



TITLE: **Metal on Metal Hip Resurfacing as an Alternative to Total Hip Arthroplasty**

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METAL ON METAL HIP RESURFACING AS AN ALTERNATIVE TO TOTAL HIP ARTHROPLASTY

A Technology Assessment

INTRODUCTION

The California Technology Assessment Forum (CTAF) is requested to review the scientific evidence for metal on metal (MoM) hip resurfacing as an alternative to total hip arthroplasty. This is an update to the CTAF assessment done on this same topic in 2007¹.

BACKGROUND

Disease affecting the hip joint is usually caused by osteoarthritis (OA), the most common form of joint disease². OA is chiefly a disease of aging; 90% of all people have radiographic features of OA in weight-bearing joints by age 40³. It is characterized by changes to the structure of the entire joint, particularly degeneration of cartilage and hypertrophy of bone at the articular margins⁴. The presenting symptom of osteoarthritis of the hip is generally pain, which may be associated with a limited range of motion; though pain in the hip may be referred from other regions of the body, referred to other structures (such as the knee) or may be confused with other etiologies such as trochanteric bursitis.

Hereditary and mechanical factors may be involved in the pathogenesis of OA. Obesity is a risk factor for knee osteoarthritis and probably for the hip. Participation in competitive contact sports increases risk as do jobs requiring frequent bending and carrying; for example, farming carries a significantly increased relative risk for OA⁵.

OA of the hip joint contributes to morbidity for the individual and costs to society. Overall, OA is the sixth leading contributor worldwide to total years lost to disability, or disability adjusted life years (DALYs)⁵. Individuals with hip OA may suffer from pain, stiffness and loss of function, adversely impacting their health related quality of life. The direct and indirect societal costs attributable to OA are enormous. For example, Individuals with OA are more likely to reduce work hours or take early retirement. Older adults with symptomatic arthritis report greater medical utilization and health care

costs compared with people not reporting arthritis⁶.

Rheumatoid arthritis (RA), an inflammatory arthropathy, may also lead to degeneration of the hip joint, but because it is a systemic condition is unlikely to affect the hip joint alone. Involvement of the hip joint in RA occurs in ten percent to 40% of individuals². Other conditions that can cause secondary OA are avascular necrosis, congenital dislocation, Paget's disease, ankylosing spondylitis and traumatic arthritis.

Treatment for degenerative disease of the hip includes pharmacological and non-pharmacological measures, including lifestyle interventions. Analgesics such as acetaminophen and narcotics can treat the pain associated with the disease and improve function; non-steroidal anti-inflammatory medications, such as ibuprofen, can also be used and are more effective in more advanced disease but are less safe. Corticosteroid injections are a mainstay of treatment for OA and RA, though injections into the hip joint often need to be done under radiographic guidance⁷. Lifestyle interventions used to prevent or ameliorate the progression of OA include weight loss, exercise and physical therapy. Surgical interventions include arthroscopy, MoM hip resurfacing arthroplasty (HRA) and total hip arthroplasty (THA). More than 168,000 total hip arthroplasties are performed annually in the United States⁸.

In the 1950's the concept of resurfacing the arthritic socket, as well as the femoral head, emerged, but the material used (first Teflon and then methacrylate cement) and design flaws led to numerous device failures and adverse events, such as avascular necrosis⁹. The third generation of hip resurfacing emerged in England in the 1990s, and while there are at least ten different commercially available hip resurfacing systems, to date only the Birmingham Hip Resurfacing (BHR), the Cormet 2000, and the Conserve Plus systems are FDA approved. All three of these systems use a MoM Cobalt-Chromium articulation, but they use different combinations of materials for the backing of the acetabular component. While there are differences in materials and design, all hip resurfacing devices consist of two parts: a cup shaped acetabular component and a cemented femoral cap with a stem that inserts into the femur.



