Review Article

My current indications for hip resurfacing

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Abstract: Hip resurfacing arthroplasty is a viable option for young male patients with end stage osteoarthritis. The controversy surrounding the technique has resulted in a decline in worldwide numbers being performed. However, with appropriate patient selection and well designed and proven implants it offers results equal or superior to that of a standard total hip replacement in this high demand population. In this focused paper we present the factors taken into consideration when selecting patients for the procedure in order to maximise positive outcomes.

Keywords: Hip resurfacing; osteoarthritis (OA); hip replacement; metal on metal; young patients

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Introduction

Hip resurfacing arthroplasty (HRA) is an alternative prosthetic solution to the traditional stem-type total hip replacements (THR) for patients with end stage osteoarthritis (OA) specifically the younger population. Literature has shown THRs in this population have higher rates of aseptic loosening and as such an increased probability of revision surgery (1). The 2016 Annual Report of the Swedish Hip Register, analysing the THRs implanted in Sweden between 1992 and 2015, indicated a cumulative Kaplan-Meier (KM) survivorship of 69.7% and 62.8% in women and men aged between 50 and 59 years respectively at 24 years versus a KM survivorship of 90.3% and 94.3% in women and men over 75 years of age respectively for the same time span (2). The 2017 Finnish Arthroplasty Registry shows a similar disparity, revision rates regardless of the gender at the 20-year mark for individuals less than 55, 65–74, and over 75 were 41%, 19.8%, and 9.9% respectively.

HRA has been enveloped with controversy since the 1980s, with first generation prostheses associated with high failure rates due to excess wear of the polyethylene bearings (3). Second generation prostheses, Metal-on-Metal (MoM) bearings designed to alleviate this issue, were further linked to adverse reactions to metal ions, metallosis, and pseudotumors leading to the removal of several prosthetic systems from the market, albeit leaving a hesitant mark on the procedure (3). In addition to select designs, other risk factors associated with failure included women, small femoral component size, and malposition of the acetabular component (4).

However, in stark contrast to this perception of overall failure of the HRA systems, recent registry data and mid to long-term studies have shown excellent survivability and outcomes with specific HRA designs, namely the Birmingham Hip Resurfacing (BHR) and ADEPT systems, in the young population. The 2019 UK National Joint Registry (UKNJR) reported a 92.05% (95% CI, 91.63–92.44%) and 88.98% (95% CI, 89.32–89.6%) cumulative survivorship at the 10- and 15-year marks respectively (5). Per the 2018 Australian Orthopaedic National Joint Replacement Registry (AOANJRR, 2018), the BHR had a lower cumulative revision rate (10.6%, 9.8–11.5%), irrespective of age and gender, when compared to THRs (10.8%, 10.5–11.1%) at the 17-year mark (6). Furthermore, several recent independent studies have echoed excellent short to long-term survivability and clinical outcomes for HRA particularly for individuals under 60 (1,4,7-12). HRA also seems to provide a clinical advantage in young men with OA, a recent systematic review noting an improved ability to return to high level activities, the restoration of native biomechanics, and decreased femoral stress shielding when compared to THR (13). Additional studies, including a randomized clinical trial, have reported superior activity and quality of life scores and a reduced mortality in favour of HRA (14-16).

Although the number of HRA procedures remain low across registries, recent literature has legitimized its beneficial clinical outcomes and survivorship with careful patient selection, pre-operative planning, surgical technique, and proven implant selection. It is the aim of this article to provide an experienced surgeon's current insight and indications for HRA to aid surgeons in optimizing their outcomes.

Patient selection

Several studies and registry data have underscored the importance of patient selection for HRA to ensure the long-term survivability and excellent clinical outcomes. Our evidence-based practice encompasses these same merits and as a result our HRA population focuses mostly on osteoarthritic males less than 55, with some extension of age to 65, motivated to return to physical activity. The 2018 AOANJRR (6) reports a cumulative percent survivorship of 90.3% and 91.4% at 15 years for males with OA less than 55 years and 55 to 65 years respectively, albeit the younger age bracket has a higher cumulative survivorship up to 10 years. The 2019 UKNJR shows a similar trend with a cumulative survivorship of 88.9% and 89.87% for osteoarthritic males less than 55 years and 55 to 65 years respectively. This data includes prostheses which have now been removed from the market due to higher rates of failure. Multiple recently published independent studies (mean age 48.9–52.5 years, 52.5–93% of male subjects, 56–93% diagnosed with OA, BHR prostheses) have shown a minimum 10-year survivorship ranging from 92.2% to 98% (1,4,11,17-19).

Review of the literature reveals certain risk factors that may promote complications and pre-mature failure of the HRA systems including—the elderly, females, severe osteoporosis or decreased bone mineral density, increased acetabular inclination angles, femoral head cysts, dysplasia, osteonecrosis of the femoral head, renal disease, and known metal hypersensitivities (20,21). Our current practice considers these variables to maximise potential patient outcomes and these are discussed in the sections below.

