Hip Resurfacing Arthroplasty: Tissue Reactions and Results in Registries

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Modern metal-on-metal hip resurfacing arthroplasty has been a very popular operation during the last decade for arthritic and painful hips among relatively young patients. However, alarming reports of severe periprosthetic tissue reactions around metal-on-metal replacements have been published within last few years. Pseudotumors and aseptic lymphocytic vasculitis-associated lesions (ALVAL) are the terms used for these reactions, which can lead to large soft tissue necrosis and permanently poor function of the hip after revision surgery. Risk ratio to get these reactions in eight years follow-up vary from 0,5% to 13 % depending on patient age, gender, and size of the implant. Nevertheless, it seems that resurfacing arthroplasty is a safe procedure for arthritic relatively young male patients.

Very appropriately, Richard Villar started his lecture in the Finnish Orthopaedic Course at Hotel Levitunturi ten years ago by stating that "Hip Resurfacing Artrhoplasty (HRA) is as old as the time". His view was based on the fact that the earliest hip replacement surgeries consisted mainly of attempts of resurfacing atrthroplasty. The first generation of "new" HRA started in the 1970s with cobalt-chromium or titanium alloy femoral component bearing against a polyethylene (PE) metal-backed acetabular component. These HRAs generated large amounts of PE wear debris resulting in osteolysis and loose components (1). During the late 1990s and early 2000s the modern metal-on-metal (MoM) HRA established its place in hip replacement surgery, when good short term follow-up results were reported for young and active patients (2). The benefits of HRA over conventional total hip replacement (THR) are preservation of the femoral bone and the original biomechanics of the hip joint. There is also some evidence suggesting that patients with HRAs attain higher levels of function than those with conventional hip replacements (3).

Call back of ASR implants

During the last months, the long-term outcomes of resurfacing arthroplasty have been widely discussed. New data from the National Joint Registry of England and Wales show a five-year revision rate of approximately 12% for the JJ Depuy's ASR HRA (4, Table 1). This was clearly higher than overall HRA five-year revision rate of 6 %, and far worse than five-year revision rate of 2% in for cemented total hip replacement, THR. These ASR HRA revision rates were calculated across the entire size range. More specifically, the risk for revision was highest with ASR head sizes below 50 mm in diameter and among female patients. JJ Depuy recalled all the ASR implants and promised to pay reasonable examination and revision costs. These data and procedures have created an active public debate on HRA and MoM pairs.

Metal-on-metal articulation and cup position

The alloy employed in modern HRAs is cobalt-chromium with small amounts molybdenum and nickel as well. The function of MoM pairs is based on fluid lubrication caused by protein-rich synovial fluid. Cup positioning is very critical for good lubrication: vertical cups cause increased edge-loading, more moments without lubrication, and thus more metallic wear particles around the joint and more metal ions in serum (5). It has been found that the optimal cup position

Table 1. Revision (for any reason) rates HRA brands for primary hip resurfacing procedures, undertaken between 1st April 2003 and 31st December 2009 in National Joint Registry for England and Wales 2010. For reference, revision rates for conventional hips are listed, too.

Brand	Number of patiens	Revision rate at three years (95% CI)	Revision rate at five years (95% CI)
HRAs			
BHR	8,213	3.2% (2.8% to 3.6%)	4.3% (3.8% to 4.9%)
Cormet 2000	2,036	6.1% (5.0% to 7.4%)	10.0% (8.2% to 12.1%)
ASR	1,599	6.9% (5.7% to 8.5%)	12.0% (9.3% to 15.4%)
Adept	1,197	4.1% (2.8% to 5.8%)	5.0% (3.1% to 8.0%)
All	13,045	4.2% (3.8% to 4.6%)	6.0% (5.5% to 6.6%)
Conventional hips for reference:			
Cemented	99,359	1.4% (1.3% to 1.5%)	2.0% (1.8% to 2.1%)
Cementless	62,937	2.5% (2.4% to 2.7%)	3.4% (3.2% to 3.7%)
Hybrid	31,662	1.8% (1.6% to 1.9%)	2.7% (2.4% to 3.0%)

for HRA is 40 degrees of inclination and 25 degrees of anteversion (6).

