Adoption of Hip Resurfacing Arthroplasty at Hospital for Special Surgery: a Cohort Study

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Abstract *Background:* Hip resurfacing arthroplasty (HRA) is an alternative to traditional total hip replacement (THR) that allows for the preservation of femoral bone. It is a more technically difficult procedure that has led some researchers to report an unsatisfactory learning curve. *Purpose:* The purpose of this study was to investigate the adoption of HRA at our institution, examining the clinical results, revision rate, and modes of failure. Additionally, a comparison of three different implant systems was performed. *Methods:* A retrospective review of a consecutive series of HRA performed at our institution between the years 2004 and 2009 was carried out. A total of 820 HRA with a minimum of 2 years of follow-up were included in the study. The majority of included patients were males (70%), with osteoarthritis (92%). The average age was 49.8 years, and the mean BMI was 27.5 kg/m². *Results:* The average Harris hip score improved from 61 to 96.5 postoperatively. Thirteen revisions (1.6%) were performed for femoral neck fracture, femoral head osteonecrosis, acetabular loosening, metal reactivity/metallosis, and metal allergy. The overall Kaplan–Meier survival curve with revision surgery as an endpoint showed 98.5% survival at 5 years. There were no observable differences in clinical scores or revision rates between the different implant systems. *Conclusions:* HRA can be successfully adopted with a low complication rate,

given careful patient selection, specialized surgical training, and use of good implant design.

Keywords hip resurfacing arthroplasty · results · complications · learning curve

Introduction

The concept of hip resurfacing arthroplasty (HRA) was originally developed in the 1970s as a way to preserve femoral bone in younger patients. However, the materials (metal on polyethylene) and cemented fixation of the first generation of implants led to early osteolysis and implant loosening. Due to a high rate of failure in early follow-up [10], hip resurfacing was largely abandoned until improvements in materials and fixation were made.

Metal on metal hip resurfacing was introduced in the late 1990s as a way to take advantage of the tribology of a metal articulation, hopefully avoiding the osteolysis and loosening that plagued the first generation of HRA. In the last decade, it has become established as an alternative to total hip replacement (THR) in the treatment of end-stage arthritis in younger, active patients. The main driving force for hip resurfacing has been the preservation of bone [17] and the high level of activity that has been possible postoperatively [18]. The indications for HRA have been refined as a greater understanding of risk factors has evolved, and complications have emerged.

HRA is described by many authors as a more technically difficult procedure than THR, with a substantial learning curve [3, 5, 13, 14]. The surgical exposure for HRA is more challenging due to the need to prepare the acetabulum with the femoral head and neck still intact; positioning the acetabular component needs to be precise; and the femoral head preparation is a novel procedure generally not familiar to the THA surgeon. Due to these challenges, the senior author (EPS) sought to obtain specialized training in HRA by visiting several hip resurfacing surgeons and additionally performing procedures on cadaveric specimens.

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The midterm results of HRA have been variable in the literature. HRA series performed by designer surgeons have shown excellent results in the range of 95–99% implant survival at 5–8 years [1, 6]. However, some independent series have reported a high complication rate [5, 15], leading those investigators to decrease their use of HRA. Literature has also emerged about the possible complications of a metal on metal articulation, leading to additional concerns. This type of articulation is subject to edge-loading and the generation of metal debris when the acetabular component is malpositioned [7]. Pseudotumors and tissue reactions have been described as a consequence of the metal debris [9, 15]. Therefore, we sought to examine our experience with HRA with regard to these described failure mechanisms.

The aims of this study were to: (1) examine the clinical results of the initial cohort of hip resurfacing patients performed at our institution; (2) to calculate the survivorship of this cohort and to analyze the incidence and cause of revision; and (3) to assess whether or not there were differences in survival between the devices used.

