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A Review of a Tertiary Referral Centre's CT Coronary Angiography Programme

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Abstract

Aims

To investigate the implication of outpatient CT coronary angiogram (CTCA) waiting times on patient outcomes and service provision.

Methods

All outpatient CTCAs requested for stable chest pain during 2017 in our catchment area were included. Rate of major adverse cardiovascular events (MACE), presentations with chest pain to the emergency department (ED), cardiology outpatient attendance, time interval in alteration of Coronary artery disease (CAD) prognostic treatment, rate of angiography and percutaneous coronary intervention (PCI) were noted.

Results

172 CTCAs were included. 11 (6.4%) presented to ED with chest pain. 38 (22.1%) attended outpatients prior to scan completion. 17 (9.9%) required alteration of prognostic treatment, taking on average 10.4 (+/-4.5) months to occur. 21 (12.2%) underwent coronary angiography and 7 (4.1%) had PCI, which took on average 9.9 (+/-6.6) months. One non-fatal MI requiring CABG was noted.

Conclusion

The low rate of MACE and revascularisation likely represents appropriately low risk patient selection for CTCA. Presentation to clinic prior to scan completion highlights a need for better administration support.

Introduction

CTCA is becoming increasingly utilised in the investigation of CAD in low to intermediate risk patients presenting with stable chest pain, predominantly due to its high sensitivity (95%) and specificity (83%) for CAD, and a negative predictive value of up to 99% for significant (>50% stenosis) CAD[1]. It allows for non-invasive imaging of the coronary arteries to identify the presence of CAD as well as providing important prognostic information such as the degree of stenosis, site of the lesion and the presence of multi-vessel disease, expediting invasive angiography in patients with high-risk lesions on CTCA [2]. Current NICE guidelines recommend CTCA as a first line investigation in patients with typical or atypical angina.[3] Recent technological advances have allowed for enhanced image quality, lower radiation dose and even CT fractional flow reserve in the target vessel predicting that its use in chest pain pathways will most likely continue to rise[4-5]. Despite recently reported benefits in CTCA incorporation into chest pain pathways its usage remains underfunded. A recent study done in the UK reported that the number of CTCA scans done would need to increase eightfold to fully implement the updated NICE guidelines[6].

The SCOT-Heart study found the addition of CTCA to standard care in low-medium risk patients allowed for a 41% relative reduction in the rate of death from coronary heart disease (CHD) or non-fatal MI versus patients who underwent standard care in a 5 year analysis on clinical outcomes.[7] There was a significant increase in the implementation of preventative therapies in the CTCA arm versus standard care and similar rates of invasive angiography and PCI across both groups. Patients in the CTCA arm had their scans completed in a 6-week period. This reduction in mortality from CHD and non-fatal MI is thought to be due to important prognostic information obtained from the scan and a more aggressive therapeutic strategy and better patient engagement[7]. **H**owever**,** despite this observed clinical benefit there remains a long outpatient waiting list for CTCA in our centre.

In our study we aimed to identify the implications of long waiting times for CTCA in terms of re-presentation to the emergency department with chest pain or attendance to outpatient clinics prior to the completion of the scan. We also aimed to identify the time interval between commencing, or up-titrating primary preventative medications, rate of coronary angiography, percutaneous coronary intervention (PCI) and major adverse cardiovascular events (MACE) while patients were waiting for their scan.

Methods

In this single centre retrospective review, a compiled list of all CTCAs booked from 1st January 2017 to the 31st December 2017 was obtained using the PACS database in our centre. Scans booked during this time period were examined to allow a 12-month period for completion at the time of initial data collection in January 2019. Only scans that occurred on an outpatient basis for the investigation of possible CAD were included in the study. Scans booked during an inpatient episode but happened as an outpatient were also included. CTCAs booked for another indication, such as pre-TAVI, were excluded.

Only patients within our catchment area were included to maximise accurate recording of attendances to the emergency department and outpatients. Patients with known CAD were also excluded. All patients who met the above criteria were selected for inclusion in the study.

All scans were vetted based on urgency by the hospital's radiology department. All CTCAs that met the inclusion criteria, including those booked and discussed as urgent to expedite scan performance, were included for analysis.

We documented the indication, date of booking, date of completion and result of the scan, including the presence of both obstructive and non-obstructive CAD. The electronic patient record was used to assess their medication list prior to ordering the CTCA and whether primary preventative medications were initiated or titrated after scan completion. The time period between ordering the scan and this modification was noted. Subsequent clinic attendances were also reviewed to see if the patient attended a cardiology clinic prior to scan completion. Individual patient episodes were studied to identify attendance to the emergency department with chest pain due to suspected CAD during the intervening period.

In patients whom invasive angiography was undertaken as a result of the scan, the rate of PCI and the waiting period from scan booking was recorded. The rate of myocardial infarction, CVD related death and stroke in our patient cohort was also documented.

Results

A total number of 398 scans were booked, of which 241 were completed, during the study period. 172 patients met the inclusion criteria. The mean (mean (+/- SD)) waiting time to CTCA completion in included scans was 8.8 (+/-4.4) months.

