HONG KONG COLLEGE OF RADIOLOGISTS

Recommendations on Heart Rate Control in Coronary Computed Tomography Angiography (CTA)

Introduction

Coronary CTA (CCTA) has become a well-recognized imaging technique in the investigation of chest pain. Optimal image quality is reliably achieved with a low heart rate and regular cardiac rhythm during the scan. Even with improved temporal resolution of new CT scanners, there remains tangible benefit with heart rate control which includes both image quality and ability to employ dose reduction scan acquisitions which are not possible at higher heart rate.

This document aims to provide general recommendations on the standards of practice for heart rate control in CCTA, emphasizing on the achievement of diagnostic-quality images obtained in an environment in which patient safety is paramount.

Recommendations

All CCTA examinations should be performed and interpreted by staff adequately trained in CCTA, including adequate knowledge of cardiac anatomy and ALARA principle in radiation exposure. Certification of expertise is desirable but not compulsory.

Target heart rate for coronary CTA set at 65 bpm or less is ideal. However, depending on the scanner temporal resolution, the image acquisition method and the imaging indication, scanning at a heart rate higher than the target heart rate may be acceptable.

In view of the frequent need to administer heart rate-controlling drugs to achieve target heart rate, the CCTA imaging team members should have awareness of the potential complications of these drugs. Team members with up-to-date training in basic life support (BLS) would be recommended, and at least one person certified with advanced cardiac life support (ACLS) readily available during the examination acquisition would be desired. Resuscitation facilities should be immediately available. Availability of Cardiologists or Anaesthetists support when required would be preferred. Please also refer to reference guidelines for adult basic and advanced life support in the provided links:

1. "Highlights of the 2020 American Heart Association Guidelines For CPR and ECC" https://cpr.heart.org/-/media/CPR-Files/CPR-Guidelines-Files/Highlights/Hghlghts_2020_ECC_Guidelines_English.pdf

2. "2023 American Heart Association Focused Update on the Management of Patients With Cardiac Arrest or Life-threatening Toxicity Due to Poisoning: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care" https://www.ahajournals.org/doi/epub/10.1161/CIR.0000000000001161.

Beta-blocker is one of the commonly used drugs for achieving short-term heart rate reduction for the purpose of coronary CTA. Metoprolol is most commonly used due to its demonstrated safety and availability. Beta-blocker protocols prior to coronary CTA may utilize oral, intravenous or both routes of drug administration. Other commonly used agents include sino-atrial nodal inhibitor such as Ivabradine and calcium channel blocker such as Diltiazem. Heart rate control regimes can be individualized at each imaging department as endorsed by CCTA team members with Cardiologists in collaboration.

All patients should have risk assessment to ensure that it is safe for them to undergo the scan. Screening for contraindications to heart rate control medication should be performed prior to administration.

All patients should have their blood pressure and pulse measured and recorded before and after the administration of heart rate control medication. This should be done every 15-30 minutes and the patient should be seated or laying where they can be seen and monitored by staff, ideally in a dedicated monitoring area. The length of time the patient remains in the imaging department after the scan is a matter of local practice and depends on the presence of patient symptoms related to the drugs or contrast medium administered. Monitoring of the patient for 15-30minutes before leaving would be recommended. If the patient has persisting symptoms related to heart rate controlling medication, they should remain monitored in the department until these symptoms are resolved. Advice or review from Cardiologists may be required.

We recommend single agent regimes for heart rate control in coronary CTA in adult patients as follows. For individualized regimes requiring combination of different heart rate control agents or for paediatric patients, please also consult local specialist advice and ensure availability of necessary supportive care.

Beta-blockers

1. Oral beta-blocker premedication, followed by supplemental IV beta-blocker if the target heart rate is not achieved prior to image acquisition
    - Oral metoprolol 50-100mg 1 hour prior to scan
    - If target heart rate is not achieved, repeated dose of oral beta-blocker is not recommended and supplemental titrated IV doses immediately prior to the CT scan is recommended instead
        - Initial dose of 5mg IV metoprolol, followed by 3-5 minutes of monitoring to observe heart rate response
        - Further repeated IV dose of 5mg each may be administered as indicated to achieve the desired heart rate
        - Typically, up to a maximum dose of 20mg