Materials and Methods

A retrospective review of consecutive HRA performed by the senior surgeon (EPS) in the time period 2004–2009 was carried out. A minimum of 2-year postoperative follow-up was necessary for inclusion. The mean follow-up time was 2.53 years [range 2.0–7.8 years]. The surgeon had received specialized training in HRA from surgeons involved in designing the Conserve Plus (Wright Medical Technologies, Inc., Memphis, TN), the Biomet Recap (Biomet, Inc., Warsaw, IN), and the Birmingham Hip Resurfacing (BHR; Smith and Nephew, Inc., Memphis, TN). The specialized instruction consisted of both surgical observation and cadaveric training. Patients received the Conserve Plus implant initially through a compassionate use application to the US FDA, starting in 2004. The Biomet Recap was used as part of the US Investigational Device Exemption trial in the years 2006–2008 and the BHR was used after its approval by the FDA in May 2006.

A total of 997 hip resurfacings were performed in 907 patients between February 2004 and September 2009; 90 patients had simultaneous bilateral resurfacings under a single anesthetic. Overall, 69.7% of HRAs were performed in men. Eight hundred twenty hips had a minimum of 2-year follow-up, giving a follow-up rate of 82.2%. Six hundred forty-three BHRs, 157 Conserve Plus, and 20 Biomet Recap were performed. The average age of the patients was 49.8 years; average body mass index was 27.5 kg/m². Diagnoses for surgery were osteoarthritis (91.8%), osteonecrosis (3.0%), dysplasia (2.7%), inflammatory arthritis (1.7%), and posttraumatic arthritis (0.6%).

A posterior surgical approach with regional anesthesia was used in all cases. The acetabular component was press-fit; the femoral implant was cemented with low-viscosity cement. Postoperatively, patients were allowed to bear weight as tolerated with crutches for 3 weeks and wean off assistive devices thereafter. Enteric-coated aspirin (325 mg

po bid) for 1 month was used for prophylaxis against venous thromboembolism. Patients were evaluated clinically and radiographically at 1 month, 3 months, and yearly postoperatively.

Anteroposterior pelvis and cross-table radiographs were evaluated for the presence of radiolucent lines and osteolysis by the senior surgeon (EPS), utilizing the method previously described by Beaulé et al. [4]. Osteolysis was defined as a circumscribed area of radiolucency in the periprosthetic bone, visible with edge enhancement software (Sectra Imtec AB PACS, Sweden). Radiographs were taken at 1 month postop and annually thereafter. Harris hip scores (HHS) were calculated and range of motion was assessed at postop visits.

Statistical analysis was performed using Microsoft Excel 2010 (Redmond, WA). Student's *t* test and chi-square test were used to compare numerical values, with statistical significance set at the $p < 0.05$ level.

Results

There was one deep venous thrombosis, below the knee, in this group of patients; this was treated with anticoagulation and has resolved without sequelae. No nerve palsies, infections, or dislocations were seen in the cohort.

In examining the clinical results of HRA, we found a significant improvement in the pain and function components of the Harris hip score. The average preop HHS was 60.1 [range 30–76]; postoperatively, this increased to 96.5 [range 80–100]. Improvements in HHS were similar in both males and females and in all implant types. No difference in ROM could be attributed to implant type.

Thirteen revisions (1.6%) had been performed on this group of patients. Five were for femoral head osteonecrosis; two for acetabular cup loosening; three for femoral neck fracture, two for metal reactivity/metallosis, and one for metal hypersensitivity. The revisions occurred in eight males and five females. The average time to revision surgery was 25.6 months. The Kaplan–Meier survival curve for the entire group was 98.5% at 5 years (Fig. 1). The femoral neck fractures (Fig. 2) and femoral head osteonecrosis cases were treated with conversion to total hip replacement, using a

Fig. 1. The Kaplan–Meier curve shows implant survival free from revision to be 98.5% at 5 years. Error bars showing the 95% confidence intervals are depicted

Fig. 2. Radiograph of a femoral neck fracture complication that occurred at 5 weeks postop

large diameter metal head that matched the retained acetabular implant. The acetabular cup loosening and metal hypersensitivity cases were treated with full revision, with placement of new acetabular and femoral implants. One of the metallosis cases was treated with full revision (Fig. 3) and the other with acetabular revision only. Radiographically, there were no patients with evidence of osteolysis. There were two patients with asymmetric radiolucent lines around their femoral stems, indicating possible loosening. However,

these patients were not clinically symptomatic enough to warrant revision surgery. We did not find any difference in survivorship, clinical scores, or incidence of complications between the three different implant types.

