Metal on metal hip resurfacing arthroplasty. An economic analysis

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Metal on metal hip resurfacing arthroplasty

An economic analysis

Abstract

This paper explores the cost utility of metal-on-metal hip resurfacing arthroplasty (MOM) as an alternative intervention to total hip replacement or 'watchful waiting' for patients with advanced hip disease. Early implant failure among younger and more active elderly patients can mean that the use of total hip replacement (THR) is delayed, with patients managed through 'watchful waiting', a combination of pain control and other non-surgical interventions. Information on costs is combined with evidence on effectiveness from a systematic review in a Markov model in order to estimate the incremental cost per quality adjusted life year (QALY) of MOM relative to THR and 'watchful waiting'.

Keywords

Economic evaluation · Hip arthroplasty · Markov modelling · Systematic review

Although the conventional method used to treat advanced hip disease in the United Kingdom is total hip replacement (THR), the evidence suggests that younger patients and those with a more active life-style experience relatively high rates of early THR implant failure with the need for revision. Persons who are expected to outlive a primary THR are typically referred for surgery when their symptoms (e.g. pain, loss of physical function) become unmanageable by non-surgical means. Prior to deterioration that justifies surgery these persons are managed by 'watchful waiting' accompanied by painkilling medication and physiotherapy. However, an alternative intervention, metal-on-metal hip resurfacing arthroplasty (MOM), has recently been developed. MOM conserves femoral bone and is recommended as one option for treating younger or more active patients who may be considered ineligible for THR. MOM might offer these patients an earlier improvement in their quality of life, through increased levels of activity and reduced pain levels, than would have been achieved if surgical treatment were delayed due to the problems associated with THR.

This study estimated the cost per quality-adjusted life year (QALY) of MOM for treatment of hip disease relative to 'watchful waiting' and THR over a 20-year follow-up period. The focus of the analysis is on two groups of persons who would be likely to outlive the life of a total hip replacement: those aged less than 65 years, and those aged 65 or over who participate in activities predicted to shorten the life of a total hip replacement and therefore would outlive the life of a THR. The evaluation is based on a Markov model populated with the data obtained from a systematic review of the evidence.

Background

In 1999-2000 in the National Health Service in England there were 46,608 operations coded as total prosthetic replacement of the hip joint (W37–W39). Eighteen percent of these operations were performed on persons aged between 15 and 59 years; 46% on persons aged 60–74, and 36% on persons aged 75 or over [7]. Data on revisions of THRs as a percentage of the total number of THR procedures suggest that in 1998-1999 over 10% of all THRs were carried out as revisions [26]. The number of persons who have their symptoms managed by pain control and other non-surgical interventions (such as the use of transcutaneous electrical nerve therapy and strengthening exercises) within England and Wales is difficult to ascertain. The evidence suggests that 15.2 individuals per 1000 aged 35–85 years from a population survey had hip disease severe enough for surgery [8].

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Description of interventions

Total hip replacement

THR aims at re-establishing functional joint movements and relieving pain in affected hip joints. To reach this goal the damaged hip joint is replaced with an artificial prosthesis composed of two or three different components [9]:

- The 'head', a metal ball (stainless steel or cobalt chrome) that replaces the original femoral head (some prostheses, for example, the standard Charnley, come as a monobloc as the head is attached to the stem)
- The 'femoral component', a metal stem placed into the femur
- The 'acetabular component', a plastic cup (high-density polyethylene) implanted into the acetabulum

With constant use small fragments of components, wear debris, can accumulate in the hip joint. Wear debris is responsible for causing bone destruction (i.e. osteolysis) that in turn causes loosening of the hip replacement. To overcome this problem attempts have been made to manufacture prosthesis components using materials to reduce wear of the femoral head such as ceramic, titanium, and MOM bearing combinations. A THR operation lasts 2–3 h [9]. Full recovery occurs within 3–6 months, depending on the type of surgery and the general health of patients.

