International Journal of Cardiology 221 (2016) 898–905

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Review

A systematic review and meta-analysis of multidetector computed tomography in the assessment of coronary artery bypass grafts

Michael Chan [a], Lloyd Ridley [a], Douglas J. Dunn [b], David H. Tian [c], Kevin Liou [c], Jessica Ozdirik [c], Chaitu Cheruvu [d], Christopher Cao [c,*]

[a] Department of Radiology, Concord Repatriation and General Hospital, Sydney, Australia
[b] The University of Sydney, Sydney, Australia
[c] The Collaborative Research Group, Macquarie University, Sydney, Australia
[d] Department of Cardiology, Prince of Wales Hospital, Sydney, Australia

ARTICLE INFO

Article history:
Received 10 April 2016
Received in revised form 4 June 2016
Accepted 27 June 2016
Available online 1 July 2016

Keywords:
CT coronary angiography
Invasive coronary angiography
Coronary artery bypass graft surgery
Meta-analysis

ABSTRACT

Purpose: The present meta-analysis aimed to compare the diagnostic accuracy of more recent computed tomography coronary angiography (CTCA) with invasive coronary angiography (ICA) in the assessment of graft patency after coronary artery bypass graft surgery (CABG).

Material and methods: A systematic review was performed using nine electronic databases from their dates of inception to July 2015. Predefined inclusion criteria included studies reporting on comparative outcomes using ≥64 slice multidetector computed tomography (MDCT) and ICA. The primary endpoints included graft occlusion and significant graft stenosis ≥50%. Secondary analyses included the comparison of arterial versus venous graft conduits, and the use of different MDCT techniques.

Results: Thirty-one studies were identified according to selection criteria, involving 1975 patients with 5364 assessed grafts. Combined assessment of stenosis and occlusion for all grafts demonstrated a sensitivity of 96.1% [95% confidence interval (CI) 94.3–97.4%] and specificity of 96.3% (95% CI 95.1–97.3%). CTCA assessment of venous grafts demonstrated higher sensitivity compared to arterial grafts, when testing for both occlusion and stenosis (97.6% vs 89.2%, $p = 0.004$).

Conclusion: Results of this study demonstrated that CTCA had a relatively high pooled sensitivity, specificity and negative predictive value compared to ICA. However, patient baseline characteristics varied between studies, and the results should be interpreted with caution. Nonetheless, our results indicate that CTCA should be recognized as an accurate and non-invasive investigation for graft patency in symptomatic patients after CABG.

1. Introduction

Coronary artery bypass graft surgery (CABG) has demonstrated superior long-term outcomes compared to drug-eluting stents for selected patients with coronary artery disease [1]. However, ischemic symptoms may recur as a result of graft failure, progression of native coronary artery disease, or a combination of both [2]. The incidence of graft failure is partly dependent on the selected conduit, with up to 10–15% failure rate after ten years for arterial conduits, and up to 60% for venous conduits [3–5]. With the increasing survival of patients who undergo CABG, there is a heightened interest in the optimal diagnostic assessment of patients who present with ischaemic symptoms after surgery.

Currently, invasive coronary angiography (ICA) remains the gold standard for assessing patients with previous CABG who present with ischaemic symptoms. This invasive procedure is however associated with potential risks of vascular complications such as dissection, bleeding, pseudoaneurysm, cardiac arrhythmia and stroke [6]. More recently, a non-invasive approach through computed tomography coronary angiogram (CTCA) has emerged as a feasible alternative, but there is a relative paucity of robust clinical data on the accuracy of 64-slice or dual source multidetector computed tomography (MDCT) [7,8].

The aim of the present systematic review and meta-analysis was to determine the diagnostic accuracy of ≥64 slice MDCT versus ICA in the diagnosis of graft occlusion or stenosis in patients who underwent previous CABG. Secondary analyses included graft patency outcomes for arterial versus venous grafts, comparison of 64-slice versus >64-slice detectors, and comparison between dual source versus single source MDCT. To enable statistical analysis, graft patency was assessed

* Corresponding author at: The Collaborative Research Group, Macquarie University, Level 1, 75 Talavera Road, Macquarie Park, NSW 2113, Australia.
E-mail address: drchriscao@gmail.com (C. Cao).

http://dx.doi.org/10.1016/j.ijcard.2016.06.264
0167-5273/

according to graft stenosis, occlusion or pooled stenosis/occlusion as defined by individual studies.

2. Materials and methods

2.1. Search strategy and selection criteria

Electronic searches were performed using Ovid Medline, Embase, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, Cochrane Methodology Register, ACP Journal Club, Database of Abstracts of Reviews and Effectiveness, and NHS Economic Evaluation Database from their dates of inception to July 2015.

To maximise the sensitivity of the search strategy we combined the terms "computed tomography" with "angiogram" or "angiography" with "coronary artery bypass" or "bypass surgery" or "bypass graft", inclusive of relevant MeSH terms or keywords. Potentially relevant studies were identified based upon title and abstract screen by two reviewers (M.C. and D.D.). Full texts of these potentially relevant studies were obtained for further evaluation. The reference lists of all retrieved articles were reviewed for further identification of potentially relevant studies.

