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Coronary stent evaluation with coronary computed tomographic angiography: Comparison between low-osmolar, high-iodine concentration iomeprol-400 and iso-osmolar, lower-iodine concentration iodixanol-320

Daniele Andreini MD[a,b,*], *Gianluca Pontone MD*[a], *Saima Mushtaq MD*[a], *Antonio L. Bartorelli MD*[a,b], *Edoardo Conte MD*[a], *Erika Bertella MD*[a], *Andrea Baggiano MD*[a], *Andrea Annoni MD*[a], *Alberto Formenti MD*[a], *Giovanni Ballerini MD*[a], *Piergiuseppe Agostoni MD, PhD*[a,b], *Cesare Fiorentini MD*[a,b], *Mauro Pepi MD*[a]

[a] *Centro Cardiologico Monzino, IRCCS, Via C. Parea 4, 20138 Milan, Italy*
[b] *Department of Clinical Sciences and Community Health, Cardiovascular Section, University of Milan, Milan, Italy*

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ABSTRACT

Background: Reliability of coronary angiography by multidetector row CT (MDCT-CA) for stent evaluation is still a matter for debate, and it is unknown whether contrast medium characteristics may affect diagnostic performance of MDCT-CA.

Objective: We compared iomeprol-400 with iodixanol-320 to evaluate coronary stents with MDCT-CA.

Methods: We randomly assigned 254 patients undergoing coronary stent follow-up with the use of MDCT-CA to iomeprol-400 at 5.0 mL/sec flow rate (group 1; n = 83), iodixanol-320 at 6.2 mL/sec flow rate (group 2; n = 87), and iodixanol-320 at 5.0 mL/sec flow rate (group 3; n = 84). Heart rate (HR) immediately before and at the end of scanning, HR variation, premature heart beats, and heat sensation by visual analog scale during scanning were recorded. Mean attenuation was measured in the aortic root and coronary arteries. Image quality score and type of artifacts were assessed.

Results: Mean attenuation was significantly lower in group 3 than in the other groups. In group 3, stent evaluability was significantly higher and artifact rate was significantly lower than in group 2 (99% vs 91% and 4% vs 15%) and group 1 (99% vs 92% and 4% vs 17%), respectively, mainly because of a significant lower rate of beam-hardening artifacts (3 cases in group 3 vs 22 and 27 in groups 2 and 3, respectively). In group 3, visual analog scale, HR at the end of imaging, and number of patients with premature heart beats during the scan were significantly lower than in the other groups.

Conflict of interest: The authors report no conflict of interest.

* Corresponding author.
E-mail address: daniele.andreini@ccfm.it (D. Andreini).

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Conclusions: Iodixanol-320 provides better image quality of coronary stents, allowing higher MDCT-CA evaluability, than iomeprol-400.

1. Introduction

Coronary angiography by multidetector row CT (MDCT-CA) is increasingly being used as a noninvasive tool for evaluating native coronary arteries, stents, and bypass grafts. Good diagnostic accuracy has been reported for coronary arteries and bypass grafts, yet beam-hardening artifacts because of metallic struts may preclude accurate quantification of neointimal hyperplasia and coronary stent narrowing. Although single-center studies with 64-slice MDCT-CA showed good diagnostic performance for detecting in-stent restenosis (ISR), recent pooled analyses reported an overall sensitivity of 84% with a 13% rate of nonassessable stents.[1–3] Because of these limitations, current appropriateness criteria describe MDCT-CA as an uncertain method to evaluate coronary stents.[4] Another debate is going on over the diagnostic performance of different contrast media (CM). Indeed, it is unclear whether characteristics of different CM such as iodine concentration, osmolarity, and pharmacokinetics may affect MDCT-CA results. Although high-iodine concentration CM have been considered good contrast agents for MDCT-CA, providing higher intracoronary attenuation,[5,6] recent studies found some advantages of dimeric, iso-osmolar, lower-iodine concentration iodixanol-320 such as reduction of arrhythmias, less patient discomfort because of heat sensation, and more favorable behavior of heart rate (HR) during the scan.[7,8] We hypothesized that the use of iodixanol-320 would be particularly useful for coronary stent assessment with MDCT-CA because its use is likely associated with an attenuation of beam-hardening artifacts, as a result of its lower iodine concentration. Thus, the aim of the present study was to prospectively compare the effects on stent evaluability, image quality, patient heat sensation, premature heart beats (PHBs), and HR response during scanning with the use of CM with a low-osmolar, high-iodine concentration (iomeprol-400) or an iso-osmolar, lower-iodine concentration (iodixanol-320) in patients undergoing evaluation of coronary stents with the use of MDCT-CA.

