Cost-Effectiveness of Hip Resurfacing in Younger Adults in the United States

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Summary

Advanced degenerative hip disease is associated with deterioration of cartilage and underlying bone that supports weight-bearing joints. It can cause prolonged pain and significantly reduced mobility. Sufferers may be unable to work or to maintain normal functioning. The primary cause of degenerative hip disease is osteoarthritis (OA). Almost 27 million adults in the United States have symptomatic osteoarthritis, of whom between 9.5 million and 10.2 million have OA of the hip.[1] In 2005 there were 738,000 hospital discharges with a principal diagnosis of OA.[2]

CONSERVATIVE (NON-SURGICAL) TREATMENT involves use of analgesics or anti-inflammatory medication, activity modification, weight loss and/or physiotherapy. Inherent complications associated with analgesics and anti-inflammatory drugs include dyspepsia, ulceration, and gastrointestinal bleeding. There is evidence that prolonged use of anti-inflammatory medication may lead to bone destruction of the arthritic hip which makes subsequent surgery difficult.[3-5]

Patients are usually referred for surgery when symptoms become severe and unmanageable with conservative approaches. The normal surgical choice is primary total hip replacement (THR). In 2005 there were more than 237,000 primary THR procedures in the United States (800 per 100,000 population). The majority of replacements were in patients aged 65 and above (56 percent), and the mean age for a primary THR in 2005 was 65.6 years.[6]

Total hip replacement involves removal of the femoral head and neck, revision of the diseased acetabulum and implantation of a prosthesis with a stemmed femoral component and press-fit acetabular cup. Metal-on-metal THR is a reliable surgical intervention with high success rates and proven joint survivorship beyond 10 years. However THR may be associated with bone loss or weakening of the existing bone and the subsequent risk of device dislocation and loosening contribute to the risk of implant failure. Revision risk is relatively high in young, active adults. THR revision rates in younger patients are between 25 and 30 percent after 15 years and this compares with rates typically less than 10 percent in adults aged 60 years or more at first operation.[7-9] Because the initial procedure involves implantation of a stemmed femoral prosthesis, a revision procedure is more complex than primary THR, involving longer length of stay, higher rates of perioperative complications, and possibly also poorer prognosis. For these reasons, patients who are likely to outlive the life of a standard prosthesis are often recommended to postpone surgery and rely instead on conservative treatment.

Hip resurfacing (HR) involves removal and replacement of the surface of the femoral head with a hollow metal hemisphere which fits into a metal acetabular cup. The technique conserves the native femoral bone and maintains normal loading and stress by eliminating the conventional long stem on a femoral prosthesis. For this reason, revision surgery is easier to perform and is likely to produce better outcomes than revision of THR. Metal-on-metal resurfacing devices are not subject to loosening due to polythene degradation and as such are less likely to fail for this reason. Hip resurfacing has been performed in the UK since 1997 and UK Registry data suggest revision rates of less than 10 percent at eight years in patients aged 50 or younger.[10]

Primary hip resurfacing offers an opportunity for younger patients to achieve the same improvement in quality of life as total hip replacement but without the additional risk and expense of gastrointestinal complications while awaiting surgery.

The aim of this analysis is to assess the utility benefits to patients and the cost implications to a private

Exhibit 1: Conservative Treatment: Annual Expected Costs Per Patient

Routine treatment		Cost per patient/year
Physician office visits		$151-$223
Lab tests		$35-$70
Medication		$1,388-$1,735
Sub-total		$1,574-$2,028
Treatment complications	Cost per episode	Cost per patient/year*
Gastroenterologist office visits	$143-$210	$29-$42
Diagnostic tests	$317-$468	$63-$94
Medication	$1,421-$1,777	$284-$355
Hospitalization**	$225-$270	$45-$54
Sub-total		$421-$545
TOTAL annual cost		$1,995-$2,573

* 20% of patients annually ** 7.5% of patients with complications

insurance payer or managed care organisation in the United States of early hip resurfacing compared with a period of conservative treatment followed by total hip replacement at a later age.

