a consistent percentage of patients.

In patients at low to intermediate risk of CAD computed tomography coronary angiography can represent a one-shot examination allowing to diagnose/exclude both CAD and hiatal hernia and refer the patient promptly to the correct specialist.

A careful analysis by radiologists of CTCA images, reporting coronary, cardiac non-coronary and extra-cardiac findings is mandatory.
References


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