CTCA Outcome

54 (31.4%) studies were positive for CAD, of which 14 (8.1%) had obstructive CAD. 2 (1.2%) patients had evidence of three vessel disease, 8 (4.7%) had obstructive proximal LAD disease and 2 (1.2%) patients had left main stem disease evident on CTCA. Of these 12 patients with significant prognostic findings on CTCA, 5 (41.7%) had significant findings confirmed on invasive angiography. 4 (2.3%) underwent PCI and 1 (0.6%) underwent CABG.

17 (9.9%) patients had initiation or titration or primary preventative medications such as antiplatelet and statin therapy. The mean waiting time to have this change made was 10.4 (+/-4.5) months. The longest waiting period noted was 18.2 months.

21 (12.2%) patients underwent further invasive imaging with angiography based on their CTCA result. A total of 7 (4.1%) patients subsequently underwent PCI. 4 (2.3%) patients had PCI to proximal LAD and/or LMS. The mean waiting time noted was 9.9 (+/- 6.6) months from scan ordering to revascularisation.

Major Adverse Cardiovascular Events (MACE)

Only one MACE was documented during the study period. One patient suffered from non-fatal MI after scan completion, but before attendance at cardiology outpatients, and required an emergency inpatient coronary artery bypass grafting (CABG). This patient had their CTCA booked 10.5 months prior to their non-fatal MI. Their CTCA showed evidence of significant triple vessel disease. The patient's inpatient angiogram showed severe obstructive triple vessel disease (Figures 1,2).

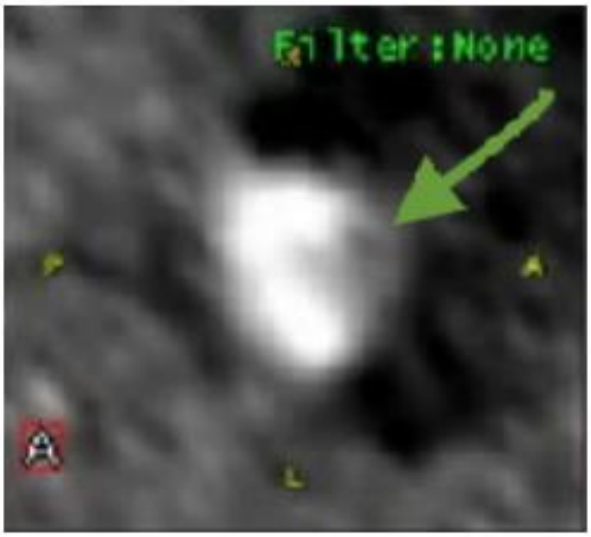

Figure 1 shows a cross-sectional view of the LAD, showing calcification of the coronary artery from 6 o'clock, through to 12 o'clock. with an area of low attenuation plaque at 2 o'clock (green arrow).

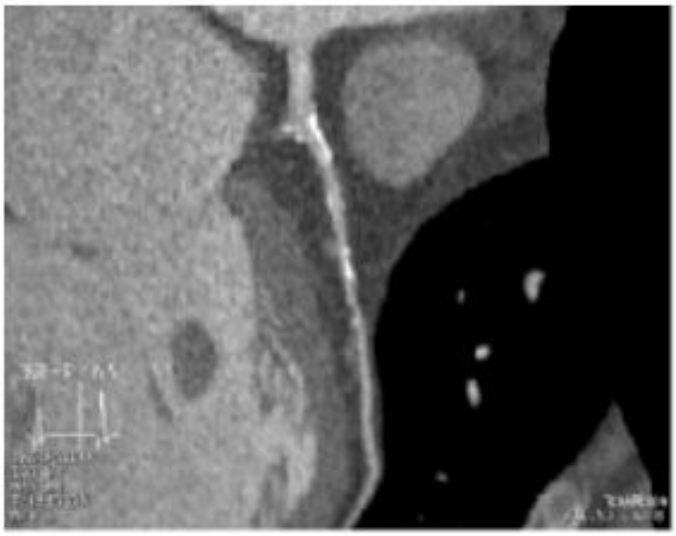

Figure 2 shows a constructed multi-planar reformatted image of the LAD, with areas of calcification at the origin of the LAD and in the mid-LAD

Figures 1 and 2 show one patient who suffered a non-fatal MI following 4 weeks following CTCA, prior to attendance at outpatient clinic. He presented to the emergency department with a NSTEMI and underwent inpatient Coronary Artery Bypass Grafting.

Impact on Service Provision

38 (22.1%) patients awaiting CTCA attended a cardiology clinic prior to the completion of their scan. 4 patients attended clinic twice and 2 patients attended clinic three times prior to scan completion. In all cases an outpatient appointment was booked prior to the average waiting time for CTCA completion in the outpatient setting. 11 (6.4%) patients attended the emergency department with chest pain while awaiting CTCA with all patients staying for one day or less. All patients were thought to have non-cardiac chest pain, and none underwent inpatient angiography based on their presentation or revascularization at any stage.