Economic Analysis

We conducted an economic analysis from the perspective of a private insurance payer in the United States. We estimated the net present value of direct costs and patient utilities from first intervention to end-of-life. Life expectancy was derived from U.S. Life Tables[11] and is dependent on the age of the patient at first operation. Payer costs (including the costs of treatment-related complications and revision surgery) were estimated from clinical pathways and associated fee codes used to bill for services. Costs were derived from Medicare 2006 fee schedules and prospectively set rates (private payer costs are assumed to range between 85 and 125 percent of the national average Medicare rate). Patient outcomes were measured by utility scores assigned to pain-related health states.

Two treatment alternatives were considered for patients aged 45 to 49, 50 to 54, and 55 to 59, presenting with moderate-severe symptoms of degenerative hip disease: (a) conservative treatment with analgesics and anti-inflammatory medication for (up to) five years followed by primary total hip replacement, or (b) immediate hip resurfacing. Within each age group, life expectancy was assigned assuming the patient was at the mid-point in each age range (ages 47, 52 and 57).

Treatment Costs

Conservative Treatment

Conservative treatment includes any non-surgical approach to managing pain resulting from degenerative hip disease. In our analysis we have only included the costs of prescription drug therapy. Information on clinical pathways and resource use was obtained from interviews with three orthopaedic surgeons in the United States and surveys of five U.S. gastroenterologists. Costs were assigned to resources on the basis of Common Procedural Terminology (CPT) codes for physician office visits and laboratory tests, and on average wholesale prices for drugs. Information on representative managed care rates were obtained from interviews with three managed care medical directors in different areas of the United States.

Patients present initially to a primary care physician and are managed either by a physician, rheumatologist or orthopaedic surgeon. Costs associated with conservative treatment are summarised in Exhibit 1.

All patients have an initial physician visit and laboratory tests (such as blood count, urea nitrogen, creatine, liver function). Further physician visits and laboratory tests occur every six months until the treatment is changed. For the first six months following the start of conservative treatment, patients are assumed to take over-the-counter analgesics only (these costs are not included in the model). In the subsequent period, patients are prescribed non-steroidal anti-inflammatory drugs (NSAIDs) or Cox-2s. Medication costs are a weighted average of the costs of typical drugs (Naprosin, Voltaren XR, Celebrex and Mobic).

Common complications associated with drug therapy are abdominal pain, dyspepsia, peptic ulcer disease, and gastrointestinal bleeding. Approximately 20 percent of patients per year will develop a serious complication (peptic ulcer or GI bleed).[12] Costs

include an initial gastroenterologist office visit and diagnostic tests (including colonoscopy, endoscopy, barium swallow, or H.pylori test). Patients receiving on-going treatment have a total of four office consults per year, but no further testing. Medication costs are a weighted average of the costs of five common drug treatments (Nexium, Prevacid, Protonic, Prilosec, and Zantac). A small proportion of patients (7.5 percent) may require hospitalization because of complications. The average inpatient stay for these patients is three to four days.

Surgery

Surgical options are hip resurfacing and total hip replacement. Information on clinical pathways and resource use for both surgical options was obtained from interviews with three orthopaedic surgeons. In addition, private managed care rates were estimated from interviews with three managed care medical directors in different parts of the United States (Exhibit 2). Because U.S. surgeons had limited experience of hip resurfacing at the date of the interviews (April-May 2005), we interviewed two Canadian surgeons with extensive resurfacing experience, and one U.S. surgeon who had participated in previous resurfacing trials. Costs were assigned on the basis of relevant payment codes [such as CPT or Ambulatory Payment Classification (APC) codes].

Patients referred to an orthopaedic surgeon have an initial assessment to determine suitability for surgery. This assessment involves a physician office visit including X-rays of the symptomatic hip. Female patients being considered for HR have a bone density scan. Following an initial assessment, the patient is referred to an internist for an assessment of fitness for surgery that includes a number of tests (e.g. chest X-ray, blood count, comprehensive metabolic panel, electrocardiogram, urinanalysis, creatine, urea nitrogen).