MoM pairs release metal ions all the time; levels of cobalt and chromium in blood serum are clearly higher in MoM patients than in controls. Bigger femoral heads in HRAs release more ions than 28 mm MoM THRs (7). This metal ion release is more active during the first year after implantation of MoM implants (8). Even though these metal ions are mainly due to corrosion, mechanical wear and wear particles contribute to the ion formation as well. The more micro particles exist in the tissue, the more surface for corrosion and ion formation is available.

Periprosthetic tissue reactions

Large amounts of microscopic metallic wear particles lead to macroscopic quantities of metal debris around the joint and often very aggressive synovitis and osteolysis. These reactions are often clinically wider, more necrotising, and more difficult to remove properly from the tissue than reactions caused by PE wear particles.

The main concerns in HRAs and MoM pairs are these severe soft tissue reactions, which are often thought to arise from metal toxicity or hypersensitivity. The first histological analysis of the painful and revised MoM hip replacements periprosthetic tissue reactions showed abundant or excessive perivascular lymphocytic infiltration in 9/19 cases (9). All specimens showed at least few metal particles and only 4/19 cases had abundant or excessive amount of metal particles. They concluded these lymphocytic reactions to be caused by hypersensitivity reactions. Nuffield Orthopaedic centre published alarming report of 20 symptomatic HRA hips with soft-tissue mass, which they termed a pseudotumour (10). The tissue reactions have many forms and names: osteolysis, aseptic lymphocytic vasculitis-associated lesions (ALVAL), pseudotumors. Pseudotumor periprosthetic tissue reactions around MoM hip replacements are probably one entity of these MoM reactions, and can cause pain and lead to revision surgery (11,12). Pseudotumour masses can be cystic or solid; histologically extensive necrosis and lymphocytic infiltrations have been reported. Unfortunately, the reasons still remain largely unknown; excessive wear and toxic reaction, metal hypersensitivity (type IV), or an as-yet-unknown reason have been suggested.

Reported incidence of these reactions varies a lot, from 0.03 % to even 13 % of the MoM articulations. The Nuffield group reported the pseudotumour risk to be about 1.8% in series of 1419 hips (11). The cumulative revision rate increased progressively with time, being as high as 4% at eight years. Risk factors for pseudotumour formation seemed to be female gender, age under 40, small components, and dysplasia of the hip joint. The risk for pseudotumors in men was 0.5% at eight years, whereas it was 13.1% for women under 40.

Table 2. Yearly Cumulative Percent Revision of Primary Total Resurfacing Hip Replacement for any reason by Gender and Head Size (Primary Diagnosis OA), Australian National Joint Replacement Registry

Gender	Head Size	1 Yr	3 Yrs	5 Yrs	7 Yrs	9 Yrs
Male	<50mm	3.3 (2.5, 4.3)	4.9 (3.9, 6.2)	6.5 (5.2, 8.2)	10.2 (7.9,13.3)	
	≥50mm	1.4 (1.2, 1.7)	2.1 (1.8, 2.4)	2.8 (2.4, 3.2)	3.5 (3.0, 4.2)	3.9 (3.2, 4.7)
Female	<50mm	2.5 (1.9, 3.1)	5.1 (4.3, 6.1)	7.5 (6.4, 8.7)	10.3 (8.8,12.1)	
	≥50mm	0.5 (0.1, 1.9)	1.0 (0.4, 2.7)	1.8 (0.8, 4.1)	3.3 (1.5, 6.9)	

Resurfacing arthroplasty results in national arthroplasty registries

Australian National Joint Replacement Registry shows the risk for revision for any reason to be 3,9 % at nine years for male patients with over 50 mm femoral head size (13, Table 2). This is clearly less than overall 9-years revision risk for cemented or non-cemented conventional THRs. We know from the earlier studies and registries that young active men are the worst group for hip replacement; 9-year revision rate for any reason of the conventional THRs was about 9 % for <50 year-old men in Danish Arthroplasty registry and even 18 % at 14 years (14). The overall risk for revision for any reason in Finnish arthroplasty registry for young osteoarthritic THR patients is about 20 % at ten years and 29-42% at 15 years (15).