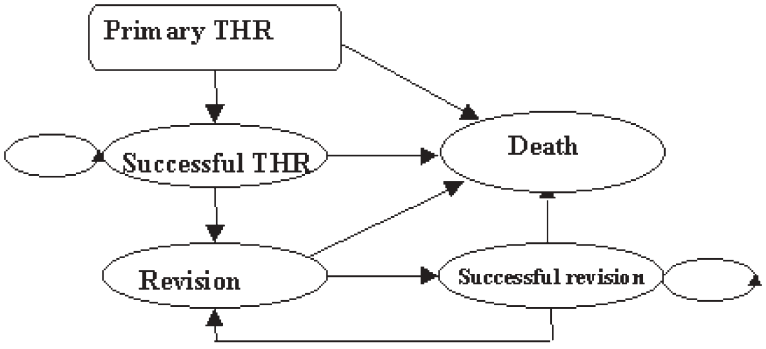
Young, more active patients who receive a THR may require revision surgery at a higher rate than those who are older or less active [11]. Revision surgery is more problematic, expensive and difficult to perform than primary replacements, and outcomes, such as pain and mobility, are usually less satisfactory.

MOM

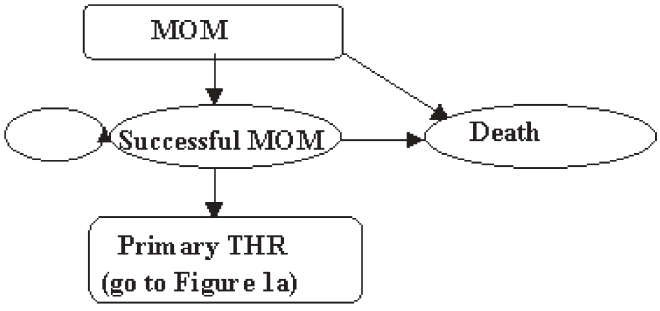
Hip resurfacing involves the removal of the diseased and damaged surfaces of the proximal femur and the acetabulum. The prepared femoral head is then covered, and the acetabulum is lined with a pair of metal bearings, which provide an articulating surface that allows mobility of the hip joint. The technique maintains normal femoral loading and stresses and claims to conserve femoral bone [14]. As the bone may be conserved, the joint might be revised subsequently, if necessary, using a primary hip prosthesis together with a large diameter modular head, effectively allowing use of a primary prosthesis in a first revision procedure and hence 'buying time' for the patient. MOM hip resurfacing prostheses were originally re-designed from older metal on polyethylene implants. The resurfacing devices currently used are the Cormet 2000 (Corin Medical), the Birmingham Hip (Midland Medical Technologies), Conserve Plus (Wright Medical, Tennessee) and Wagner Resurfacing (Sulzer).

The two major causes of primary hip failure in conventional THR are component loosening caused by ultra-high molecular weight polyethylene wear induced osteolysis and dislocation of the

a) Markov model for an individual receiving a THR as their initial replacement procedure



b) Markov model for an individual receiving a metal on metal hip resurfacing arthroplasty as the initial replacement procedure



c) Markov model for an individual receiving 'watchful waiting'

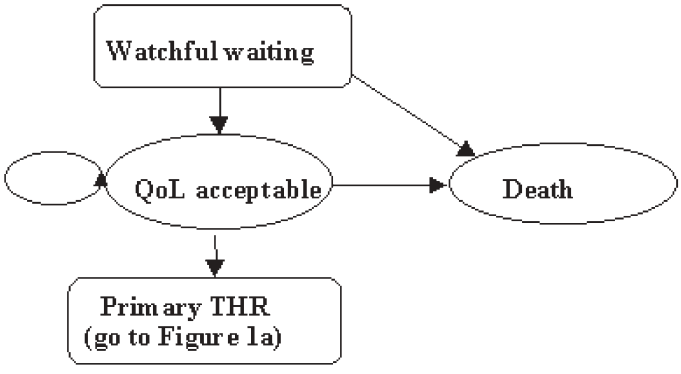


Fig. 1 ▲ **Markov models for each treatment alternative.** a **Markov model for an individual receiving a THR as their initial replacement procedure.** b **Markov model for an individual receiving a metal on metal hip resurfacing arthroplasty as the initial replacement procedure.** c **Markov model for an individual receiving 'watchful waiting'**

femoral head from the acetabular component. MOM articulations may be less prone to loosening than combined polyethylene/metal articulations (i.e. polyethylene acetabulum with metal femoral head). The larger diameter of bearing surface than with conventional THR enhances joint stability and is claimed to reduce the risk of dislocation [3]. MOM may also allow higher levels of post-surgery activity than a conventional stem-type device. This increased stability may be particularly conducive for sports and work activities when a more normal range of motion of the hip is required.

