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Hip Resurfacing Implants: A Literature Review and Our Experience

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Abstract

Hip resurfacing offers a suitable solution for young patients with high function demands and good bone quality affected by hip diseases.

The bone stock preservation along with the restoration of the normal proximal femur anatomy, the lack of stress-shielding and the resumption of sporting activity are proven advantages of hip resurfacing.

However there are some disadvantages such as fracture of the femoral neck, onset of neck-narrowing and possible complications due to the metal-on-metal bearing: pseudotumors, peri-implant osteolysis and chronic elevation of metal ions serum levels.

Recent data suggest that the ideal candidate for hip resurfacing is an active male, younger than 65 years old, suffering from primary or post-traumatic osteoarthritis with a femoral head diameter larger than 50/54 mm.

Based on these selection criteria literature reports an implant survival similar to total hip replacement. Our experience confirms the low failure rate and the excellent functional outcomes, with stable metal ions serum levels over time in well-functioning implants. Proper surgical technique, correct patient selection together with the right choice of a well established prosthetic model are essential elements for the long-term success of these implants.

Keywords: Hip resurfacing; Results; Survivorship; Metal-on-metal

Hip Resurfacing

The purposes of hip replacement are hip pain relief, resumption of range of motion with a normal ambulation and a long-term implant survival.

Results of total hip arthroplasty [THA] are excellent in elderly patients, whereas in young patients they are poorer. Data from the Emilia-Romagna regional registry of orthopedic prosthetic implantology [RIPO] show that about 24% of hip replacements are performed in patients younger than 60.

Hip pain relief and restoration of the range of motion [ROM] is generally obtained in young patients; however, long term implant survival is not always achieved with only 72% of THA still in place at 10 years follow-up [1].

This high failure rate may be due to elevated functional demands of this younger patients population that may lead to high wear and mobilization of the implant.

During the last fifteen years second-generation hip resurfacing [HR] has been introduced in order to obtain better functional results and longer implant survival in a population of young and active patients. These implants resurface with a thin metal layer both acetabulum and femoral head thus sparing patient's bone stock.

Major advantages of HR include: femoral bone stock preservation which facilitates conversion to a stemmed prosthesis [2], low dislocation risk due to the large femoral head diameter, physiological hip loading thus preventing stress-shielding, negligible risk of implant rupture and resumption of sporting activities. HR is the only prosthesis that allows almost complete proximal femur preservation, much more than short stems; moreover on the acetabular side the same amount of bone removal is required compared to THA [3].

The willing of HR patients to resume sporting activities is of paramount importance. Girard et al. reported that 98% of patients returned playing sports after surface arthroplasty, 82% of them were involved in high-impact activities such as playing tennis. These results were not achieved with THA [4]. In a similar study, 91.6% of patients returned to running practice after HR even with some degree of competition [5]. Nevertheless, choosing activities in which the cardiovascular system is challenged such as cycling or backpacking might be more reasonable choices than distance running or singles tennis, leading to a longer survival of the implant [6].

The better functional outcome achievable with HR has been evaluated with some gait analysis studies.

Aqil et al. suggest that HR does indeed enable superior levels of function when treadmill walking at variable speeds; in particular, the gait cycle of HR implanted limbs was closer to 'normal' at top walking speed and top walking inclination [7]. Postural balance analysis found identical data for HR and healthy subjects; conserved bone capital and the numerous intraosseous receptors allow better proprioception and would seem to contribute to this advantage [8].

Meeting patient's expectations is crucial nevertheless implant survival over time is even more important. At 10 years follow-up HR showed a lower revision rate for males patients regardless age compared to either cemented or uncemented THA [9]. Moreover a lower mortality rate for patients with HR compared to THA was observed in a retrospective cohort analysis [10].

HR has some disadvantages such as a more difficult surgery, femoral neck fracture [11] limited ROM due to the high head/neck ratio, higher incidence of groin pain compared to THA [12] and eventually onset of neck-narrowing [13].

