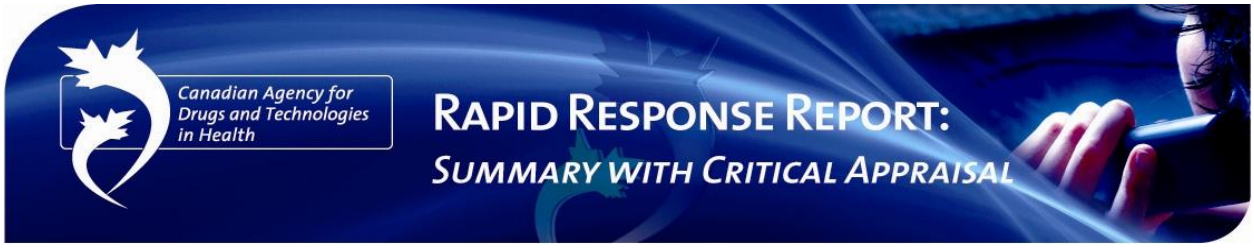

TITLE: Metal on Metal Total Hip Replacements or Hip Resurfacing for Adults: A Review of Clinical Effectiveness and Cost Effectiveness

DATE: 15 November 2012

CONTEXT AND POLICY ISSUES

Total hip replacement (THR), or total hip arthroplasty, is a common orthopedic procedure used to restore function to patients with damaged or degenerated hips and chronic pain.[1] According to the Canadian Joint Replacement Registry (CJRR), 13,068 patients underwent THR in Canada in 2009-2010, a number that has steadily increased over the years.[2] Hip resurfacing arthroplasty (HRA) is another option for treating degenerative hip disease, particularly in younger patients with active lifestyles.[3]

During THR, the head of the femur is removed and replaced with a prosthesis that has a protruding ball.[1] The ball fits into an acetabular cup that is secured to the pelvis with cement or by promoting bone ingrowth.[4] The inside of the cup may contain a lining to reduce friction and decrease wear.[4] Different models of hip prostheses are comprised of varying combinations of metal, ceramic or polyethylene balls, cups and liners. Implant type and mode of fixation are based on patient needs and surgeon preference.[1,4] During HRA, a metal cap is placed on the femoral head to cover damaged bone and a metal shell is placed in the acetabulum.

Metal-on-polyethylene (MOP) hips, where the ball is made of metal and the cup is lined with polyethylene, has become gold standard for hip prostheses.[1,4] Conventional MOP hips typically last 10 to 15 years or more, but wear and osteolysis are an issue for young, more active patients. Cross-linked polyethylene liners improve the longevity of MOP hip implants, but they do not eliminate the wear issue.[1] Metal-on-metal (MOM) hips, where the ball and cup are both made of metal, with or without a metal liner, tend to have better wear rates than MOP hip implants.[1] The size of the femoral head may also vary, with larger heads making for more stable joints with reduced risk of dislocation.[1] Conversely, larger femoral head sizes may increase the wear rate by increasing surface area and friction in MOP bearings.[1]

MOM hip implants, made of stainless steel, titanium or cobalt chrome, may erode and gradually release metal ions into the bloodstream resulting in toxicity.[1,5,6] Due to adverse reactions to metal debris, MOM hips have also been associated with high failure rates and surgical revisions.[6]

This review evaluates the comparative clinical and cost-effectiveness of MOM total hip replacement versus MOP (cross-linked polyethylene) total hip replacement. The comparative clinical effectiveness of hip resurfacing versus total hip replacement in adults is also examined.

RESEARCH QUESTIONS

1. What is the clinical- effectiveness of metal-on metal (MOM) large head total hip replacement (THR), acetabulum- without a metal liner versus standard total hip replacement metal on cross-linked polyethylene liner in adult patients?

2. What is the clinical-effectiveness of metal on metal (MOM) total hip implants for total hip replacements (≥36 mm), acetabulum- with metal liner, versus standard total hip metal on cross-linked polyethylene liner in adult patients?

3. What is the cost-effectiveness of metal on metal (MOM) implants for total hip replacements (≥36 mm), acetabulum- with metal liner, versus standard total hip metal on cross-linked polyethylene liner in adult patients?

4. What is the clinical-effectiveness of metal on metal (MOM) hip implants for total hip replacements (<36 mm), acetabulum- with metal liner, versus standard total hip replacement metal on cross-linked polyethylene liner in adult patients?

