Coronary stent evaluation with computed tomography coronary angiography: comparison between Iomeprol-400 and Iodixanol-320

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Purpose

Multi-detector computed tomography coronary angiography (MDCT-CA) is becoming an increasingly widespread tool for the non-invasive evaluation of coronary arteries, stents and bypass grafts (1). Although good diagnostic accuracy has been demonstrated for native coronary arteries and bypass grafts, beam-hardening artifacts resulting from 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 in-stent restenosis (ISR) detection, recent pooled analyses reported an overall sensitivity for ISR detection of 84% with a 13% rate of non-assessable stents (2-5). Due to these limitations, current appropriateness criteria have described MDCT-CA as an uncertain method for coronary stent evaluation (6). A debate is also going on over the question whether contrast medium (CM) characteristics such as iodine concentration, osmolality and pharmacokinetics of different agents may affect MDCT-CA diagnostic performance. Although high-iodine concentration CM have been considered the gold standard contrast agents for MDCT-CA, providing higher intra-coronary attenuation (7,8), recent studies demonstrated some advantages of dimeric, iso-osmolar, lower-iodine concentration Iodixanol-320 such as reduction of arrhythmias, less patient discomfort due to heat sensation and more favourable behaviour of heart rate (HR) during the scan (9,10). 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, thanks to its lower iodine concentration. The aim of the present study was to prospectively compare the effects on stent evaluability, image quality, patient heat sensation, prevalence of premature heart beats (PHB) and HR behaviour during scanning of a low-osmolar, high-iodine concentration CM (Iomeprol-400) vs. an iso-osmolar, lower-iodine concentration CM (Iodixanol-320) in patients undergoing MDCT-CA evaluation of coronary stents.
Methods and Materials

Three-hundred consecutive patients with previous coronary stent implantation who were scheduled for non-invasive coronary imaging follow-up with MDCT-CA between July 2011 and June 2012 were considered for inclusion in this study. A total of 22 patients were excluded due to breath-holding inability (6 patients), impaired renal function (10 patients) and cardiac arrhythmias (6 patients). Therefore, 278 patients were divided into 3 groups using a computer-generated randomised process. Twenty-four patients were further excluded from the study because target HR#65 beats/min was not reached. Therefore, a total of 254 patients were included in the study and subsequently underwent MDCT-CA (83 in group 1, 87 in group 2 and 84 in group 3). The mean interval between coronary stent implantation and MDCT-CA examination was 6±3 months. For each patient, age, sex, body mass index (BMI), cardiovascular risk factors, serum creatinine, HR before and after scanning, HR variation and PHB number during scanning were recorded. Moreover, assessment of patient heat sensation was obtained immediately after scanning using a visual analog scale (VAS), as previously described (9). In group 1, 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, 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, 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.
Results

The three groups were homogeneous in terms of gender, age, BMI, prevalence of cardiovascular risk factors and serum creatinine. No significant differences were also found in intravenous or oral b-blockade pre-treatment and stent characteristics. At least one stent with significant ISR at MDCT-CA was found in 36 patients of group 1, in 31 patients of group 2 and in 35 patients of group 3.

The HR before imaging was similar in the 3 groups. On the contrary, the HR after imaging was significantly lower in group 3 than in group 2 (53.7 vs. 56.7 bpm, p=0.001) and group 1 (53.7 vs. 56.2 bpm, p=0.008). During the scan, HR showed a decrease in all groups associated with patient breath hold. However, HR decrease was significantly higher in group 3 than in group 2 (-6.6 vs. -4.8 bpm, p=0.001) and group 1 (-6.6 vs. -3.8 bpm, p=0.0001). The number of MDCT-CA with at least one PHB during the scan was significantly lower in group 3 than in group 2 (0 vs. 7, p=0.008) and group 1 (0 vs. 8, p=0.003). The VAS was significantly lower in group 3 than in group 2 (4.3 vs. 5.3 mm, p=0.0001) and group 1 (4.3 vs. 8 mm, p=0.0001). The VAS was also significantly lower in group 2 than in group 1 (5.3 vs. 8 mm, p=0.0001).

Mean attenuations in the aortic root and coronary arteries were no significant different between groups 1 and 2. Mean attenuation values in the aortic root and coronary arteries, with the exception of the right coronary artery, were significantly lower in groups 3 than in groups 2 and 1.

The overall stent evaluability was significantly higher in group 3 than in group 2 (98% vs. 91%) and group 1 (98% vs. 92%) due to the presence of a lower number of severe artifacts in group 3 as compared to groups 2 and 1. In a sub-analysis of severe artifacts, we found a significantly lower number of severe beam-hardening effects in group 3 vs. groups 2 and 1. The overall number of artifacts was also significantly lower in group 3 vs. group 2 and group 3. In a sub-analysis of all artifacts, we found a significantly lower number of beam-hardening effects in group 3 vs. groups 2 and 1, of motion artifacts in group 3 vs. group 1 and of slice misalignment in group 3 vs. group 1. Figure 1,2 and 3 depict an example of excellent visualization of stent lumen using Iodixanol-320 at 5.0 mL/sec flow rate.
Fig. 1: Visualization of LAD stent lumen using Iodixanol-320 at 5.0 mL/sec flow rate
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**Fig. 2:** Excellent visualization of a small caliber stent using Iodixanol-320 at 5.0 mL/sec flow rate

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**Fig. 3:** Excellent visualization of stent lumen using Iodixanol-320 at 5.0 mL/sec flow rate

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Conclusion

The main finding of the study is that Iodixanol-320 provided better image quality allowing higher evaluability of coronary stents in comparison to Iomeprol-400 when the two CM were injected at the same flow rate. This was the result of a significant reduction of the beam-hardening effect, which often leads to artifacts that may preclude accurate assessment of coronary stent lumen. Moreover, Iodixanol-320 decreased heat sensation, reduced PHB number and minimized the effect of CM injection on heart rate during MDCT-CA scan. The substantial reduction was mainly due to a significantly lower number of severe beam-hardening artifacts in group 3 in comparison with the two other groups.
References


