Metal-on-metal or metal-on-polyethylene for total hip arthroplasty: a meta-analysis of prospective randomized studies

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CRD summary
The authors concluded that there was insufficient evidence to identify any clinical advantage of metal-on-metal compared with metal-on-polyethylene total hip replacement. The authors acknowledged the small number of trials and that most trials were underpowered and of short duration. This was a generally well-conducted review and the authors’ conclusions appear to be reliable.

Authors' objectives
To compare the efficacy of metal-on-metal versus metal-on-polyethylene implants for total hip arthroplasty.

Searching
MEDLINE and EMBASE were searched up to December 2010 for relevant publications. There were no language restrictions. Cochrane Central Register of Controlled Trials (CENTRAL), PREMEDLINE and HealthStar were also searched. Search terms were reported. Reference lists and abstracts of the American Society for Bone and Joint Surgeons Research (1995 to 2010) were searched manually. Primary authors and other experts in the field were contacted for additional studies and unpublished or ongoing studies.

Study selection
Randomised controlled trials (RCTs) that compared metal-on-metal versus metal-on-polyethylene implants for total hip arthroplasty were eligible for inclusion. Trials needed to provide sufficient data on at least one of the outcomes: reoperation for any cause, all-cause mortality, local and general complications, radiographic outcomes and metal ion concentrations or function and health-related quality of life where these had been assessed using valid measurement tools.

The included trials were conducted in USA, Canada, the Netherlands or Sweden. Where reported, patient age ranged from 18 to 80 years. Between 20.5% and 75.3% of patients were male. Measured metal ion concentrations included serum metal ions (cobalt and chromium), urine metal ions (cobalt, chromium and titanium) and erythrocyte metal ions (cobalt, chromium and titanium). Health-related quality of life was measured using the Harris hip score or Western Ontario and McMaster Universities (WOMAC) index to assess pain, stiffness and physical function.

Two independent reviewers screened studies for inclusion.

Assessment of study quality
Two reviewers independently assessed study quality according to Detsky’s 21-point scale. Disagreements were resolved by referral to a third reviewer.

Data extraction
Two reviewers independently extracted event rates for dichotomous outcomes (reoperations, mortality and complications) to calculate relative risks (RRs) and 95% confidence intervals (CIs). Means and standard deviations were extracted for continuous outcomes (metal ions, functional scores and quality of life data) to calculate mean differences and 95% CIs. Disagreements were resolved with a third reviewer.

Methods of synthesis
Fixed-effect (where no statistical heterogeneity) or random-effects models (where there was evidence of statistical heterogeneity) were used to pool relative risks and pool mean differences to calculate weighted mean differences (WMDs) or standardised mean differences (SMDs), and 95% CIs. For metal ion concentration outcomes, analyses were performed between pre-operative versus postoperative metal-on-metal implants, pre-operative versus postoperative metal-on-polyethylene implants and metal-on-metal versus metal-on-polyethylene implants.
Results of the review
Eight RCTs (669 patients) were included in the review. Follow-up ranged from two to 10 years.

Cobalt: At two years patients who received metal-on-metal implants had significantly higher postoperative versus preoperative serum cobalt concentrations (WMD 0.67, 95% CI 0.48 to 0.86) and significantly higher postoperative levels compared to metal-on-polyethylene (WMD 0.64, 95% CI 0.49 to 0.79). Pre-operative and postoperative levels were not significantly different in metal-on-polyethylene patients. Similar patterns were reported for urine and erythrocyte cobalt concentrations.

Chromium: Metal-on-metal implants significantly increased postoperative (at two years) serum (WMD 0.59, 95% CI 0.44 to 0.74), urine (WMD 1.91, 95% CI 1.49 to 2.34) and erythrocyte (WMD 0.46, 95% CI 0.15 to 0.77) chromium concentrations compared to pre-operative levels. There were no statistically significant differences in pre-operative and postoperative levels in patients who received metal-on-polyethylene implants for serum or urine. All concentrations were significantly higher in metal-on-metal groups compared to metal-on-polyethylene at two years for serum (WMD 0.58, 95% CI 0.34 to 0.82), erythrocyte (WMD 0.38, 95% CI 0.03 to 0.73) and urine (WMD 1.88, 95% CI 1.46 to 2.30).

Titanium: At two years there were no significant differences in erythrocyte titanium concentrations for any comparison. Both metal-on-metal and metal-on-polyethylene showed significant differences between pre-operative (WMD 0.20, 95% CI 0.08 to 0.32) and postoperative urine titanium concentrations (WMD 0.18, 95% CI 0.09 to 0.27). There were no significant differences in postoperative concentration between implant groups (p=0.56).

There were no significant differences in complication rates (four RCTs), reoperation rates (six RCTs), function and health-related quality of life (seven RCTs) or radiographic evaluation (three RCTs).

Authors’ conclusions
There was insufficient evidence to identify any clinical advantage of metal-on-metal compared with metal-on-polyethylene total hip replacement. Metal-on-metal implants increased cobalt and chromium ion concentrations but there were no significant differences in total complication rates between the two implants in the short- to mid-term.

CRD commentary
The review question was clearly defined and was supported by clear inclusion criteria. A satisfactory search of the literature was undertaken. Attempts were made to reduce language and publication biases. Publication bias was not assessed formally, which seemed appropriate given the low number of trials. Trial quality was reported to have been assessed, but no further details or results were reported. Therefore, the quality of the trials was unclear but all were randomised controlled trials. Each stage of the review process was performed in duplicate, which minimised potential for reviewer error and bias.

It appeared that appropriate statistical methods were used. The authors acknowledged that the trials were low in number and most trials were underpowered and had short follow-up duration.

This was a generally well-conducted review and the authors’ conclusions appear to reflect the evidence and are likely to be reliable.

Implications of the review for practice and research
Practice: The authors stated that metal-on-metal bearings should be used with caution in total hip replacement.

Research: The authors stated that large long-term controlled trials were needed to further assess total hip replacement-induced low-intensity trace-element exposure to rule out potential for metal-induced cancers and nephrotoxicity.

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