5. What is the cost-effectiveness of metal on metal (MOM) total hip implants (<36 mm), acetabulum- with metal liner, versus standard total hip replacement metal on cross-linked polyethylene liner in adult patients?

6. What is the clinical-effectiveness of hip resurfacing compared to total hip replacement in adults?

KEY FINDINGS

Based on a systematic review, second-generation stemmed MOM THA demonstrated greater longevity than HRA.[7] Two meta-analyses suggest that while HRA patients may have as good or better functional outcomes as THA patients, they also have greater risk of revision, femoral neck fractures, component loosening and heterotopic ossification than THA patients. No significant differences in the rates of mortality, dislocation or deep hip joint infection were found between groups.[8,9] No evidence was found regarding the clinical and cost-effectiveness of MOM THR versus MOP (cross-linked polyethylene) THR based on ball size or liner material.

METHODS

Literature Search Strategy

A limited literature search was conducted on key resources including PubMed, The Cochrane Library (2012, Issue 10), University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. Methodological filters were applied to limit retrieval to health technology assessments, systematic reviews, meta-analyses, and randomized controlled trials. Where

possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2007 and October 18, 2012.

Selection Criteria and Methods

One reviewer screened the titles and abstracts of the retrieved publications and evaluated the full-text publications for the final article selection, according to selection criteria presented in Table 1.

Table 1: Selection Criteria

Population	Adult patients with degenerative hip disease
Intervention	Q1: Metal-on-metal (MOM) large head total hip replacement (THR) Q2-3: MOM THR (≥36 mm) with a metal liner Q4-5: MOM THR (<36 mm) with a metal liner Q6: Hip resurfacing arthroscopy (HRA)
Comparator	Q1-5: Standard total hip replacement (THR) metal on cross-linked polyethylene liner Q6: THR
Outcomes	Q 1, 2, 4, 5: Failure rates, reasons for failure, Q3, 5: Cost effectiveness
Study Designs	Health technology assessments, systematic reviews, meta-analyses, RCTs, non-randomized studies, economic evaluations

Exclusion Criteria

Studies were excluded if they did not meet the selection criteria, were duplicate publications or included in a selected systematic review, or were published prior to 2007.

Critical Appraisal of Individual Studies

The quality of included systematic reviews was assessed using the Assessment of Multiple Systematic Reviews (AMSTAR) tool.[10] No individual RCTs, non-RCTs or economic evaluations were identified for critical appraisal. A numeric score was not calculated, instead study strengths and limitations are described.

SUMMARY OF EVIDENCE

Quantity of Research Available

The literature search yielded 148 citations. Upon screening titles and abstracts, 18 potentially relevant articles were retrieved for full-text review. No further potentially relevant reports were retrieved from grey literature or hand searching. Of the 18 potentially relevant reports, one was a protocol, two contained an irrelevant population, five contained an irrelevant comparator, three contained irrelevant outcomes, and four articles were already contained in an included systematic review. The three publications included in this review report on the clinical effectiveness of HRA versus THR.[7-9] The process of study selection is outlined in the PRISMA flowchart (Appendix 1).

Summary of Study Characteristics

Detailed characteristics of individual studies are provided in Appendix 2.

Study design

Two meta-analyses[8,9] and a systematic review[7] were selected for review. The reports, were published in China,[8] the United States,[7] and the United Kingdom[9] in 2010[9] and 2011.[7,8] The meta-analyses and systematic review included between four[8] and 64 studies.[7] Both RCTs and non-randomized studies were included in the reviews.

Population

The Chinese meta-analysis included four studies involving 968 adults with end-stage hip disease but the number of hips, age, and sex of patients were not reported.[8] The British meta-analysis included 46 studies involving 3,799 HRA in 3,279 patients and 3,282 THA in 2,910 patients.[9] While patients had a mean age of 53 years, not all studies included in the meta-analysis reported on the sex of the patients.[9] The American systematic review included 64 studies involving 3,057 hips in more than 1,979 adult patients.[7]

Interventions and comparators

The Chinese meta-analysis compared second-generation MOM HRA with standard THR for the treatment of hip disease in active, young adults less than 65 years of age.[8] The British meta-analysis compared a variety of different HRA with over 33 types of THR prostheses.[9] The Birmingham Hip Resurfacing system (Smith and Nephew, Warwick, UK) was used in 15 papers, the Durom hip resurfacing system (Zimmer, Warsaw, IN) was used in eight studies, and the Conserve Plus (Wright Medical Technology, Arlington, TN) was used in six studies.[9] Of the 64 reports included in the American systematic review, 21 addressed stemmed MOM THR, 22 addressed MOM HRA, 21 reported on ceramic-on-ceramic THR while no studies reported on ceramic-on-metal THR.[7]