The potential advantage of MoM hip resurfacing over THA is that it allows for most of the femoral head to be preserved and only replaces the surface of the joint; this maintains the femoral canal and can make revision surgery, if necessary, less complex¹⁰. Thus, MoM hip resurfacing has been promoted for younger patients with end-stage OA of the hip or RA, traumatic arthritis, hip dysplasia or avascular necrosis for whom conventional THA is not expected to last their lifetime. Other potential advantages of hip resurfacing over THA include earlier return to function and less restriction on function compared to THA. However, one expert points out that the posterior approach favored in resurfacing devascularizes the femoral head, possibly permanently, potentially leading to avascular necrosis over time¹¹. Hip resurfacing is considered by most to be a more challenging operation for the surgeon than THA and requires specialized training and a significant learning curve^{12 13, 14}.

The 2007 CTAF assessment concluded that the peer-reviewed literature had not kept pace with changes in hip resurfacing technology; most of the published literature consisted of case series from single surgeons, and there were no randomized controlled trials of FDA approved hip resurfacing devices.¹ We undertake the current assessment to review the peer-reviewed literature of the three FDA approved MoM hip resurfacing systems published since the 2007 assessment, with a particular focus on randomized controlled trials (RCT) and comparative study (level 1-4) evidence.

TECHNOLOGY ASSESSMENT (TA)

TA Criterion 1: The technology must have final approval from the appropriate government regulatory bodies.

The Birmingham Hip Resurfacing (BHR) system (Smith & Nephew Inc., Memphis, TN, USA) received FDA PMA approval in 2006.

The Cormet 2000 Hip Resurfacing System (Corin USA, Tampa, FL, USA) received FDA PMA approval in July 2007.



Wright Medical Technologies (Arlington, TX, USA) CONSERVE Plus Hip System received FDA PMA approval in November 2009.

There are several other hip resurfacing devices which have been developed but which have not received FDA clearance at this time.

TA Criterion 1 is met.

TA Criterion 2: The scientific evidence must permit conclusions concerning the effectiveness of the technology regarding health outcomes.

The Medline, Embase, and Cochrane clinical trials database, Cochrane reviews database and the Database of Abstracts of Reviews of Effects (DARE) were searched for relevant references through April 2010. While the majority of the search results were published case studies, there were four RCTs, two since the 2007 CTAF assessment and none of which studied an FDA approved device¹⁵⁻¹⁸. One of these RCTs resulted in multiple publications¹⁸⁻²². There was a final publication which presented the study protocol for a planned RCT comparing MoM hip resurfacing to THA, but didn't state which MoM would be studied²³. In addition, there were nine publications reporting on six non-randomized comparison studies²⁴⁻³².

Level of Evidence: 3,4,5

TA Criterion 2 is met.

TA Criterion 3: The technology must improve net health outcomes.

Randomized Controlled Trials

As noted above, there are three published RCT's of MoM hip resurfacing compared with total hip arthroplasty, none of which studied an FDA approved device. As noted in the 2007 CTAF assessment, the first, by Howie et al, was stopped early due to early failures in the MoM hip

resurfacing group¹⁷ The second, by Venditoli et al, found no difference in satisfaction or complication rates, but the MoM hip resurfacing group had better postoperative functional performance¹⁸. The third, by Garbuz et al, compared a non-FDA approved device to large diameter MoM total hip arthroplasty and while they found no difference in quality of life (QoL) outcomes, they noted increased serum cobalt and chromium ion levels in both groups, but highest in MoM large head total hip arthroplasty, demonstrating that circulating metal ions are a concern for all MoM hip devices¹⁶. The final trial, by Lavigne et al, compared a non-FDA approved device to large diameter total hip arthroplasty and found no difference in gait speed, postural balance, and clinical scores; both groups achieved similar function to a healthy control group by three months¹⁵.

Non-Randomized Comparative Studies

Again, as noted above, our search turned up nine publications reporting on six non-randomized comparison studies. (Table 1) All of these studies had small sample sizes and for many of them their comparator groups were either recruited selectively or were historical controls. Only one study – Brennan et al – reported on the BHR and they compared the weight of acetabular reamings for BHR patients to differentially selected un-cemented THA patients and found the weights to be similar; this is at best a surrogate marker for potential adverse outcome of a femoral neck fracture²⁴.