'Watchful waiting'

'Watchful waiting' involves patient monitoring, drug-based treatments and other supportive activities such as physiotherapy. The objective of 'watchful waiting' is to delay or prevent the need for subsequent surgical intervention. Patients often have adverse side effects to the drugs used, especially if they require a high dose over a long period of time. The main drugs administered are analgesics and anti-inflammatory agents. Their inherent complications include dyspepsia, ulceration and gastrointestinal bleeding. Other rare but possible effects include hypertension, congestive heart failure and renal damage. There is evidence that prolonged use of some anti-inflammatory medication results in bone destruction of the arthritic hip [17, 19, 21]. Reduced bone integrity may occur and can make future surgery difficult. Another complication with patients taking anti-inflammatory medication is that they tend to bleed excessively from their wounds at hip replacement. This excessive bleeding and haematoma formation may increase the risk of deep infection [13].

Methods

Model Structure

A Markov model was used to estimate a typical patient's costs and outcomes for the treatment alternatives for 20 cycles, with each cycle lasting 1 year. The Markov models for THR, MOM and 'watchful waiting' are illustrated in Fig. 1. The model for MOM assumes that an initial decision to use MOM is ultimately followed by a decision to use THR unless death occurs before the need for other treatment. Insufficient data were available to consider modelling a decision to have a revision MOM resurfacing operation, although such an occurrence is a clinical possibility that may merit future study. The THR model assumes that the initial decision to use THR is followed by a decision to use revision THR unless death occurs first. The model for the 'watchful waiting' alternative assumed that an initial decision to use 'watchful waiting' is ultimately followed by a decision to use THR unless death occurs beforehand. Once THR is used following MOM or 'watchful waiting', the Markov model is identical in structure to the primary THR model, though once again the probabilities, quality of life, and calculated total cost vary where appropriate and data allow. Models for each treatment alternative were developed and applied using DATA software [23].

Analysis

Separate models were estimated for younger persons (e.g. aged 45–50 on entry) and more active elderly persons (e.g. aged 65–70 on entry). The costs, probabilities, and outcome estimates (e.g. length or quality of life within a state) that were incorporated into the estimation of the models are described below.

Costs

Total procedure costs included operation costs, hospital ward costs, and follow-up costs (discounted at 6%), thereby taking a health service perspective, focussed on direct medical costs.

THR

Table 1 shows the estimated costs for THR, revision THR and MOM. The costs of THR and revision of THR were taken from a previous study [7] updated to 2000 prices using the NHS price index [16]. Based on clinical opinion, the length of stay for THR patients used in the previous study was reduced from 12 to 10 days [7]. Costs also included follow-up costs incurred during the first year after discharge based on two outpatient visits, one of which would have included radiography. The costs for pri-

Table 1
Estimated costs (in 2000 UK pounds sterling) for THR and metal-on-metal (*MOM*) procedures; based on published cost estimates, inflated using the NHS price index from 1996 to 2000 [7] (*MMT* Midland Medical Technologies)

	Primary THR		Revision THR		MOM hip resurfacing arthroplasty	
	Units	Cost	Units	Cost	Units	Cost
Theatre overhead (based on time: min)	134	731.4	195	1,065.3	134	731.4
Theatre staff						
Surgeon	–	73.7	–	108.3	–	73.7
Anaesthetist	–	73.7	–	108.3	–	73.7
Registrar	–	34.6	–	50.2	–	34.6
Nurse F	–	26.8	–	39.1	–	26.8
Nurse F	–	26.8	–	39.1	–	26.8
Nurse E	–	23.4	–	33.5	–	23.4
Number of X-rays	6	149.6	6	149.6	6	149.6
Length of stay (days)	10	2,244.5	14	3,142.3	10	2,693.4
Out-patient visits	3	281.4	3	281.4	3	281.4
Prosthesis cost						
Charnley	1	341.7	1	754.9	–	n/a
Cement	2	68.1	4	136.2	–	n/a
MMT prosthesis						1,730
Total cost per patient	–	4,075.8	–	5,908.2	–	5,396.0
1st year follow-up	–	118.7	–	118.7	–	118.7
Total cost per patient	–	4,194.5	–	6,027.0	–	5,515.0

mary and revision total hip replacement were estimated at £4,076 and £5,908, respectively, with follow-up costs in the year after the operation of £119.

