Image Quality and Attenuation Values of Multidetector CT Coronary Angiography Using High Iodine-Concentration Contrast Material: A Comparison of the use of Iopromide 300 and Iopromide 370

Thesis

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا

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العليم الحكيم

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List of Abbreviations

Abb.	Full term
AA	Ascending aorta
ABI	Ankle brachial index
ACS	Acute coronary syndrome
Af	Atrial fibrillation
AHA	American heart Assosciation
BMI	Body mass index
BV	Blood volume
CAD	Coronary artery disease
CCS	Canadian cardiovascular society
CCTA	Coronary CT angiography
CM	Contrast media
CO	Cardiac output
CT	Computed tomography
CTPA	CT pulmonary angiography
CV	Cardiovascular
ECG	Electrocardiogram
eGFR	Estimated glomerular filtration rate
ESC	European society of cardiology
FBG	Fasting blood glucose
FFR	Fractional flow reserve
HU	Hounsfield units
ICA	Invasive coronary angiography
IDR	Iodine delievery rate
LAD	Left anterior descending
LCX	Left circumflex
LDL	Low density lipoprotein
LM	Left main
MDCT	Multidetector computed tomography
MIP	Maximum intensity projection
MPA	Main pulmonary artery
MPR	Multiplanar reconstruction
MRA	Magnetic resonance angiography
MRI	Magnetic resonance imaging

List of Abbreviations Cont...

Abb.	Full term
NPV	Negative predictive value
OGTT	Oral glucose tolerance test
OMT	Optimal medical therapy
PET	Positron emission tomography
PTP	Pretest probability
RCA	Right coronary artery
ROI	Region of interest
RVEDP	Right ventricular end diastolic pressure
SCAD	Stable coronary artery disease
SPECT	Single photon emission computed tomography
TAVI	Transcatheter aortic valve implantation
TC	Total cholesterol
TG	Triglycerides

INTRODUCTION

Due to developments in computed tomography (CT) technology, cardiac CT has become very useful as a non invasive investigation tool in the diagnosis of obstructive coronary artery disease (CAD), and its accuracy has increased to more than 90 % [(1)]. Specifically, cardiac CT plays a gatekeeper role in reducing invasive cardiac angiography implemented solely for the purpose of diagnosis [(2)].

However, cardiac CT also has disadvantages, particularly the exposure of patients to radiation and iodine contrast agent. Consequently, considerable effort has been devoted to identify ways to reduce the radiation exposure and the amount of contrast agent used.

Sufficient vascular enhancement is a prerequisite for the accurate detection of coronary artery stenosis on coronary CT angiography (CCTA) [(3-5)]. Achieving optimal coronary enhancement is particularly important for coronary CT angiography as coronary arteries are of small caliber, have a tortuous course, and diminution of blood flow is observed in the presence of stenosis or obstruction [(6)]. Coronary artery attenuation is determined by the iodine administration rate [(7-8)]; therefore, improved coronary enhancement can be achieved by either increasing the injection rate or by increasing the iodine concentration of contrast media. However, increased injection rate has the following limitations for clinical use of coronary

CT angiography [9]: 1) the injection rate used in clinical practice is already high, 4 to 5 mL/s; 2) larger needles, larger veins, and more set up time for the intravenous line will be necessary; and 3) the potential risk of contrast extravasation would increase. On the other hand, increasing the iodine concentration will be more feasible and without the above mentioned limitations.

Computed tomography (CT) has been revolutionized by a number of huge technological advancements, leading to the current possibility to acquire thousands of thin-slice images with voxel isotropy in a few seconds[83, 84]. Among modern CT applications, CT angiography (CTA) is one that has gained the most benefit from such evolution in terms of improved diagnostic performance and broadened clinical indications.

In fact, while in nonvascular CT, intravenously administered iodinated contrast medium (CM) tends to accumulate into the microcirculation and then in the interstitial space relatively slowly after the beginning of intravenous injection, the following conditions must be fulfilled for optimal depiction of the arterial system:

Narrow slice width (usually ≤1 mm for peripheral CTA, or even narrower down to approximately 0.5 mm for coronary CTA) for proper evaluation of the smallest arterial vessels and high quality of 2-dimensional and 3-dimensional postprocessing;

- Fast imaging time (usually in the order of seconds), so as to acquire CTA data at the peak of arterial contrast enhancement before venous enhancement occurs;
- High selective contrast enhancement of the arteries throughout the whole acquisition volume.[85-89]

In order for those requirements to be met, accurate coupling between CM injection and CTA image acquisition is of paramount importance to fully exploit the contrast bolus over the entire scan duration. In other terms, both the bolus geometry and the scan parameters should be tailored to achieve optimal, homogeneous enhancement of the arterial lumen as well as an accurate assessment of vessel walls, taking into account several factors related to patient (eg, size, cardiac output [CO], circulating blood volume [BV]), CT scanner (eg, scan speed, tube voltage, radiation dose), CM properties (eg, iodine concentration, viscosity, safety issues), and CM injection protocol (eg, flow rate and volume, administration of a saline flush or multiple CM/saline boluses).[91-95] Among them, iodine concentration (defined as the mass of iodine per unit volume of CM in terms of grams per milliliter) is a key element because it is directly related to contrast enhancement in CTA, as outlined in the following sections.

However, the effects of high iodine-concentration contrast material on the vessel visibility of CCTA using a 64-slice Multi detector CT (MDCT) have not been well evaluated.

AIM OF THE STUDY

To compare image quality and attenuation values of multidetector CT coronary angiography (MDCT) between iopromide 300 and iopromide 370 and to evaluate whether the higher iodine contrast material has better image quality or not.

Chapter 1

STABLE CORONARY ARTERY DISEASE (SCAD)

Stable coronary artery disease is generally characterized by episodes of reversible myocardial demand/supply mismatch, related to ischaemia or hypoxia, which are usually inducible by exercise, emotion or other stress and reproducible but may also be occurring spontaneously. Such episodes of ischaemia/ hypoxia are commonly associated with transient chest discomfort (angina pectoris). SCAD also includes the stabilized, often asymptomatic, phases that follow an Acute coronary sundrome (ACS).

Because the transition from unstable to stable syndromes is a continuum, without a clear boundary, angina at rest caused by coronary vasospasm may be regarded within the scope of SCAD [10-12] as in the present document or, conversely, within the scope of ACS as in some [13] but not in other ACS literature.

The various clinical presentations of SCAD are associated with different underlying mechanisms that mainly include: (i) plaque-related obstruction of epicardial arteries; (ii) focal or diffuse spasm of normal or plaque-diseased arteries; (iii) microvascular dysfunction and (iv) left ventricular dysfunction caused by prior acute myocardial necrosis and/or hibernation (ischaemic cardiomyopathy) **Table (1)**. These