Effectiveness of hip prostheses in primary total hip replacement: a critical review of evidence and an economic model


Authors' objectives
The objectives of the review were two-fold.

1. To review the available evidence on the comparative effectiveness of different prostheses types in total hip replacement (THR) for adults suffering primarily from osteoarthritis.

2. To develop an economic model, using cost data from two NHS orthopaedic centres, to model the cost-effectiveness of alternative prostheses under varying resource input assumptions.

Searching
A large bibliographic database on epidemiology and service provision for THR, which was compiled within the reviewers' department, was searched. MEDLINE was searched from 1980 to 1995 for RCTs using a modified Cochrane Collaboration strategy. EMBASE was searched from 1990 to 1996 for studies with comparison or control aspects in the study design, using search terms such as: control*, versus, compar*, match*. Both EMBASE and MEDLINE were searched for studies published in 1995, using broad criteria for THR and arthroplasty. In addition, ad hoc searching was performed to identify studies published in 1996.

A number of individuals and organisations, e.g. the Medical Devices Agency, were contacted directly.

In general, only articles or abstracts published in the English language were included. However, a very small number of English language abstracts of non-English articles were included where sufficient information was available.

Study selection
Study designs of evaluations included in the review
Observational and experimental designs were considered. These included randomised controlled trials (RCTs), other comparative studies and observational cohort studies without comparative features. For inclusion, studies had to provide clinical outcome data for specified prosthesis designs, comprising functional assessment, radiographic data, or time to failure. No minimum follow-up period was required for inclusion.

Specific interventions included in the review
THR using the following prostheses types: cemented (first, second and third generation); ceramic (heads/cups); uncoated press-fit cementless; porous-coated cementless; hybrid (cemented stem and uncemented cup); hydroxyapatite (HA)-coated cementless; and fully modular.

Participants included in the review
Adults with a primary diagnosis of hip arthropathies or congenital deterioration, excluding hip fracture, were included.

Outcomes assessed in the review
There were three main types of outcome measure:

- the lifespan of the prosthesis, which is typically represented by survivorship analysis or revision rates (i.e. the rates of prostheses replacement);

- prosthesis function in situ, which is measured typically by one of the several standardised clinical hip scoring systems, i.e. Merle d'Aubigne, Harris, Johnston, and the HSS (hospital for special surgery); and

- radiographic definitions of possible failure, including bone loss (osteolysis), subsidence of the stem component,
migration of the cup component and wear of materials.

How were decisions on the relevance of primary studies made?
The authors do not state how the papers were selected for the review, or how many of the authors performed the selection.

Assessment of study quality
RCTs, non-controlled comparative studies, and observational cohort studies without comparative features were assessed separately for validity. The studies were rated on 17 to 20 criteria, depending on the study design. These criteria included: method of randomisation, blinding, appropriateness of statistical analyses, and mean and range of follow-up. Studies were given a rating of A, A/B, B, B/C or C based on the extent to which the appraisal criteria were met. Each study was reviewed by one of the research team who was not blinded to either the author(s) or authors' affiliation.

Data extraction
The authors do not state how the data were extracted for the review, or how many of the authors performed the data extraction.

Methods of synthesis
How were the studies combined?
The studies were combined in a qualitative narrative, in which the greatest emphasis was placed on the RCTs and comparative studies.

How were differences between studies investigated?
Tests for heterogeneity were not reported.

Results of the review
A total of 234 studies were included in the review, which was comprised as follows.

Seventeen RCTs and 61 other comparative studies.

Eleven other RCT or comparative studies, which were not straightforward prosthesis versus prosthesis comparisons; these involved comparisons of patient variables and fixation types and techniques, together with reports assessing why outcomes such as dislocation and fracture may occur.

One hundred and forty-five observational studies.

In addition, a single meta-analysis was included. The total number of participants was not stated.

Comparison of prosthesis types.
Cemented designs: in general, these showed good survival rates of at least 10 to 15 years. The rate of acetabular revision in cemented implants remains problematic. There was some evidence that all-polyethylene acetabular components were preferable to metal backed designs in terms of longevity of the implant.

In comparing short- to medium-term longevity between non-cemented porous-coated and cemented prostheses designs, there was no clear advantage for either type. One comparative radiographic study suggested that cemented acetabular components performed better than porous-coated designs, but that porous-coated stems performed better than cemented models. The comparative evidence strongly suggested that thigh pain was a problem associated with non-cemented porous-coated (and other cementless) implants to which cemented designs are not prone. In the observational studies of porous-coated implants, reports of thigh pain prevalence ranged from about 25% at the 2 to 7 year follow-up; several studies reported the prevalence values at the higher 25% level, including in non-loose stems.
In contrast, a small number of studies of cementless HA-coated models reported mild to moderate thigh pain in between 0 and 5% of patients at the 2 to 5 year follow-up.

