Introducing Volume Cardiac CT imaging into the management of patients coming through the Rapid Access Chest Pain Clinic - a UK Pilot Study

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Patients presenting to primary care physicians with chest pain are typically risk stratified with an appropriate history and physical, and ECG. If the chest pain is felt to be of cardiac origin and the patients fit referral criteria (>30 years male and >40 years female) then general practitioners are able to refer these patients to a Rapid Access Chest pain Clinic. The Rapid Access Chest Pain Clinic (RACPC) allows for a specialist assessment of patients with suspected new onset angina within the National Service Framework for coronary heart disease targets. The targets propose that these patients be seen within 2 weeks of referral. Standard 8 of the framework states "People with symptoms of Angina or suspected Angina, should receive appropriate investigation and treatment to relieve their pain and reduce their risk of coronary events". Clinics are supervised by Consultant Cardiologists and patients are thoroughly investigated to identify - cardiac risk factors, family history etc. If there is sufficient concern that the chest pain is of cardiac origin then further investigation usually by exercise tolerance testing is used.

There is a significant body of existing evidence of the value of Cardiac CT for the investigation of chest pain in the acute setting. The purpose of this study was to determine whether there was a role for cardiac ct as a primary diagnostic tool in the subset of patients who are referred by general practitioners to the hospital system - via the rapid access chest pain clinic route. To my knowledge there is no previously published data looking at the use of Volume Cardiac CT (VCCT) as the primary investigative tool for these patients.

There is significant evidence that cardiac ct is better than exercise tolerance testing for the investigation of coronary artery disease. A head-to-head comparison between stress ECG and cardiac CT showed CT to have a significantly higher sensitivity (91% versus 73%) and specificity (83% versus 31%). CT was unable to assess 8% of patients, while stress ECG failed to evaluate 19% of study subjects. (1)

Cardiac CT angiography is now sufficiently robust to be used routinely for a number of clinical applications. More than 16 published studies have compared 64-slice CT with coronary angiography for the detection of coronary artery stenoses. These papers, which together draw on data from 1400 patients, conclude that on average 95% of all coronary segments are fully accessible and can be compared to cardiac catheter findings. Sensitivity, specificity, and positive and negative predictive values have been reported as 85%, 96%, 85%, and 96%, respectively. (2,3,4,5)

The particular strength of cardiac ct which best applies to this group of patients is its high negative predictive value which several studies have shown to be almost 100% (particularly in patients falling into the low to intermediate risk stratified groups) Low to
intermediate risk patients - absence of CAD has 100% negative predictive value for ACS. (6)

One of the final conclusions of The Usefulness of Coronary Computed Tomography Angiography For Early Triage of Patients with Acute Chest Pain - The Rule Out Myocardial Infarction Using Computer Assisted Tomography (ROMICAT) Trial by Udo Hoffmann et al was that the absence of any CAD in 50% of patients has a 100% negative predictive value for ACS and that this may enable safe and early discharge from the ER (0 adverse events at 6 months).

Studies have also shown that compared to other functional tests such as MIBI scans, Volume Cardiac CT has a lower dose profile and a higher sensitivity for coronary artery disease (as well as being a significant cost saving.) Very low risk patients - CT may be cost saving alternative to myocardial perfusion stress testing (7)
Methods and Materials

In a 3 month period from October to December 2009, 82 patients were seen in the Rapid Access Chest Pain Clinic at the Heartlands hospital in Birmingham, UK. Patients were usually seen by senior clinical fellows or SpRs under the supervision of a Consultant Cardiologist. After a complete history and examination was performed initial tests included a 12lead ECG and routine blood tests. Patients, in whom, after these initial tests there was still a clinical suspicion of underlying coronary artery disease went on to have further investigations. 75% underwent exercise tolerance testing as the first investigation and 12% were directed to Volume Cardiac CT imaging as their primary investigation. In this initial subset of patients - the ones who were referred for Cardiac Ct were those in whom it was felt that exercise tolerance test would be more likely to not be able to exclude coronary artery disease i.e. those unable to exercise effectively; patients with resting ecg changes e.g LBBB.

