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Review article

Predictors associated with stroke after coronary artery bypass grafting: A systematic review

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ABSTRACT

Background: Stroke is a major cause of morbidity and mortality after coronary artery bypass grafting (CABG). The purpose of this systematic review was to evaluate the predictors of perioperative stroke after CABG.
Methods: We reviewed the published literature on prognostic factors for perioperative stroke after CABG in articles using multivariate regression models. The statistical validity of prognostic models and a qualitative synthesis were performed.
Results: We identified 14 studies. The methodological quality of study reporting was variable. Overall, the incidence of stroke after CABG was 1.1–5.7%. About 37–59% of strokes occurred early (intraoperatively). No validated stroke outcome scale was used to assess morbidity and mortality in any of the included studies. Advanced age, prior (before CABG) cerebrovascular disease/stroke, prior carotid artery stenosis, prior peripheral vascular disease, prior unstable angina, and prolonged cardiopulmonary bypass time were found to be the most consistent independent predictors of perioperative stroke after CABG. Postoperative atrial fibrillations were found to be the most consistent independent variables associated with postoperative stroke after CABG. No association was found with hypercholesterolemia, prior myocardial infarct, and smoking. Other risk factors, such as gender, prior hypertension, diabetes mellitus, congestive heart failure, and chronic renal failure, showed inconsistent results.
Conclusions: Seven variables (advanced age, prior cerebrovascular disease/stroke, prior carotid artery stenosis, prior peripheral vascular disease, prior unstable angina, prolonged cardiopulmonary bypass time, and postoperative atrial fibrillation), representing and high atherosclerotic burden, were found to be associated with more perioperative stroke events. Stroke assessment scales should be included to enable a detailed description of stroke morbidity post CABG. Lessons learned from the present study should also help to improve the quality and relevance of future studies on prognostic factors in stroke after CABG.

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1. Introduction

Stroke is recognized as a devastating complication of coronary artery bypass grafting (CABG), which can lead to decreased quality of life and excess mortality [1,2]. Over the last decade, increasing numbers of elderly patients who often have comorbid diseases and are at high risk of cerebrovascular disease have undergone CABG. Although previous studies have attempted to identify predictors of stroke after CABG, uncertainty regarding its etiology and risk factors remain [3–5]. Naylor et al's systematic review of predictors of stroke after CABG only focused on the relationship between carotid artery disease and stroke, and the review was limited to English literature published before 2000 [6]. Several prognostic studies of stroke after CABG have identified many risk factors, however, the results have been somewhat inconsistent. Moreover, the best combination of variables predictive of stroke has not yet been established [7–9]. Knowledge of those at the highest risk of stroke after CABG could help to determine the most appropriate preoperative evaluation, identify therapeutic measures to reduce postoperative strokes and improve postoperative management. We performed a systematic review of the published literature to identify risk factors consistently associated with stroke after CABG.

2. Methods

2.1. Search strategy

This systematic review was undertaken following PRISMA (Preferred Reporting Items for Systematic Review and Meta-analyses) guidelines, with details summarized in Checklist S1 [10]. We searched Medline and Embase databases to retrieve relevant English literature published between January 1990 and September 2014. We used the following terms: stroke, coronary artery bypass grafting, predictors, risk factors. We also reviewed the references of the identified articles and used the "snowballing" techniques by Web of Science.

2.2. Study selection

Two reviewers (MZ and ZX) screened the titles and abstracts of all identified articles for eligibility. An article was eligible if it included CABG patients and attempted to determine factors independently associated with perioperative stroke using multivariate regression techniques. Articles were deemed ineligible if they met any of the following criteria: reports were of mixed cardiac surgery (e.g. patients undergoing CABG and simultaneous carotid endarterectomy or valvular procedures, a particularly high risk for stroke), unless separate results for patients having CABG alone were identified; studies restricted to surrogate outcomes (e.g. neuroimaging evidence of subclinical strokes). There were no restrictions in terms of antiplatelet agents, or oral anticoagulants used before CABG, but we excluded clinical trials and studies evaluating prognosis only after monotherapy e.g. aspirin, before CABG, because this can lead to bias and over-inclusion of patients with a high risk of stroke. To maximize the generalizability of our results, we included studies of all stroke (ischemic and hemorrhagic). However, studies consisted wholly or predominantly ischemic and hemorrhagic stroke. A minority of people with transient ischaemic attacks were included. Decisions about the inclusion of studies were made independently, and any disagreements were resolved through consensus or by arbitration of a third person (HX).

2.3. Quality appraisal

The methodological quality of prognostic studies was assessed following a 27-item checklist that addressed 6 major risks of bias: study participation, study attrition, predictor measurement, outcome measurement, statistical analysis, and clinical performance/validity [11–14]. As shown in Supplementary material S1A, each item was graded positive (sufficient information: low risk of bias), negative (sufficient information: high risk of bias), or partial/unknown (insufficient information: ? was assigned). Two reviewers (MZ and ZX) independently assessed the risk of bias of the included studies. Disagreements were resolved in a consensus meeting.

2.4. Data exaction

MZ extracted the following information: clinical details; study design; follow-up; stroke outcome measure (in particular, intraoperative stroke and postoperative stroke); and prognostic factors. The following terms (and associated definitions) are used throughout the review: preoperative stroke, occurring before CABG, could be a risk for post-CABG stroke; intraoperative stroke, occurring when the patient emerged from anesthesia; postoperative stroke, occurring after the patient emerged from anesthesia and within 30 days of CABG [15,16]. Although we prefer these definitions, the definition for temporal onset of stroke varied among studies. A second observer (ZX) verified the data.

2.5. Identifying consistent predictors

Meta-analysis was not performed as heterogeneity was anticipated. A chart was designed to list the variables considered for inclusion in each study model [17,18]. A large number of variables were tested for their association with stroke after CABG. We present data on variables tested for association in 5 or more studies to ensure the clinical utility and succinctness of data presentation [11,17,19]. We use the phrase 'generally consistent findings' to indicate where an association was found for that variable in >70% of the studies that tested that variable. Otherwise, 'insufficient' or 'no evidence' was allocated. Sensitivity analyses (removing small studies prone to selection bias and removing studies with retrospective case ascertainment prone to reporting bias) was conducted.

3. Results

3.1. Search results

Our search identified 1509 articles (Fig. 1). After screening, 14 studies were included in this review [3–5,15,16,20–27]. One study with 1835 people included 34 (2%) who underwent simultaneous carotid endarterectomy and CABG, after discussion with all authors, we included this study due to the small number of patients who received the dual intervention [22].

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