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Cost-Utility of Metal-on-Metal Hip Resurfacing Compared to Conventional Total Hip Replacement in Young Active Patients with Osteoarthritis

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ABSTRACT

Background: Metal-on-metal hip resurfacing arthroplasty (MoM HRA) has emerged as an alternative to total hip arthroplasty (THA) for younger active patients with osteoarthritis (OA). Birmingham hip resurfacing is the most common MoM HRA in Alberta, and is therefore compared with conventional THA. **Objective:** The objective of this study was to estimate the expected cost-utility of MoM HRA versus THA, in younger patients with OA, using a decision analytic model with a 15-year time horizon. **Methods:** A probabilistic Markov decision analytic model was constructed to estimate the expected cost per quality-adjusted life-year (QALY) of MoM HRA versus THA from a health care payer perspective. The base case considered patients with OA aged 50 years; men comprised 65.9% of the cohort. Sensitivity analyses evaluated cohort age, utility values, failure probabilities, and treatment costs. Data were derived from the Hip Improvement Project and the Hip and Knee Replacement Pilot databases in Alberta, the 2010 National Joint Replacement Registry of the Australian Orthopaedic Association, and the literature. **Results:** In the base case, THA was dominated by MoM HRA (incremental mean costs of −$583 and incremental mean QALYs of 0.079). In subgroup analyses, THA remained dominated when cohort age was 40 years instead of 50 years or when only men were assessed. THA dominated when the cohort age was 60 years or when only women were assessed. Results were sensitive to utilities, surgery costs, and MoM HRA revision and conversion probabilities. At a willingness-to-pay of Can $50,000/QALY, there was a 58% probability that MoM HRA is cost-effective. **Conclusions:** The results show that, on average, MoM HRA was preferred to THA for younger and male patients, but THA is still a reasonable option if the patient or clinician prefers given the small absolute differences between the options and the confidence ellipses around the cost-effectiveness estimates.

Keywords: Birmingham, cost-utility, hip resurfacing, osteoarthritis, total hip replacement.

Introduction

Advanced hip osteoarthritis (OA) is a common chronic condition causing severe joint pain and loss of joint function. Its incidence and prevalence are rising as the population ages, and OA now affects an estimated 10% of Canadian adults [1]. Total hip arthroplasty (THA) is recognized as one of the most effective interventions to relieve pain and improve function for patients with severe OA [2,3]. Although many different prostheses are available, they generally consist of three parts: the acetabular component, which is fitted into the patient's native acetabular pelvic bone; the femoral component, which is inserted down the femoral canal; and the bearing surfaces [4].

Revision surgery is required in about 10% of the patients with THA [5,6]. THA revision is more difficult to perform than is primary THA, and clinical outcomes are often poorer [7]. Therefore, people expected to outlive a primary THA are typically considered for THA only when their symptoms become unmanageable by nonsurgical treatment.

Other surgical approaches, such as hip resurfacing arthroplasty (HRA), have been considered. HRA is bone conserving because the head of the femur is not completely removed, although damaged surfaces of the proximal femur and the acetabulum are removed.

The first HRA developed in the early 1950s was abandoned because of high failure rates [5,6,8,9], and early results in the 1970s and 1980s with the first metal-on-metal (MoM) bearings were disappointing because of excessive wear, osteolysis, bone loss, and early failure of the prostheses leading to revision surgery [5,6,8,9]. Recent bearing material improvements have made HRA a viable option once again, particularly in younger and more active patients or those ineligible for THA. Nonetheless, the safety of MoM HRA remains controversial, with complications including femoral neck fractures, component loosening, and metallosis [5,6,8,9]. Despite these concerns and limited evidence regarding revision surgery, the Canadian Joint Replacement Registry reports an increasing trend in the number of MoM HRAs in Canada (<1% of all types of hip replacement in 2003 to 3% in 2007) [10].

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Potential advantages of the MoM HRA over THA include minimum bone resection, conservation of femoral bone, and maintenance of normal femoral loading and stress [6,7]. Hence, MoM HRA is particularly suitable for patients with a large femoral offset or a wide femoral canal, or those with femoral shaft deformity, in which it is difficult to fit a stem [11]. These characteristics are more common in men; consequently, an important indication for considering MoM HRA is sex.

Other than sex, age is considered to be another important criterion because implant survival of THA in younger patients is generally lower. Fifteen-year implant survival rate increases with age from approximately 70% in patients younger than 50 years to approximately 95% in patients older than 75 years at the time of primary surgery [12,13]. Most MoM HRA studies include only younger patients (~≤60 years) [6,14–18]. Nevertheless, some studies suggest that MoM HRA is also a suitable option for older patients (~≥60 years) [19–21].