Primary surgery includes the cost of physician time, hospital cost, and the cost of the prosthesis. Hospital cost is estimated on the basis of expected length of stay assuming a surgical per diem of $1,000 to $1,200. The average length of stay for primary procedures is assumed to be three days [which is the median length of stay for Common Classifications Software (CCS) code 153 Hip replacement, total and partial, U.S. national data, 2004, private payers].[13] For costing purposes, the length of stay is assumed to be the same for both procedures. The costs of HR and THR prostheses are average selling prices in the United States at May 2007.

Patients see the physician at four to six weeks post-operatively and at three months and one year. Costs include office visit and X-rays. Follow-up costs also include a 30-day course of pain medication and a three-week course of low dose Coumadin to prevent blood clots. Most patients require crutches or other assistive device for up to six weeks. All patients are assumed to have physical therapy on average twice weekly for two to three weeks.

The most common short-term complications following surgery are deep infection, dislocation, and deep vein thrombosis. Deep infection is assumed to affect 1 percent of patients in the first year following surgery. Costs of deep infection include the cost of incision and drainage, hospitalisation for 6.5 days (based on mean length of stay for CCS 238 - Osteomyelitis, U.S. national data, 2004, private payers)[13] and the balance of six weeks IV antibiotics

Exhibit 2: Surgical Treatment: Costs Per Patient

	Hip resurfacing	Hip replacement
Pre-operative assessment	$732-$1,255	$814-$1,711
Primary procedure (ex implant)	$4,324-$5,547	$4,324-$5,547
Implant	$9,484	$5,560
Follow-up care (1 year)	$397-$538	$416-$557
TOTAL cost (primary procedure)	$14,937-$16,824	$11,114-$13,375
Complications		
Deep infection	$10,044-$11,894	$10,044-$11,894
Dislocation	$580-$856	$580-$856
Thromboembolism	$458-$533	$458-$533
Revision procedure (ex implant)	$4,324-$5,547	$5,324-$6,747
Implant	$7,887	$7,887

Exhibit 3: Implant Survival by Age at Operation [10,15]

Total Hip Replacement		
Age at operation	Implant survival at 13-years follow-up	Sample size
< 50	72.1%	
50-59	81.6%	
60-75	90.1%	
>75	95.2%	
		N = 141,679
Hip Resurfacing (BHR)*		
Age at operation	Implant survival at 8-years follow-up	Sample size
< 40	94.3%	
40-49	97.8%	
50-54	97.0%	
55-59	95.7%	
60-69	97.4%	
70+	94.8%	
		N = 4,691

* Birmingham Hip Resurfacing (BHR)

administered at home. Dislocation is rare (0.1 percent in the first year after surgery) and is treated by closed reduction carried out in an outpatient setting. Thromboembolism affects 3.1 percent of patients in the first year after surgery.[14] Suspected thromboembolism requires Duplex scan and treatment with Lovenox. During therapy patients have a weekly platelet count.

The costs of pre-operative assessment, follow-up, and operative complications for revision surgery are the same as the costs of a primary procedure. The main difference is that a THR revision is a longer and more complex procedure than either a primary total hip replacement, or than a revision of a primary resurfacing procedure. A resurfacing revision is assumed to have the same length of stay as primary THR (median length of stay three days) and the same average implant cost as a revision THR ($7,887). The median length of stay for a THR revision is four days (median length of stay for ICD-9-CM 81.53 "revise hip replacement" 2004, private insurance payers)[13] and the average cost of a revision implant is $7,887.

Probability of Revision

The annual probability of revision was derived separately for THR and HR from implant survival data reported in the Swedish National Hip Arthroplasty Register[15] (THR) and a register of resurfacing procedures maintained by the Oswestry Outcome Centre[10] (HR). These sources provide the longest available follow-up data on hip procedures. The Swedish Register reports survival rates after 13 years by age at operation for 141,679 patients operated on since 1992. The Oswestry Outcome Centre was established to maintain an independent register of Birmingham Hip Resurfacing (BHR) procedures carried out since 1997. Survival information is available after eight years by age at operation for a total of 4,691 patients. We have used information on BHR because this is the most comprehensive register series available on hip resurfacing.

Probabilities of revision were estimated from survival data assuming constant annual revision rates. For years beyond the eight-year follow-up available for BHR, annual revision rates were assumed to be the same as for THR.