Outcomes

The Chinese meta-analysis reported on revision rates up to 10 years post-operatively, mortality, femoral neck fracture, component loosening dislocation, deep hip joint infection, hip function, and range of motion.[8] The British meta-analysis reported on complication rates and clinical and radiological outcomes using studies of at least 24 months of follow-up.[7] The systematic review reported on the survival rates of stemmed MOM THA, MOM HRA, ceramic-on-ceramic THA and ceramic-on-metal THA.[7]

Summary of Critical Appraisal

Details of the strengths and limitations of individual studies are provided in Appendix 3.

The systematic reviews with meta-analyses were based on comprehensive literature searches using pre-defined criteria.[8,9] The reviewers contacted authors[8,9] for further information and searched the grey literature for citations not identified through database searching.[9] Two reviewers independently screened citations[8,9] and data was either independently extracted in duplicate[8] or extracted by one reviewer and verified by a second reviewer.[9] Trial quality was

assessed based on predefined criteria.[8,9] While the British meta-analysis assessed for publication bias and included a conflict of interest statement,[9] the Chinese meta-analysis did not.[8]

The American systematic review was based on a literature search of one database for level I or level II studies published in English.[7] Definitions of levels of evidence were not described within the publication. Some bearing couples were developed and used extensively in non-English speaking countries and their results were reported in several respected native-language journals.[7] It is unclear whether article selection and data extraction were performed in duplicate but trial quality was assessed by three reviewers using predefined criteria.[7] The review did not include a conflict of interest statement.[7]

Summary of Findings

Two meta-analyses[8,9] and a systematic review[7] provided evidence on the comparative effectiveness of HRA and THR for degenerative hip disease. A summary of the comparative effectiveness of HRA and THR is provided in Table 2, and individual study findings are summarized in Appendix 4.

Pooled results, from two RCTs and two controlled clinical trials, showed a higher incidence of revision in MOM HRA patients than THR patients up to 10 years after surgery (Relative risk (RR) 2.6, 95% confidence interval (CI) 1.31 to -5.15; P = 0.006).[8] THR patients had a higher incidence of dislocation than MOM HRA patients at one year (RR 0.14, 95% CI 0.01 to 2.70; P = 0.26) and two years (RR 0.33, 95% CI 0.05 to 2.25; P = 0.26) after surgery but the differences were not statistically significant. The incidence of femoral neck fracture may have been higher among MOM HRA patients as it is a complication unique to HRA.[8] Three trials reported femoral neck fracture frequencies among patients who received HRA but there was clinical heterogeneity between groups because the femoral neck is sectioned during THA but not during MOM HRA.[8]The pooled results showed MOM HRA patients had a higher incidence of component loosening compared to THR patients (RR 4.96, 95% CI 1.82 to13.50; P = 0.002).[8] No significant differences in the rates of mortality, dislocation or deep hip joint infection were found between groups.[8]

Pooled results from 46 studies showed that the risk of revision surgery following HRA was almost twice that following conventional THR (RR 1.7, 95% CI 1.2 to 2.5; P = 0.003).[9] The risk of aseptic loosening following HRA was also three times greater than that following THR (RR 3.1, 95% CI 1.1 to 8.5; P = 0.03).[9] There was a reduced incidence of dislocation following HRA compared to THR (RR 0.2, 95% CI 0.1 to 0.5; P < 0.001)[9] No statistically significant difference in the incidence of postoperative fracture, joint infection, acetabular component malpositioning, trochanteric malunion, leg length discrepancy, or mortality were found between groups.[9]

A systematic review of 21 studies assessing stemmed MOM THR reported survival rates of 71% to 100% at mean follow-ups ranging from 36 months to 336 months.[7] Seventeen studies involving second-generation MOM hips reported survival ranging from 93% at 120 months to 100% at a mean follow-up of 60 months (range 44 to 88 months).[7] Four level I or II studies reported survival rates of between 96% and 100% at mean follow-ups ranging from 38 to 60 months.[7] Twenty two studies assessing MOM HRA reported survival rates of 84% to 100% at mean follow-ups ranging from 39 to 89 months.[7]

No evidence was found regarding the clinical and cost-effectiveness of MOM THR versus MOP (cross-linked polyethylene) THR based on ball size or liner material.