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Early femoral neck fracture is a severe complication, which requires revision surgery (Figure 1). Shimmin and Back [11] reported 50 cases [1,46%] of femoral neck fractures after a mean time of 15, 4 weeks in a multicentric study on 3429 HR. They demonstrated a crucial role of femoral component positioning in the majority of failures. Five degreases of varus [present in 71,1% of the cases] or notching of the superior cortical bone of femoral neck [present in 46,6% of the cases] were recognized as risk factors. Femoral neck fracture is a relatively rare complication that in most of the cases is due either to prosthesis malpositioning or inappropriate patients selection [poor bone quality].

Metal-on-metal [MoM] coupling is the unique available for HR and even if its wear rate is much lower than metal-on-polyethylene; its disadvantages are now under investigation after the high failure rate of large diameter MoMTHA [14].

Increased serum concentrations of Chromium [Cr] and Cobalt [Co] metal ions [15], pseudo-tumors [16], peri-implant osteolysis and tissue reactions such as Aseptic Lymphocitic Vascular and Associated Lesions [ALVAL] [17,18] are elements that must be considered during implant choice.

Young patients with primary or post-traumatic hip osteoarthritis and high functional demands represent the right indications for HR. Congenital hip dysplasia [DDH], rheumatoid arthritis and a vascular necrosis of femoral head are now recognized as relative contraindications for HR.

Generally DDH is characterized by a defect in proximal femur ante-version that cannot be corrected using HR. Amstutz et al reported excellent results in grade I and II DDH treated with HR [19,20], nevertheless we believe that also minor defects in components orientation due to altered hip anatomy may lead to a accelerated wear and an increased failure rate.

Some good results [21] have been reported when treating rheumatoid arthritis. However it is necessary to consider that this autoimmune disease frequently affects kidneys which are responsible of filtration and excretion of metal ions; therefore Cr and Co serum concentrations may rise and their long term effects are still under investigation.

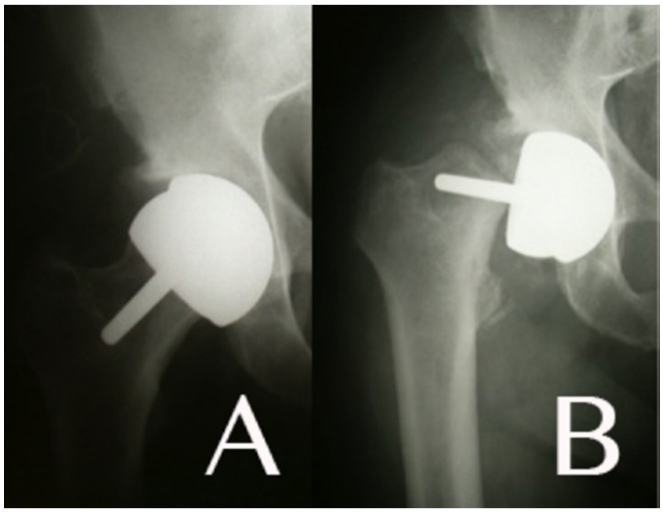

Figure 1: Rx showing Femoral neck fracture in a 55 years old male.

The acetabular component is slightly steep while the femoral component is well positioned (A). A femoral neck fracture occurred 55 days after surgery (B).

Some satisfactory outcomes have been reported [22] in patient with femoral head osteonecrosis treated with HR; nevertheless this disease is considered to progress over time even below the resurfaced head leading to inappropriate bone quality and higher failure rate. For these reasons some authors suggest performing HR in osteonecrosis after at least 5 year since the disease has stopped. To overcome this disadvantage mid-head resection arthroplasty [23] was introduced specifically for these patients.

Osteonecrosis of the femoral head might be partially due to the exothermic cement polymerization reaction. For this reason, and considering the concerns about long-term survivorship of cemented stems in THA, cementless head components in HR seems to be an attractive option. A few studies with several limitations such as the small number of patients treated and the low experience of the surgeons who performed the operations reported encouraging results [24].