Of the six publications reporting on the Conserve Plus hip resurfacing system, three reported slightly different comparisons and/or outcomes for overlapping patient populations^{27, 28, 32}, and a fourth may well also be from an overlapping population given that the authors are also overlapping²⁹. These were retrospective analyses comparing MoM hip resurfacing patients to historical control patients with ‘conventional’ THA from a separate registry; taken together they found no difference in Harris Hip Score – a measure of pain, function, satisfaction, or range of motion. There was a difference in activity level; however, activity level was different in the two groups at baseline and no adjustments were made for this, possibly because of the small sample sizes. A fifth study had similar findings and similar limitations²⁵. The sixth study of Conserve Plus was a retrospective study in which patients acted as their own controls – they assessed range of motion in those patients in their registry who had MoM hip resurfacing on one side and THA on the

other, some of which were revisions from prior resurfacing procedures²⁶. These authors found no difference by type of replacement, including no difference in the subset of patients with revisions and no difference when stratified by size of implant. Of note, the study was underpowered for these subanalyses.

Two papers reported on the Cormet 2000 hip resurfacing system in the same patient population^{30, 31}. The earlier report concludes that the resurfacing patients had equal overall clinical success with the ceramic-on-ceramic THA patients in terms of a composite score including Harris Hip Score, 'radiographic evidence of success', absence of device related complications and absence of revision; however, the MoM hip resurfacing group had substantially more revisions (7.1% vs. 1.9%) in a shorter follow-up time frame³¹. Revisions were primarily due to femoral neck fractures and femoral component loosening. The THA group was the historical control. The later report assessed the Harris Hip Score at specific time-points over two-year follow-up in the same two groups of patients, concluding that while there were differences early on, with the THA group doing better at six weeks and the MoM hip resurfacing group doing better at six months, there was no difference at 12 or 24 months with >90% of both groups scoring in the excellent range³⁰.

Table 1: Non-randomized comparison studies of MoM hip resurfacing and total hip arthroplasty

Study	Hip Resurfacing Device	Comparison Groups	Methods	Outcomes	Results	Comments
Brennan et al 2009	Birmingham (BHR)	N=31 BHR patients N=31 uncemented THA patients	Prospective Differential group assignment: obesity, older women, large subchondral pseudocysts, history of AVN to uncemented THA group	Weight of acetabular reamings in two groups adjusted for acetabular size	No significant difference in weight of acetabular reamings.	Differential assignment makes comparison difficult. Outcome is surrogate marker for clinical outcome/complication risk.
Fowble et al 2009³²	Conserve Plus	N=50 Conserve Plus patients N=35 THA patients	Prospective 2-4 year follow-up Single site, single surgeon	Harris hip score Range of motion Complete relief of pain. SF-12 physical activity scores UCLA activity scores	No significant difference in Harris hip score for resurfacing group compared to controls (97 vs. 96; p=.4) or for range of motion post-operatively. Resurfacing group with more marked pain pre-op (94% vs. 58%; p=.0001); fewer in resurfacing group had complete relief of pain than in THA group post-operatively (48% vs. 80%; p=.007). Higher functioning (SF-	No adjustment for baseline clinical characteristics, including baseline measurements of pain and activity scores which differed across groups.



