Evaluation of coronary allograft vasculopathy using multi-detector row computed tomography: a systematic review

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Summary

Coronary allograft vasculopathy (CAV) is a significant cause of morbidity and mortality after cardiac transplantation and requires frequent surveillance with catheter-based coronary angiography (CCA). Multi-detector row computed tomography (MDCT) has been shown to be effective in assessing atherosclerosis in native coronary arteries. This article systematically reviews the literature to determine the accuracy of MDCT in CAV assessment. An English-language literature search was performed using EMBASE, OVID, PubMed, and Cochrane Library databases. Studies that directly compared MDCT with CCA and/or IVUS for the detection of coronary artery stenosis or significant intimal thickening in cardiac transplant patients were analyzed. Data were pooled to obtain weighted sensitivities, specificities, and diagnostic accuracies. Negative and positive predictive values (NPV/PPV) were calculated. A total of seven studies with a sum of 272 patients were included in this review. There were three studies examining 16-slice MDCT and four studies looking at 64-slice MDCT in CAV. Using per-segment analysis, MDCT assessed between 91% and 96% of all coronary segments when evaluating for stenosis. Pooled estimates for specificity and sensitivity for MDCT ranged from 82% to 89% and 89% to 99%, respectively, while NPV was 99%. Per-patient analysis revealed a sensitivity of 87–100% and NPV of 96–100%. PPV was less than 50% for 64-slice MDCT in both per-segment and per-patient analysis. When compared with IVUS, MDCT had a sensitivity of 74–96% and specificity of 88–92% in assessment of intimal thickening. NPV and PPV were 80–81% and 84–98%, respectively. The high sensitivity and NPV of MDCT suggest that it may be a useful, noninvasive screening tool to rule out CAV.

Keywords: Coronary allograft vasculopathy • Multi-detector row computed tomography • Catheter-based coronary angiography • Intravascular ultrasound

INTRODUCTION

After the first year of transplantation, coronary allograft vasculopathy (CAV) is the leading cause of death among recipients of cardiac transplants [1]. At 5 years post-transplantation, CAV may be detected in up to 50% of patients [2]. CAV, resulting from endothelial damage due to immune and nonimmune factors, leads to luminal narrowing, myocardial ischemia, and eventually graft failure.

CAV is often clinically silent in the setting of denervation of 70–90% of cardiac allografts [3], making diagnosis difficult. Noninvasive tests are not sensitive or specific enough for assessment of CAV. Therefore, in most centers, catheter-based coronary angiography (CCA) is performed on an annual basis. In addition to being invasive, CCA also underestimates the presence of disease when compared with histopathologic analysis and intravascular ultrasound (IVUS) [4,5] due to the absence of focal lesions and positive remodeling associated with CAV [5,6]. IVUS is the gold standard for detection of CAV, but it is invasive, limited to large epicardial arteries, and costly, particularly if done on an annual basis.

Multi-detector row computed tomography (MDCT) may be a new, accurate noninvasive test for evaluating CAV. MDCT has been demonstrated to be reliable for detection of stenosis in native coronary arteries, with particularly high sensitivities and negative predictive values (NPVs) [7]. Due to its ability to visualize luminal as well as mural abnormalities, MDCT may be able to detect CAV earlier than CCA much like IVUS. This systematic review attempts to determine the accuracy of MDCT in assessing CAV when compared with CCA and IVUS.

METHODS

A literature search was performed using the online databases MEDLINE, OVID, EMBASE, and Cochrane Library with keywords describing MDCT assessment of CAV. Search terms were as follows: ‘computed tomography’ matched with ‘coronary artery’ and ‘transplant’ or ‘allograft vasculopathy’ or ‘transplant vasculopathy’. We included studies that directly compared 16-slice or 64-slice MDCT (or dual-source computed tomography – DSCT) with CCA and/or IVUS for the detection of coronary artery stenosis or significant wall thickening in cardiac transplant patients. References from included studies were manually searched to supplement electronic searches (Fig. 1).
Original articles from the electronic database and manual search were reviewed, while all other forms of publication were excluded (e.g., case reports, letters, editorials, animal and in vitro studies, abstracts only, and case series with fewer than 10 patients). References from review articles were also examined to identify original research. In addition, all foreign-language articles were excluded. Articles which failed to provide head-to-head comparison between MDCT and the reference standard of CCA or IVUS were also not included.

