

Does Off-pump Coronary Artery Bypass Confer any Advantage in Patients with End-stage Renal Failure? A Systematic Review and Meta-analysis



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Objectives

Patients with end-stage renal disease (ESRD) are often excluded from trials comparing off and on-pump coronary artery bypass grafting (CABG). Thus data in this cohort is limited to small retrospective studies. Hence we compared the adverse clinical events and outcome in patients with ESRD undergoing off (OPCABG) and on-pump surgery (ONCABG).

Methods

Pubmed, Scopus and Web of Science were searched (inception – June 2013) to identify studies comparing clinical results of OPCABG and ONCABG in dialysis dependent patients. A random effect inverse variance weighted meta-analysis was conducted. Results are presented as risk ratios (RR) with 95% confidence intervals; $p < 0.05$ is significant.

Result

Ten retrospective studies (2762 OPCABG and 11310 ONCABG) fulfilled criteria and were pooled. Patients undergoing off-pump surgery were less than 100 in most of the articles. Early mortality [OPCABG (8.4%); ONCABG (10.4%)] was comparable [RR 0.80(0.51–1.17); $p = 0.35$; $I^2 = 30\%$]. Re-exploration for bleeding [RR 0.81(0.47–1.39); $p = 0.44$] and blood transfusion [RR 0.79(0.57–1.08); $p = 0.14$] were also comparable. While patients undergoing off-pump surgery were extubated earlier ($p < 0.01$), other post-operative events like stroke ($p = 0.34$) and atrial fibrillation ($p = 0.10$) were similar. Mid-term survival (three to five years) was also comparable.

Conclusion

Patients with end-stage renal disease undergoing coronary artery bypass grafting demonstrate comparable results irrespective of method. While available data is limited to retrospective studies, we failed to demonstrate any significant advantage for performing OPCABG in this group of patients.

Keywords

End-stage renal disease • Renal failure • Dialysis • Off-pump coronary artery bypass • Coronary artery bypass grafting

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Introduction

Patients with end-stage renal failure (ESRD) are particularly prone to coronary artery disease (CAD); in fact CAD is the primary cause of death in many patients while on haemodialysis [1]. Patients with ESRD also have diffuse CAD with extensive calcification, small coronary vessels and are prone to accelerated atherosclerosis [2]. Conventional coronary artery bypass grafting (ONCABG) using cardiopulmonary bypass may cause issues related to cardiopulmonary bypass viz. volume overload, coagulopathy. Even skilled surgeons may find difficulty in conducting a perfect anastomosis with off-pump surgery (OPCABG) due to poor coronary targets in these patients. Hence, detailed knowledge regarding the optimal method of surgical revascularisation in this cohort is limited to retrospective studies.

We have thus conducted a systematic review and meta-analysis comparing clinical events after ON and OPCABG in patients with ESRD.

Methods

Search Strategy

Pubmed, Ovid Medline, Web of Science were searched (from inception till June 2013) to identify studies fulfilling our inclusion criteria. Mesh headings like 'renal failure', 'dialysis', 'coronary artery bypass grafting', and 'off-pump, on-pump' were used alone or in combination to obtain relevant articles.

Eligibility Criteria

Randomised controlled trials (RCT) or propensity-matched observational studies (OS) which met the following criteria were selected for inclusion in our review: (1) Adult human subjects, (2) English language (3) Studies compared the results of OPCABG and ONCABG. (4) All patients in the study had ESRD and were dialysis dependent prior to surgery. (5) In case patients with varying degrees of renal failure were included, the study presented data comparing our primary or secondary end-points in patients with ESRD.

Case reports, review articles, and editorials were excluded. Patients with chronic renal failure, but not dialysis dependent were not included in the meta-analysis. The systematic review has been conducted as per PRISMA guidelines [3].

Study Selection

One author (PJE) performed the systematic review. Two investigators (JYL, SVD) independently assessed all abstracts fulfilling search criteria. Thereafter, promising full-text articles were retrieved and reviewed to finalise the articles for inclusion. Differences of opinion were resolved by consensus of two authors (JYL and SVD).

Study End-points

The primary end-point studied was early mortality. Early post-operative events like stroke, atrial fibrillation, re-exploration

for bleeding, blood product usage and duration of post-operative mechanical ventilation were considered as secondary end-points. Mid-term survival was also evaluated in these patients. Prolonged ventilation was defined as > 24 hours [4,5].

Duration of Follow-up

All studies reporting late survival depicted Kaplan Meier survival curves from three to five years after surgery. Hence mid-term survival (defined as three to five years) after surgery was pooled and compared as hazard ratios.

Statistical Analysis

Statistical analysis was conducted using Review Manager 5.0.1 (The Cochrane Collaboration, Norway). Categorical variables were compared using the risk ratio (RR), reported with 95% confidence interval ($p < 0.05$ is significant). The inverse variance method with random effect modelling was implemented as the statistical method. When one cell contained zero events, the Bates correction factor was utilised rather than exclude the study from contributing to the pooled analysis [6]. However, when both experimental and control arms had no events, the study did not contribute to the pooled effect size [6].

The hazard ratio was pooled to compare late mortality. When not reported, it was derived from the Kaplan Meier survival curve using methods reported earlier [7].

Sensitivity analysis was conducted by stratifying studies according to sample size (< 100 / > 100) and then comparing results.

The forest plot pictorially demonstrates the results. A forest plot is a representation of the risk ratio of each individual study along with the pooled event rate and risk ratio obtained from the statistical analysis. The square box depicts the weight (W) of each study with the horizontal lines depicting the range of the risk ratio with 95% confidence intervals. The diamond demonstrates the pooled risk ratio. The centre of the diamond is at the obtained risk ratio value with the sides extended to reach the 95% confidence intervals.

We used the I^2 statistic, which estimates the percentage of total variation across studies that is due to heterogeneity rather than chance. Suggested thresholds for heterogeneity were used, with I^2 values of 25–49%, 50–74%, and $\geq 75\%$ indicative of low, moderate, and high heterogeneity [6].

A visual inspection of the funnel plot has been implemented for assessing publication bias.

Results

From a review of 126 abstracts, 10 studies best fulfilling inclusion criteria were selected for systematic review and statistical analysis. The detailed search strategy is presented in Fig. 1. Nine studies were single-centre retrospective studies [4,5,8–14], with one study [15] reported results of the United States Renal Data Systems (USRDS). Four studies contained [4,5,11,14] more than 50 patients in the OPCABG cohort. Eight studies presented separate demographics for

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