					12 physical score, UCLA activity score) at baseline and post-operatively in resurfacing group.	
Le Duff et al 2009	Conserve Plus	35 patients bilateral hip replacements, one side resurfacing, one side THA	Retrospective Mean follow-up 7 years Patients act as own controls All resurfacing procedures were primary; 14 THA were revisions (12/14 from resurfacing to THA)	Range of motion	No difference in range of motion. No difference for subset of patients with revisions. No difference when stratified by size of implant.	Strength to have patients as own controls. Still likely underpowered to see a difference. Heterogeneity in which surgery was done first, time of follow-up, whether primary or revision surgery. Time between surgeries not reported.
McGrath et al 2009 (same patients as Mont 2009)	Conserve Plus	N=34 Conserve Plus patients requiring conversions to THA (21 with total hip resurfacing; 13 with hemi-resurfacing) N= matched group of 34 patients with 'conventional' THA	Retrospective Single surgeon for all procedures. Cases subset of cohort of 510 total hip resurfacing and 602 hemi-resurfacing arthroplasties. Matched with parallel cohort of THA during same time period on diagnosis, gender, age, BMI, pre-operative Harris hip score, length of follow-up.	Harris hip score Range of motion	No significant difference in Harris hip score (92 vs. 94 points; p=.25), or mean range of motion scores (4.9 vs. 4.8; p=.69) for conversion vs. primary THA patients.	Comparison between those with conversion to THA vs. primary THA; better comparison may be to patients requiring revision of their primary THA since theoretical advantage of hip resurfacing is in great ease of conversion to THA due to bone preservation.



<p>Mont et al 2009 (same patients as McGrath 2009)</p>	<p>Conserve Plus</p>	<p>N=54 Conserve Plus patients N= matched group of 54 patients with 'conventional' THA</p>	<p>Retrospective Drawn from same cohorts as McGrath et al 2009 paper; single surgeon. Controls matched to cases during same time period on diagnosis, gender, age, BMI, pre-operative Harris hip score, length of follow-up. 3-year average follow-up (2-5 year range)</p>	<p>Harris hip score Satisfaction Activity score</p>	<p>No significant difference in Harris hip score (90 vs. 91; $p=.77$), satisfaction score (9.2 vs. 8.8; $p=.40$) for resurfacing compared to THA. Larger increase in activity score for resurfacing group ($p=.0004$); baseline activity scores in resurfacing group also higher ($p=.01$).</p>	<p>Matching done retrospectively; cases are a subgroup of large cohort – unclear how cases chosen or why studies only a small number.</p>
<p>Zywiell et al 2009 (same patients as McGrath 2009)</p>	<p>Conserve Plus</p>	<p>N=33 Conserve Plus patients N= matched group of 33 patients with 'conventional' THA</p>	<p>Retrospective Drawn from same cohorts as McGrath et al 2009 and Mont et al 2009 papers. Matched with parallel cohort of THA during same time period on diagnosis, gender, age, BMI, pre-operative activity level.</p>	<p>Activity score Harris hip score Satisfaction Pain</p>	<p>Mean activity score higher for resurfacing group than for THA group (10.0 vs. 5.3; $p<.001$). No difference for Harris hip score, satisfaction or pain.</p>	<p>Matching done retrospectively; cases are a subgroup of large cohort – unclear how cases chosen or why studies only a small number. Attempted to match 54 patients, but couldn't find match for 21 cases. Unclear why matching different in this study than in Mont 2009 study as apparently same cases.</p>



<p>Stulberg et al 2009 (same patients as Stulberg 2008)</p>	<p>Cornet 2000</p>	<p>N= 337 Cornet 2000 patients with unilateral hip resurfacing and minimum 2 year follow-up</p> <p>N= 266 THA patients (ceramic on ceramic) historical controls with unilateral hip arthroplasty</p>	<p>Multicenter Comparison to historical controls. Examined results at similar time points post-operatively up to 2-years.</p>	<p>Harris hip score at 6 weeks, 6 months, 12 months, and 24 months.</p>	<p>At six weeks, THA group with higher scores (p=.01); at 6 months, resurfacing group with higher scores (p<.001); at 12 months no difference between groups (p=.10); at 24 months both groups with >90% with scores in 90-100 range (p=.93).</p>	<p>Historical controls. Only 2 year follow-up.</p>
<p>Stulberg et al 2008 (same patients as Stulberg 2009)</p>	<p>Cornet 2000</p>	<p>N= 337 Cornet 2000 patients with unilateral hip resurfacing and minimum 2 year follow-up</p> <p>N= 266 THA patients (ceramic on ceramic) historical controls with unilateral hip arthroplasty.</p>	<p>Multicenter Comparison to historical controls Non-inferiority study</p>	<p>Harris hip score</p> <p>Composite clinical success score used for non-inferiority test with 4 components:</p> <ol style="list-style-type: none"> 1. Harris hip score \geq 80 2. radiographic evidence of success 3. absence of device-related complications 4. absence of revision <p>Revision rate</p> <p>Outcomes examined at 2 –years</p>	<p>No difference in Harris hip score at 24 months or at >24 months.</p> <p>Composite clinical success score difference between two groups = -.015.</p> <p>More revisions in the resurfacing group (24/7.1% vs. 5/1.9%; no p-value given) at time of publication (16 pre-24 months and 8 in follow-up; 3 pre-24 months and 2 in follow-up).</p>	<p>Historical controls. Non-inferiority test was 1-sided test.</p> <p>Non-inferiority based on composite clinical summary score, but clearly more revisions necessary in the resurfacing group primarily due to femoral neck fracture and femoral component loosening</p>