Age

When HRA was initially introduced it was thought of as a temporising technique for patients that were too young for a conventional THA keeping the option of a revision at a later date (22). With early studies showing a 3-year survivorship at 99.1% (23), the technique was introduced to Australia in 1999. Numbers of HRA being performed annually rose to peak in 2005 primarily in the under 55-year age group and represented 29% of hip replacements performed in this age group. Despite a significant decline in the number of HRA being performed across worldwide registries the number being performed has remained fairly constant in recent years with the under 55-year age group representing over 50% of the total number of HRA performed in the AOAJRR.

Since 2013 the number of resurfacings performed in both the 55–64 and 65–74 age groups has been proportionately increasing (6). This is most likely a reflection of the 10-year cumulative revision rate in these age groups being similar to that of the under 55 patients. It should be noted that patients over 65 years have a higher revision rate at 1 year (3.1%) compared to the under 55 (1.2%) or 55–64 (1.6%) age groups.

As the number of failing HRA implants have been withdrawn the results of the two remaining HRA implants on the market, BHR and ADEPT, have continued to show promising results with cumulative revision rates of 4.4% and 2.4% respectively at 7 years in the <55 age group. This is comparable to a 3.9% cumulative revision of primary THA performed in the same age group at 7 years. As a result of this published 10-year data my threshold for offering an HRA have been extended to now include patients up to age 65.

Gender

In its infancy hip resurfacing was offered to young patients of both genders. Following the published results of these patients it was evident that females had a higher revision rate and poorer outcome following HRA (24). Indeed, the Canadian arthroplasty registry reported female gender as an independent risk factor for early failure (25). The systematic review by Haughom *et al.* demonstrated a higher rate of complications including adverse local tissue reaction (ALTR), dislocation, aseptic loosening and revision in women following MoM resurfacing (26). These findings are reflected in the Australian registry data with cumulative revision rates between 13.2–19.1% across all age groups in females at 10 years (6).

In a general consensus meeting (27) it was felt that gender itself may not be the main factor affecting outcome of an HRA with size of the patient's anatomy and implant likely more important. Females generally have smaller head and cup sizes compared to males which can result in increased edge loading of the bearing surface. Regardless of gender, a small head size of less than 46 mm would be considered a contraindication by many due to this increased risk. In addition, the most common indications for revision in HRA are loosening, metal related problems or femoral neck fracture all of which are increased with head size under 50 mm.

Other factors to take into consideration in female patients include potential increased ligament laxity, decreased bone density and an increased incidence of developmental dysplasia of the hip (DDH) (26). DDH is often observed in younger female patients but again has higher revision rates at 10 years (20.6%) when compared to OA as the primary diagnosis (6). This is most likely due to the increased anteversion observed in these patients which may influence poor cup positioning and increased edge loading resulting in failure (28). Caution should be taken in females of child bearing age due to possibility of pregnancy and transplacental transfer of metal ions. Although a link between teratogenicity of metal ions from MoM has not been demonstrated caution should be advocated. As a result of this work we currently preserve HRA to male patients with head size above 48 mm.

Pathology

The primary indication for an HRA is generally end stage OA, dysplasia or avascular necrosis (AVN). It is generally accepted that HRA performed for end stage OA is the best indication with the lowest revision rate (9.5%) in the Australian registry at 10 years (6). Patients presenting with AVN may still be offered an HRA provided enough healthy bone is present for a good femoral head fixation and for the creation of a circumferential seal around the implants. The presence of osteonecrotic areas larger than one third of the femoral head, severe cystic change or poor-quality bone in the femoral head and neck are at high risk of failure with resurfacing. We would also extend this contra indication to HRA in severe leg length discrepancy, Legg-Calvé-Perthes and slipped capital femoral epiphysis.

OrWe can still offer HRA as an alternative to THA for patients with large offsets or usual pathology that may not have accurate restoration of biomechanics with a conventional total hip arthroplasty.

Activity level

A common expectation and request by our patients undergoing hip replacement is the return to sporting activities from which they have often had to stop due to the restrictions of hip arthritis. During the consultation process we take this into account when selecting our patients for HRA. This expectation can be often be achieved in the majority of patients with advances in HRA technology which have reduced the dislocation risk, restored hip biomechanics, reduced thigh pain and provide a low wear surface. It has been reported in previous studies that return to even high demand sports such as competitive ironman triathlon (29) is possible, although low impact sports such as swimming and cycling are more achievable in most.

Surgical factors

There are a number of technical factors which may be influenced by the surgeon during an HRA which can contribute to the survivorship and long-term outcome. We aim to highlight certain aspects of the technique in this section which we have found to maximise success.

