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Is Patient Selection Important for Hip Resurfacing?

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Abstract The optimal implant option for hip arthroplasty in the young, active patient remains controversial. There has been renewed interest for metal-on-metal hip resurfacing due to improved design and manufacturing of implants, better materials, enhanced implant fixation, theoretical advantages over conventional total hip arthroplasty, and recent Food and Drug Administration approval of two devices. Recent studies indicate satisfactory short- and midterm clinical results (1- to 10-year followup) with low complication rates, but there is a learning curve associated with this procedure, a more extensive surgical approach is necessary, and long-term results have yet to be determined. Proper patient selection may help avoid complications and improve patient outcomes. Patient selection criteria in the literature appear based predominantly on theoretical considerations without any consensus on stratifying patient risk. The most commonly reported complications encountered with hip resurfacing include femoral neck fracture, acetabular component loosening, metal hypersensitivity, dislocation, and nerve injury. At the time of clinical evaluation, patient age; gender; diagnosis; bone density, quality, and morphology; activity level; leg lengths; renal function; and metal hypersensitivity are important factors when considering a patient for hip resurfacing. Based on our review, we believe the best candidates for hip resurfacing are men under age 65 with osteoarthritis and relatively normal bony morphology.

Level of Evidence: Level V, prognostic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Introduction

Modern metal-on-metal hip resurfacing has recently gained popularity in North America. The indications for hip resurfacing are similar to primary THA, which includes end-stage arthritis recalcitrant to nonoperative treatments in healthy and willing patients. Most arthroplasty surgeons recommend patients refrain from running and participating in high-impact activities after THA [56], whereas many resurfacing surgeons [35, 70] allow high-impact activities such as jogging, but the results of these activities have not been closely studied.

There are a number of theoretical advantages of hip resurfacing over conventional THA, including preservation of bone stock [1, 20, 64], less stress shielding [47], less thigh pain [88], fewer dislocations [26, 87], reduced osteolysis [87], improved biomechanics [44, 81, 89], retention of proprioception, and ease of revision in comparison to THA [1, 14, 64, 75]. Clinical disadvantages of hip resurfacing include the risk of femoral neck fracture [6, 63], component malpositioning secondary to increased surgical complexity [20, 24], femoral component loosening [5, 8, 18], decreased head-neck offset causing impingement [22, 24], and metal ion production [36, 59]. In the 1970s, hip resurfacing with metal femoral components and cemented polyethylene acetabular components was popular, but early failures (30% to 56%) [50, 85] within 5 years resulting from osteolysis and component loosening caused them to fall out of favor [7, 50, 85]. Although the short- and midterm results (93%–97% survivorship at mean 5 years) of contemporary metal-on-metal resurfacing implants surpass previous resurfacing designs [13, 29, 37, 49, 61, 72, 75, 84, 86], there are no long-term results (longer than 10 years) available for these current-generation hip resurfacing implants.

Indications for hip resurfacing as an alternative to traditional THA favor the younger, more active patient with osteoarthritis [15]. The incidence of early revision varies widely depending on such factors as gender and age [29], making prudent patient selection particularly important with this procedure. We provide an overview of the hip resurfacing literature, specifically covering patient characteristics, underlying diagnoses, bone morphology, and metal ions in an attempt to determine which factors are important when selecting patients for hip resurfacing.

Search Strategies and Criteria

We reviewed current literature on hip resurfacing with an emphasis on patient selection, including patient demographics (age, gender, underlying diagnosis, obesity), bone quality (femoral head cysts, osteopenia, extensive osteonecrosis, inflammatory arthropathy), bone pathoanatomy (considerably decreased head-neck offset, Perthes disease, severe dysplasia, previous surgery or fracture, limb-length inequality, severe slipped capital femoral epiphysis, coxa vara, coxa breva), and other factors (women of childbearing age, metal hypersensitivity, renal insufficiency, patients with a high risk of developing heterotopic ossification) to determine what factors influence outcomes.

We conducted a structured search to identify all published literature related to hip resurfacing using PubMed, Medline, EMBASE, the Cochrane Database of Systematic Reviews, and the Internet using Google Scholar [67, 91]. The search strategy comprised (1) an initial text search with the key words “hip resurfacing” to identify all potentially relevant articles for inclusion; and (2) a modified search using “hip resurfacing” with the modifier and in combination with a specific keyword (ie, obesity, osteonecrosis, metal ion, etc.). The literature searches failed to identify any randomized or comparative observational studies specifically designed to analyze patient selection factors as a determinant of outcome after hip resurfacing. The majority of studies were case series or observation studies with limited division of data into patient-specific parameters.

