Primary total hip arthroplasty versus hemiarthroplasty for displaced intracapsular hip fractures in older patients: systematic review

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ABSTRACT

Objective To determine whether total hip arthroplasty is associated with lower reoperation rates, mortality, and complications, and better function and quality of life than hemiarthroplasty for displaced fractures of the femoral neck in older patients.

Design Systematic review and meta-analysis of randomised trials, quasirandomised trials, and cohort studies.

Data sources Medline, Embase, Cochrane register of controlled trials, publishers’ databases, and manual search of bibliographies.

Study selection Randomised controlled trials, quasirandomised trials, and cohort studies (retrospective and prospective) comparing hemiarthroplasty with total hip arthroplasty for treating displaced femoral neck fractures in patients aged more than 60 years.

Data extraction Relative risks, risk differences, and mean differences from each trial, aggregated using random effects models. Analyses were stratified for experimental and non-experimental designs, and two way sensitivity analyses and tests for interaction were done to assess the influence of various criteria of methodological quality on pooled estimates.

Data synthesis 3821 references were identified. Of the 202 full papers inspected, 15 were included (four randomised controlled trials, three quasirandomised trials, and eight retrospective cohort studies, totalling 1890 patients). Meta-analysis of 14 studies showed a lower risk of reoperation after total hip arthroplasty compared with hemiarthroplasty (relative risk 0.57, 95% confidence interval 0.44 to 0.73). Total hip arthroplasty consistently showed better ratings in the Harris hip score (three studies, 246 patients, weighted mean difference 5.4, 95% confidence interval 2.7 to 8.2) after follow-up periods of 12 to 48 months. The standardised mean difference of different scores from five studies was 0.42 (95% confidence interval 0.24 to 0.61), indicating a medium functional advantage of total hip arthroplasty over hemiarthroplasty. Total hip arthroplasty was associated with a slightly higher risk of dislocation (relative risk 1.48, 95% confidence interval 0.89 to 2.46) and general complications (1.14, 0.87 to 1.48).

Conclusion Single stage total hip arthroplasty may lead to lower reoperation rates and better functional outcomes compared with hemiarthroplasty in older patients with displaced femoral neck fractures. However, heterogeneity across the available trials and distinct subgroup effects preclude definitive statements and require further research in this area.

INTRODUCTION

Hip fractures in older patients are associated with impaired mobility, excess morbidity and mortality, and loss of independence. With the reversing ageing pyramid and the high prevalence of osteoporosis, hip fractures remain a public health concern. Incidence estimates vary considerably among industrial countries.1-9 Models aimed at projecting the contribution of hip fractures to the future global burden of disease produced inconclusive results,10 and depended on assumptions about the effectiveness of multifaceted interventions for preventing falls and managing osteoporosis.11-20

Typical predilection sites for fractures of the proximal femur are the femoral neck and the intertrochanteric and subtrochanteric regions. Displaced, unstable fractures of the femoral neck generally represent an indication for early surgical intervention. Established treatment options include internal fixation with cannulated or sliding hip screws, hemiarthroplasty, or total hip replacement. Well recognised goals of surgical treatment are immediate pain relief, rapid mobilisation and ambulation, accelerated rehabilitation, and maintenance of independent living. In addition to these prerequisites, the ideal implant must be associated with a low risk of surgical complications and subsequent revision. At best, patients should not be hampered by the treated hip during their remaining lifetime.

Evidence is now compelling from randomised controlled trials that, in displaced femoral neck fractures, primary arthroplasty outperforms internal fixation for complication and revision rates, function, and health...
related quality of life. This is reflected in recent clinical guidelines that assigned a grade A recommendation for arthroplasty to treat these fractures in older, biologically less fit patients.

Hemiarthroplasty is a quick and highly standardised procedure that allows for early weight bearing and recovery. However, most patients with a hip fracture have osteoarthritis, which may necessitate secondary conversion to total hip replacement, especially in active elderly people with higher physical demands. Single stage surgery with acetabular replacement seems straightforward to avoid secondary admission to hospital and operation with its possible risks and extra costs. These potential benefits, however, must be traded off against the potential harms of prolonged and more invasive surgery.