MOM

The cost of the prosthesis used in MOM was obtained by contacting relevant manufacturers. Through discussions with local clinical experts it was felt reasonable to assume that the same theatre time and theatre staff and follow-up used for a primary THR would be required. Length of stay following MOM was assumed to be 10 days. Using the industry estimate of £1,730 for the cost of a prosthesis, the total cost for a MOM procedure was estimated at £5,396 with follow-up costs the year after the operation of £119.

'Watchful waiting'

The costs of care for patients with hip disease in 'watchful waiting' were based on estimated physiotherapy requirements, general practitioner visits and pain-killing medication during the course of a year. Information on the nature and amounts of this health care was obtained through discussions with local medical staff. Patients taking long-term courses of pain killing medication are prone to side effects of medications which may be of varying degrees of severity. The costs of these possible side effects were added to the total estimated cost per patient in the 'watchful waiting' option. These costs are shown in Table 2. The annual cost for a patient in the 'watchful waiting' treatment scenario was estimated at £642. This estimate was derived by adding the estimated cost of physiotherapy, general practitioner visits and medication to an estimate of the 'overall average cost' for the cost of treating these side effects of £238.

Event probabilities

The event probabilities for the model were mortality rates, complication rates, and revision rates (e.g. the annual probability that following initial use of a treatment alternative a revision to a second procedure is necessary). A structured literature search was conducted to identify evidence relating to the clinical effectiveness of the three interventions for treatment of hip disease [24]. This included an electronic search of databases and websites. The objective of the search strategies was to identify any randomised or comparative observational studies or systematic reviews comparing MOM with THR or 'watchful waiting'.

The models used annual rates of mortality in 5-year bands over the 20-

Table 2
Estimated cost per patient (in 2000 UK pounds sterling) in 'watchful waiting' for a person with moderate osteoarthritis (*MMT* Midland Medical Technologies, *BNF* British National Formulary)

Area of resource use	Quantity of resource use	Unit cost	Annual cost per patient	Source
Physiotherapy sessions outpatients	8 sessions per annum	37	296	PSSRU [16]
Physiotherapy in the community	3 sessions per annum	16	48	PSSRU [16]
Ibuprofen (assume 270 days per year)	1.2 g daily (0.6 g 84 tablets =3.66 pounds)		23.53	BNF [2]
General practitioner visits	2 per annum	18	36	PSSRU [16]
Nonsteroidal anti-inflammatory drug events	–	–	238	MMT [14]
Total	–	–	641.53	–

Table 3
Summary of variables used in analysis (costs in 2000 UK pounds sterling)

	Definition	Value	Source/notes
Costs			
C_1	MOM procedure cost (including follow-up costs)	5,515	See Table 1 for further details
C_2	THR procedure cost (including follow-up costs)	4,195	See Table 1 for further details
C_3	Revision THR procedure cost (including follow up costs)	6,027	See Table 1 for further details
C_4	Annual cost in 'watchful waiting'	642	See Table 1 for further details
Probabilities			
P_1	MOM revision risk	0.01516	Average value from McMinn et al. [12]
P_2	THR revision risk	0.01357	Derived from data for patients aged under 50 years in Fitzpatrick et al. [7]
P_5	Annual probability of THR for 'watchful waiting' patients	0.0833	Based on mean time to surgery in Dieppe et al. [5, 6]
P_6	Mortality (all causes) for persons aged 45–50 at outset in 5-year age bands; includes 1% operative mortality for MOM and THR	–	–
P_7	Mortality (all causes) for persons aged 65–70 at outset in 5-year age bands; includes 1% operative mortality for MOM and THR	–	–
Quality of life			
Q_1	MOM	0.964	Based on assumed % patients by degree of pain and 'time trade-off' values in Laupacis et al. [10]
Q_2	THR (including revision THR)	0.964	As above
Q_3	'Watchful waiting'	0.503	Based on % patients by degree of pain in Dieppe et al. [5, 6] and 'time tradeoff' values as above
Q_6	Death	0	