We assessed all identified abstracts from the database searches for relevance. Non-English studies were excluded (52 articles). Full papers were obtained and formally assessed for inclusion by one reviewer (RMN). Articles were judged by the level of evidence, number of patients, patient characteristics, diagnoses, use of a patient selection criteria, radiographic findings, survivorships, and complications. No restrictions on implant manufacturer were imposed. We carefully reviewed nonclinical abstracts and selectively included them in the formal review. The first documented abstracts identified dated back to the mid-1970 s. These abstracts were included and reviewed despite reporting on first-generation hip resurfacing systems because it was believed patient selection parameters are primarily independent of the hip resurfacing system. We excluded unpublished data found on the Internet or distributed by implant manufacturers.

Literature Review Results

The initial search identified 409 potentially relevant “hip resurfacing” or “hip surface arthroplasty” studies. After reviewing the abstracts and applying the inclusion and exclusion criteria, we were left with 207 papers to review. Of these hip resurfacing papers, 72 were associated with osteonecrosis, 20 with metal ions, nine with dysplasia, eight with bone density, five with metal sensitivity, three with limb length inequality, three with inflammatory arthropathy, two with pregnancy, and one with obesity.

Quality of Studies

The majority of studies (138 of 207) reviewed had limited or no description of patient demographics, underlying diagnosis, bone morphology, or medical comorbidities. One hundred-twelve of the 207 articles had small sample sizes, poor study design, limited control of bias, and inadequate statistical analysis to make rational interpretations. Forty-six of these studies were designed to give a broad overview of an expert’s clinical results with hip resurfacing procedures. The duration and completeness of followup is variable in these papers. We identified only two randomized, controlled trials (RCTs) comparing clinical outcomes between hip resurfacing and primary THA [51, 87]. Unfortunately, one of these involved cemented acetabular hip resurfacing components instead of cementless components, which is inconsistent with the current-generation resurfacing systems. These authors stopped the trial early because of a high incidence of failure (eight of 11 hips) in the patients undergoing hip resurfacing with the cemented acetabular component [51]. The other RCT was designed specifically to compare the results of metal-on-metal hip resurfacing with metal-on-metal THA in patients younger than 65 years of age [87]. They enrolled 210 patients and reported patients with hip resurfacing had higher activity levels (University of California-Los Angeles [UCLA] score 6.3 versus 7.1), a greater percentage of patients undergoing resurfacing returned to heavy or moderate activity, and both groups had similar complication rates. They concluded, in the short term, better functional results favored patients with hip resurfacing over THA. This study was limited by the small sample size, short followup, and the fact patients were not blinded to which surgical procedure they received. There were three additional RCTs evaluating nonclinical outcome parameters after hip resurfacing, which we did not include in this review.

Results

Age and Gender

There is no clear consensus on the upper age limit for male patients considering hip resurfacing, but the most commonly used criteria was age younger than 65 years [35, 37, 48, 76]. Several authors gave special consideration to male patients older than 65 years on a case-by-case basis depending on bone quality and patient activities [30, 53, 58, 61, 78], and one study included male patients up to age 89 years [68]. Conversely, several articles [2–4, 53, 63, 66, 77–79] believed female patients should be cautiously evaluated before performing hip resurfacing on them, especially if they are postmenopausal or have decreased bone mineral density [79].

The largest pooled multicenter numbers come from the Australian registry, in which the data suggest hip resurfacing has fewer complications when performed on men younger than 65 years of age and women younger than 55 years [29, 79]. Shimmin and Back [79] reviewed the Australian registry and identified 50 cases of femoral neck fractures (1.49%) in 3429 hip resurfacing procedures over a 4-year period. The overall rate of fracture was 0.98% for men and almost double that for women (1.91%). Although technical issues, including notching, varus stem positioning, and incomplete femoral seating, were identified in 85% of cases, advanced female age was a major contributor to these fractures.