Patient Utility

We measured patient outcomes by assigning utility scores to pain-related health states ("no pain," "mild pain," "moderate pain") to derive a measure of quality-adjusted life years (QALYs). Average levels of pain for patients with degenerative hip disease following conservative treatment, hip resurfacing and total hip replacement[16-18] were combined with patient-derived utility scores for each of these different pain states[19] (Exhibit 4). The utility assigned to mild pain, for example, is 0.69. Thus, one year with mild pain is equal to 0.69 quality-adjusted life years (QALYs), or the equivalent of 0.69 years in a hypothetical perfect health state with utility value = 1. Patients requiring revision are assumed to be in the "pre-surgery" health state (utility = 0.29) for the year preceding revision.

Results

In this analysis patients are either managed with analgesics and anti-inflammatory medication for a period of up to five years followed by primary total hip replacement, or have an immediate hip resurfacing procedure. For each of the age groups considered (45 to 49, 50 to 54 and 55 to 59), immediate resurfacing is the dominant option – expected costs to the private insurance payer are lower and patient utility is higher (Exhibit 5).

For example in the age group 45 to 49, a 47-year-old patient is managed conservatively until primary THR at age 52. Costs and outcomes are estimated to 65 and over the remaining lifetime of the patient (at 47, average life expectancy in the United States is 33 additional years). Expected cost to age 65 is lower with resurfacing by $4,233 per patient ($23,453 - $19,220), and expected utility is higher by 1.48

quality-adjusted life years (15.56 - 14.08) (Exhibit 5). The expected cost over the remaining lifetime of the patient is lower with resurfacing by $3,384 ($27,071 - $23,687) and expected utility is higher by 1.57 quality-adjusted life years (26.97 - 25.40).

Patient utility is higher with immediate resurfacing for two reasons: Surgical intervention is expected to improve hip pain (and function) by more than long-term drug therapy in patients with severe symptoms. Surgery is expected to leave 85 to 90 percent of patients pain-free, whereas with drug treatment most patients continue to experience mild or moderate pain (Exhibit 4). Early surgical intervention improves utility directly by increasing the number of years free of pain.

The cost difference between early resurfacing and conservative treatment is the difference in the cost of a primary HR and the cost of a primary THR, less the annual costs of drug treatment. The additional cost of HR compared with THR in the first year following surgery is between $3,400 and $3,800 and this is almost entirely due to the additional cost of the HR prosthesis (Exhibit 2). Offset against this is the saving in the cost of drug treatment of between $1,995 and $2,573 per year (Exhibit 1). Thus, the net additional cost of HR in the year of surgery is between $1,405 and $1,805. In each subsequent year, the cost of early surgery is lower than the cost of conservative treatment.

For all of the age groups considered, expected costs are lower with resurfacing and the improvement in patient quality of life is higher. Treatment costs per patient are lower for older patients for both treatment options simply because the number of years of treatment is fewer. Patient utility is lower for older patients for the same reason.

Sensitivity Analysis

The cost difference between early resurfacing and drug treatment followed by THR also is dependent on the probability of revision surgery following HR or THR. The baseline analysis uses revision rates based on observed THR and HR survival from long-term patient registries. For patients 45 to 59, survival is better with resurfacing, and long-term revision costs are therefore lower. If the revision rates were the same for both procedures as for THR, the cost of resurfacing would increase. However, this would not change the conclusions of the analysis.

For a 47-year-old patient, for example, expected cost to age 65 with resurfacing would be $19,655 (compared with $19,220 with observed revision rates), and cost over the remaining lifetime of the patient would be $25,718 (compared with $23,687). In both cases, the cost of resurfacing is still less than the cost of conservative treatment. Immediate resurfacing remains the dominant option for all of the age groups considered, although for a patient 55 to 59, lifetime costs for the two options are approximately equal. For a 57-year-old patient, expected cost of resurfacing to age 65 would be $18,059 assuming survival is the same as for THR, compared with $20,476 for conservative treatment. Over the remaining lifetime of the patient, the cost of resurfacing would be $22,846, compared with $22,889 for conservative treatment.