Comparative studies that provided diagnostic data on graft occlusion and stenosis for patients who had both a ≥64-slice CTCA and the gold standard of ICA were considered eligible for analysis. To maintain the consistency of comparative data, 'stenosis' was defined as ≥50% stenosis of the graft. The characteristics of the MDCT used in each study including the presence of dual source were noted. Study characteristics such as age, sex and arrhythmias were noted. Studies including arrhythmic patients were included for analysis. Exclusion criteria were studies with <64-slice, electron beam CT, no comparison with ICA, duplicate study or cohort and absence of defined stenosis criteria. Searches were limited to human subjects and English language. Abstracts, case reports, conference presentations, editorials, expert opinions and review articles were excluded due to potential publication bias and duplication of results.

2.2. Data extraction and critical appraisal

All data were extracted from article texts, tables and figures. Two investigators (M.C. and D.D.) independently reviewed each retrieved article. Discrepancies between the two reviewers were resolved by discussion and consensus, and the final results were reviewed by the senior investigator (C.C.).

2.3. Statistical analysis

A bivariate random-effects model was implemented for the meta-analysis of diagnostic accuracy [9]. This model assumes the logit-transformed sensitivities and specificities are approximately distributed around a mean value with a certain variability around this mean, and is able to estimate the extent of between-study variations in sensitivity and specificity. Pooled estimates for sensitivity, specificity, positive likelihood ratio (LR) and negative LR were obtained with associated 95% confidence intervals (CI). Positive LR > 10 and negative LR < 0.1 were considered strong diagnostic evidence [10]. Summary Receiver Operating Characteristic curves (sROC) were constructed using the bivariate model to produce prediction ellipses (95% CI), taking into account the possible correlations between sensitivity and specificity. Each data point within the sROC curve represents a single study's relationship between true positive rate and false positive rate. Publication was assessed visually and statistically by generating a scatterplot of the inverse of the square root of the effective sample size (1/ESS1/2) versus the diagnostic log odds ratio and performing regression analysis, with p value <0.1 indicating significant asymmetry [11]. Statistical calculations were performed using R (version 3.2.0) or Stata (StataCorp LP, Version 14).

3. Results

3.1. Quantity and quality of trials

A total of 2668 references were identified through nine electronic database searches. After exclusion of duplicate or irrelevant studies, 94 potentially relevant articles were retrieved for more detailed evaluation. Manual search through reference lists did not yield any additional relevant studies. After applying predefined selection criteria, 31 articles remained for statistical assessment, including a total of 1975 patients and 5364 graft assessments. A summary of the study selection process according to the PRISMA format is presented in Fig. 1.

Of the selected 31 articles, all were observational studies, with four studies recruiting more than 100 patients [12–15]. Overall, 75% of patients were male, with a mean age ranging from 58.6–68.4 years.

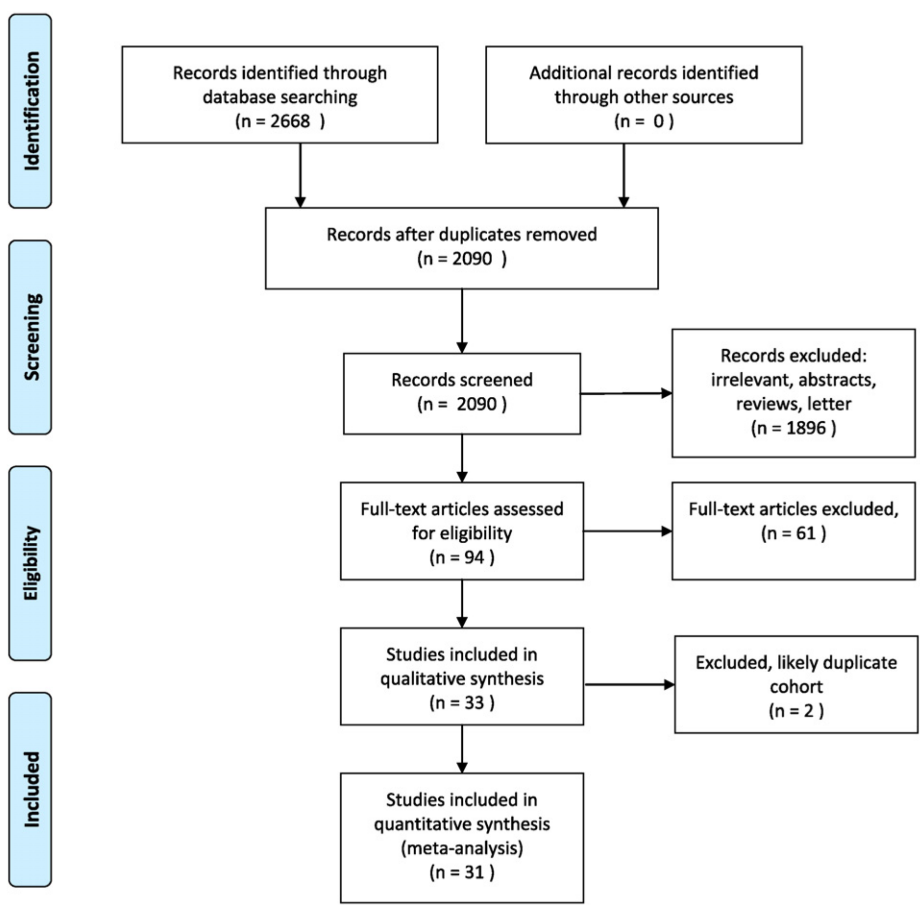

Fig. 1. PRISMA flow diagram.