Radiographic studies of cemented versus HA-coated designs suggested that HA-coated models have better early fixation and less migration than cemented models. One comparative study indicated that the lesser migration of the HA-coated models may be associated with less early post-operative pain.

Hybrid designs were comparable with the best cemented designs for early survival (6 to 7 years), and were superior to porous-coated implants in terms of both survival and thigh pain. However, the available studies could not give any indications for their mid- or long-term results.

There was little evidence available on fully modular prostheses. One comparative study suggested that a fully modular stem performed less well than cemented stems. A laboratory analysis of the retrieved components suggested that mixed-alloy components were more prone to corrosion than single-alloy devices.

The wear rates for ceramic hips were less than those for other materials at the articulating surface of the joint. Comparative studies suggested either lower or equivalent revision rates for ceramic versus cemented implants at the medium term follow-up.

The uncoated press-fit and resurfacing types of hip prosthesis had survival rates that were notably inferior to those of other types.

Cost information
Yes. The economic modelling indicated that prosthesis cost and revision rate are the components of the model with the greatest impact in terms of changing the total expected costs for the THR procedures.

Very high and very low estimates of the hospital costs changed the total expected costs for the individual prostheses, but had little effect on their relative cost-effectiveness when compared with each other.

Compared with survival data for the Charnley cemented prosthesis from 'centres of excellence', and assuming a prosthesis cost of £353 including cement, even a 'no revisions' prosthesis should not cost more than about £650 (at 1997 prices) in order to have equivalent total expected costs over 20 years. Only cemented prostheses were available at this price.

Authors' conclusions
The authors' conclusions are concerned with policy implications and research recommendations, which are discussed in the 'Implications of the Review' section.

CRD commentary
The review answered a well-defined question. The validity of the included studies was adequately assessed. Sufficient details of the primary studies were presented. The primary studies were summarised appropriately.

The literature search was reasonable, but it could have been extended to include studies published in languages other than English, in order to avoid the possibility of important information being lost. The inclusion and exclusion criteria were appropriate; however, it was not stated how the authors made decisions about whether a study should be included. This was a thorough review that presented implications for policy and research recommendations.

Implications of the review for practice and research
Policy: The effectiveness of novel designs of prostheses is unknown. The mechanisms for improving the use of appropriate prostheses could be examined.

Commissioners and providers could also ascertain the range and extent of use of routinely-used prostheses known to
have results poorer than the best cemented designs. These studies should distinguish between different design types, taking account of age-groups, and seek audit of outcomes including revision rates.

Research: Further inclusion of patient-derived quality of life measures in studies of hip prosthesis performance is essential, as clinical hip-scoring systems do not take into account the patient's views when assessing the outcomes.

Patients' values and choices regarding the quality of life in relation to THR should be investigated.

Longer follow-up studies are required for the following: hybrid and cementless HA-coated THR models; thigh pain and longevity in HA-coated models; and porous-coated cementless and fully modular THR designs. Follow-up of the coated acetabular component of hybrid implants is required to ascertain the medium and long-term performance of this prosthesis design.

The extent and significance to patients of thigh pain associated with porous and HA-coated implants should be assessed.

The relationship between radiographic signs of loosening or migration and later mechanical failure should be explored.

More up-to-date information is needed on the use of new cementation techniques so that their use can be encouraged.

Funding
NHS R&D Health Technology Assessment (HTA) Programme, project number 93/11/04.

Bibliographic details

PubMedID
9728294

Original Paper URL
http://www.hta.ac.uk/project.asp?PjtId=889

Indexing Status
Subject indexing assigned by NLM

MeSH
Arthritis, Rheumatoid /economics /surgery; Arthroplasty, Replacement, Hip /economics /methods; Biocompatible Materials; Costs and Cost Analysis; Female; Fractures, Bone /etiology; Hip Prosthesis /adverse effects /economics; Humans; Male; Models, Economic; Osteoarthritis, Hip /economics /surgery; Pain /etiology; Prognosis; Prosthesis Design; Prosthesis Failure; Randomized Controlled Trials as Topic; Technology Assessment, Biomedical; Weight-Bearing

AccessionNumber
11998009010

Date bibliographic record published
31/12/1999

Date abstract record published
31/12/1999

Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract
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