year time horizon of the model, with the addition of a 1% operative mortality risk [18]. An average of the rates for men and women at either 45 years or 65 years of age on entry to the models was used. It was assumed that complications during the operations are reflected in the average cost and quality of life adjustments associated with each of the interventions.

The revision rate for any intervention is defined as the risk of a patient requiring an alternative intervention some time after the original treatment. While follow-up data on THR are available for 20 years, no data were available to assess the revision rate beyond 4 years for MOM. In the absence of long-term data for MOM it was decided to apply available annual equivalent risk data as a constant hazard rate to the full follow-up period for both MOM and THR. Since the analysis was concerned with revision rates for younger persons or more active elderly persons, the estimates for revision rates for THR were derived from the only studies reporting data for persons aged 50 years or younger [7, 22]. Due to lack of follow-up data for MOM a constant annual revision rate was used, although an exponential revision rate has been shown to fit the data better for THR. For the base case analysis the estimated annual equivalent revision rate for THR among younger and more active elderly patients is 1.36%. The annual equivalent revision rate for person's aged 50–70 years was calculated to be slightly lower at 1.14% (reflecting the lower activity level for this age group). A recent study of a group of patients with an average age of 50 years with mean follow-up of 9.4 years, however, yielded annual equivalent revision rates of 1.59% and 2.02% for the two methods of THR investigated [22].

The review process revealed very little evidence on MOM revision rates, largely due to the fact that this is a fairly new procedure. Of the available evidence, the data from the published McMinn et al. [12] study was chosen. The other published studies either had a very small sample size (n=21) [20], or included a particularly young patient group who had had many previous operations and considerable deformity [25]. In the base case analysis the MOM revision rate was 1.52%, which was derived by taking the weighted average of the annual equivalent revision rates from the four subgroups in a study by McMinn et al. [12]. However, this rate was higher than unpublished industry revision rates which were based on substantially more cases for at least 3 years of follow-up and may reflect more recent experience following refinements to the technique as well as greater experience. Sensitivity analyses were therefore conducted on this parameter.

For 'watchful waiting' or waiting list patients the relevant risk is the probability of undergoing a surgical intervention at a given time after entering the 'watchful waiting' situation. Estimates of the annual risk of a primary THR for someone on 'watchful waiting' were only obtainable from one small study [5, 6]. From this study an average annual equivalent probability of having surgery in the 'watchful waiting' group of 8.33% was derived [4, 5, 6].

A range of outcome measures was available for hip disease, including the Harris Hip score, the Merle d'Aubigne or Charnley score, and the WOMAC score [1, 10]. Most of the available data related to hip scores or percentages of patients with different severities of pain. All such measures are disease specific and only very limited evidence was found to facilitate a translation of any of the individual measures into a global quality-of-life score. One study of quality-of-life scores for patients undergoing total hip replacement did report, along with disease-specific outcome measures, the results of a time trade-off study for alternative states of osteoarthritis of the hip pre- and post-THR [10]. In the study by Laupacis and colleagues [10] a group of patients with osteoarthritis of the hip were asked to consider hypothetical scenarios that were designed to reflect patients having mild, moderate and severe osteoarthritis of the hip. They were then asked to state how many years in each of these hypothetical states they would give up to achieve a certain number of years in perfect health. Their answers were mapped onto a utility scale from 0 to 1 where 0 represented death and 1 represented perfect health. In the absence of better information these data were used to define quality of life scores for each of the health states in the models [10].