Table 2: Summary of the Comparative Effectiveness of HRA and THR

Intervention	Evidence	Results
HRA versus THR	2 meta-analyses[8,9] and a systematic review[7]	**Effectiveness** • MOM HRA patients experienced higher rates of revision,[8,9] femoral neck fractures[8] and component loosening[8,9] than THR patients. • There was a reduced incidence of dislocation following HRA compared to THR.[9] • Stemmed MOM THR had survival rates of 71% and 100% at mean follow-ups ranging from 36 months to 336 months.[7] • MOM HRA had survival rates of 84% to 100% at mean follow-ups ranging from 39 to 89 months.[7] • No significant differences in the rates of mortality,[8,9] dislocation[8] or deep hip joint infection[8,9] were found between groups.

HRA: hip resurfacing arthroscopy; MOM: metal-on-metal; THR: total hip replacement

Limitations

Two meta-analyses[8,9] and a systematic review[7] of up to 64 studies evaluated the comparative clinical effectiveness of HRA versus THR for degenerative hip disease. While the meta-analyses were based on comprehensive literature searches using predefined criteria,[8,9] the systematic review was based on a search of one database for level I or II studies published in English.[7] The four studies meta-analysed in Jiang et al.[8] were also evaluated in the meta-analysis by Smith.[9] All reviews cited the potential for bias based on deficiencies in randomization,[7-9] allocation concealment and blinding[7] of participants, assessors and analysts in the included studies. Most level I studies in the systematic review had a mean follow-up of five years or less which limits discernable differences in long-term survival.[7] One meta-analysis assessed for publication bias.[9] No evidence was found regarding the clinical effectiveness of variations in ball size, liners or cost-effectiveness.

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING

While HRA allows for greater bone preservation, lower wear rates, and equal or better functional outcomes compared to THA,[9] MOM HRA patients experienced higher rates of revision,[8,9] femoral neck fractures[8] and component loosening[8,9] than THR recipients. MOM HRA reported survival rates of 84% and 100% at mean follow-ups ranging from 39 to 89 months.[7] No significant differences in the rates of mortality,[8,9] dislocation[8] or deep hip joint infection[8,9] were found between groups. No evidence was found regarding the clinical and cost-effectiveness of MOM THR versus MOP (cross-linked polyethylene) THR based on ball size or liner material.