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<p>Mont et al 2007</p>	<p>Conserve Plus</p>	<p>N=15 Conserve Plus patients N=15 THA patients N=10 patients with hip osteoarthritis</p>	<p>Retrospective from registry of resurfacing patients and parallel registry of THA patients. Unclear if OA patients recruited prospectively. Used normative database of 30 subjects without disease for gold standard.</p>	<p>Gait speed Hip abductor and extensor moments</p>	<p>Walk speed greater for resurfacing group than for either THA or OA groups, but not greater for THA group compared to OA group. No difference between resurfacing and THA groups in abductor or extensor moment.</p>	<p>Very small study. Retrospective. No adjustment for baseline differences.</p>
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Studies focused on adverse outcomes or side effects

Our search found eight publications since the 2007 CTAF assessment which specifically focus on adverse events associated with FDA approved hip resurfacing device systems, four reporting on early failure³³⁻³⁶ and four reporting on blood metal ion levels³⁷⁻⁴⁰. Of the four studies focused on early failure and revision rates, three were case series and one was a meta-analysis³⁶. The case series with the longest follow-up period (mean five years) included patients with varying MoM hip resurfacing devices in place, but most were BHR, and reported a 5.2% failure rate with pain being the predominant reason for revision and loosening of the femoral component the next most common cause³³. The other study of BHR had a much lower revision rate (2.8%) with a shorter mean follow-up time of 3.5 years, and pain was also the predominant cause, followed by femoral neck fracture³⁵. At time of revision, these authors found evidence of metallosis (immune reaction to metal) and necrosis. The meta-analysis included multiple devices for both MoM hip resurfacing and the comparator THA patients, although all of the THA had cementless femoral components, and all of the included studies had a young patient population (mean age <55)³⁶. These authors found a higher overall failure rate for THA when failure was defined as all reasons, including after revision and asymptomatic radiographic failure. The THA patients had approximately double the follow-up time as the hip resurfacing patients (8.5 years vs. 3.9 years). When the authors defined failure more narrowly to focus on the greatest risk with MoM hip resurfacing as ‘femoral failure due to mechanical failure’, the hip resurfacing group had about double the rate of failure.

There has been increasing concern in the literature about blood metal ion levels as a result of wear from metal on metal hip replacements, in both hip resurfacing and THA. While there is no safe or toxic level of chromium and cobalt in the blood, the concern about increased levels ranges from local tissue toxicity, to chromosomal damage and malignant cellular transformation⁴¹⁻⁴⁴. The four publications that focused on this topic all studied patients with BHR. One found that both hip resurfacing and metal-on-metal THA patients with small diameter (28mm) heads had similar chromium and cobalt levels, both higher than healthy controls without metal implants⁴⁰. Another study compared unilateral MoM BHR, bilateral MoM BHR with metal-on-polyethylene THA and ceramic-on-ceramic THA³⁷. They report the highest chromium and cobalt ion levels with both types of MoM hip replacement, smaller elevation for the metal-on-polyethylene group, and negligible



levels for the ceramic-on-ceramic group. A third study again reported increased ion levels for patients with MoM hip resurfacing implants; however, they found that as the femoral component size increased, ion levels decreased, implying that with less friction and wear there is less release of ions³⁹. The fourth study found enhanced lymphocyte activity for nickel, but not for chromium and cobalt; there was no difference for patients with and without pseudotumors (a cystic or solid mass relating to resurfaced hip), although the pseudotumor group was very small (n=10)³⁸.