Using a method similar to that used in an earlier study [7] the quality-of-life values from Laupacis and colleagues [10] were applied to the alternative health

Table 4

Incremental cost effectiveness results for MOM vs. comparators: base case. Costs in 2000 UK pounds sterling are discounted by 6% per year over 20 years; QALYs are discounted by 1.5% per year over 20 years. The estimated annual revision rates are 0.01516 for MOM and 0.01357 for THR (*WW* watchful waiting)

	Younger persons	More active elderly
Total costs (pounds)		
MOM	6,297	6,180
WW followed by THR	6,476	–
THR	4,940	4,818
QALYs		
MOM	16.20	12.31
WW followed by THR	12.46	–
THR	16.22	12.33
Additional cost for MOM vs. (pounds)		
WW followed by THR	–179	–
THR	1,357	1,362
QALYs gained by MOM vs.		
WW followed by THR	3.73	–
THR	–0.02	–0.02
Incremental cost per QALY for MOM vs.		
WW followed by THR	MOM dominates	–
THR	THR dominates	THR dominates

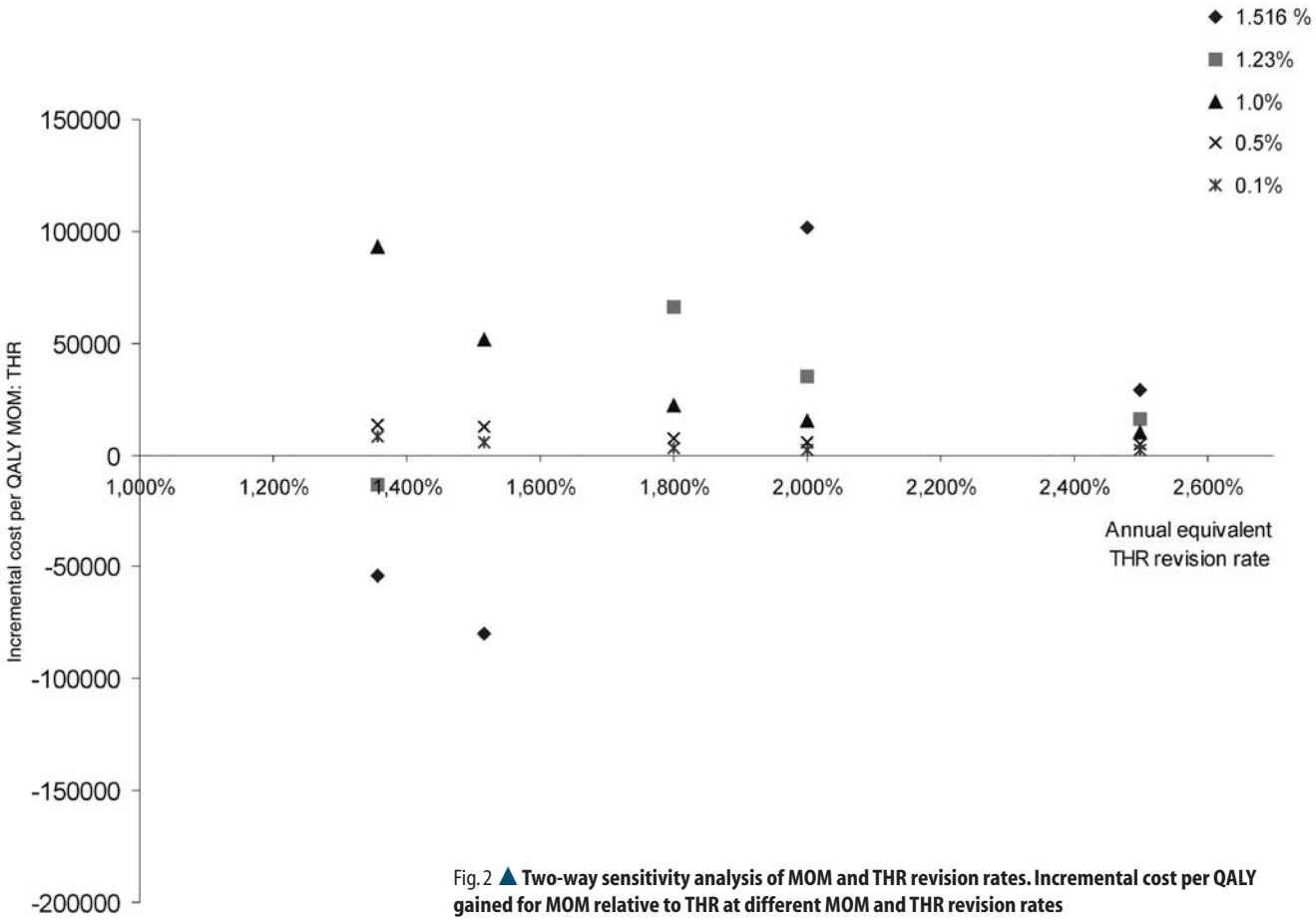


Fig. 2 ▲ **Two-way sensitivity analysis of MOM and THR revision rates. Incremental cost per QALY gained for MOM relative to THR at different MOM and THR revision rates**

states in the models according to the assumed percentages of patients in no pain, mild, moderate or severe pain. For patients who had either a MOM or primary THR it was assumed that 20% would have mild pain and 80% no pain. Applying this assumption to the values from Laupacis and colleagues gave a quality of life score of 0.964. The same assumption was also used for revision THR due to the limited data on quality of life following revision THR, although clinical indications are that persons in this state probably do have reduced function and quality of life. For the 'watchful waiting' state, the quality of life value was estimated using outcome information on the proportions of patients experiencing no pain, mild, moderate or severe pain [6]. Using this information, an average quality-of-life value for patients in the 'watchful waiting' group of 0.503 was estimated. The quality of life adjustment figure was used to weight the length of time spent in each state of health. The summation of these weighted times was used to provide an estimate of the QALYs associated with each intervention over a 20-year period.

The parameter estimates for costs, event probabilities, and quality of life described above are summarised in Table 3. In order to reflect the loss of utility prior to surgery and over the recovery period it was assumed that at the time of any transition involving a surgical intervention a patient is assumed to lose 50% of their pre-operative quality-of-life value for that cycle before returning to the relevant post operative quality of life state in subsequent cycles. The models also assumed that all patients were in the same underlying health state prior to treatment or entry to the 'model'. Discount rates of 6% and 1.5% per annum (the UK Treasury recommended rates) were applied in the model to costs and health related quality of life values, respectively. Therefore all costs and benefits that occur in the future were given less weight than costs and benefits that occur in the present.