All Cardiac CTs were carried out on a Toshiba Aquilion One CT scanner. Patients were positioned on the couch supine, with head first. An ECG scan was performed with 80% of scans were performed with a single ECR R-R interval beat acquisition, 20% requiring a 2 beat acquisition. Patients were required to hold their breath for approximately 5s for the duration of the scan. The scan was optimized by attempting to reduce the patient's heart rate using an IV B Blocker - Metropolol. This was titrated up in 10ml aliquots as required with the aim of reducing the heart rate to below 65 beats per minute. B Blockers however were avoided in patients in whom there was a contraindication:

- Asthma
- Sinus bradycardia
- Hypotension: BP <90systolic
- Overt heart failure
- Cardiogenic shock
- 2nd or 3rd degree block
- Right ventricular failure secondary to pulmonary hypertension

Further image optimization was performed by using sublingual GTN. 70mls of Optiray 350 strength contrast was used. A variable dose with alteration of kV and mA was used depending on the patient's BMI - with the aim of producing the best quality images whilst keeping the radiation dose to a minimum.

Reconstructions were performed at 75% of the R-R interval and then 3% above and below this level allowing for analysis of 3 sets of data. Data was transferred to a Vitrea workstation and was analysed by a Consultant Cardiothoracic Radiologist.
Results

10 patients came into the CT group. Of these 60% were female and 40% were male. The average age of the group was 63.4 years with a range of 49-79 years. The mean BMI was 29 but there was a large range of BMIs from 23.5 to 39.

The average dose over all these patients including those in whom we were unable to control their heart rate and therefore a 2 beat acquisition had to be performed was 6.78mSv. Excluding the patients who had 2 beat acquisitions, average dose was 4.63 mSv. The lowest dose achieved was 1.8 mSv in a patient with a BMI of 25.

All scans were diagnostic and subjectively rated as good in 80% and excellent in 20%. In all scans, all coronary artery segments were deemed to be of diagnostic quality. 70% of scans were normal and patients were well at 6 month follow up. 30% of scans were abnormal and patients had invasive coronary imaging.

Table 1

<table>
<thead>
<tr>
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<th>Cardiac CT Result</th>
<th>Invasive Angiogram Result</th>
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<tbody>
<tr>
<td>1</td>
<td>Significant LAD lesion</td>
<td>Lesion identified and LAD stent inserted</td>
</tr>
<tr>
<td>2</td>
<td>Calcified Atherosclerotic Plaque 3 Vessel Disease with significant blooming artifact ?Significant lesion</td>
<td>Mild 3 Vessel Disease with ?Significant LAD lesion. Pressure wire showed non flow limiting - Medical Management</td>
</tr>
<tr>
<td>3</td>
<td>RCA Occlusion. Proximal LAD disease</td>
<td>Lesion identified and RCA stent inserted</td>
</tr>
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As the data from Table 1 shows - CT findings were corroborated in the three patients who went on to have invasive angiographic imaging. (see figures 1-11) 2 patients had stent insertions to identified lesion and 1 patient had their disease confirmed with a suspicious lesion in the LAD warranting further investigation with a pressure wire. This lesion was determined to be non flow limiting and therefore medical management was commenced.
Fig. 0: Figure 1 - Cardiac CT angiogram on Patient 1 shows a tight stricture in the Mid LAD

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Fig. 0: Figure 2 - Cardiac CT angiogram on Patient 1 shows a tight stricture in the Mid LAD

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Fig. 0: Figure 3 - Invasive angiogram confirms the presence of the lesion

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**Fig. 0:** Figure 4 - Stent insertion

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**Fig. 0:** Figure 5 - Stent insertion

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Fig. 6: Figure 6 - Post stent insertion LAD image

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Fig. 0: Figure 7 - Cardiac CT of Patient 3 shows complete occlusion of the RCA

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**Fig. 0:** Figure 8 - Invasive angiogram of Patient 3 confirms complete occlusion of the RCA

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**Fig. 0**: Figure 9 - Stent insertion

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**Fig. 0:** Figure 10 - Stent insertion

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**Fig. 0:** Figure 11 - Post Stent insertion image of the RCA

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Conclusion

This small initial study demonstrates that there is a role for Volume Cardiac CT imaging in the investigation of chest pain in a Rapid Access Chest Pain Clinic setting. Although the study group was small - this initial data does demonstrate that:

• All segments of all coronary arteries were visualised in our study even in patients with BMIs up to 39
• Coronary artery disease was excluded in 70% of the patients with satisfactory 6 month follow up
• Coronary artery disease was accurately identified in 30% of the patients who went on to have invasive treatment.
• Scan could be performed with a low dose - lowest dose achieved was 1.8mSv