Conclusion

Even though there is a risk for severe tissue reactions around MoM HRAs, it seems that relatively young and active men with osteoarthritic and painful hip joints constitute the best patient group for hip resurfacing arthroplasty. A consensus statement from the advanced hip resurfacing course in Ghent, June 2009, was that ideal candidate for MoM HRA is a relatively young man with normal anatomy and primary osteoarthritis (De Smet et al. 2010). The risk to have revision surgery after MoM HRA in this subgroup for any reason is less than 4% and about 0,5 % for pseudotumors in nine years (Glyn-Jones 2009, Australian).

References

1. Kabo JM, Gebhard JS, Loren G, Amstutz HC: In vivo wear of polyethylene acetabular components. J Bone Joint Surg Br. 1993;75-B:254-258.

2. McMinn D, Treacy R, Lin K, Pynsent P: Metal on metal surface replacement of the hip. Experience of the McMinn prothesis. Clin Orthop Rel Res. 1996;329:89-98.

3. Daniel J, Pynsent PB, McMinn DJ: Metal-onmetal resurfacing of the hip in patients under the age of 55 with osteoarthritis. J Bone Joint Surg Br. 2004;86-B:177-184.

4. National Joint Registry for England and Wales, 7th Annual Report, 2010. www.njrcentre.org.uk

5. De Haan R, Pattyn C, Gill HS, Murray DW, Campbell PA, De Smet K: Correlation between inclination of the acetabular component and metal ion levels in metal-on-metal hip resurfacing replacements. J Bone Joint Surg Br. 2008;90-B:1291-1297.

6. Grammatopoulos G, Pandit H, Glyn-Jones S, McLardy-Smith P, Gundle R, Whitwell D,et al: Optimal acetabular orientation for hip resurfacing. J Bone Joint Surg Br. 2010;92-B:1072-1078.

7. Clarke MT, Lee PTH, Arora A, Villar RN: Levels of metal ions after small- and large diameter metal-on-metal hip arthroplasty. J Bone Joint Surg Br. 2003;85-B:913-917.

8. Daniel J, Ziaee H, Pradham C, McMinn DJW: Six-year results of a prospective study of metal ion levels in young patients with metal-on-metal hip resurfacings. J Bone Joint Surg Br. 2009;91-B:176-179.

9. Willert H-G, Buchhorn GH, Fayyazi A, Flury R, Windler M, Köster G, et al: Metal-on metal bearings and hypersensitivity in patients with artificial hip joints. J Bone Joint Surg Am. 2005;87-A:28-36.

10. Pandit H, Glyn-Jones S, McLardy-Smith P, Gundle R, Whitwell D, Gibbons CLM, et al: Pseudotumours associated with metal-on-metal hip resurfacings. J Bone Joint Surg Br. 2008;90-B:847-851.

11. Glyn-Jones S, Pandit H, Kwon Y-M, Doll H, Gill HS, Murray DW: Risk factors for inflammatory pseudotumour formation following hip resurfacing. J Bone Joint Surg Br. 2009;91-B:1566-1574.

12. Campbell P, Ebramzadeh E, Nelson S, Takamura K, De Smet K, Amstuzt HC: Histological features of pseudotumor-like tissues from metal-on.metal hips. Clin Orthop Rel Res. 2010;468:2321-2327.

13. Australian Orthopaedic Association. National Joint Replacement Registry. Annual Report 2010; http://www.dmac.adelaide.edu.au/aoanjrr/publications.jsp

14. Dansk Hoftealloplastik Register Årsrapport 2009; http://www.dhr.dk/Ny%20mappe/DHR%20Aarsrapport_2009%20t_web.pdf

15. Mäkelä KT, Eskelinen A, Pulkkinen P, Paavolainen P, Remes V: Results of 3,668 primary total hip replacements for primary osteoarthritis in patients under the age of 55 years from the finnish arthroplasty register - a concise follow-up of a previous report. Acta Orthop, accepted.