Both per-segment and per-patient analysis for MDCT assessment of CAV was performed when possible. Coronary segments were described most often using the system proposed by the American Heart Association [8], or modified versions of this system. Significant stenosis was defined by the presence of a >50% or ≥50% obstructive lesion [9–14] in every study except one where >70% obstruction was used as a cutoff [15]. Early CAV, as visualized by IVUS, was defined as intimal thickening of >0.5 mm [12,14] or the presence of intimal thickening in the absence of obstructive coronary lesions (<50% stenosis) [13]. In studies included for analysis, the sensitivity and specificity of MDCT had to be noted or calculable from provided data. Data from all studies were pooled to obtain a weighted sensitivity, specificity, NPV, positive predictive value (PPV), and diagnostic accuracy for MDCT.

The quality of each study cited was reviewed using the quality information questionnaire from the University of Alberta Evidenced Based Working Group. This questionnaire has been used for selection of studies in previous MDCT-based guidelines [16]. Both authors reviewed each citation.

**RESULTS**

**Study characteristics**

There were seven studies included in the analysis of MDCT assessment of CAV [9–15]. In all investigations, the reason for patient assessment with the reference standard was annual surveillance of CAV. Exclusion criteria for most studies included renal dysfunction (creatinine > 106–212 µmmol l⁻¹) [10–15], atrial arrhythmias [10,13,14], and evidence of clinical instability [10–12,14]. β-Blockers were administered for heart rate reduction in only one 16-slice and two 64-slice studies [10–12] because transplant patients are often denervated and have decreased response to these medications. The efficacy of β-blockers was variable with two studies reporting reductions in heart rate by >10 beats min⁻¹ with administration [11,12], while one study noted no significant change [10]. Only two investigations did not corroborate qualitative CCA assessment of coronary stenosis with quantitative coronary angiography (QCA) [9,11]. Observers were blinded to the results of the reference standard in each study analyzed.

Radiation doses were reported in only four of seven studies [11–14]. These doses ranged from 3 to 10 mSv [11,13] in 16-slice studies and 10 to 18 mSv [12,14] in 64-slice studies. Approximately 60–100 cm³ of iodinated contrast was administered for both 16-slice and 64-slice MDCT [10–14]. The absence of contrast-induced nephropathy and contrast-associated allergic reaction was documented in five studies [10–14], but not reported in the remaining two studies [9,15].
Baseline characteristics

A total of 272 cardiac transplant patients underwent MDCT for assessment of CAV (Table 1). Of these, 173 patients had 16-slice MDCT, while 99 underwent 64-slice MDCT [9–15]. Mean age for patients was between 35 and 58 years. Participants in these studies ranged from 77% to 100% male. MDCT scan was performed a mean of 2.8–8.5 years after transplantation [10–12,14,15]. Average heart rate for patients was between 69.5 and 90 BPM at the time of scanning [10–15]. Body mass index was 26–29.5 kg m$^{-2}$, but this was reported in only four of seven studies [12–15].

Assessment of significant CAV: comparing MDCT to CCA

There were three 16-slice and three 64-slice studies that directly compared MDCT with CCA in evaluating CAV (Table 2). When analysis was performed on a per-coronary segment basis, 16-slice and 64-slice MDCT were able to respectively assess 96% and 91% of all coronary segments visualized by CCA. In comparison with CCA, 64-slice MDCT had a sensitivity and specificity of 89%, similar to results obtained with 16-slice MDCT. 16-Slice and 64-slice MDCT had an NPV of 99%. The pooled PPV for 64-slice MDCT was poor at 49%, substantially lower than that observed with 16-slice MDCT.

Four studies provided sufficient data for per-patient assessment of MDCT efficacy in CAV (Table 3). Only one of these investigations used 64-slice MDCT. In this analysis, MDCT was able to assess between 84% and 93% of transplant patients for CAV. Sensitivity and specificity for MDCT ranged from 87% to 100% and 81% to 91%, respectively. NPV was notably very high at 96–100%. As with per-coronary segment analysis, PPV was markedly lower with 64-slice MDCT when compared with 16-slice MDCT.