The most recent data from the Australian joint replacement registry show hip resurfacing procedures accounted for 7.9% of all primary hip arthroplasties performed, 74.1% are performed in male patients, and 90.7% are performed in patients younger than age 65 years of age [12, 29]. Nearly all hip resurfacing procedures (95.8%) had hybrid fixation (cementless acetabular and cemented femoral component). The registry suggests the revision rate for hip resurfacing varies considerably with age and gender with older women having a revision rate in excess of 10% at 4 years, whereas men younger than 55 years of age had a revision rate of less than 2%, which was as good or better than conventional hip arthroplasty in that cohort (Table 1). The 5-year cumulative revision rate for patients younger than 55 years of age undergoing hip resurfacing was 2.8% and for patients aged 55 to 64 years, it was 4.5%. There were insufficient 5-year data for patients 65 years and older, but at 4 years, the cumulative revision rate was 4.6% in patients aged 65 to 74 years and 9.7% for patients 75 years of age and older. A major difference in revision rates was associated with gender. At 3 years followup, the revision rate was twice that of males, and at 5-year followup, this difference was almost three times higher (7% for women, 2.5% for men). The revision rate for female patients when stratified by age was greater for those younger than age 55 years (3.9%) compared with those aged 55 to 64 years (6.3%) and 65 years and older (11.2%). In male patients, there was less of a difference in revision rates in patients younger than 55 years (1.9%) and those aged 55 to 64 years (2.2%), but this rate increased in men aged 65 years and older (4%) [12].

Table 1. Four-year cumulative percentage revision of primary resurfacing hip and primary conventional THA procedures by gender and age (primary diagnosis osteoarthritis excluding infection) [12]

Age (years)	Resurfacing		Conventional total hip	
	Male	Female	Male	Female
Younger than 55	1.9%	3.9%	2.2%	3.2%
56–64	2.2%	6.3%	2.2%	2.7%
65 or older	4.0%	11.2%	2.4%	2.2%

Adapted with permission from the Australian Orthopaedic Association National Joint Registry. Annual Report. Adelaide:AOA; 2007.

Obesity

Obesity, defined as body mass index greater than 35 kg/m^2, can be viewed as a relative contraindication to hip resurfacing due to the difficulty involved in exposing the hip, the challenge of accurate component placement, and the increased risk of femoral notching [64]. Historically, excessive body weight greater than 80 kg was associated with a higher rate of aseptic loosening in patients undergoing THA [32, 83]. Recently, several studies by Amstutz et al. [4, 17, 58] demonstrate greater patient weight is not associated with earlier component loosening and femoral neck fracture risk, and survivorship up to 5 years are similar between the obese (98.6%) and nonobese (93.6%) patients with metal-on-metal hip resurfacing. One of these studies [58] reported that as body mass index increases, the actual risk of revision decreased twofold. The authors attributed this finding to reduced activity levels, larger component size, and increased bone density in the obese patients. They note excessive weight in combination with poor implant positioning, especially the femoral component, can increase the risks for femoral neck fractures in this patient population [6, 58].

Patient Risk Index

The Surface Arthroplasty Risk Index (SARI) has been used in several studies to assess patient outcomes after hip resurfacing [4, 20, 21, 23]. The SARI is scored on a six-point system using patient history (previous hip surgery, 1 point; UCLA activity score greater than 6, 1 point), clinical findings (weight < 82 kg, 2 points), and radiographic measurements (femoral head cyst > 1 cm, 2 points). The first study to use the SARI scoring system was aimed at evaluating outcomes in patients younger than age 40 with metal-on-metal hybrid hip resurfacing. They reported a SARI score greater than three was associated with a 12-fold increased risk of early failure or adverse radiographic changes [21]. Amstutz et al. [4] reported the results from 400 hybrid metal-on-metal hip resurfacings and reported patients with a SARI score greater than three had a 89% survivorship at 4 years compared with 97% survivorship in patients with a SARI score of three or less.

In another study, 1016 patients who underwent hip resurfacing were divided into two cohorts and the complication rates were compared between the first 292 patients and a second cohort of 724 patients [66]. After reviewing the complications and outcomes from the first 292 patients, the authors reviewed their techniques and results. They made systematic changes in their indications and surgical techniques in an attempt to improve their results. Three categories of risk factors for implant failure were identified: (1) preoperative (femoral head cysts, head-neck junction abnormalities, poor bone density); (2) operative (leaving reamed bone uncovered, minimizing the femoral component to conserve acetabular bone, leaving the femoral component proud, malpositioning the acetabular component); and (3) postoperative (noncompliance with postoperative restrictions, traumatic events, weight-bearing, malpositioning of the acetabulum < 30° or > 60°, femoral component < 135°). After changes were made to the indications and technique, there was a considerable reduction in the overall complication rate from 13.4% to 2.1%. The femoral neck fracture rate was reduced from 7.2% to 0.8%. The authors concluded refining patient selection, improving surgical technique, and learning from their own experience helped optimize patient outcomes and reduce the number of complications.