TA Criterion 3 is met.

Table 2: Studies of MoM hip resurfacing focusing on adverse outcomes

Study	Device	Methods	Adverse Events	Comments
Failure				
Eswaramoorthy et al 2009	Birmingham (BHR) Cormet 2000 Conserve Plus McMinn	Multisurgeon case series of 504 patients over 10 years, mean follow-up 5years (range 1.7-11.7)	<u>29 revisions (5.2%) for failure</u> – 23 BHR, 4 Mc Minn, 1 Cormet 2000, 1 Conserve Plus <i>Causes:</i> 11 pain, 7 loosening of femoral component, 4 femoral neck fracture, 3 loosening of femoral and acetabular component, 2 loosening of acetabular component, 1 infection, 1 groin mass <i>Mean time to revision</i> 42 months (range 4-102)	No deaths; no loss to follow-up.
Kim et al 2008	Conserve Plus	Multicenter case series of 200 patients, mean follow-up 31 months (range 12-54)	<u>14 revisions (7.0%) for failure</u> <i>Causes:</i> 10 loosening of acetabular component, 2 femoral neck fracture, 1 loosening of femoral component, 1 pain <i>Mean time to revision</i> 19.5 months (range 3-47) <u>Association with failure:</u> Younger age Higher BMI Smaller femoral component	No loss to follow-up. 4/5 surgeons with limited experience with resurfacing prior to study (range 5-30 cases); 5 th surgeon had done 80 cases and had no failures in study. Authors conclude that since most failures due to loosening of acetabular component, likely related to learning curve
Ollivere et al 2009	Birmingham (BHR)	Multisurgeon case series of 463 patients over 6 years, mean follow-up 43 months (range 6-90)	<u>13 revisions (2.8%) for failure</u> <i>Causes:</i> 7 pain, 3 femoral neck fracture, 2 dislocation, 1 infection 9 had evidence of <i>metallosis</i> (immune reaction to metal resulting in inflammation & scarring) and necrosis <u>Association with failure:</u> Female Higher BMI Smaller femoral component	2 patients died of 'unrelated causes' and 3 lost to follow-up. Too few outcomes (failure) to draw firm conclusions about predictive factors. With observational study cannot draw conclusions about causality.



<p>Springer et al 2009</p>	<p>Multiple for both hip resurfacing (including BHR, Cormet 2000 and Conserve Plus) and THA.</p>	<p>Meta-analysis: failure rates for young patients undergoing hip resurfacing vs. total hip arthroplasty (THA) with cementless femoral components. Studies through March 31, 2008 including young adults (mean age <55) undergoing TA with modern</p>	<p><u>Hip resurfacing</u>: 15 studies, 3002 patients, mean age 46.6 (34.2-57.8), mean follow-up 3.9 years (0.6-8.7).</p> <p><u>THA</u>: 22 studies, 5907 patients, mean age 41.4 (32-55.4), mean follow-up 8.5 years (4.8-13.5).</p> <p><i>Overall failure rate for any reason (including revision and radiographic failure)</i> Hip Resurfacing 3.7 (2.0-6.5) THA 11.6 (7.5-17.4) (Random effects model)</p> <p><i>Femoral failure due to mechanical failure requiring revision surgery</i> Hip Resurfacing 2.6 (2.0-3.4) THA 1.3 (1.0-1.7) (Fixed effects model) Hip Resurfacing 2.4 (1.5-3.8) THA 1.3 (1.0-1.7) (Random effects model)</p>	<p>THA studies with considerably longer follow-up than resurfacing studies.</p> <p>Overall failure rates higher for THA – these results include failure for any reason including after revision & radiographic failure.</p> <p>Authors argue that concern with hip resurfacing greatest for mechanical femoral failure and so focus on this result as providing evidence that ‘modern’ cementless THA in young patients may be just as good or perhaps better than hip resurfacing, negating primary reason for hip resurfacing.</p> <p>Includes devices which are not FDA approved</p>
<p>Blood metal ion Theoretical concern with increased ion levels: local tissue toxicity, inflammation, bone loss, renal insufficiency, immune modulation, hypersensitivity, chromosomal damage, malignant cellular transformation</p>				
<p>Moroni et al 2008</p>	<p>Birmingham (BHR)</p>	<p>Non-randomized, prospective comparison of ion levels (chromium, cobalt) from 1) 20 hip resurfacing patients with large diameter MoM heads (average 48mm) 2) 26 THA patients with 28mm MoM heads 3) ‘healthy subjects’</p>	<p>Median follow up for hip resurfacing 24 months Median follow up for THA 25 months</p> <p>Hip resurfacing and THA groups both had elevated serum levels of chromium and cobalt compared to healthy controls. There was no statistically significant difference between the operative groups in either ion level.</p>	<p>Unclear how ‘selected’ patients. Nothing reported about the health controls’ baseline characteristics.</p> <p>Trend toward higher levels of chromium with hip resurfacing, but not statistically significant. Study underpowered.</p>



