Off-pump coronary artery bypass surgery and acute kidney injury: a meta-analysis of randomized and observational studies
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CRD summary
This review concluded that although more research using consistent definitions was needed, evidence suggested that off-pump coronary artery bypass reduced the risk of acute kidney injury. Randomised trials were underpowered to detect any effect on need for renal replacement therapy; evidence from observational studies suggested a beneficial effect. Most data came from observational studies. The authors' conclusions appear suitably cautious.

Authors' objectives
To evaluate the impact of off-pump coronary artery bypass (OPCAB) on acute kidney injury during the postoperative period.

Searching
MEDLINE (1966 to May 2008), EMBASE (1980 to May 2008) and Cochrane Renal Register (Issue 4, 2007) databases and Google Scholar were searched. Search terms were reported. Reference lists from relevant articles were checked and experts were contacted. Only published studies were sought. No language restrictions were applied.

Study selection
Randomised controlled trials (RCTs) and observational studies in adults (over 18) that compared OPCAB to conventional on-pump coronary artery bypass were eligible for inclusion. Studies had to report at least one renal outcome (acute kidney injury, acute kidney injury that required renal replacement therapy (RRT), postoperative serum creatinine/creatinine clearance). The primary outcomes of interest were acute kidney injury and acute kidney injury that required RRT. Studies of people on long-term RRT for end-stage renal failure (or where this was not clear) were excluded.

In the included studies, mean age ranged from 50 to 70 years. Most participants were men. All participants underwent isolated coronary artery bypass graft (CABG) and were variously described as low-risk, high-risk and elective. Where given, baseline mean serum creatinine ranged from 0.9 to 2.6mg/dL in the OPCAB group and 1.0 to 2.7mg/dL in the coronary artery bypass group.

Two authors independently assessed studies for inclusion. Discrepancies were resolved with discussion with an arbitrator.

Assessment of study quality
The quality of RCTs was assessed using items such as randomisation, allocation concealment, blinding of outcome assessors and intention-to-treat analysis. Trials that described randomisation method and allocation concealment in adequate detail were considered good quality. Observational studies that reported on propensity score matching were considered good quality. No other details of any assessment of observational studies was reported.

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

Data extraction
Odds ratios (ORs) and 95% confidence intervals (CI) were calculated for dichotomous data. Mean differences (MD) and standard deviations (SD) were calculated for continuous data. Where necessary, standard error of the mean (SEM) and interquartile ranges were converted to standard deviations using appropriate formulae.

Data were extracted by two authors independently. Disagreements were resolved by discussion with an arbitrator. Study authors were contacted for additional information.
Methods of synthesis
A random-effects model was used to calculate pooled odds ratios and 95% CI and WMD and 95% CI. Statistical heterogeneity was assessed using $X^2$ and $I^2$. Heterogeneity was explored if $I^2 > 25\%$. Sensitivity analyses were made of studies that were considered to be of good quality and studies that included people with pre-existing renal impairment.

Results of the review
Twenty-two studies (27,806 participants) were included: six RCTs (498 participants) and 16 observational studies (6,600 participants in OPCAB group and 20,708 in the coronary artery bypass group). Three RCTs and five observational studies were considered to be of good quality.

Compared to coronary artery bypass, OPCAB reduced the incidence of acute kidney injury (OR 0.57, 95% CI 0.43 to 0.76, $I^2 = 67\%$; five RCTs and 14 observational studies). When analysed separately, observational studies and RCTs gave similar results to the main analysis.

OPCAB reduced the incidence of acute kidney injury that required RRT (OR 0.55, 95% CI 0.43 to 0.71, $I^2 = 0\%$; five RCTs and 13 observational studies). Results for observational studies were similar to the main analysis. Results for RCTs showed no statistically significant difference between groups.

Compared to coronary artery bypass, peak postoperative serum creatinine was lower in the OPCAB group (WMD -0.08, 95% CI -0.14 to -0.02, $I^2 = 28.1\%$; one RCT and five observational studies). There was no statistically significant difference in effect in the RCT. There was no difference in preoperative to postoperative changes in levels of serum creatinine (two observational studies) and changes in creatinine clearance (one observational study).

Sensitivity analyses of studies that included participants with pre-existing renal insufficiency showed a reduction in acute kidney injury (OR 0.47, 95% CI 0.32 to 0.70, $I^2 = 17.7\%$; six studies) and acute kidney injury that required RRT (OR 0.43, 95% CI 0.23 to 0.80, $I^2 = 0\%$; five studies).

Good quality studies alone found a reduction in acute kidney injury and in requirement for RRT therapy (three RCTs and five observational studies).

Authors' conclusions
Available evidence suggested a protective effect of OPCAB in terms of a reduced risk of acute kidney injury. Available RCTs were underpowered to detect any effect on acute kidney injury that required RRT; evidence from observational studies suggested a reduction in requirement of RRT. Future studies should apply a standard definition of acute kidney injury and report outcomes based on severity of kidney injury.

CRD commentary
The aims of the review were clearly stated in terms of inclusion criteria for study design, participants, treatment and outcomes. The search covered a number of sources. Only published studies were sought, so studies may have been missed and publication bias may have affected the review. Study selection and data extraction methods aimed at reduced reviewer error or bias; methods for quality assessment were unclear. The quality of RCTs was assessed appropriately; methods for observational studies were not well described. Little detail was provided about the methods and participants of the observational studies and so it is not possible to comment on the quality of data from these. The authors acknowledged that general data from observational studies is considered of lower quality because of the possibility of confounding factors influencing results. Data from RCTs and observational studies were combined, but results were also presented by study design. Details of the characteristics of participants in the included studies were limited and this could affect the generalisability of results.

Although most data came from observational studies, the authors' conclusions included the need for further research and appear suitably conservative.

Implications of the review for practice and research
Practice: The authors stated that in people at high risk of developing acute kidney injury and if feasible, OPCAB may...
reduce postoperative kidney injury.

**Research:** The authors stated a need for a large RCT to define the role of OPCAB in preventing postoperative kidney injury. Future studies should apply a standard definition of acute kidney injury and report outcomes based on severity of kidney injury.

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