Sensitivity analyses

The models were run using alternative key parameter values as part of a sensitivity analysis. The relative revision rates for MOM and primary THR are not only important factors in the model but are also subject to considerable uncertainty. The costs of treating a patient in the 'watchful waiting' scenario were not precisely measurable, and the nature and extent of possible complications were uncertain. The impact of time horizon was assessed, running the model for 5, 10 and 15 cycles. Further analysis also considered the sensitivity of the incremental cost per QALY of MOM compared to 'watchful waiting' using alternative quality-of-life estimates for patients treated by 'watchful waiting'.

Results

Base case

The incremental cost per QALY ratios are reported in Table 4. For younger persons THR dominated MOM throughout the 20-year follow-up as THR was less costly and had a slightly lower revision rate. It is important to note that the difference in utilities from MOM and THR was so small because of the similarity in

the revision rates. The initial costs of MOM were greater than the costs of the 'watchful waiting' for a number of years, but the cumulative discounted costs of 'watchful waiting' followed by THR eventually exceed the MOM costs. The gain in utility from MOM is substantial due to the low quality of life experienced during 'watchful waiting'.

Cost per QALY estimates for MOM and THR for older patients (i.e. active patients aged 65 years or over) used higher mortality rates in the model and showed essentially the same results as for the younger patient population. THR dominates MOM throughout the follow-up period.

Sensitivity Analysis

Sensitivity analysis was used to explore how robust the initial results were to variations in the values of these parameters. Two-way sensitivity analysis of THR and MOM revision rates is shown in Fig. 2. MOM becomes cost-effective as the revision rate of THR increases or the revision rate of MOM decreases. Increasing the THR revision rate, MOM ceases to be dominated when its rate is roughly 80% of the THR rate. By decreasing the MOM hip resurfacing revision rate the procedure ceases to be dominated when the revision rate is roughly 88% of the THR. As the revision rate of MOM falls relative to THR, the incremental cost effectiveness ratios also fall to rates that may be deemed as affordable to society, or possibly even result in cost savings.