Only three studies have examined the accuracy of MDCT in quantifying luminal stenosis. When compared with CCA as a reference standard, Pearson correlation coefficients ranged from 0.64 to 0.89, suggesting good correlation. When assessing the accuracy of measurements, the standard error of estimate in these studies was 14.4–15.0%.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Patient numbers</th>
<th>Mean age (years)</th>
<th>Mean duration from transplantation (years)</th>
<th>Men (%)</th>
<th>BMI (kg m$^{-2}$)</th>
<th>Mean HR</th>
</tr>
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<tbody>
<tr>
<td>16-Slice MDCT</td>
<td>Romeo et al.</td>
<td>53</td>
<td>48</td>
<td>7.6</td>
<td>75</td>
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<td></td>
<td>Sigurdsson et al.</td>
<td>54</td>
<td>54</td>
<td>N/S</td>
<td>89</td>
<td>28.1</td>
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<td></td>
<td>Pichler et al.</td>
<td>66</td>
<td>58</td>
<td>8.5</td>
<td>91</td>
<td>26.8</td>
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<tr>
<td>Total</td>
<td></td>
<td>173</td>
<td></td>
<td></td>
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<td>69.5 ± 11</td>
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<tr>
<td>64-Slice MDCT</td>
<td>Nunoda et al.</td>
<td>10</td>
<td>35</td>
<td>N/S</td>
<td>77</td>
<td>N/S</td>
</tr>
<tr>
<td></td>
<td>Gregory et al.</td>
<td>20</td>
<td>52</td>
<td>5.8</td>
<td>80</td>
<td>29.5</td>
</tr>
<tr>
<td></td>
<td>von Ziegler et al.</td>
<td>28</td>
<td>53</td>
<td>7.7</td>
<td>100</td>
<td>N/S</td>
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<tr>
<td></td>
<td>Schepis et al.</td>
<td>41</td>
<td>40</td>
<td>2.8</td>
<td>81</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>99</td>
<td></td>
<td></td>
<td></td>
<td>87 ± 17</td>
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</table>

N/S: not specified.

a β-Blockers were not administered for heart rate reduction.
b Blinding was not specified.
c DSCT used for scanning.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Patient numbers</th>
<th>Per-segment prevalence of CAV (%)</th>
<th>Vessel diameter analyzed (mm)</th>
<th>Assessibility (%)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>NPV (%)</th>
<th>PPV (%)</th>
<th>Diagnostic accuracy (%)</th>
</tr>
</thead>
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<tr>
<td>16-Slice MDCT</td>
<td>Romeo et al.</td>
<td>53</td>
<td>&gt;1.5</td>
<td>96</td>
<td>80</td>
<td>99</td>
<td>99</td>
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<td>99</td>
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<tr>
<td></td>
<td>Sigurdsson et al.</td>
<td>54</td>
<td>≥1.5</td>
<td>96</td>
<td>86</td>
<td>99</td>
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<td></td>
<td>Pichler et al.</td>
<td>66</td>
<td>≥1.5</td>
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<td>71</td>
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<td>Nunoda et al.</td>
<td>10</td>
<td>&gt;1.5</td>
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<td>97</td>
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<td></td>
<td>von Ziegler et al.</td>
<td>28</td>
<td>N/S</td>
<td>81</td>
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<td>97</td>
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<td></td>
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<td>41</td>
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<td>89</td>
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<td>99</td>
<td>49</td>
<td>49</td>
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N/S: not specified. Severe coronary artery stenosis was defined by >50% or ≥50% obstruction of lumen in the coronary artery tree of a patient after cardiac transplantation.
a Quantitative coronary angiography was not performed. Evaluation of coronary artery stenosis was made based on assessment with qualitative angiography.
b Severe coronary artery stenosis was defined by >70% obstruction of lumen in the coronary artery tree.
Three studies compared the efficacy of MDCT with IVUS for the detection of intimal thickening due to CAV (Table 4). All studies used per-segment-based analysis and none provided sufficient data for per-patient analysis. Proximal coronary segments were predominantly analyzed. Only 19–36% of all potential segments visualized by CCA or MDCT were examined with IVUS. MDCT was able to assess between 97% and 99% of all segments analyzed by IVUS. 16-slice and 64-slice MDCT had a sensitivity of 74–96% and specificity of 88–99%. NPVs for MDCT were between 80 and 81%, while PPV ranged from 84% to 98%. The overall diagnostic accuracy for MDCT in assessing intimal thickening was 83–91%. There was no documented attempt to describe plaque characteristics, such as calcification, with MDCT or IVUS in any study.