Uncertainty as to which type of endoprosthesis is the ideal choice for treatment of fractures in older patients leads to significant variation in the use of each intervention internationally. Total hip replacement is three times more likely to be used to treat hip fractures in Sweden than it is in England and Wales, and twice as likely than in Canada.

To provide greater clarity about outcomes with primary hemiarthroplasty or total hip arthroplasty for displaced intracapsular hip fractures in older patients, we...
Table 2: Description of interventions received by each treatment group

| Study                | Design                  | Surgical approach                      | Total hip arthroplasty | Type            | Hemiarthroplasty |
|----------------------|-------------------------|----------------------------------------|------------------------|-----------------|------------------|
|                      |                         |                                        | Fixation              | No              | Fixation         | No              |
| Baker 2006          | Randomised controlled   | Transgluteal lateral                   | Cemented              | 40              | Bipolar          | Cemented        | 41              |
| Blomfeldt 2007       | Randomised controlled   | Modified Hardinge anterolateral       | Cemented              | 60              | Bipolar          | Cemented        | 60              |
| Dorr 1986           | Lesser quality randomised controlled trial | Posterior                          | Cemented              | 39              | NS               | Cemented or uncemented | 50 |
| Eyssel 1994         | Retrospective cohort    | Transgluteal                           | Cemented              | 213             | Bipolar          | Cemented        | 150             |
| Gebhard 1992        | Retrospective cohort    | NS                                     | Cemented              | 44              | NS               | Cemented or uncemented | 122 |
| Healy 2004          | Retrospective cohort    | NS                                     | Cemented              | 23              | Unipolar or bipolar | Cemented        | 43              |
| Keating 2006        | Randomised controlled   | Posterior or lateral                   | Cemented              | 69              | Bipolar          | Cemented        | 111             |
| Levi 1995           | Retrospective cohort    | Posterior                              | Cemented              | 98              | Unipolar         | Cemented or uncemented | 123 |
| Macaulay 2008       | Randomised controlled   | Posterolateral or modified Hardinge anterolateral | Cemented or uncemented | 17              | Unipolar or bipolar | Cemented or uncemented | 23 |
| Mouzopoulos 2008    | Lesser quality randomised controlled trial | NS                                   | Cemented              | 43              | Bipolar          | NS              | 43              |
| Narayan 2006        | Retrospective cohort    | NS                                     | Cemented or uncemented | 29              | Bipolar          | Cemented or uncemented | 32 |
| Ravikumar 2000      | Lesser quality randomised controlled trial | Posterolateral                      | Cemented              | 91              | Unipolar         | Uncemented      | 89              |
| Schleicher 2003     | Retrospective cohort    | NS                                     | Hybrid                 | 54              | Bipolar          | NS              | 52              |
| Squires 1999        | Retrospective cohort    | Posterolateral or modified Hardinge anterolateral | Cemented or uncemented | 32              | Unipolar or bipolar | Cemented or uncemented | 43 |
| Xu 2002             | Retrospective cohort    | Posterior                              | Cemented              | 32              | Unipolar or bipolar | Cemented        | 24              |

No of events/No in group

Retrospective cohort studies

| Study      | Treatment | Control | Relative risk (95% CI) | Weight (%) | Relative risk (95% CI) |
|------------|-----------|---------|------------------------|------------|------------------------|
| Gebhard 1992 | 1/44      | 12/122  | 5.42 (0.23 to 1.73)    | 3.04       | 6.00 (0.60 to 0.50)    |
| Eyssel 1994  | 8/213     | 6/150   | 13.38 (0.94 to 2.65)   | 28.15      | 9.34 (0.17 to 0.68)    |
| Squires 1999 | 2/32      | 16/43   | 3.24 (0.75 to 11.39)   | 16.15      | 5.82 (0.96 to 6.59)    |
| Xu 2002     | 1/32      | 1/24    | 3.01 (0.14 to 2.40)    | 13.38      | 2.47 (3.30 to 7.79)    |
| Schleicher 2003 | 2/54  | 2/52    | 4.27 (0.24 to 0.50)    | 42.68      | 6.12 (0.51 to 7.26)    |
| Healy 2004   | 0/23      | 6/43    | 16.15 (0.04 to 3.08)   | 28.15      | 29.17 (0.10 to 2.59)   |
| Narayan 2006 | 1/29      | 0/32    | 28.15 (0.16 to 0.66)   | 42.68      | 0.51 (0.24 to 1.06)    |