Surgical approach

Hip resurfacing can be a technically challenging procedure requiring good exposure of both the femoral head and acetabulum to minimise errors in implant positioning. This is particularly important in the presence of bony deformity which can often be present in the young arthritic patient. Various surgical approaches have been utilised including surgical dislocation via the trochanteric slide, direct anterior and the posterior approach. The former having potential complications including trochanteric non-union and injury to the lateral femoral cutaneous nerve (30). The posterior approach remains the most commonly used approach for the HRA technique despite concerns over the compromise to the vascularity of the remaining femoral head. It allows excellent visualization for bone preparation and is the approach I currently utilise.

The vascular anatomy of the femoral head has been well described in the normal adult hip (31) and despite the potential vulnerability of the blood supply with both posterior approach exposure and bone preparation the influence of this on the formation of osteonecrosis remains unproven. Reduction in the blood flow ranging from 40–70% has been shown in many studies (32,33), however there is an abundant vascular anastomosis between the epiphysis and metaphysis during OA development (34) which may negate this.

An incision positioned more posterior than that used for either primary THR or revision hip replacement has been found to be most useful, allowing the accommodation of the dislocated femoral head within the surgical field and without compromising implant position.

Bone preparation

The femoral head is routinely prepared prior to the acetabulum during a hip resurfacing procedure. Any defects visualised following the preparation reaming of the femoral head may potentially result in reduced structural support under the femoral component. This can often be identified and anticipated with preoperative imaging and the space either filled with bone graft or cement. If felt structurally unsuitable for an HRA the procedure can still be converted to conventional arthroplasty intra operatively. To aid implant positioning we routinely obtain a pre-operative CT scan and use templating to aid both femoral neck entry point and neck angle to avoiding varus placement of stem.

Careful attention should be made to avoid notching of the femoral neck as this is associated with increased risk of neck fracture. Violation of the cortex creates a stress riser and therefore increased risk of fracture in the post-operative period. It has been shown biomechanically that a notch depth of just 2 mm weakens the neck by 25% and 5 mm by 50% (35).

The surgical exposure of the acetabulum and bone preparation is key to obtaining a secure peripheral fit with no soft tissue interposition. Indeed, failure of bone ingrowth into the acetabular component is not unique to HRA and can be an issue in both uncemented total and resurfacing hip procedures and is often difficult to identify unless the implant migrates.

To improve the peripheral fit around the acetabular component an over reaming of the floor of the acetabulum using a reamer 2 mm smaller than that of the final finishing reamer size provides an apex relief. This technique stops the cup bottoming out encouraging the desired peripheral fit and reduces early cup failure. A similar technique has been described in the literature by Gaillard-Campbell *et al.* (36).

Implant selection

With the technique aiming to be bone preserving, hip resurfacing implant designs and thickness are often kept to a minimum. In general, the thickness between the inner and outer diameter of the acetabular and femoral components is approximately 6 mm, producing a combined 12 mm of thickness of the resurfacing construct (37). This is maintained throughout the implant size ranges by many manufactures, thus the smaller implant sizes have relatively more thickness. Differences in design and thickness of materials affects the component articular arc, defined as the angle subtended by the articular surface and is generally less than a hemisphere. This can be influenced further by the concentricity of the components, cup insertion grooves and chamfers.

An increased range of movement arc reduces the possibility of impingement however, a reduction in the articular arc increases the risk of edge-loading and steepening the effective inclination angle at the bearing surface. A steeper angle has been associated with higher metal ion concentrations as a result of edge loading. The two MoM resurfacing implants currently available on the market, the ADEPT and BHR, have larger articular arc values and therefore reduced edge loading potentially explaining their relative success compared to previous implants.

The values of articular arc which vary amongst implant manufacturers and implant sizes have been previously published (38). This effect can be further compounded by poor implant positioning (39), in particular increased inclination angles, resulting in higher metal ion levels. We currently aim for an intraoperative acetabular position of 40±5 degrees inclination and 20±5 degrees of anteversion. This again is guided with pre-operative CT templating and the use of an intraoperative computer hip navigation system. Our own unpublished series using hip navigation has shown to improve both the accuracy and reproducibility of cup position.

Since 2008 an inverse relationship has been identified between the size of the femoral component and risk of HRA revision. This is independent of gender and hips with a femoral component size of ≤44 mm have a fivefold increase risk of revision compared to those with ≥55 mm (37). Based on Australian registry data we would currently avoid HRA in patients with head component size ≤48 mm as there is a much higher revision rate.

Summary

HRA remains a viable option for the treatment of young patients requiring a hip replacement. Recent media exposure in high level athletes has further increased the public's awareness and enthusiasm for the technique but careful patient selection and a well-designed implant remain a priority in order to achieve good outcomes. I would have reservations regarding a patient with small component size or abnormal anatomy that would compromise implant position.

Based on the available evidence in 2019 my current indications for patients suitable for HRA are active males with end stage OA and femoral head >48 mm. Age *per se* is not necessarily a restriction to the technique based on the registry data and we currently offer this to patients up to 65 years of age.

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Footnote

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