Radiographic Bone Assessment

Schmalzried et al. [78] retrospectively reviewed the short-term results (minimum 2-year followup) of 147 consecutive hips treated with hip resurfacing by a single surgeon. They developed a radiographic arthritis hip grading system in an attempt to correlate preoperative radiographic findings with patient outcomes after hip resurfacing. Four characteristics of the proximal femur (bone density, shape, biomechanics, bone defects) were assessed and then graded A to F depending on the number of unfavorable characteristics [78].

Bone density was evaluated on preoperative radiographs and judged normal or below normal [78]. The proximal femoral head-neck shape was considered suboptimal if the head-neck ratio was less than 1.2 or if the neck length was less than 2 cm [78]. Hip biomechanics were considered poor if there was greater than 1 cm of limb-length inequality or a neck-shaft angle less than 120° [78]. Bone defects were considered important if they were greater than 1 cm in diameter [78]. Each unfavorable radiographic characteristic was given one point, and the total number of points for each of the four categories was added to determine the grade for the hip. They concluded hips with fewer unfavorable characteristics have better outcomes after hip resurfacing [78].

Bone Mineral Density

We identified one biomechanical study and three clinical articles using dual-energy xray absorptiometry (DEXA) to determine bone density after hip resurfacing [47, 55, 69, 73], but reported none using preoperative DEXA scans to determine patient outcomes. Anecdotally, arthroplasty surgeons have recommended DEXA screening for postmenopausal female patients and any male with questionable bone mineral density (BMD) on plain radiographs before performing hip resurfacing. Anglin et al. [10] suggested in a biomechanical study that for specimens with normal BMD, femoral component placement, especially more than 10° of valgus, had a greater effect than BMD on fracture load variance. They concluded there is currently no accepted threshold for BMD, but patients with BMD below 0.65 g/cm^2 are likely inappropriate candidates for hip resurfacing. Although they ended by stating there is not yet sufficient evidence to recommend routine preoperative DEXA scans [10], it would be reasonable based on laboratory data to consider a T-score below −1.0 (which is considered the marker for “normal bone density”) as a risk factor for fracture after resurfacing.

While there are currently no conclusive data on hip resurfacing performed in patients with decreased bone density, the FDA Web site (www.fda.gov) indicates hip resurfacing "should not be used in a patient who have bones that are not strong enough or healthy enough due to severe bone loss (osteoporosis) or a family history of severe bone loss" [40]. Patients with decreased bone density have an increased risk of femoral neck fracture following hip resurfacing.

Childhood Hip Disorders

Patients with developmental dysplasia of the hip, Legg-Calve-Perthes disease (LCP), and slipped capital femoral epiphysis (SCFE) commonly develop advanced hip arthrosis at an early age. Boyd et al. [27] reported retrospective clinical and radiographic results on 18 patients (19 hips) with LCP treated with metal-on-metal hip resurfacing and trochanteric advancement and compared them with similar patients treated with a standard THA in the literature. These patients had a mean of 2.7 previous procedures performed on the same hip for treatment of Perthes disease before hip resurfacing. Five patients had a previous proximal femoral osteotomy, which would have made a standard THA more challenging. At a mean 51-month followup, 18 hips had a Harris hip score greater than 80 points, all patients had an improvement in range of motion, 16 hips had increased leg length postoperatively, and only one patient had been converted to a THA. They concluded the short-term results for patients with Perthes disease receiving hip resurfacing and trochanteric advancement compared similarly with those found in the literature with standard THA.

Amstutz et al. [2] reported retrospective results on 51 patients with Crowe type I and II developmental dysplasia at an average of 6 years followup. They reported disappointing midterm results with five femoral failures requiring conversion to THA. They had no acetabular failures despite incomplete lateral acetabular coverage with porous-coated components without adjuvant fixation. They concluded rigorous patient selection is essential to minimize femoral component failures in this patient population, and the morphology and quality of the bone stock of the femoral head should be judged on a case-by-case basis before proceeding with hip resurfacing.