Quasirandomised trials

| Study       | Treatment | Control | Relative risk (95% CI) | Weight (%) | Relative risk (95% CI) |
|-------------|-----------|---------|------------------------|------------|------------------------|
| Dorr 1986   | 2/39      | 4/50    | 7.41 (0.64 to 3.32)    | 4.00       | 16.15 (0.11 to 0.63)   |
| Ravikumar 2000 | 6/91   | 22/89   | 16.15 (0.33 to 2.10)   | 4.59       | 28.15 (0.32 to 1.60)   |
| Mouzopoulos 2008 | 1/43  | 3/43    | 28.15 (0.32 to 1.60)   | 42.68      | 0.51 (0.24 to 1.06)    |

Quasirandomised trials

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| Ravikumar 2000 | 6/91   | 22/89   | 16.15 (0.33 to 2.10)   | 4.59       | 28.15 (0.32 to 1.60)   |
| Mouzopoulos 2008 | 1/43  | 3/43    | 28.15 (0.32 to 1.60)   | 42.68      | 0.51 (0.24 to 1.06)    |

Randomised trials

| Study       | Treatment | Control | Relative risk (95% CI) | Weight (%) | Relative risk (95% CI) |
|-------------|-----------|---------|------------------------|------------|------------------------|
| Baker 2006  | 1/40      | 6/41    | 5.16 (0.17 to 2.36)    | 20.00      | 0.00 (0.57 to 0.96)    |
| Keating 2006 | 6/69      | 6/111   | 12.67 (1.61 to 4.79)   | 15.00      | 1.05 (0.40 to 2.79)    |
| Blomfeldt 2007 | 4/60      | 3/60    | 8.84 (1.33 to 5.70)    | 30.00      | 3.24 (0.13 to 13.38)   |
| Macaulay 2008 | 1/17     | 0/23    | 2.50 (0.20 to 0.70)    | 30.00      | 0.17 (0.02 to 0.14)    |
| Subtotal:    | 17/168    | 45/235  | 29.17 (0.19 to 2.50)   | 0.17       | 0.05 (0.34 to 0.96)    |
| Overall:     | 36/786    | 87/883  | 100.00 (0.57 to 0.96)  | 0.17       | 0.05 (0.34 to 0.96)    |

Fig 2 | Random effects meta-analysis comparing relative risk of reoperation after total hip arthroplasty and hemiarthroplasty for displaced intracapsular hip fractures

METHODS

Two reviewers (CH and DS) independently carried out a comprehensive search (last update 27 March 2010) of Medline, Embase, the Cochrane register of controlled trials, and publishers’ databases for randomised controlled trials, quasirandomised trials, and cohort studies (both retrospective and prospective) that compared hemiarthroplasty with total hip arthroplasty for treating displaced femoral neck fractures in patients aged more than 60 years. We excluded registry data and case series—that is, studies that investigated either total hip arthroplasty or hemiarthroplasty for treating hip fractures.

We used medical subject headings (or their equivalents in other databases), including the following key search and wild card terms: hip, femoral neck, intra-articular, intra-articular, fracture*, surg*, hemi*, total*, bipolar, unipolar, arthroplast*, replacement, random*. Terms were connected by the Boolean operators “AND” and “OR”.