### DISCUSSION

#### Assessment of significant CAV: comparing MDCT to CCA

As cardiac denervation is frequent after transplantation, patients with CAV remain asymptomatic and commonly present with graft failure or malignant cardiac arrhythmias [17]. Therefore, CCA is performed annually as surveillance for CAV. However, the clinical utility of annual assessment has been questioned [18]. From a histopathologic viewpoint, CAV is associated with concentric intimal thickening, positive remodeling and distal disease, making diagnosis difficult on CCA [19]. CCA has been shown to have poor sensitivity for assessing CAV when compared with IVUS [20]. In addition, CCA carries a small (0.1%) but significant risk for stroke, myocardial infarction, or death [21]. These risks may increase in the setting of repeated testing as is the standard for transplant patients [18].

MDCT has recently been shown to accurately assess native CAD [7], suggesting that it may be a useful screening tool for detection of CAV. In addition to being noninvasive, MDCT may be able to evaluate both luminal and mural changes associated with CAV, unlike CCA. However, elevated heart rates seen in transplant patients lead to motion artifact and image degradation, potentially limiting the efficacy of MDCT in this setting. Patients with rapid heart rates were often excluded entirely from native CAD studies [7]. In a preliminary study involving pediatric cardiac transplant patient population, motion artifact prevented the analysis of 25% coronary segments with 4-slice MDCT [22]. Newer scanners have increased spatial and temporal resolution and may permit accurate detection of CAV despite increased heart rates.

A total of six studies compared the efficacy of 16-slice and 64-slice MDCT to CCA in assessing CAV. When analysis was performed on a per-coronary segment basis, both 16-slice and 64-slice MDCT were able to respectively assess 96% and 91% of all segments visualized by CCA. As in native CAD assessment,
MDCT had good-to-excellent sensitivities, specificities, and NPVs when evaluating coronary disease in cardiac allografts compared to the reference standard of CCA. In particular, sensitivities of 82–89% and NPVs of 99% for MDCT on a per-coronary-segment-based analysis indicate that MDCT can reliably exclude CAV in transplant populations. This is emphasized further when looking at per-patient analysis of MDCT, which showed a sensitivity of 87–100% in detecting significant CAV, suggesting that between 8 and 9/10 patients may be able to avoid or delay initial screening CCA if MDCT was used as a gatekeeper to more invasive testing.

In comparison to MDCT assessment of native CAD, PPV was lower for 64-slice MDCT in the detection of CAV [7]. This was likely attributable to the low prevalence (18–19%) of CAV in this population. In the ACCURACY trial [23], MDCT had a similarly low PPV (51% with vessel-based analysis) in assessing significant native CAD where disease prevalence was also low (25%). The low PPV reinforces the limitations of MDCT as primarily a screening rather than confirmatory test for diagnosis of CAV. In addition, in the setting of low-disease prevalence commonly seen with referrals for MDCT, one or two false positives may substantially worsen PPV.

The reason for reduced assessment of coronary artery segments with 64-slice MDCT when compared with 16-slice MDCT remains unclear considering the improved spatial and temporal resolution associated with newer scanner technology. Although not obviously explained, this has been a finding described in previous meta-analysis examining the efficacy of both scanners [24]. No appreciable differences in heart rates, body mass index, or calcification were noted between the 16-slice and 64-slice study populations, although these indices were not reported in all studies (Table 1). The most plausible explanation for these results is better initial screening of patients who may be suitable for MDCT scanning in the 16-slice studies. In addition, one study looking at 64-slice MDCT did not report cutoff diameters for coronary segments assessed, and therefore may have attempted to examine vessels smaller than 1.5 mm which are still poorly visualized by current-generation scanners. The factors were amplified by the relatively small cumulative sample size of transplant patients undergoing MDCT, likely leading to unexpectedly better efficacy of 16-slice MDCT.