2. Methods

2.1. Study population

Between July 2011 and June 2012, 300 consecutive patients who were scheduled for noninvasive coronary imaging follow-up with MDCT-CA of previously implanted coronary stents were considered for inclusion in this study. Exclusion criteria were contraindications to CM, impaired renal function (creatinine clearance < 60 mL/min), inability to sustain a 15-second breath hold, HR > 65 beats/min despite β-blockade treatment, and cardiac arrhythmias. A total of 22 patients were excluded because of breath-holding inability (6 patients), impaired renal function (10 patients), and cardiac arrhythmias (6 patients). Therefore, 278 patients were divided into 3 groups with the use of a computer-generated randomized process. In all patients with a resting HR > 65 beats/min before MDCT-CA, metoprolol was intravenously administered with a titration dose up to 25 mg to achieve a target HR of $\leq$65 beats/min. Twenty-four additional patients were excluded because target HR was not reached (8 in group 1, 8 in group 2, and 8 in group 3). Therefore, a total of 254 patients were included in the study and underwent MDCT-CA (83 in group 1, 87 in group 2, and 84 in group 3). The mean $\pm$ SD interval between coronary stent implantation and MDCT-CA examination was 6 ± 3 months. Written informed consent was obtained from all patients, and the study protocol was approved by the institutional ethics committee. For each patient, age, sex, body mass index (BMI; calculated as weight divided by height squared; kg/m^2), cardiovascular risk factors, serum creatinine, HR immediately before and at the end of scanning, HR variation, mean HR, and PHB number during scanning were recorded. Moreover, assessment of patient heat sensation was obtained immediately after scanning with the use of a visual analog scale (VAS), as previously described.[7]

2.2. Imaging protocol

In all patients, MDCT-CA was performed with a LightSpeed VCT XTe scanner (GE Healthcare, Milwaukee, WI) with the use of the following parameters: slice configuration of 64×0.625 mm, gantry rotation time of 350 milliseconds, and prospective electrocardiogram triggering (SnapShot Pulse; GE Healthcare, Milwaukee, WI). The adaptive statistical iterative reconstruction image processing algorithm was used for image reconstruction. A BMI-adapted scanning protocol was used as follows: BMI < 20, tube voltage and tube current of 100 KVp and 500mA, respectively; $20 \leq$ BMI < 25, tube voltage and tube current of 100 KVp and 550mA, respectively; $25 \leq$ BMI < 30, tube voltage and tube current of 100 KVp and 600 mA, respectively; and $30 \leq$ BMI < 35, tube voltage and tube current of 120 KVp and 650mA, respectively. A short x-ray window of 100 milliseconds in only 1 end-diastolic phase (ie, 75% of the R–R cycle) was used. In group 1, all patients received an 80-mL bolus of iomeprol-400 (Iomeron 400 mg/mL; Bracco, Milan, Italy) through an antecubital vein at an infusion rate of 5 mL/sec. In group 2, all patients received a 80-mL bolus of iodixanol-320 (Visipaque 320 mg/mL; GE Healthcare, Oslo, Norway) through an antecubital vein at an infusion rate of 6.2 mL/sec. In group 3, all patients received an 80-mL bolus of iodixanol-320 (Visipaque 320 mg/mL; GE Healthcare, Oslo, Norway) through an antecubital vein at an infusion rate of 5 mL/sec. In all patients, CM administration was followed by 50 mL of saline solution, and imaging was performed according to the bolus tracking technique.