<p>Hart et al 2009</p>	<p>Birmingham (BHR)</p>	<p>Cross-sectional study assessing levels of chromium and cobalt ions and absolute number of circulating lymphocytes in patients with 1) unilateral MoM hip resurfacing, 2) bilateral MoM hip resurfacing, 3) metal on polyethylene THA, and 4) ceramic on ceramic THA</p>	<p>Both Chromium and cobalt ion levels the highest for both MoM groups (unilateral and bilateral) and the lowest for the ceramic-on-ceramic group. The metal-on-polyethylene group had minimally elevated levels.</p> <p>MOM unilateral</p> <p>CD8+ lymphocytes counts were significantly reduced in both MoM hip resurfacing groups.</p>	<p>Safe or toxic level of chromium and cobalt not know. Unclear clinical implications of lowered T-cells under these circumstances.</p>
<p>Langton et al 2009</p>	<p>Birmingham (BHR) (ASR results not reported here; not FDA approved device)</p>	<p>Cross-sectional assessment of relationship of femoral size and acetabular component orientation with circulating metal ion levels in 70 patients with Birmingham hip resurfacing.</p>	<p>Both cobalt and chromium ions were elevated in patients with Birmingham hip resurfacing devices in place.</p> <p>As the femoral component size increased, the serum ion levels decreased (correlation $-.265$; $p=.04$).</p> <p>Acetabular orientation was not correlated with ion levels for those patients with the largest femoral components; however, for those with smaller femoral components, as acetabular anteversion increased, so did ion levels.</p>	<p>Size and positioning of MoM devices impacts serum metal ion levels; it remains unclear what level is safe or toxic.</p>
<p>Kwon et al 2010</p>	<p>Birmingham (BHR)</p>	<p>Cross-sectional assessment in 92 patients of relationship between MoM hip resurfacing with and without pseudotumor and systemic metal hypersensitivity.</p>	<p>Level of enhanced lymphocyte activity only increased for nickel & not for chromium and cobalt in patients with BHR compared with controls.</p> <p>No significant difference for patients with pseudotumor compared to those without pseudotumor.</p>	<p>Authors conclude that systemic hypersensitivity type IV reactions may not be dominant etiology of soft tissue pseudotumors related to MoM hip resurfacing implant.</p>



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		<p>Three groups: 1) BHR and pseudotumor (cystic or solid mass relating to resurfaced hip) N=10 2) BHR and no pseudotumor N=60 3) age-matched controls without metal implant or known metal allergy N=22</p>		
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TA Criterion 4: The technology must be as beneficial as any established alternatives.

The primary established alternative is total hip arthroplasty. While there are no RCTs of the FDA approved hip resurfacing devices comparing to current conventional THA devices, the comparison studies cited above all report results showing equivalent functional results after MoM hip resurfacing and THA. While there is concern about early failure requiring revision after MoM hip resurfacing, THA presents other concerns particularly for younger, more active patients who have risk of shattering their femur in the event of trauma and who will undoubtedly require repeat THA with less and less available bone over time. Concern about metal ions exists for both resurfacing and THA (metal-on-metal).