The accuracy of MDCT relies on image quality, which, in turn, is partially dependent on heart rate. Even with the improved temporal resolution of 64-slice scanners, heart rate has been shown to correlate inversely with image quality by causing motion artifact [25]. In the setting of considerably increased heart rates associated with cardiac transplant patients, MDCT was able to assess a high percentage of coronary segments and maintain good diagnostic accuracy for evaluation of CAV. However, in comparison to its assessment of native CAD, 64-slice MDCT had mildly reduced specificity and diagnostic accuracy when assessing CAV. Poor image quality of coronary segments was attributable to motion artifact in 21–61% of cases [12–14]; therefore, heart rate likely did have an impact on accuracy. To improve the efficacy of MDCT, newer technologies such as DSCT may allow for high-quality imaging, despite elevated heart rates. In the one study where DSCT was used for assessment of CAV, 96% of all coronary segments were deemed evaluable. No correlation was noted between DSCT image quality and heart rate [14]. In addition, the use of multisegment reconstruction algorithms has been proposed to reduce the effects of heart rate on MDCT efficacy [26].

In the transplant patient population, accurate quantification of luminal diameter is important to evaluate annual progression of CAV. In studies that compared the efficacy of MDCT in assessing the degree of luminal stenosis to QCA, Pearson correlation coefficients ranged from moderate to excellent (r = 0.64–0.89), suggesting good correlation between both modalities [10–12]. However, only three studies included quantification of luminal diameter assessments by MDCT. In addition, standard error of estimation in these studies was substantial (14.4–15.0%). Therefore, it remains unclear as to whether MDCT can monitor progression of CAV in patients with pre-existing disease.

**Initial evaluation of early CAV: comparing MDCT to IVUS**

IVUS is the preferred modality for assessing onset and progression of CAV [14]. It allows for evaluation of luminal diameter, as well as assessment of intimal and medial thickness unlike CCA. IVUS can detect CAV in greater than 50% of asymptomatic patients within 1-year posttransplantation, whereas CCA detects disease in only 10–20% of such patients [27]. Despite this, there are a number of limitations associated with IVUS, including an inability to evaluate the distal aspects of the coronary tree, as well as cost and risk of repeated procedures. The risk of serious complications associated with IVUS has been estimated at between 1% and 3% [28].

Like IVUS, MDCT allows for visualization of the coronary vessel lumen and wall. Due to its efficacy in delineating soft tissue accurately, MDCT can potentially assess both intimal thickening and plaque burden. In native CAD, pooled weighted analysis revealed MDCT had very good sensitivities of 87–92% and specificities of 81–86% at visualizing atherosclerotic plaques when compared with IVUS [29]. This suggests that MDCT may be an ideal noninvasive modality for assessment of early CAV (Fig. 2).

In the three studies comparing MDCT with IVUS for the detection of intimal thickening due to CAV, MDCT was able to visualize between 97% and 99% of all segments analyzed by IVUS. This is considerably higher than values obtained when MDCT was measured against CCA because only proximal coronary segments were assessed by IVUS. Compared to IVUS, both 16-slice and 64-slice MDCT had excellent sensitivity and specificity in evaluating intimal thickening in transplant patients. The NPVs for MDCT were between 77% and 84%, which further emphasized the utility of MDCT at ruling out early disease.

In addition, the PPV for MDCT in assessing CAV when compared with IVUS ranged from 82% to 98%, substantially higher than values obtained with CCA comparisons. This is again partially attributable to the evaluation of only large, proximal coronary vessels with IVUS. These results may also be due to the fact that there is comparatively little calcium deposition in CAV in contrast to native CAD [30]. In the assessment of native noncalcified plaques, MDCT has a tendency to underestimate plaque volume when compared to IVUS, resulting in fewer false positive tests [14]. Unfortunately, the prevalence of significant calcification in our pooled analysis could not be determined as it was not reported in any MDCT and IVUS CAV study.

Using IVUS as the reference standard, MDCT has been shown to have substantially better sensitivity (70% vs 11%) at detecting nonobstructive (<50% stenosis) CAV when compared with CCA.
MDCT may be capable of detecting CAV-related wall thickening in up to 45% more coronary segments than CCA [11]. This again reinforces the utility of MDCT in assessing early disease where luminal narrowing may not be present.

In addition to diagnosis, the presence of intimal thickening detected by IVUS also provides prognostic information regarding patient mortality and future cardiac events [31,32]. MDCT may accurately evaluate intimal thickening in CAV, yet evidence on clinical outcomes associated with disease detection is lacking. However, in native CAD, total plaque score and CAD severity as assessed by MDCT have been shown to be predictors of major adverse cardiovascular events [33]. Therefore, further study of whether early CAV detection by MDCT offers similar prognostic information is needed.