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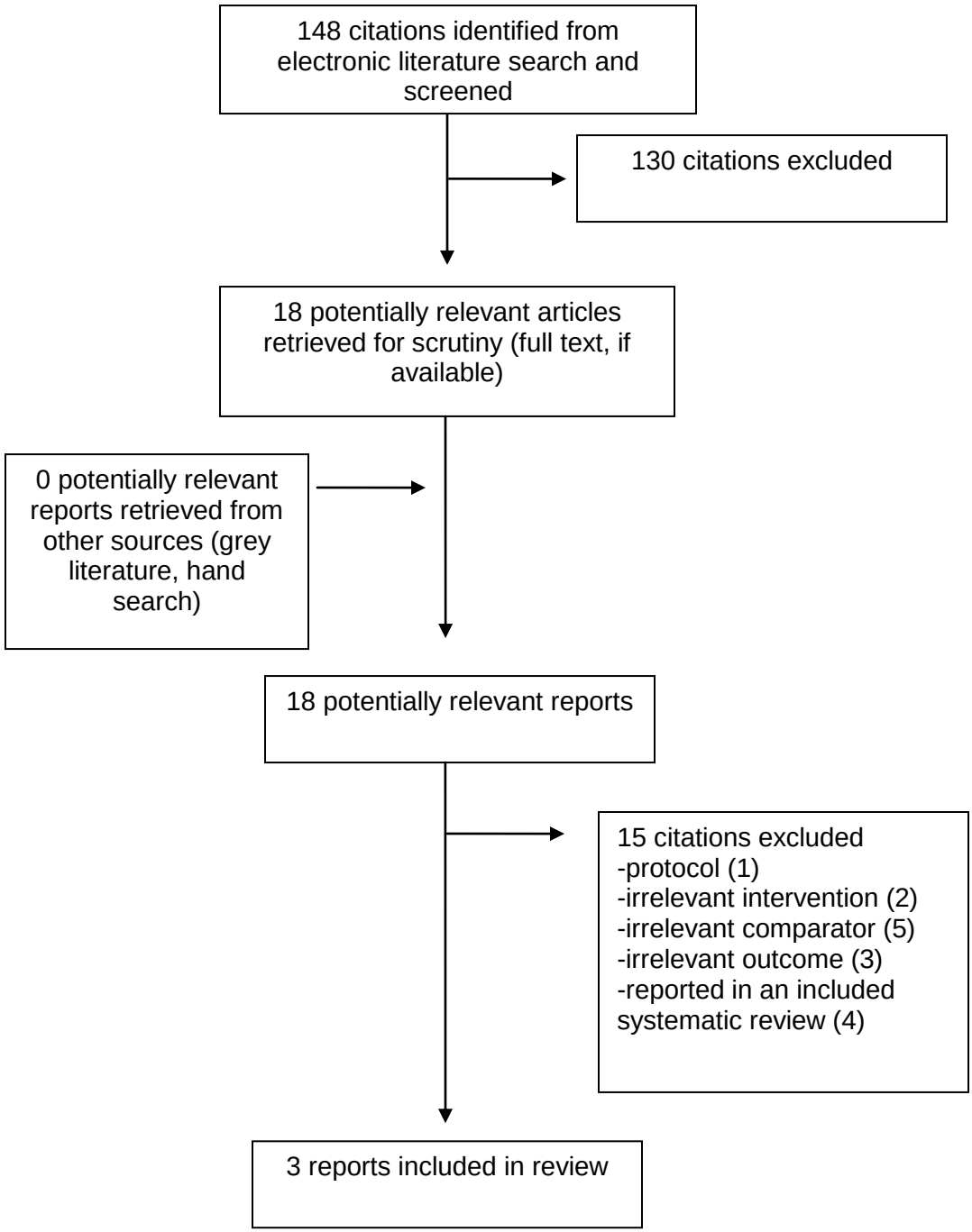
APPENDIX 1: Selection of Included Studies



APPENDIX 2: Summary of Study Characteristics

First Author, Publication Year Country	Study Design	Patient Characteristics	Intervention	Comparator	Clinical Outcomes Measured
Comparative Clinical Effectiveness of HRA versus THR					
Systematic Reviews and Meta-analyses					
Jiang[8] 2011 China	Systematic review, meta-analysis (4 studies, study type NR, 968 patients, number of hips NR)	Adults < 65 years, end-stage hip disease (mean age NR, % F NR)	MOM HRA (n=503)	Standard THR (n=465)	Revision rate at 1, 3, 5, 10 years, mortality, femoral neck fracture, component loosening, dislocation, deep hip joint infection, hip function, range of motion
Smith[9] 2010 United Kingdom	Systematic review, meta-analysis (28 observational studies, 8 retrospective studies, 10 RCTs, 3,799 HRA in 3,279 patients and 3,282 THA in 2,910 patients)	Adults; mean age 53 years; % F NR in all studies included in meta-analysis	HRA (Birminigham in 15 studies; Durom in 8 studies, Conserve Plus in 6 studies)	THR (>33 different kinds of prosthesis; at least one study of MOM THA)	Clinical and radiological outcomes, complication rates
Zywiel[7] 2011 United States	Systematic review (64 reports, 21 studies addressed MOM THR, >1,979 patients, 3,057 hips, minimum mean follow-up of 24 months)	Adults; mean age NR; % F NR	MOM THR MOM HRA, COC THR and COM THR	NA	Survival rate up to 60 months

COC: ceramic-on-ceramic; F: female; MOM: metal-on-metal; HRA: hip resurfacing arthroplasty; MOP: metal-on-polyethylene; NA: not applicable; NR: not reported; RCT: randomized controlled trial; SR: systematic review; THR: total hip replacement