Cementless “fit and fill” femoral-side fixation, may be a viable alternative to fixation with cement in MoM HR for future device generation.

In the first division of Rizzoli Orthopaedic Institute 1417 HR were performed with a mean follow-up of 4,5 years. The HR were performed using 1325 BHR [Smith and Nephew], 59 Mitch [Stryker] and 33 Romax [Medacta].

Although the BHR was prevalently used, we tested different prosthetic devices with specific implant and instrumentations characteristics. The Mitch system has a shorter femoral stem compared to the widely used BHR. The Romax HR has an acetabular component with the presence of a notch in order to reduce groin pain due to the ileopsoas impingement. Considering the raising concerns regarding MoM and the well-established performance of the BHR both in terms of clinical outcome and implant survival we now perform only BHR. While the Mitch is no more available, the Romax HR has been temporary suspended by the manufacturer but not formally withdrawal from the market.

From the first day after surgery the rehabilitation started with passive mobilization, from the second day the patient was raised with partial weight bearing and allowed walking with two crutches. Patients were discharged after a mean of 6 days, when they were able to go up and down the stairs.

We registered 23 failures. The revision rate was 1,35% for BHR [18 on 1325], 3% for Romax [1 on 33] and 6,8% for Mitch [4 on 59]. Sixteen of these failures were due to femoral neck fractures, 5 to aseptic loosening or metallosis, one to a vascular necrosis and another one to a pseudo-tumor of the ileopsoas muscle.

In the first 132 patients performed the mean preoperative Harris Hip Score [HHS] was 58,6 [25-88] and it improved up to 94,4 (60-100) at a minimum follow-up of 5 years [p<0,0005], with an implant survival rate of 97,8% at 6 years [25].

Madhu et al. [26] reported positive clinical results in a series of 117 HR in 101 patients at a mean follow-up of 7 years. He experienced a little lower survival [91,5%] compared to our results probably due to the longer average follow-up.

Treacy et al. [27] reported excellent results with144 BHR implanted in 130 patients at a minimum follow-up of 10 years. Implant survival was 93,5% including the septic mobilizations, whereas it was 95,5% if these were not considered. Reito et al. [28] reported similar positive results at a follow-up between 5 and 8 years.

Despite these encouraging results, when we analyze data collected from registries, HR has a worse survival rate than THA in specific patients population: female, small diameter femoral head [<50-54 mm], patient older than 65 years and affected by specific diseases such as DDH or osteonecrosis. It is therefore necessary to consider these elements as exclusion criteria for HR.

Data from the British Commonwealth register show a survival rate of HR at 10 years follow-up similar or even better than THA in males younger than 65 years, with a femoral head diameter larger than 50 mm [29]. This result was confirmed also in a study from the Australian registry at 7 years follow-up [30].

Despite the ideal patient for HR is a young active male, affected by primary hip osteoarthritis with the femoral head larger than 50 mm, in our experience also other patients can benefit from these prosthesis. Nevertheless, it is necessary to evaluate HR advantages and drawbacks as well as the theoretically higher failure rate.

In order to meet patients' expectations and to minimize failure rate, it is mandatory proper patients selection and correct implant positioning: inclination and version of the shell, avoiding notching of the femoral neck and varus placement of femoral component. Considering the differences regarding either tribology [forged, as cast, carbon content] or implant design [acetabular coverage angle, radial clearance, cemented or uncemented fixation] between different HRs available the choice of a well-established prosthetic model is crucial to achieved a good clinical outcome and a long term survival.

RIPO data show the use of 10 different HR models in our Region [BHR – Smith and Nephew, ADEPT – Finsbury, ASR – DePuy, MRS – Lima, MITCH – Stryker, RECAP – Biomet, ROMAX – Medacta, CONSERVE PLUS – Wright, ICON – International Orthopedics, DUROM HIP RESURFACING – Zimmer]. Different survival rates correspond to different HRs ranging from 97,1% [the better] to 80,9% [the worst] at 5 years follow-up.

For this reason concerns have raised over the safety of some of these implants and the suitability of their use.