Amstutz et al. [9] also retrospectively reviewed 25 patients with hip resurfacing performed for advanced hip arthrosis secondary to LCP and SCFE. The mean age was 38.1 years, 20 patients were male, and the mean followup was 4.7 years. One patient in the LCP cohort required bilateral conversions to THA resulting from progressive femoral component migration. They experienced no hip dislocations, no femoral neck fractures, and only one transient femoral nerve palsy. They concluded the deformity associated with LCP (coxa plana, coxa breva, coxa vara) results in a loss of length and reduced head-neck offset, which made it difficult to restore limb length, improve biomechanics, and allow proper seating of the femoral component without damaging the femoral neck. Patients in the SCFE cohort had femoral head offset medially and posteriorly making correct femoral component placement challenging. Overall, the survivorship for both cohorts was 92% at 4.7 years. The authors acknowledge there is a high risk of notching in this patient population, and they recommend if notching is necessary, it is better to notch medially where the cortical bone is thicker [9]. These patients present with difficult pathoanatomy and special care should be used when performing hip resurfacing to avoid component malpositioning.

Osteonecrosis

Published data from several national joint registries suggest 5% to 10% of THAs are performed for advanced osteonecrosis [11, 25, 34, 71]. The use of hip resurfacing in patients with osteonecrosis remains controversial. Previous-generation hip resurfacing implants had high rates of early failure and poor results in patients with osteonecrosis [38, 45]. Recently, several authors have reported better implant survivorship using the current-generation hip resurfacing implants [4, 19, 65, 84, 86]. Mont et al. [65] published results on 42 patients with osteonecrosis treated with hip resurfacing and compared them with an age- and gender-matched control group of patients receiving hip resurfacing for osteoarthritis. Both groups had similar outcomes, survivorship, and number of patients converted to THA at a mean of 41 months.

Beaule et al. [19] compared the outcomes of 56 hips with osteonecrosis treated with metal-on-metal hybrid hip resurfacing with 28 hips treated with hemiresurfacing arthroplasty. At 55-month followup, the patients undergoing metal-on metal resurfacing had better UCLA scores and an improved physical component of the SF-12 compared with the patients undergoing hemiresurfacing. Although the patients undergoing hip resurfacing had improved results, two hips were converted to THA and five additional patients had radiographic findings indicating an increased risk for implant failure. The authors did not include data on the extent of femoral head necrosis or the quality of the prepared proximal femora.

When assessing the results between THA and hip resurfacing for osteonecrosis, it is difficult to compare results in the published literature. Most studies list the total number of patients with osteonecrosis but do not categorize patients by the percentage of femoral head involvement or the underlying etiology causing the osteonecrosis. Several recent small case series have reported improved survivorship for patients with osteonecrosis treated with THA and an advanced bearing surface [43, 54]. At this time, there are no published reports of randomized clinical trials or prospective studies comparing modern hip resurfacing implants with THA with advanced bearing surfaces and uncemented femoral stems.

The optimal hip arthroplasty implant for patients with osteonecrosis varies widely. Successful outcomes are dependent on careful patient selection, the underlying etiology, and assessment of the femoral head bone quality. Longer-term followup using a standardized patient risk classification and more rigorous scientific testing is needed to help determine which patients with osteonecrosis are best treated with hip resurfacing. Each patient should be evaluated on an individual basis and risks determined by radiographic assessment of the femoral head involvement, adequacy of the bone for supporting an implant, and risk of further collapse (eg, continued use of steroids or alcohol).

Femoroacetabular Impingement

A recent study reported approximately 57% of hips undergoing resurfacing had decreased head-neck offset (≤ 0.15) on preoperative radiographs [22]. In comparison to total hip arthroplasty, hip resurfacing preserves the femoral head-neck junction. Therefore, failure to restore adequate head-neck offset may lead to femoroacetabular impingement and pain postoperatively. Hip resurfacing patients with impingement may experience abnormal wear patterns and pain, especially with malpositioned implants [22]. Adequate removal of femoral neck osteophytes is important to restore head-neck offset, prior to femoral head preparation, to ensure accurate component sizing and positioning, which will minimize the potential for postoperative impingement [24].

Pregnancy

The use of metal-on-metal implants remains an area of concern for young female patients who have the potential to become pregnant in the future and for patients with impaired renal clearance. There is clear evidence to support the fact that metal ion levels increase, at least temporarily, in patients who have received metal-on-metal implants [28, 59–61]. It is challenging to critically assess the published results because of the variability in study protocols, methodology, and metal ion analysis [60].