APPENDIX 3: Summary of Critical Appraisal

First Author, Publication Year	Strengths	Limitations
Comparative Clinical Effectiveness of HRA versus THR		
Systematic Reviews and Meta-analyses		
Jiang[8] 2011 China	• Comprehensive literature search based on pre-defined criteria • Authors contacted for further information • Data were independently extracted in duplicate • Trial quality assessed based on predefined criteria (Cochrane)	• Unclear whether article selection was performed in duplicate • While RCTs and controlled clinical trials were selected, they did not report each study type • Excluded studies were not listed • The total number of hips included the SR was unclear • Results are based on trials with potential bias based on deficiencies in randomization methods, allocation concealment, and blinding • Publication bias was not assessed • Conflict of interest statement NR
Smith[9] 2010 United Kingdom	• Comprehensive literature search based on pre-defined criteria • Grey literature was searched and authors were contacted for citations not identified through database searching • Two reviewers independently screened citations • Data was extracted by one reviewer and verified by a second reviewer using a predefined data extraction spreadsheet • Trial quality assessed by two reviewers using a modified CASP assessment tool; disagreements resolved through discussion • Publication bias was assessed • Conflict of interest statement was included	• Excluded studies were not listed
Zywiel[7] 2011 United States	• Literature search based on pre-defined criteria • Hand searching for additional articles • Trial quality assessed by three reviewers based on predefined criteria (Cochrane) • Conflict of interest statement was included	• One database was search for level I or II studies published in English • Some bearing couples were developed and used extensively in non-English-speaking countries and their results were reported in several respected native-language journals[7] • Unclear whether article selection and data extraction were performed in duplicate

First Author, Publication Year	Strengths	Limitations
		• Excluded studies were not listed • Results are based on trials with potential bias based on deficiencies in randomization, allocation concealment, and blinding of participants, assessors and analysts • Variability in the study methods and data reporting resulted in heterogeneity and precluded accurate aggregation or comparison of reported findings across multiple studies[7] • Most level I studies have a mean follow-up of 5 years or less, limiting the ability to discern differences in long-term survival • Publication bias was not assessed

CASP: Critical Appraisal Skills Programme assessment tool; HRA: hip resurfacing arthroplasty; NR: not reported; RCT: randomized controlled trials; THR: total hip replacement

APPENDIX 4: Summary of Findings

First Author, Publication Year	Main Study Findings	Authors' Conclusions
Comparative Clinical Effectiveness of HRA versus THR		
Systematic Reviews and Meta-analyses		
Jiang[8] 2011 China	Increased rates of revision, femoral neck fractures and component loosening were reported in MOM HRA patients compared to THR patients.[8] **Comparative Clinical Effectiveness** • MA of 4 trials involving 968 patients, reported a higher incidence of revision in MOM HRA patients than in THR patients within 10 years of surgery [RR 2.60; 95% CI 1.31, 5.15; P=0.006].[8] • UCLA scores showed significantly higher activity levels in MOM HRA patients (6.3 versus 7.1; P=0.037) and a greater return to moderate activities (72% versus 39%; P=0.007 compared to THA patients.[8] • MOM HRA patients had higher activity scores than THA patients (14 versus 13; P<0.001).[8] • One study reported a significantly shorter mean surgical time in the THA group (85 minutes; range 50-150 minutes) than in the MOM HRA group (101 minutes; range 65-155 minutes; P<0.001).[8] **Adverse Effects** • THR patients had a higher incidence of dislocation than MOM HRA patients at 1 year [RR 0.14; 95% CI 0.01, 2.70; P=0.19] and 2 years [RR 0.33; 95% CI 0.05, 2.25; P=0.26] after surgery but not statistically significant.[8] • Pooled results showed NSD in dislocation rates between groups within 2 years of surgery [RR 0.25; 95% CI 0.05, 1.21; P=0.08][8] • One study reported NSD in mortality between groups at 3 years [RR 1.05; 95% CI 0.24, 4.66; P=0.95][8] • MOM HRA patients showed higher incidences of component loosening than THA patients at 1 and 5 years but was only significant at 2 years [RR 6.10; 95% CI 1.41, 26.39; P=0.02].[8] • Pooled results showed that MOM HRA patients showed a significant difference in component loosening within 10 years of surgery compared to THA patients [RR 4.96; 95% CI 1.82, 13.50; P=0.002].[8] • Pooled results found NSD in the rate of deep hip joint infection between treatment groups [RR 2.25: 95% CI 0.61, 8.31; P=0.22].[8]	• "RCTs and controlled clinical trials have provided insufficient evidence to determine whether modern MOM HRA offers clinical advantages over standard THA for treatment of hip disease in active young patients. Successful outcomes depend on strict patient selection and improvement of surgical skills: MOM HRA should be used by a limited number of experienced hip surgeons (Page 425)."[8]