2. Intravenous beta-blocker alone
    - Starting dose of 5mg IV metoprolol, followed by 3-5 minutes of monitoring to observe the heart rate response
    - Further repeated IV dose of 5mg each administered as indicated to achieve desired heart rate
    - Typically, up to a maximum dose of 20mg

Absolute contraindications to beta-blockers include

- Hypotension (BP<90/60mmHg)
- Uncontrolled heart failure
- History of sick sinus syndrome or 2nd/3rd degree heart block (unless a functioning pacemaker is present)
- Known hypersensitivity to beta-blocker

Relative contraindications to beta-blockers include

- Asthma or bronchospastic disease
- Chronic obstructive pulmonary disease
- Severe aortic stenosis / peripheral vascular disease
- Controlled heart failure
- Patients who are on other atrioventricular nodal blocking agents such as calcium channel blockers e.g. verapamil

Ivabradine

Ivabradine is an alternative to beta-blocker for heart rate reduction. It selectively inhibits the I(f) current in the sinus node, leading to heart rate reduction without affecting blood pressure. It does not work in patient not in sinus rhythm (e.g. atrial fibrillation).

- The most common regime is single dose of oral Ivabradine 15mg or 7.5mg (in chronic beta-blockade) 1-2 hour prior to scan.
- It can be used in combination with oral or IV metoprolol to achieve target heart rate

Absolute contraindications to Ivabradine include

- Hypotension (BP<90/60mmHg)
- Severe hepatic insufficiency (e.g. Child Pugh's C liver cirrhosis)
- Acute decompensated heart failure or acute myocardial infarction
- History of sick sinus syndrome or 2nd/3rd degree heart block
- Known hypersensitivity to Ivabradine
- Pregnancy and breastfeeding
- Combination with strong cytochrome P450 3A4 inhibitors

Relative contraindications to Ivabradine include

- Atrial fibrillation
- Mild to moderate hepatic impairment (Child Pugh's A and B liver cirrhosis)

Calcium Channel Blockers

Calcium channel blockers cause a negative chronotropic effect by slowing conduction through the atrioventricular node, thus more effective than beta-blocker in reducing ventricle rate in atrial fibrillation. It is also useful alternative to beta-blocker in patients with asthma or obstructive pulmonary disease. Diltiazem is generally the calcium channel blocker of choice in CCTA, and can be administered using oral or intravenous route.

1. Oral calcium channel blocker regime
   - Single dose of oral Diltiazem 30mg-60mg 1 hour prior to scan

2. Intravenous calcium channel blocker regime
   - Starting dose of 10mg IV Diltiazem, followed by 10mins of monitoring to observe the heart rate response
   - Further repeated IV dose of 10mg may be administered as indicated to achieve the desired heart rate
   - Typically, up to a maximal dose of 20mg

Absolution contraindications to calcium channel blockers include
- Hypotension (<90/60mmHg)
- History of sick sinus syndrome or 2nd/3rd degree AV block (unless a functioning pacemaker is present)
- Sick sinus syndrome
- Decompensated heart failure
- Hypersensitivity to calcium channel blocker

Relative contraindications to calcium channel blockers include
- Wolf-Parkinson-White Syndrome
- Patients on long term beta-blocker therapy

References

1. SCCT guidelines for the performance and acquisition of coronary computed tomographic angiography: A report of the Society of Cardiovascular Computed Tomography Guidelines Committee Endorsed by the North American society for Cardiovascular Imaging (NASCI). S. Abbara et al., Journal of Cardiovascular Computed Tomography 10 (206) 435 - 449.

2. The Royal College of Physicians, the British Society of Cardiovascular Imaging and The Royal College of Radiologists. Standards of practice of computed tomography coronary angiography (CTCA) in adult patients. London: The Royal College of Radiologists, 2014.

Acknowledgement

Hong Kong College of Radiologists expresses gratitude to the followings for their contributions:

Dr. CHAN Wing Sze Carmen (Specialist in Cardiology)
Dr. CHEUNG Chi Wai Stephen (Specialist in Radiology)
Dr. LAM Hiu Yin Sonia (Specialist in Radiology)
Dr. LEE Chun Yin Jonan (Specialist in Radiology)
Dr. LI Man Wah Andrew (Specialist in Cardiology)
Dr. SHU Shang Jen Jack (Specialist in Radiology)
Dr. WONG Ka Tak Jeffrey (Specialist in Radiology)