Evaluation of Patients with Previous Coronary Stent Implantation with 64-Section CT

Schuijf JD, Pundziute G, Jukema JW, Lamb HJ, Tuinenburg JC, et al.
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Review

Stent implantation has been increasingly performed for patients with significant coronary artery disease. Patients with coronary artery re-stenosis frequently present with chest pain. The occurrence of re-stenosis in patients with stent placement is less frequent than those with balloon angioplasty. The clinical incidence of re-stenosis after coronary stent implantation is 20–35% for bare metal stents and 5–10% for drug-eluting stents (1). It can be higher in certain subsets of lesions such as long stenoses, bifurcation lesions, or lesions in small coronary arteries.

Due to the blooming artifacts caused by the metallic struts, the evaluation of the lumen within coronary artery stents by MDCT is particularly challenging compared to the assessment of the native coronary arteries. The extent of this artifact depends on the material and design of the stent, with more severe artifacts given by stents with high metal content (2, 3). 64-section CT scanners have been shown to detect stenoses of native coronary arteries with sensitivities and specificities up to 99%. It was not until the last 2 years that a number of investigators reported the application of 16-section or 64-section CT in the evaluation of coronary in-stent restonosis (4-12).

Schuijf's work (4) that appeared in Radiology in November 2007 is selected as the ASCI choice for this month. Based on conventional coronary angiography as the golden standard, the group reported their experience in the diagnostic accuracy of 64-section CT for the assessment of coronary artery in-stent or peri-stent restenosis. They reported that all six significant (≧ 50%) in-stent restenoses were detected, and the absence of significant restenosis was correctly identified in the 52 remaining stents, resulting in a sensitivity, specificity, and a negative and a positive predictive value of 100%. This figure is higher than the figures reported by others in 2007 using 64-section CT, which were 89-97%, 88-95%, 90-99% and 63-94%, respectively (5-7). In Schuijf's series, the sensitivity, specificity, negative and positive predictive values for the detection of significant peri-stent stenosis were 100%, 98%, 71% and 100%, respectively (4).

Despite the promising outcomes of 64-section CT in assessing in-stent restenoses, one should consider that 11 (14%) of 76 stents were not assessable in Schuijf's series. In addition, both elevated heart rate and overlapping position of the stents appeared to be associated with decreased interpretability, although no effect of stent type or location was observed (4). The incidence of non-assessable metallic stents with 64-section has been reported to be 7% by Cademartiri et al (5), 2.2% by Rist et al (8), and 24% by Rixe et al (1), while the corresponding incidence with 16-section CT was 8-11% (9), 36% (10), 31% (11) and 23% (13). Compared with 16-MDCT, it seems that the incidence of non-assessable metallic stents occurred less when 64-MDCT was used. This could be partly attributed to the improved temporal and spatial resolution of higher-end MDCT.

There are several factors that may degrade the image quality leading to unassessable stent lumen. First, stents with smaller diameters (e.g. ≦ 3.0 mm) tend to be affected by degraded image quality. Gilard et al (10) reported that detection of in-stent restenosis depended on stent diameter. With small stents (≦ 3 mm), sensitivity and specificity of 16-MDCT were 54% and 100%, respectively, and positive and negative predictive values were 100% and 94%. For stents with larger diameters (> 3mm), corresponding values were 86%, 100%, 100%, and 99%, respectively. Rixe et al (1) described that the mean diameter of evaluable stents was 3.28 ± 0.40 mm, whereas that of non-evaluable stents was 3.03 ± 0.31 mm ($P < 0.0002$). Second, stents with thicker struts were more prone to high-density artifacts (and thus decreased assessability) than were stents with thin struts (12). Images of 41% of stents with thick struts were uninterpretable, as compared with images of 11% of stents with thinner struts (12). Third, partially overlapping stents are also associated with degraded image quality (4). The increased metal content is likely to amplify high-attenuation artifacts. In Schuijf's study, images of 93% of single stents were interpretable, while images of 33% of partially overlapping stents were of nondiagnostic quality (4). A final factor degrading the image quality of stents involves motion artifacts due to elevated heart rate. In Schuijf's series (4), where all patients were receiving continuous beta adrenergic blocking agent therapy and no additional blocking agents were administered prior to multisection CT, the average heart rate was 58 ± 10 bpm. Of the 11 non-assessable stents, the reasons were motion artifacts in 5 (45%) and attenuation artifacts in the other 6 (55%). The mean heart rate during data acquisition was significantly higher in those due to motion artifacts (bpm = 72 ± 9) than in those due to attenuation artifacts (bpm = 55 ± 2) ($P = 0.002$). It is expected that dual sources or 320-section CT scanners may avoid the motion artifacts or image degradation attributed to elevated heart rate.

In conclusion, studies by Schuijf et al and a number of investigators suggest that in-stent restenosis can be evaluated with 64-section MSCT with satisfactory diagnostic accuracy. In particular, the high negative predictive value of 100% indicates that 64-section CT may be most valuable for noninvasive detection of coronary in-stent restenosis. However, the incidence of non-assessable metallic stents with 64-section MDCT is 2-24%, and such non-interpretability in imaging is persistently a challenge to us in the future.

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