Discussion

The goals of this study were to examine the adoption of HRA at our institution with respect to: the clinical results at a minimum of 2 years of follow-up; the causes and incidence of failure; and a comparison between different implant systems. We found that HRA had an excellent clinical result with an improvement in the mean HHS from 61 to 96.5. There was a revision rate of 1.6% in this cohort, with a calculated Kaplan–Meier survival curve of 98.5% free of revision at 5 years. We did not find any difference with respect to implant type with regard to clinical results or revision rate.

There are limitations to our findings, as with any retrospective study. We were able to achieve a follow-up rate of 82.2%; though this is similar to many studies of this type, it could bias the results in favor of increased implant survival. However, we did not feel it would be accurate to consider all of the patients lost to follow-up as failures either; thus, we have reported on the patients with a minimum of 2-year follow-up. Furthermore, the results of our study may not be generalizable, as the senior surgeon is fellowship trained in arthroplasty, with further specialized training in HRA. Nevertheless, it is encouraging to see that this experience encompasses the so-called learning curve, representing a consecutive series from the index procedure. Finally, the follow-up interval is short, thus it can be expected that the failure rate will increase with time. With our minimum follow-up of 2 years, the study likely includes most femoral neck fractures, one of the predominant modes of failure of HRA, which occurs most often in the first 3 months postoperative. Based upon the literature, we would expect that the

Fig. 3. **a** AP radiograph of a metal reactivity/metallosis complication that occurred at 3.2 years postop. Progressive neck narrowing occurred due to external pressure from intra-articular tissue. **b** The lateral radiograph of this hip shows excessive anteversion. Implant removal, synovectomy, and revision to a nonmetal on metal THR was performed

number of failures due to metal debris related consequences will increase at longer follow-up.

HRA has not been widely accepted because of the technical challenges inherent in the procedure [5], complications unique to the procedure such as fracture [2, 16], and concerns over the metal-on-metal bearing surface [8, 12, 15]. Concerns about the metal articulation include metal sensitivity (i.e., ALVAL reaction) and edge-loading leading to metallosis. Though designing surgeons have reported 95–99% survival rates at midterm follow-up, other series cite a higher rate of failure due to metal-related complications [12]. Langton et al. [12] describe a 10% failure rate of the articular surface replacement (ASR; Depuy, Inc.) implant at 5 years due to reactions to metal debris. Another study has estimated that 1% of all patients will have a pseudotumor to develop within 5 years [15].

We believe that our results are in line with those reported from centers using the Birmingham Hip Resurfacing and the Conserve Plus, as the majority of our cases (97.5%) used these two devices. Other studies using the BHR have reported 99.5% survival at 5 years in men less than 55 years of age [6], and a multicenter study demonstrated 96% survival at 8 years [11]. Studies reporting on Conserve Plus results have shown similarly excellent results, with 95.2% survival at 8 years [1]. These two implants have also had significantly fewer failures due to reactions to metal debris when compared to the ASR implant [12].

Based upon our findings, we believe that complications after can be kept to a minimum with the cautious adoption of hip resurfacing, i.e., being selective with patients, careful surgical technique, and the use of good implant designs. As evidenced by our patient demographics, majority of patients had the diagnosis of osteoarthritis (92%) and were men (70%), two characteristics that have been shown to have superior results in the literature [6]. A dedicated effort to learn the HRA procedure by visiting experienced surgeons and performing cadaveric implantations is also likely to minimize complications. Finally, results emerging in the literature and national joint registries have demonstrated a difference in survivorship between implants. In our study, we found that all three resurfacing implants had comparable results. Of course, continued vigilance and monitoring is necessary to ensure that these procedures maintain success.

Disclosures One or more of the authors (ES) certifies that he or she has or may receive payments or benefits from a commercial entity (Smith and Nephew) related to this work.

Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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