First Author, Publication Year	Main Study Findings	Authors' Conclusions
Smith[9] 2010 United Kingdom	Meta-analysis showed functional outcomes for HRS patients were better than or the same as THA patients, but there were statistically significantly greater incidences of heterotopic ossification, aseptic loosening, and revision surgery with HRS compared to THA.[9] **Comparative Clinical Effectiveness** • THA patients showed significantly poorer functional ability than HRA at final follow-up (MD -2.4,95% CI -3.9, -0.9; P=0.001)[9] • HRA patients had better range of motion than THA patients (MD -0.05, CI -0.1, -0.03; P<0.001)[9] • HRA patients showed greater heterotopic ossification than THA patients (RR 1.6, CI: 1.2, 2.1; P=0.006)[9] • HRA patients had almost double the risk of revision surgery compared to THA patients (RR 1.7, 95%CI 1.2, 2.5; P=0.003)[9] **Adverse Effects** • HRA patients had a 3 times greater risk of aseptic loosening compared to THR patients (RR 3.1, 95% CI 1.1, 8.5; P=0.03)[9] • HRA patients showed a reduce incidence of dislocation compared to THA patients (RR 0.2,95% CI 0.1, 0.5; P<0.001)[9] • The larger head size of HRA provides greater stability (reduced risk of dislocation), the removal of the femoral head in THA reduces risk of avascular necrosis of the femoral head, and the need to site the femoral componenet would predispose HRA to show a greater incidence of femoral neck notching compared to THA[9] • NSD between groups regarding the incidence of postoperative fracture, VTE or pulmonary embolism, joint infection, acetabular component malpositioning, trochanteric malunion, peroneal or sciatic nerve palsy, trochanteric bursitis, clinical leg length discrepancy, squeaking, positive Trendelenburg sign, or mortality (P>0.05)[9] • NSD between the frequency of adverse reaction to metal debris between HRS and THA[9]	• "While functional outcomes following HRA were better or the same as those following THA, there is a higher risk of heterotopic ossification, aseptic loosening, and early revision surgery for patients who undergo HRA rather than THA. THA appears to be superior to HRA on the basis of current evidence (pg 689)"[9] • "Our findings indicate that functional outcomes following HRA are better or the same as for THA, but that there is an increased risk of heterotopic ossification and aseptic loosening after HRA and the revision rate with HRA is twice that with THA. THA would therefore appear to be superior to HRA (Page 695)."[9]
Zywiel[7] 2011 United States	Four level I or II second-generation stemmed MOM THA studies reported between 96% and 100% mean survival at 38 and 60 months. Two level I HRA studies reported 94% and 98% mean survival at 56 and 33 months.[7] **Comparative Clinical Effectiveness** • 21 studies assessing stemmed MOM THA reported	• "While MOM bearing survival rates have been variable with earlier designs, contemporary implants have demonstrated survival of 95% or greater at follow-up of between 3 and 10 years.

First Author, Publication Year	Main Study Findings	Authors' Conclusions
	survival rates of 71% to 100% at mean follow-ups ranging from 36 to 336 months[7] • 4 studies involving first-generation MOM bearings (prior to cross-linking) reported survival rates ranging from 96% at a mean follow-up of 36 months (range 24 to 48 months) to as low as 71% at a mean follow-up of 135 months (range 24 to 140 months)[7] • 17 studies encompassed second-generation MOM bearings and reported survival ranging from 93% at 120 months to 100% at a mean follow-up of 60 months (range 44 to 88 months)[7] • The longest reported mean follow-up was 126 months (range 120 to 143 months) with survival rate of 94%[7] • 22 studies assessing MOM HRA reported survival rates of 84% to 100% at mean follow-ups ranging from 39 to 89 months[7] • 3 reports were level I or II studies whereas 16 were level 4; 2 level I studies reported survival rates of 94% at a mean follow-up of 56 months (range 36 to 72 months) and 98% at a mean follow-up of 33 months (range 24 to 60 months[7] • The single level II study reported a survival rate of 95% at a mean follow-up of 36 months (range 24 to 72 months)[7]	Some variability in survival may be due to differences in surgical technique, component positioning, and implant designs. As bearing designs continue to improve with modified materials and manufacturing techniques, use will increase, especially in young and active patients, though concerns remain about the increased reports of adverse events after MOM bearings (Page 1536)."[7]

HRA: hip resurfacing arthroplasty; MA: meta-analysis; MOM: metal-on-metal; MOP: metal-on-polyethylene; NR: not reported; NSD: no significant difference; RCT: randomized controlled trial; SR: systematic review; THR: total hip replacement