If the annual cost of 'watchful waiting' falls below approximately £620 per patient per annum, MOM would no longer be dominant. Such a situation may arise if care provided during 'watchful waiting' was less intense, as may pertain to persons with lower pain or impairment (who would also have a higher quality of life anyway) or if there were fewer side effects associated with medical therapy.

The cost for a THR prosthesis used in the base case analysis is that of the most commonly used prosthesis, a Charnley device. However, more expensive prostheses are often used in younger patients [15]. Even with THR prosthesis costs at 300% higher than the baseline prosthesis cost, THR continued to dominate MOM.

Cost per QALY results were estimated for time horizons of 5, 10 and 15 years. THR dominated MOM at each of these shorter time horizons as well as at 20 years. The incremental cost per QALY gained for MOM compared with 'watchful waiting' diminishes until approximately 14.5 years after MOM, beyond which MOM dominates 'watchful waiting' [24]. MOM continued to dominate 'watchful waiting' even at 'watchful waiting' quality of life values of up to 0.963.

Discussion

Patients with hip disease generally experience a low quality of life. Current evidence is limited to short follow-up. If, when longer follow-up is available, MOM could be proven to have lower revision rates than THR over an extended time period and to result in better outcomes overall, for persons who are likely to outlive a primary THR, MOM may provide an incremental cost per QALY that is judged acceptable, or has cost savings and the same or greater QALYs.

The economic modelling was constrained substantially by lack of data on key parameters. The most severe problem pertained to the limited information available for MOM revision rates. Unpublished case series data suggest that revision rates for MOM will follow a similar (or better) trajectory than revision rates for primary THR. Another critical absence is the lack of data on health outcomes for revision THR following MOM. It could be hypothesised that, because MOM is bone-conserving relative to THR, revision from MOM to THR following resurfacing procedure would result in better outcomes than revision to THR following a primary THR. While such speculation merits further scientific investigation, it was not felt to be worthwhile to estimate all the possible scenarios in the absence of any data. Further qualifications about the need for data from a randomised controlled trial (or patient data enabling better matching in observational studies) and for better measures of health outcomes and quality of life also apply.

If MOM revision rates are shown to be substantially lower than rates for total hip replacement, persons likely to outlive a primary THR (as well as the carers for these patients) could benefit from MOM. Insufficient data were available, however, to determine whether such benefits would be likely over an extended follow-up period. Although information was not available on the quality of life of family and carers, an increase in the quality of life for persons with hip disease will most likely reduce the burden of care for family members and carers. Similarly it may be argued that quality of life for a person suffering from osteoarthritis of the hip is likely to reflect the levels of pain and mobility, and this improved quality of life would probably be associated with higher levels of activity. This may enable a patient to be more economically active, and perhaps less reliant on other family members, than would be the case if in a 'watchful waiting' treatment group. Again, arguments are not substantiated in this evaluation by any available data.

Conclusions

All data and modelling results indicate that MOM merits further scientific investigation. The lack of any controlled studies comparing MOM to THR and 'watchful waiting' needs to addressed, ideally through studies with long-term follow-up. Any comparison of MOM with 'watchful waiting' is hampered by the absence of long-term data on MOM, health outcome data following revision, and virtually any data on 'watchful waiting'. Research is required to more clearly define what 'watchful waiting' entails and how its outcomes compare to MOM.

The initial results based on case series data with limited follow-up for MOM do appear to support its use, but there have been cases in the past where early results have not been maintained [7]. If the initial results are confirmed by further research which shows that MOM is sufficiently more effective than THR (i.e. has a sufficiently lower revision rate and sufficiently better outcomes following revision), the use of MOM instead of 'watchful waiting' in younger persons may decrease net costs for some 'watchful waiting' patients or may result in increases in QALYs at a cost deemed to be affordable. In addition, the use of MOM in lieu of THR in more active elderly patients may result in additional QALYs at a cost that may be considered affordable to society (although the effectiveness would have to be substantially higher to achieve cost savings). For these conclusions to be drawn further long-term, controlled studies are required.

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