Results will be sensitive to the cost of drug treatment (physician office visits, lab tests, medications and the expected cost of treatment-related complications). The expected cost of drug therapy is between $1,995 and $2,573 per patient per year (Exhibit 1), between $9,975 and $12,865 for five years. The additional cost of a conservative strategy (drug treatment followed by THR) compared with immediate resurfacing is approximately $4,200 to age 65 and $3,300 over the remaining lifetime of the patient. Thus the cost of drug treatment would need to be between 26 percent and 42 percent of the current estimate to offset the projected cost difference in favour of resurfacing.

It is usual in economic evaluation to discount future costs and (in some circumstances) patient utility as well. Costs and utility were discounted at 4 percent, which is the mid-point of the range (3 percent to 5 percent) suggested in Academy of Managed Care Pharmacy (AMCP) guidelines.[20] Discounting reduces the present value of costs and outcomes for both of the treatment alternatives, but does not change the conclusions of the analysis. For all of the ages considered, immediate resurfacing remains the dominant option.

Exhibit 4: Health-State Utility [16-19]

Pain state	Utility score	Patients in each health state following intervention		
		Conservative	Resurfacing	Replacement
No pain	0.84	-	91%	84%
Mild pain	0.69	55%	9%	16%
Moderate pain	0.38	45%	-	-
Pre-surgery	0.29	-	-	-

For a 47-year-old patient, the discounted present value of costs to age 65 is lower with resurfacing by $1,945 (compared with $4,233 undiscounted). The benefit in patient utility also is slightly lower (1.38 QALY, compared with 1.49 undiscounted). Including all costs incurred over the remaining lifetime of the patient, the discounted present value of costs is lower with resurfacing by $1,585 (compared with $3,384 undiscounted). The reason the difference in discounted costs is less is that relative to immediate resurfacing, drug treatment followed by total hip replacement involves lower costs in the first one to two years and higher costs in the future. Discounting reduces the impact of cost differences that occur further in the future. The discount rate would need to be more than 10 percent before the cost of immediate resurfacing exceeded the cost of the conservative alternative.

Discussion

Total hip replacement is recognised as an effective intervention for patients with degenerative hip disease. However, the treatment of younger patients presents a challenge. In young, active adults, the risk of implant failure following primary THR is high and revision surgery is likely to be complex, involving longer length of stay, higher risk of complications and poorer patient outcomes. As a result, patients who are likely to outlive a conventional total hip replacement are often advised to postpone surgery. Hip resurfacing may provide a means for these patients to achieve the same improvement in quality of life as THR, but because the procedure conserves the native femoral bone, subsequent revision surgery is easier to perform and is likely to produce better outcomes.

Published evidence suggests significant functional and symptomatic improvements with HR that are comparable to the results obtained with the current generation of THR prostheses. A recent evidence review[21] identified one randomized controlled trial comparing HR with THR and 13 published uncontrolled studies of HR. The randomized controlled trial[22] compared clinical outcomes for patients randomized to receive metal-on-metal hip resurfacing (107 hips) and metal-on-metal hip replacement

Exhibit 5: Conservative Treatment for 5 Years Followed by Hip Replacement (THR), Compared with Immediate Hip Resurfacing (HR)

	To age 65	Patient Lifetime
Age 45-49 (life expectancy 33 years)		
Conservative treatment for 5 years followed by THR		
Cost per patient	$23,453	$27,071
QALY per patient	14.08	25.40
Immediate HR		
Cost per patient	$19,220	$23,687
QALY per patient	15.56	26.97
Age 50-54 (life expectancy 29 years)		
Conservative treatment for 5 years followed by THR		
Cost per patient	$22,160	$26,037
QALY per patient	10.03	22.16
Immediate HR		
Cost per patient	$17,144	$20,443
QALY per patient	11.51	23.79
Age 55-59(life expectancy 24 years)		
Conservative treatment for 5 years followed by THR		
Cost per patient	$20,476	$22,889
QALY per patient	6.00	18.18
Immediate HR		
Cost per patient	$16,216	$19,513
QALY per patient	7.41	19.69