TA Criterion 4 is met.

TA Criterion 5: The improvement must be attainable outside of the investigational setting.

MoM hip resurfacing has been used broadly outside of investigational settings. Each device requires training and given a considerable learning curve – and adverse events including early failure associated with inexperienced surgeons – hip resurfacing should only be performed after appropriate training and early cases should be supervised by experienced surgeons.

TA Criterion 5 is met.

CONCLUSION

While there are more published studies comparing hip resurfacing with THA than at the time of the CTAF 2007 assessment, all of which suggest equivalent results for resurfacing and THA, some of the same questions that were of concern at that time remain and we reiterate them here: What is



the long term durability of the resurfaced hip compared with THA? What will be the short and long term results when this generation of younger patients who have undergone hip resurfacing are eventually converted to THA? Will there be unforeseen long term complications that will make this revision more problematic than anticipated? What are the long term health consequences of increased low levels of circulating metal ions produced by MoM hip resurfacing? It is incumbent upon the hip resurfacing community to continue to investigate these questions and assure that metal-on-metal hip resurfacing continues to be a viable and safe option for young active patients with degenerative hip disease.

Despite these remaining questions, after considerable discussion and expert testimony regarding the existing data on both benefits and harms, the forum supported approval of metal-on-metal hip resurfacing as an alternative to total hip arthroplasty.

RECOMMENDATION

It is recommended that metal on metal hip resurfacing by surgeons who have completed training using FDA-approved devices meets CTAF criteria 1 through 5 as an intervention for degenerative hip disease in appropriate patients younger or <65 who have an active life expectancy of more than 10 to 15 years.

June 2, 2010

This is the second assessment of this technology.

The CTAF panel voted in favor of the recommendation as noted above.



RECOMMENDATIONS OF OTHERS

Blue Cross Blue Shield Association (BCBSA)

A June 2007 assessment by the BCBSA Technology Evaluation Center found that “use of an FDA-approved metal-on-metal total hip resurfacing device as an alternative to THA in patients who are likely to outlive the 10 years or more functional lifespan of a traditional MoM prosthesis meets the TEC criteria.”

Centers for Medicare and Medicaid Services (CMS)

Neither a National Coverage Decision nor a Local Coverage Decision was found through a search of the CMS Coverage database.

California Orthopaedic Association (COA)

The COA was invited to have a representative attend the meeting and to provide an opinion on this technology.

Alliance for Orthopedic Solutions

The Alliance for Orthopedic Solutions provided an opinion and attended the meeting to provide testimony.

National Institute for Health and Clinical Excellence (NICE)

In 2002 NICE issued a guidance document which states (in part):

“MoM hip resurfacing is recommended as an option for people with advanced hip disease who would otherwise receive a conventional primary total hip replacement (THR) and are likely to live longer than the device is likely to last.” This document is available at:

<http://guidance.nice.org.uk/TA44>.

Canadian Coordinating Office for Health Technology Assessment (CCOHTA)

In March 2005 the CCOHTA published a document on Minimally Invasive Hip Resurfacing. This is the most current document as of March 2010. The CCOHTA notes: “Outcome-based research and long-term follow-up are necessary to assess the clinical and economic impact of a minimally



invasive approach to hip resurfacing. There is also a need for defined criteria to determine which patients might benefit from this surgical approach”.

ABBREVIATIONS USED IN THIS REVIEW

CTAF	California Technology Assessment Forum
MoM	Metal on metal
OA	Osteoarthritis
DALYs	Disability adjusted life years
RA	Rheumatoid arthritis
HRA	Hip resurfacing arthroplasty
THA	Total hip arthroplasty
BHR	Birmingham Hip Resurfacing
RCT	Randomized controlled trial
DARE	Database of Abstracts of Reviews of Effects
QOL	Quality of life

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