Two recent studies have evaluated the potential transplacental transfer of cobalt and chromium ions in patients with metal-on-metal hip resurfacing [28, 92]. These studies analyzed the metal ion concentrations in samples taken from the mother and the umbilical cord immediately after delivery. One study evaluated three women at an average of 3.8 years from the time of hip surgery and reported low levels of chromium in all three women but were unable to detect any cobalt or chromium ions in the umbilical blood [28]. In this study, two of the babies were healthy and one had craniofacial malformations, agenesis of corpus callosum, cardiac malformations, and extremity malformations. The authors did not think the malformation was caused by the metal-on-metal articulation and they concluded the placenta prevents the passage of cobalt and chromium ions, at least at the time of delivery.

The second study was a controlled comparison of 10 women with a history of metal-on-metal hip resurfacing at a mean of 4.4 years after surgery and a comparison group of 10 women without any metallic implants [92]. Cobalt and chromium ions were detected in all the maternal and umbilical cord blood specimens in both the study and control groups. There were no congenital abnormalities in any of the babies in either group. They concluded cobalt and chromium ions can cross the placenta, but the placenta exerts a modulatory effect on the rate of metal ion transfer.

Amstutz et al. [2] reported on a series of 51 patients with developmental dysplasia of the hip treated with metal-on-metal hybrid hip resurfacing. There were four patients in this series that went on to have normal pregnancies and gave birth to a total of six healthy children after hip resurfacing.

Women of childbearing age should be informed the literature is not clear about the potential for transplacental transfer of metal ions after hip resurfacing. Although the potential adverse effects of transplacental metal ion transfer are not known, it is important to educate younger female patients and to document your discussion to avoid potential medicolegal issues in the future.

Metal Hypersensitivity

The prevalence of metal sensitivity in the general population is approximately 10% to 15% [16, 46]. This rate can increase to 25% in patients with well-functioning THAs and approximately 60% in those with poorly functioning implants [46]. Patients receiving metal-on-metal implants tend to be younger and more active, both of which increase the lifetime exposure to metal ions. Metal ions can initiate a hypersensitivity response in which a delayed cell-mediated response or a delayed-type hypersensitivity can occur through the release cytokines by T-lymphocytes and an increase in macrophage activation [46, 60]. Although many metals have the potential to initiate a hypersensitivity response, the three most common metals are nickel, cobalt, and chromium [60]. Patients with metal-on-metal hip resurfacing have increased levels of cobalt and chromium and theoretically have an increased potential to develop a hypersensitivity reaction [60].

Metal-on-metal articulations release local particulate debris and have been reported to cause wear induced osteolysis [52, 57] due to component malpositioning and metallosis. There are also reports of metal sensitivity causing unexplained pain, effusions, and rarely requiring reoperation [33, 46, 90]. Tissue specimens retrieved from around three failed hip resurfacing implants revised for unexplained pain showed extensive lymphocytic infiltration suggestive of a metal sensitivity immune response [30]. The term aseptic lymphocytic vasculitis-associated lesions (ALVAL) has been used to describe these metal sensitivity-like histologic features and there are several studies reporting similar results [31, 59, 60, 80, 90]. Our understanding of these complications and patient risk factors is continuously evolving.

Metal-on-metal bearings should likely be avoided in female patients of childbearing age who desire to get pregnant in the future, patients with known metal allergy and hypersensitivity, and patients with impaired renal function, all of which are listed as contraindications to hip resurfacing by the FDA (Table 2) [39–41].

Table 2. Food and Drug Administration* list of contraindications for hip resurfacing [39–41]

Absolute contraindications
Active or suspected infection
Skeletally immature patients
Inadequate bone stock to support the device
Severe osteoporosis
Family history of severe osteopenia or osteoporosis
Osteonecrosis of greater than 50% femoral head involvement
Multiple cysts greater than 1 cm in the femoral head
Compromised implant stability or postoperative recovery
Vascular insufficiency
Muscular atrophy
Neuromuscular disease
Females of childbearing age
Patients with known moderate or severe renal insufficiency
Patients who are severely obese
Patients with known or suspected metal sensitivity
Immunosuppressed patient (AIDS/high-dose corticosteroids)

Warnings and precautions
Patient medication or comorbidity for future renal impairment
Diagnosis other than osteoarthritis (avascular necrosis/inflammatory arthritis)
Leg-length discrepancy greater than or equal to 1 cm
Low baseline Harris hip score

* Available at the FDA website: http://www.fda.gov/cdrh/pdf5/p050016c.pdf.

