Off-pump coronary artery bypass in patients with left ventricular dysfunction: a meta-analysis
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CRD summary
This review concluded that compared to off-pump coronary artery bypass, on-pump bypass was associated with short-term but not mid- or long-term mortality in patients with left ventricular dysfunction. Off-pump bypass was associated with more incomplete revascularisation. Uncertainties about the possibility of missed studies, selection bias and data quality suggest the conclusions should be treated cautiously.

Authors' objectives
To assess the effects of off-pump coronary artery bypass compared to on-pump coronary artery bypass in people with left ventricular dysfunction.

Searching
PubMed and EMBASE databases and Google Scholar were searched to January 2011. Search terms were reported. Only studies published in English were sought. Reference lists were checked.

Study selection
Studies that compared outcomes for off-pump coronary artery bypass to on-pump bypass in people with preoperative ejection fraction of 0.40 or less were eligible. Primary outcomes of interest were 30-day mortality, midterm mortality (30 days to five years) and long-term mortality (more than five years) and 30-day or in-hospital myocardial infarction. Secondary outcomes were completeness of revascularisation and proportion of patients who received a graft to a circumflex branch or posterior descending artery.

In the included studies, reported mean ages ranged from 50.5 to 70 years. Some participants had previous myocardial infarction, hypertension, diabetes, chronic obstructive pulmonary disease or renal impairment. Generally there were more people in the on-pump groups with these conditions than in the off-pump groups and some differences between the two groups were statistically significantly different. Ejection fractions were measured in various ways and low ejection fractions were defined variously (between ≤25.0 and ≤40.0). Where reported, mean ejection fractions ranged from 0.161 to 0.361. Where stated, some participants had left main stem coronary disease and/or three vessel disease. Most studies did not report on the number of participants converted from off pump to on pump bypass.

The authors mentioned that they used PRISMA and MOOSE guidelines but did not state explicitly how many of reviewers selected studies for inclusion.

Assessment of study quality
Quality was assessed using a modified Newcastle-Ottawa scale based on items for assignment to treatment, representativeness of treatment groups to general population under study, comparability of groups, clearly defined outcomes and follow-up. The maximum score appeared to be 15.

A matching score was calculated to assess the comparability between groups. This was based on whether there were statistically significant differences between groups for 36 items for patient risk factors, symptoms, operative status and hospital/surgeon experience. The best matching score would be 36. Studies that scored more than the median score (>7) for quality were considered high quality and more than the median score for matching (>12) were considered to have a high degree of matching.

The authors did not state how many of them performed the quality assessment.

Data extraction
Data were extracted in order to calculate odds ratio (OR) and 95% confidence intervals (CI) for binary outcomes and hazard ratio (HR) and 95% confidence intervals for survival data.
The authors did not state how many reviewers performed data extraction.

**Methods of synthesis**

Pooled odds ratios and 95% confidence intervals and hazard ratios and 95% confidence intervals were calculated using a random-effects model. Heterogeneity was assessed using $I^2$ statistic and $X^2$ test. Meta-regression was used to assess any effects of renal failure, stroke, arterial revascularisation and redo surgery on the outcomes of 30-day mortality and myocardial infarction. Date of publication and completeness of revascularisation was investigated. Subgroup analyses was undertaken based on poor left ventricular function ($\leq$30%), study size (>200), matching score between comparison groups (>12) and quality score of more than 7. Sensitivity analyses investigated the removal of outlying studies.

Funnel plots and Egger’s test were used to assess publication bias.

**Results of the review**

Twenty-three retrospective studies were included with 7,759 participants (range 39 to 1,314) 2,822 of whom were off-pump and 4,937 on-pump. Quality scores ranged from 2 to 11. Ten studies were considered high quality. Matching scores ranged from 1 to 21. Eleven studies were considered to have high matching. Funnel plots did not show evidence of publication bias.

Compared to on-pump bypass, off-pump bypass was associated with lower 30-day mortality (OR 0.64, 95% CI 0.51 to 0.81; $I^2$=0%; 22 studies) but no statistically significant difference in mid-term mortality (OR six studies; HR seven studies), long-term mortality (four studies) and myocardial infarction ($I^2$=4%; 18 studies). There was no significant statistical heterogeneity. In meta-regression analyses total arterial revascularisation in the on-pump groups was associated with lower 30-day myocardial infarction. Other analyses showed no significant effects.

Compared to on-pump, off-pump bypass was associated with less complete revascularisation (OR 0.23, 95% CI 0.12 to 0.42; four studies with no significant heterogeneity), fewer grafts to circumflex branch (OR 0.06, 95% CI 0.01 to 0.23; five studies with significant heterogeneity) and fewer grafts in the posterior descending artery (OR 0.13, 95% CI 0.04 to 0.38; four studies with significant heterogeneity).

Subgroup analyses for only studies with participants with poor left ventricular function ($\leq$30%), outcomes for short (13 studies; $I^2$=0%), mid-term (OR three studies; HR four studies) and long-term (two studies) mortality were similar to the main analyses (no significant heterogeneity). Results for other subgroups were reported.

**Authors’ conclusions**

Compared to off-pump coronary bypass, results indicated an association between on-pump coronary bypass and short-term mortality in patients with impaired left ventricular function but no difference for mid-term and long-term mortality. Off-pump coronary bypass was associated with more incomplete revascularisation.

**CRD commentary**

The aims of this review were clearly stated in terms of the inclusion criteria. The search was limited to studies in English and it was unclear whether unpublished studies were sought so it is possible that studies were missed and publication and language biases may have affected the review. Review methods were not described so it was difficult to comment on the possibility of reviewer error or bias. Quality was assessed and details were reported. Methods of synthesis appeared appropriate and heterogeneity was assessed.

Included data came from retrospective studies and the authors acknowledged that there was likely to have been bias in the way patients were selected for treatment. This was reflected to some extent in the different proportions of participants with other conditions in the different groups; off-pump participants appeared to be healthier. The authors also commented that most studies did not report on conversion rates from off-pump to on-pump and whether intention-to-treat analyses were used, which led to a possible effect on comparisons for mortality rates.

The authors stated that the significant limitations of the studies must be taken into account when interpreting conclusions for longevity and degree of revascularisation provided by off-pump bypass. This and questions about review methods, possible missed studies and the quality of included data mean the conclusions should be treated with caution.
Implications of the review for practice and research

**Practice:** The authors stated that off-pump coronary artery bypass may be a strategy to reduce early mortality in selected high-risk patients with left ventricular dysfunction when perhaps long term survival was not relevant.

**Research:** The authors did not state any implications for research.

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