Table 1 outlines patient demographics, CTCA result, rate of invasive angiography and initiation/titration of primary preventative medications, ED/OPD presentations and MACE.

Table of Results (n=172)				
Age in Years (mean (+/- SD))	53.1 (+/-9.3)			
Sex (n, %)	Male		Female	
	81 (47.1%)		91 (52.9%)	
CTCA Waiting Time in Months (mean (+/- SD))	8.8 (+/- 4.4)			
CTCA Result (n, %)	Negative	Non-Obstructive CAD	Obstructive CAD	
	118 (68.6%)	40 (23.3%)	14 (8.1%)	
Prognostic Information (n, %)	LMS Disease	Three Vessel Disease	Obstructive Proximal LAD Disease	Significant Disease Confirmed on Angiography
	2 (1.2%)	2 (1.2%)	8 (4.7%)	5 (2.9%)
Invasive Procedure Based on CTCA Result (n,%)	Diagnostic Angiography	Proceed to PCI	Mean Waiting Time in Months to Revascularisation (mean (+/- SD))*	
	21 (12.2%)	7 (4.1%)	9.9 (+/- 6.6)	
Initiation/Titration of Preventative Medication (n,%)	Total	Mean Waiting Time in Months (mean (+/- SD))*		
	17 (9.9%)	10.4 (+/- 4.5)		
Presentations to ED with Chest Pain (n, %)	11 (6.4%)			
Number of Presentation to OPD Prior to Scan Completion (n, %)	1	2	3	
	30 (17.4%)	4 (2.3%)	2 (1.2%)	
MACE (n, %)	1 (0.6%)			

Data are presented as mean (+/- standard deviation), absolute values and percentages, as appropriate.

CTCA=Computed Tomography Cardiac Angiogram, CAD=Coronary Artery Disease, LMS=Left Main Stem, LAD=Left Anterior Descending Artery, ED=Emergency Department, OPD=Outpatient Department, MACE=Major Adverse Cardiovascular Events

**Mean waiting times refer to the time from CTCA booking to either revascularization or medication titration.*

Discussion

The most notable implication of long waiting periods for CTCA in our centre was attendance to a cardiology clinic prior to completion of the scan. All patients were considered low to intermediate risk and many underwent CTCA to out rule CAD as a cause of their chest pain. Of note 4 patients attended outpatients twice, and 2 patients attended an outpatient clinic 3 times prior to scan completion. The most notable reason for this was booking a subsequent clinic visit sooner than the average wait period for CTCA in our centre.

Implementation of safeguarding mechanisms such as advising secretaries to only book outpatient appointments after patients have undergone CTCA may help improve service efficiency and reduce waiting times in general for cardiology OPD.

11/172 (6.39%) of patients re attended the emergency department with chest pain in the intervening period. Although this is not a significantly high figure, shortening waiting times for CTCA may reduce the number of patients re attending the hospital with further episodes of chest pain. Although the mean waiting period was 10.4 (+/-4.5) months for implementation or alteration of preventative strategies and 9.94 (+/-6.6) months for revascularisation in those who underwent PCI, the rate of MACE noted in our study was very low (1, 0.6%). The most likely explanation for the low rate of MACE in our study is the appropriate selection of low to intermediate risk patients undergoing CTCA and a short period of follow up.

CTCA also has the advantage of providing important prognostic information on coronary anatomy and plaque morphology. Post hoc analysis of Scot-Heart Data showed that adverse plaque, defined by low attenuation or the presence of positive remodeling, was associated with a two to three-fold increase in death from CHD and non-fatal MI, although this finding is not independent of calcium scoring[9]. In our study CTCA also provided important prognostic information to risk stratify our patient group. 12 patients had adverse features such as obstructive left main stem lesions, proximal LAD lesions and three-vessel disease, although there wasn't routine reporting of specific adverse plaque characteristics. All of these patients went on to have invasive angiography and 4 had PCI. 1 patient presented with a non-ST segment elevation MI and required an emergency inpatient CABG.

40 (23.3%) and 14 (8.1%) patients had evidence of non-obstructive and obstructive CAD respectively on CTCA, which is lower than that previously reported in the original SCOT-Heart study (38% non-obstructive and 25% obstructive CHD). The rate of invasive angiography based on CTCA result (12.2%) is in keeping with results from SCOT-Heart, however lower rates of PCI were documented in our study (4.1% vs 8.9%). These findings may indicate that our cohort was relatively lower risk than that studied in SCOT-Heart and suggests a selection of lower risk patients undergoing CTCA[8].

Despite delays in implementation of therapeutic strategies in patients with a positive CTCA in our study, only one MACE was noted during the study period. This is most likely a result of the low risk patient cohort included in the study as noted by the low rate of revascularization in the group (4.7%). Inefficiencies in booking clinic appointments for patients undergoing CTCA into clinic were noted in this study.

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Declaration of Conflicts of Interest:
The authors have no conflicts of interest to declare.

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