Discussion

There has been a renewed interest in hip resurfacing by North American surgeons following the recent FDA approval of two devices. Most of the technical problems reported on the first-generation hip resurfacing implants have been identified and resolved. Although the early and midterm results are encouraging, hip resurfacing should be used cautiously to achieve good outcomes and minimize complications, since less is known about the long-term durability of these implants.

Total hip resurfacing can be regarded as an acceptable alternative to total hip replacement and may actually have a number of theoretical advantages, as well as a number of disadvantages. We reviewed all the published literature on hip resurfacing to determine what patient characteristics, diagnoses, and bone morphologies are important when selecting patients for hip resurfacing. We found the ideal patient for hip resurfacing is an active male, younger than 65 years old, with osteoarthritis and normal femoral and acetabular anatomy with a need or desire to return to an active lifestyle or vocation.

Well-accepted absolute contraindications to hip resurfacing include patients with inadequate bone stock to support the implant, severe osteoporosis, osteonecrosis involving more than 50% of the femoral head, multiple cysts larger than 1 cm in the femoral head, cognitive or medical impairments that would compromise component stability or rehabilitation, severe deficiency of femoral head-neck bone stock, acetabular bone deficiency, impaired renal function, women of childbearing age who desire to get pregnant in the future, and known metal hypersensitivity. Relative contraindications include the elderly, postmenopausal patients, inflammatory arthropathy, abnormal proximal femoral geometry, femoral head cysts (< 1 cm), severe dysplasia, limb-length inequality greater than 1 cm, and osteonecrosis with less than 50% involvement of the femoral head, and ongoing disease (ie, continued corticosteroids, alcohol use, chemotherapy, etc.).

Several studies [13, 24, 59] have described uncommon clinical scenarios in which hip resurfacing may have a unique advantage over standard THA. A summary of these indications includes (1) patients with proximal femoral deformity from previous disease, fracture, or surgery that makes standard femoral stem prosthesis placement difficult; (2) patients with a high risk of joint sepsis because of prior infection or immunosuppression; (3) patients with a neuromuscular disorder in which a larger diameter femoral component may reduce the dislocation risk; (4) retained hardware that would be difficult to remove before placement of a stemmed femoral component; and (5) patients with a historically high risk of implant-related failure with

THA (sickle cell disease with sclerotic femoral bone and alcoholism with a higher dislocation rate).

Many advantages of hip resurfacing are more applicable to historical data. In the Swedish registry, survivorship of young, active men with conventional THA shows poor long-term results [42, 62, 74, 76, 82]. Unfortunately, these commonly quoted data preceded the use of improved bearing surfaces such as highly crosslinked polyethylene and large-diameter femoral heads, especially metal-on-metal large heads. With the advent of improvements in THA, a high complication rate for hip resurfacing is not warranted. Careful patient selection helps minimize complications and early revisions.

This study was limited by the paucity of evidence-based studies on hip resurfacing in the literature. A substantial number of the published studies were either expert opinion or small case series without controls. The best data come from the national hip registries, but they are limited in scope and may not represent a comparable patient population. Limited information is available at this time to determine the incidence of metal hypersensitivity following hip resurfacing and whether there is a potential for this to increase with longer followup. The topic of metal-on-metal implants in women of childbearing age remains a challenge despite having several small case series indicating limited transplacental transfer of metal ions. Lastly, the use of hip resurfacing for selective male patients older than 65 years with adequate bone stock and active lifestyles remains controversial despite data from the Australian hip registry indicating higher failure rates with age.

In summary, the purpose of this review was to take a critical look at the current literature to determine what selection criteria were predictive of successful results and, conversely, what patient factors correlated with early failure. Although the current literature on hip resurfacing is limited in quality, with no Level I studies available, current-generation hip resurfacing has been widely performed for over 10 years. The Australian registry represents the most helpful database relating to patient selection. The data indicate age and gender predict risk of revision at 2 and 5 years. Expert opinion and observational studies support consideration of renal function, childbearing status, metal sensitivity, bone quality, and deformity among other factors to consider when contemplating hip resurfacing. As this procedure becomes more popular, there is an increasing need for independent high-quality research in the orthopaedic literature to assess complications and survivorship of these implants.

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