The US Company DePuy on the 24th of August 2010 withdrew the HR ASR, due of the high failure rate, about 13% according to the national registry of articulation of England and Wales.

BHR is one of the most used HR, with one of the lowest failure rate. Excluding ASR, the relative risk of revision surgery of other HRs compared to BHR is 3,3 time higher [p=0,04].

High revision rate of large diameter femoral head MoMTHA aroused concerns also about long term survival of HR; in particular the possible effect of long term chronic exposition to Cr and Co should be investigated.

The debris products of metal, such as micro particles, ions, metal-organic compounds may be responsible of pathological local or systemic disease: pseudo-tumor, osteolysis, ALVAL, cobaltism, chromosomal alterations and hypothetically carcinogenesis and teratogenicity.

The complication of pseudo tumors formation [16] may create additional difficulties during a revision surgery, with worse clinical and functional results [31].

Metal ions serum concentrations and their behavior over time in HR patients have been investigated in our Clinic in recent years [32-34] (Figure 2). Also possible differences due to patient gender were considered.

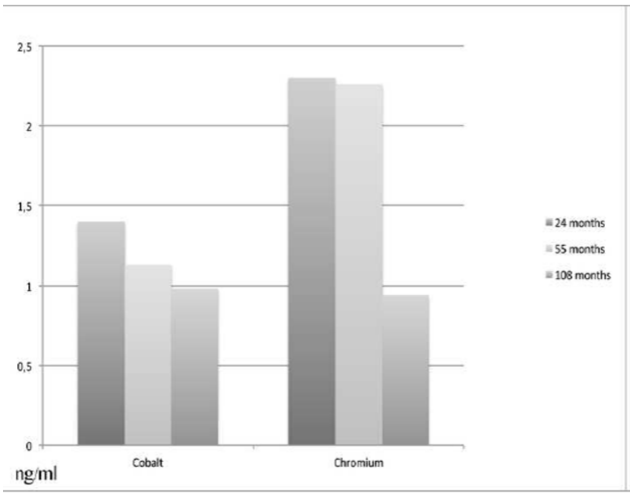

Figure 2: Metal ions serum concentrations.

The diagram shows concentrations (ng/ml) of Chromium and Cobalt in a population of patients who underwent Hip Resurfacing at 2 years, 5 years and 9 years follow-up.

At 2 years follow-up we found an average metal ions serum concentration of 2,30 mcg/l [range 0,69-7,24] and 1,40 mcg/l [range 0,08-8,96] for Cr and Co respectively.

After 55 months follow-up the mean concentration was 2,26 mcg/l [range 0,49-10,47] and 1,13 mcg/l [range 0,30-5,60] for Cr and Co respectively. At last follow-up available, after 9 years, mean levels was 1,94 mcg/l [range 0,56-1,19] and 0,98 [range 0,29-2,45] for Cr and Co respectively. Females showed a tendency toward increased Cr ions levels compared to males.

Therefore it is of paramount importance to pay particular attention to female patients when proposing HR.

A recent study with an average follow-up of 11 years reported increased serum concentrations of Cr and Co ions during the first two years; after this running-in period they progressively decrease and maintain stable over time [35].

Our results are similar to those reported in literature [15], both in term of ions serum concentrations and their behavior over years.

The Italian Society of Orthopedics and Traumatology [SIOT] set a Co level <2 mcg/l as reference value in patients with MoM bearing prosthesis. If Co values are between 2 and 7 mcg/l a strict follow-up is recommended. In case of Co levels higher than 7 mcg/lfurther analysis using US, TC with contrast and RMN is recommended even in asymptomatic patients. De Smet et al. [36] suggest to consider a revision surgery in case of elevated ions concentrations [Co>20 mcg/l].

The Food and Drug Administration [FDA] established that in asymptomatic patients with BHR it is not necessary to modify the follow-up protocol without performing metal ions analysis.