To the best of our knowledge, only three randomized controlled trials (RCTs) comparing THA and MoM HRA have been published [22–24]. None of these studies compared health-related quality of life (HRQOL) and costs in age- and sex-specific subgroups. Given the lack of appropriate and high-quality data for a sufficiently long follow-up period, decision analytic modeling is a useful approach to estimate the long-term costs and HRQOL associated with MoM HRA and THA on the basis of known information regarding costs, HRQOL, and the probability of clinical outcomes such as revisions and complications [25].

The purpose of this study was to inform health policy by estimating the expected incremental cost-utility of MoM HRA to THA, for a base-case population and in age- and sex-specific subgroups. The comparison is based on current orthopaedic practice patterns in Alberta, Canada, where MoM Birmingham HRA and THA are most frequently used.

Methods

Model Structure

A probabilistic Markov state-transition model with a 15-year time horizon was developed to undertake a cost-utility analysis of primary MoM HRA compared with THA. The model was built in TreeAge Pro 2012 (TreeAge Software, Inc., Williamstown, MA) following established economic evaluation modeling guidelines [25,26]. We calculated the cost per quality-adjusted life-year (QALY) for each intervention. The analysis adopted a health care system perspective. Both costs and outcomes were discounted at 3% per annum to reflect society's rate of time preference [27–29].

The model begins with a decision for either MoM HRA or THA (Fig. 1). After the primary surgical procedure, patients enter either the postprimary MoM HRA or postprimary THA health state. Patients are always in one of a finite number of health states and can move between health states annually. One-year cycles were chosen because a revision surgery, which is one of the most important events to happen in the context of the decision model, is on average likely to occur no more frequently than once per year. Patients are at risk of death from surgery-related or other causes and therefore can always move to the absorbing death state.

Patients in the postprimary MoM HRA state can remain in that state or fail and then either have their MoM HRA revised or undergo a conversion to THA. The choice for revision or

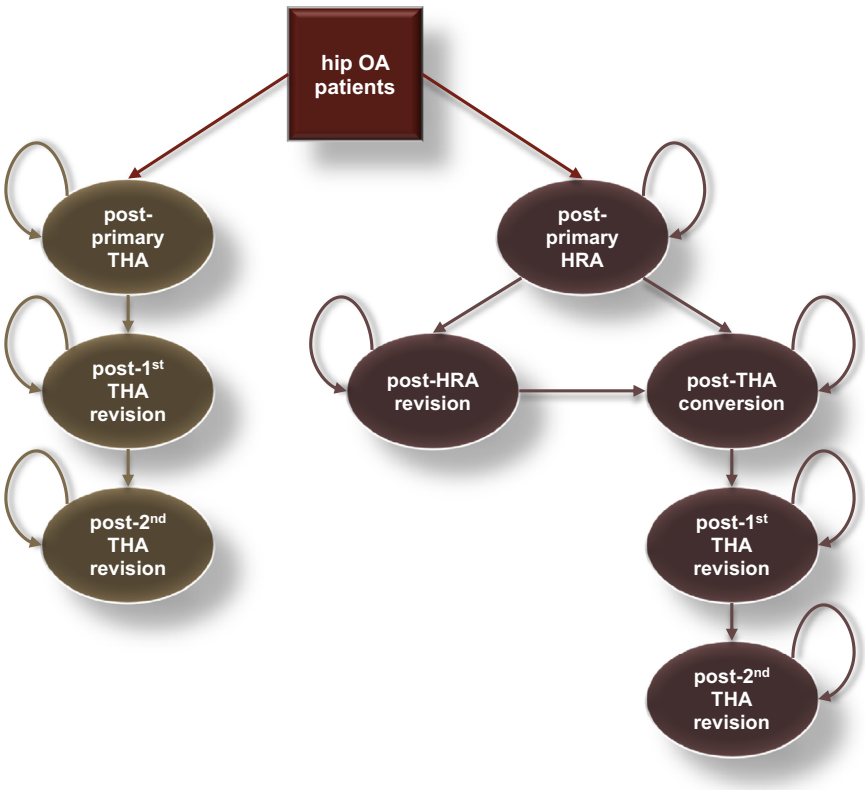

Fig. 1 – Markov model comparing MoM HRA and THA procedures. Transition to the absorbing death state is possible from every health state (not shown in the figure). Each state is a 15-year tunnel (not shown in the figure). MoM HRA, metal-on-metal hip resurfacing arthroplasty; THA, total hip arthroplasty.