Limitations

The majority of 16-slice and 64-slice MDCT studies excluded the analysis of coronary segments smaller than 1.5 mm. This may result in underestimation of CAV, particularly in early disease where distal vasculopathy is often described. Although detection of distal disease may not result in revascularization, it still offers important diagnostic and prognostic value [34]. It may also serve as an indication for more aggressive therapy and frequent follow-up.

The complication rates associated with MDCT have not been well established, but sequelae associated with radiation and contrast exposure remain major concerns. Radiation doses for MDCT are higher than those for CCA. In studies included for analysis, effective radiation doses cited were between 3 and 10 mSv for 16-slice MDCT and between 10 and 18 mSv for 64-slice MDCT in comparison to 6 mSv for CCA [35–37]. The National Council on Radiation Protection and Measurements identifies a risk factor for lifetime cancer mortality of $5 \times 10^{-2}$ per 1 Sv exposure [38] which translates into a risk of developing a fatal cancer of 0.05–0.09% for each 64-slice MDCT and 0.03% for each CCA. The associated increased malignancy risk with repeated studies needed for detection and monitoring of CAV is an important limitation to the introduction of MDCT for disease assessment. There is an increasing number of radiation dose-reducing strategies such as ECG-controlled tube current modulation, prospective ECG-gated techniques, and image reconstruction algorithms, which were used only in one study included in this review [11]. Unfortunately, a number of these strategies depend on the presence of low heart rates which is often not feasible with transplant patients.

Along with radiation, administration of contrast required for MDCT can also lead to adverse events, most notably contrast-associated allergic reactions and contrast-induced nephropathy (CIN). The use of noniodinated contrast for radiological examinations is associated with severe allergic reactions in 0.2–0.7% of patients [38]. The incidence of renal dysfunction after administration of contrast is approximately 3% in the general patient population, but substantially higher in individuals with multiple risk factors for CIN such as transplant patients on calcineurin inhibitors [39]. Even though no reports of contrast-related adverse events were documented in our studies, use of MDCT for assessment of CAV must be balanced carefully with risk of potential allergic reaction and CIN.

Although MDCT provides an accurate assessment of the coronary arteries, it currently gives little information on left ventricular function or hemodynamics which are two important features gained by performing CCA. Impaired left ventricular function can signal underlying CAV or rejection. Similarly, the

Figure 2: Correlation of CAV detected by MDCT and IVUS. (A) Curved multiplanar reformatted MDCT image and (B) multiplanar reformatted image of the vessel cross section demonstrates a noncalcified coronary plaque (arrow) and lumen (asterisk) of the proximal left anterior descending coronary artery. (C) IVUS image in the same location confirms presence of CAV (arrow). (D) Maximum intensity projection MDCT image and (E) multiplanar reformatted image of vessel cross section of the mid-left anterior descending coronary artery show a calcified nodule ‘embedded’ in the noncalcified plaque (arrow) and the lumen (asterisk). (F) An IVUS image in the same location confirms the presence of CAV with a calcified nodule (arrow). Reprinted with permission from Gregory et al. [12].
presence of restriction in transplant patients can similarly indicate rejection and may also portend to poor prognosis [40]. There were considerable methodological limitations with studies used in this systematic review. There was a significant selection bias, as most investigations excluded patients with clinical instability, renal dysfunction, and atrial arrhythmias. In addition, studies often did not sufficiently report characteristics that could potentially affect MDCT accuracy, such as body mass indices and the presence or absence of significant coronary calcification. Effective radiation doses and contrast-associated adverse events were also frequently not cited. In order to fully elucidate both benefit and harm of imaging, future studies must be stringent in reporting hazards associated with testing.

CONCLUSION

MDCT is a noninvasive modality that can accurately diagnose CAV when compared with CCA. Patient-based analysis noted sensitivities of 87–100% with MDCT in assessing CAV, suggesting that 8–9/10 post-cardiac transplant patients may avoid or delay screening CCA. In evaluating early CAV, MDCT also demonstrated good specificity and sensitivity when measured against IVUS. MDCT has not conclusively been shown to accurately quantify luminal narrowing associated with CAV implying that it cannot yet be used for assessment of disease progression once diagnosis has been confirmed.

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Abbreviations


Conflict of interest: none declared.

REFERENCES