Conclusions

We consider extremely positive our experience with HR. The low revision rate and the excellent functional results encouraged us to perform this prosthesis in young and active patients. Implant choice is especially important when dealing with a young patient population where THA leads to high revision rate [1]. Hip resurfacing is particularly suitable for patients younger than 30 years of age with an estimated

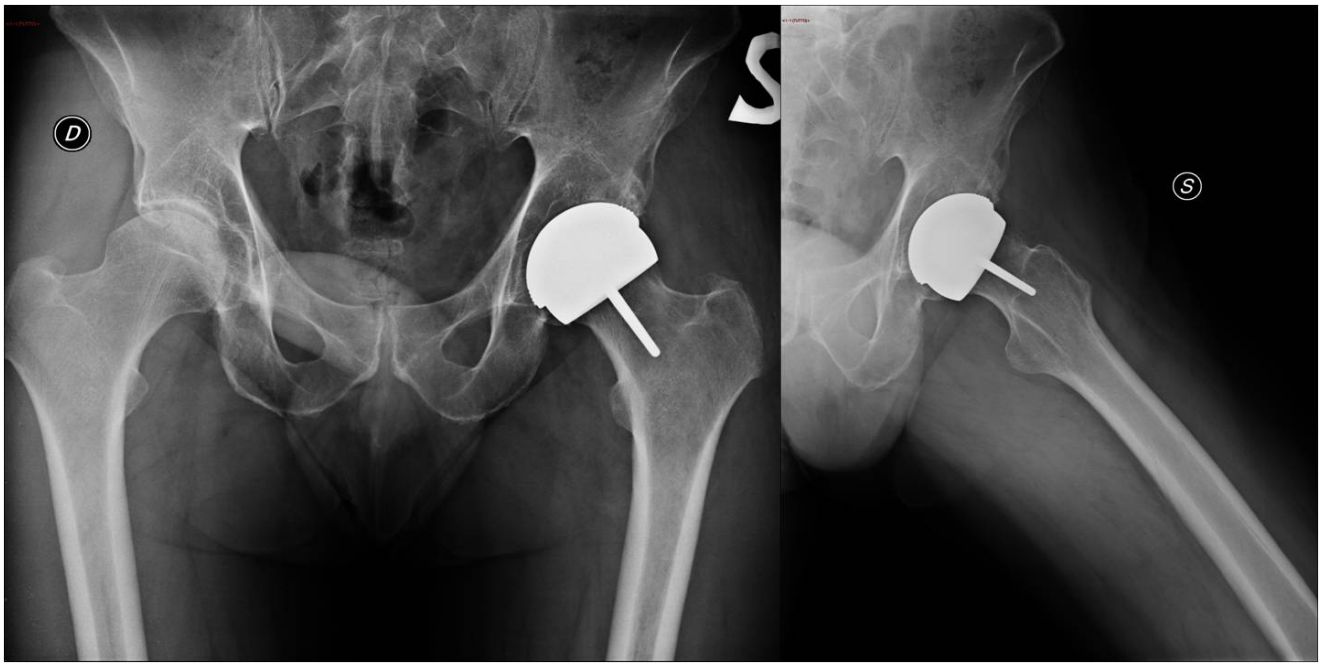

Figure 3: Romax Resurfacing System. Rx showing Hip resurfacing (Romax, Medacta) in a male patient aged 30 with good implant orientation at 5 years follow-up.

implant survival of 95% at 8 years follow-up [37,38] (Figure 3). Recent knowledge on possible complications due to MoM coupling made us to reconsider the role of HR and further restrict the indications for its use.

Young male patients with femoral head diameter larger than 50 mm, affected by primary or post-traumatic hip osteoarthritis with high functional demand are the ideal candidate for HR. Data from literature and from international registries confirm that in this specific patient's population HR survival is equal or even better than THA.

However it is necessary to underline that several factors play a role in determining the success of this implant, such as a precise components orientation and the correct choice of a well-established HR model.

The possible long-term effects of the debris of MoM bearing must be controlled over time.

Finally, the choice of HR must be shared with the patient, who needs to be carefully counseled over advantages and disadvantages.

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