Off-pump coronary artery surgery for reducing mortality and morbidity: meta-analysis of randomized and observational studies

CRD summary
This generally well-conducted review compared the morbidity and mortality associated with off-pump coronary artery bypass surgery (OPCAB) with that of conventional bypass surgery. Randomised controlled trials showed no difference in morbidity or mortality, apart from the incidence of atrial fibrillation. Observational studies showed OPCAB to be more favourable. The authors' conclusions are likely to be reliable, but the generalisability of the results is less certain.

Authors' objectives
The aim was to assess the effects of off-pump coronary artery bypass (OPCAB) surgery on morbidity and mortality.

Searching
MEDLINE (1966 to June 2004), EMBASE (1980 to June 2004) and PubMed (to June 2004) were searched; the search terms were reported. The bibliographies of identified papers were checked. No language restrictions were applied.

Study selection

Study designs of evaluations included in the review
RCTs were eligible for inclusion, as were observational studies that reported acceptable risk-adjusted effects of OPCAB.

Specific interventions included in the review
Studies that assessed the effects of OPCAB surgery in comparison with conventional coronary artery bypass surgery (CCAB) were eligible for inclusion.

Participants included in the review
Studies of people undergoing CCAB were eligible for inclusion. Two randomised controlled trials (RCTs) included participants with chronic lung disease, while three observational studies included people described as 'high risk' or who had severe atheromatous disease of the aorta. Where reported, the mean ages of the participants ranged from 50 to 70 years in the RCTs and from 63 to 73 years in the observational studies, and the percentage of females ranged from 9 to 37% and from 17 to 100%, respectively. In the observational studies, between 3% and 64% of the participants underwent OPCAB.

Outcomes assessed in the review
The primary outcomes were death, stroke, myocardial infarction (MI), atrial fibrillation and acute renal failure. The outcomes were reported as short term (within 30 days of surgery) and at long term (1 to 2 years). The other outcomes reported were inotrope requirement, low cardiac output syndrome, reoperation for bleeding, blood transfusion, and revascularisation at 1 to 2 years.

How were decisions on the relevance of primary studies made?
Two reviewers performed the quality assessment.

Assessment of study quality
RCTs were assessed for quality according to items such as method of randomisation, allocation concealment, blinded outcome assessment and drop-outs. Observational studies were assessed according to published criteria: e.g. the use of prospective data, reporting the odds ratio (OR) with confidence intervals (CIs), specifying inclusion variables and describing the selection process. Two reviewers performed the quality assessment.
Data extraction
Two reviewers extracted the data and any disagreements were resolved by consensus. The analysis was conducted on an intention-to-treat basis. The number and proportion of participants experiencing each outcome were extracted.

Methods of synthesis
How were the studies combined?
The results from RCTs were pooled separately to those from observational studies. A fixed-effect model was used to pool the data where there was no significant heterogeneity, otherwise a random-effects model was used. ORs with 95% CIs were presented for dichotomous outcomes, while continuous outcomes were expressed as weighted mean differences with 95% CIs.

How were differences between studies investigated?
The studies were grouped according to their design and study details, and the results of the quality assessment were tabulated. Heterogeneity was assessed using the Q statistic. A post hoc analysis was undertaken to investigate any heterogeneity. Sensitivity analyses were conducted to assess the effects of study quality.

Results of the review
Thirty-seven RCTs (3,449 participants) and 19 observational studies (293,617 participants) were included.

Short-term outcomes.
Ten RCTs showed no difference in 30-day mortality between OPCAB and CCAB (OR 0.91, 95% CI: 0.45, 1.83).

Fourteen observational studies showed a decrease in mortality associated with OPCAB (OR 0.72, 95% CI: 0.66, 0.78, P<0.00001).

Twelve RCTs showed no statistically significant reduction in stroke with OPCAB (OR 0.51, 95% CI: 0.25, 1.05, P=0.07). Fifteen observational studies showed a reduction in stroke associated with OPCAB (OR 0.62, 95% CI: 0.55, 0.69, P<0.00001).

Nineteen RCTs showed no statistically significant reduction in MI with OPCAB (OR 0.79, 95% CI: 0.50, 1.25). Six observational studies showed a reduction in MI associated with OPCAB (OR 0.66, 95% CI: 0.50, 0.88, P=0.004).

Eighteen RCTs showed a reduction in atrial fibrillation with OPCAB (OR 0.59, 95% CI: 0.46, 0.77, P<0.00001), although there was significant heterogeneity (P=0.09). Stratified analyses showed that the levels of atrial fibrillation in the control groups and baseline atrial fibrillation levels explained this heterogeneity. Four observational studies showed a reduction in atrial fibrillation associated with OPCAB (OR 0.78, 95% CI: 0.74, 0.82, P<0.0001).

Five RCTs showed no difference in acute renal failure between OPCAB and CCAB (OR 0.61, 95% CI: 0.25, 1.47). Eight observational studies showed a reduction in acute renal failure with OPCAB (OR 0.54, 95% CI: 0.39, 0.77, P=0.006).

The results for other outcomes were also reported.

Long-term outcomes.
Five RCTs showed no differences in 1- to 2-year mortality (OR 0.82, 95% CI: 0.40, 1.68), MI (OR 0.61, 95% CI: 0.32, 1.18) or revascularisation (OR 1.72, 95% CI: 0.78, 3.94) between OPCAB and CCAB.

Two observational studies showed no differences in 1- to 2-year mortality (OR 1.01, 95% CI: 0.74, 1.40), MI (OR 0.91, 95% CI: 0.55, 1.49) or revascularisation (OR 1.35, 95% CI: 0.76, 2.39) between OPCAB and CCAB.

In the RCTs, the mean number of bypass grafts was lower in the OPCAB group than in the CCAB group (difference -0.19, 95% CI: -0.25, -0.13, P<0.0001).
Sensitivity analyses showed that the treatment effects were not generally affected by study quality.

Authors’ conclusions
Apart from atrial fibrillation, RCTs did not find any reduction in short-term mortality or morbidity with OPCAB. However, observational studies did show favourable changes in mortality and morbidity, but interpretation of these results should be limited to associations, with no causal inferences drawn.

CRD commentary
The inclusion criteria in this review were clearly stated. The search seemed appropriate, as did the methods of the review, which were described. The quality of the studies was assessed using appropriate criteria. There was little information about the participants in the included studies, although the authors stated that the people were generally of a low risk. The authors appropriately analysed studies grouped according to study design, and discussed possible reasons for differences in outcomes between observational studies and RCTs. In addition, it should be noted that the quality of evidence from RCTs is generally accepted to be of a higher value than that from observational studies. This was a generally well-conducted review and the authors’ conclusions are likely to be reliable. However, with the results being based primarily on ‘low-risk’ individuals, the generalisability of the results is less certain.

Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: The authors stated that further research is needed to investigate nonfatal morbid events and provide long-term data, and such research should focus on people at higher risk for peri-operative events. They also stated that future studies should report more transparent analytical plans, account for misclassification of converted OPCAB procedures, and incorporate longer term outcomes.

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