(103 hips) in the period 2003 to 2006. The authors conclude that at a follow-up period of one year, hip resurfacing and conventional hip replacement provided similar improvements in quality of life, but resurfacing arthroplasty may offer better functional performance in activity level and capacity to return to work. This study also reported longer procedure time (101 minutes vs. 85 minutes) and shorter length of stay (5.0 days vs. 6.1 days) for the resurfacing group. Results from the uncontrolled studies of HR consistently show symptomatic and functional improvements from baseline at two-to-three-years follow-up. Initial results from a prospective Canadian study comparing THR and HR in patients under 56 found no significant difference in WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) at three months post-operatively (16.38 HR vs. 16.79 THR, $p=0.834$), and no significant difference in operating room time (130 minutes HR vs. 129.6 minutes THR). A significant difference was observed in length of stay (4.10 days HR vs. 4.74 days THR).[21]

Based on this analysis of patient utility and the cost implications to a private payer in the United States, for patients 45 to 59 hip resurfacing is less costly and produces better patient outcomes than a period of conservative treatment followed by THR. Quality of life is higher because surgical intervention (either THR or HR) is expected to improve symptoms and function by more than drug treatment, and hip resurfacing makes it possible to intervene earlier without the risk of complex revision surgery. Costs are lower to 65, and over the remaining lifetime of the patient, because the additional cost of the HR procedure over a conventional THR (between $3,400 and $3,800) is offset within two years by the saving in the cost of drug treatment (between $1,995 and $2,573 per year). Additional cost savings arise in future years because HR revision rates are lower than revision rates for primary THR in patients of the same age.

Our results are supported by an economic analysis carried out using UK costs which concluded that metal-on-metal hip resurfacing dominated a "watchful waiting" alternative over a period of 20 years from first operation.[23] Watchful waiting involved NSAIDs and other non-surgical approaches to pain management, followed by THR when symptoms deteriorate. The annual probability of surgery in this analysis was 8.33 percent. After 20 years, the expected cost per patient with immediate resurfacing was lower by around 3 percent, but the gain in quality of life with HR was 3.73 QALYs, a substantial (30 percent) improvement on a baseline of 12.46 QALYs achieved with watchful waiting. The Alberta (Canada) Hip Improvement Project compared costs and patient utility pre- and post-surgery for patients less than 56 receiving metal-on-metal resurfacing, ceramic-on-ceramic (COC) THR, and other THR devices. Utility gains (QALYs) following surgery were 2.41 (HR), 2.07 (COC), and 2.02 (other THR). Average costs (in Canadian dollars) were $11,661 (HR), $10,929 (COC), and $11,226 (other THR). Incremental cost per QALY was lowest for hip resurfacing ($4,827).[21]

Our conclusions are not sensitive to the assumption that revision rates are lower with HR for patients under 60. If revision rates for HR and THR were the same, the cost of HR would be higher but would not exceed the costs of THR. Resurfacing would become a more expensive option if the costs of conservative treatment were lower by between 26 percent and 42 percent, but resurfacing continues to provide a greater gain in patient utility. Discounting reduces the present value of costs and utilities for both treatment options, but is unlikely to overturn the dominance of resurfacing at discount rates less than 10 percent. In some respects our analysis is conservative. For example, we have assumed that length of stay is the same for primary resurfacing as for primary total hip replacement. There is evidence that length of stay for HR may be shorter than for THR in patients of comparable age.[21,22] Similarly, the cost of a revision procedure is assumed to be lower for a resurfacing revision by $1,000 (approximately one day shorter length of stay). In practice, the cost difference may be greater because the implant required for a HR revision is likely to cost less than a conventional THR revision implant.

Conclusion

Compared with non-surgical methods of pain management, primary hip resurfacing offers significant improvement in patient quality of life, which is comparable to the improvement achieved with primary total hip replacement. For patients who are at increased risk of THR failure, resurfacing is both less costly and more effective than a conservative approach involving drug treatment followed by total hip replacement at a later date. Typically, these patients are likely to be younger, active, and in good health, with men being at greater risk than women. **JMCM**

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Acknowledgements
We are grateful to Mary Kelly and Dr. Skip Whitman for their significant help with this work.

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