Reviewers traced the bibliographies of all retrieved trials and other relevant publications, including reviews and meta-analyses, for citations missed by the
Selection process

Two reviewers (CH and DS) reviewed titles and abstracts first, and independently decided whether the papers potentially contained sufficient information. If deemed eligible by either reviewer, the full paper was obtained for a detailed review. We included studies published in languages that could be read and understood by the reviewers (English, German, Dutch, Swedish, French, Spanish, and Italian). Eligible studies compared hemiarthroplasty and total hip arthroplasty in a head to head fashion and provided sufficient numerical information on at least one of the following prespecified end points: reoperation for any cause, dislocation, deep infection, one year mortality, and any general perioperative complication (including nosocomial pneumonia and urinary tract infection, as well as a thromboembolic or cardiovascular event). General complications were handled as a composite end point. We also investigated function and health related quality of life (if assessed by valid scoring systems or questionnaires).

Data abstraction and assessment of methodological quality

Two reviewers (CH and DS) independently abstracted data in duplicate, including general information [author, publication year], type of study, fracture classification, period of patient enrolment, mean patients’ age, sex distribution, prefracture comorbidity, cognitive function and mobility, average length of follow-up, type of prosthesis, and use of bone cement. The reviewers also extracted and entered into an electronic database event rates with nominators and denominators for different end points, as well as means and standard deviations of functional score and quality of life assessments.

Three reviewers (CH, DS, and MW) independently assessed the methodological quality of papers according to the set of items used by Parker in two previous Cochrane reviews related to this subject. Quality criteria included concealment of allocation; description of entry criteria, demographic profiles, and outcomes; adherence to the intention to treat principle; blinding; handling of withdrawals; explanation of cointerventions; and a minimum follow-up of one year after surgery. The reviewers resolved disagreement by discussion.

Data analysis

We analysed binary end points (for example, reoperation and mortality) by calculating relative risks and corresponding risk differences. For differences in functional scores and quality of life instruments we calculated the weighted mean difference and the pooled

| Author | Total hip arthroplasty | Hemiarthroplasty | Total hip arthroplasty | Hemiarthroplasty | Total hip arthroplasty | Hemiarthroplasty |
|--------|------------------------|------------------|------------------------|------------------|------------------------|------------------|
| Baker 2006 | 74 (6)               | 76 (5)           | 20                     | 22               | Median ASA 2 (1-3)   | Median ASA 2 (1-3) |
| Blomfeldt 2007 | 81 (5)               | 81 (5)           | 22                     | 10               | Ceder A/B 88%        | Ceder A/B 83%    |
| Dorr 1986   | 69 (9)               | 69 (12)          | 41                     | 30               | NS                     | NS               |
| Eyssel 1994 | 78 (9)               | 84 (7)           | 9                      | 21               | Comorbidity 76%       | Comorbidity 87%  |
| Gebhard 1992 | 75                  | 76               | NS                     | NS               | Mean ASA 3           | Mean ASA 3      |
| Healy 2004  | 80                    | NS               | NS                     | NS               | NS                     | NS               |
| Keating 2006 | 75 (6)               | 75 (7)           | 25                     | 17               | Comorbidity 80%       | Comorbidity 70%  |
| Levi 1996   | 80                    | 80               | 22                     | 22               | NS                     | NS               |
| Macaulay 2008 | 82 (7)               | 77 (9)           | 59                     | 39               | Mean No of comorbidities 4 (SD 3) | Mean No of comorbidities 4 (SD 3) |
| Mouzopoulos 2008 | 73 (5)               | 74 (4)           | 24                     | 29               | Mean ASA 2 (SD 2)   | Mean ASA 2 (SD 3) |
| Narayan 2006 | 59                  | 63               | NS                     | NS               | NS                     | NS               |
| Ravikumar 2000 | 81                  | 82               | 10                     | 10               | No significant differences in age, sex, preoperative mobility, or comorbidity |
| Schleicher 2003 | 81 (12)             | 81 (10)          | 17                     | 13               | ASA 3/4 94%         | ASA 3/4 91%    |
| Squires 1999 | 69                  | 71               | 12                     | 6                | NS                     | NS               |
| Xu 2002    | 72 (5)               | 75 (6)           | 46                     | 46               | NS                     | NS               |

NS=Not specified.
standardised mean difference. In general, higher scores indicate better function—for example, the Harris hip score, the short form 36 (SF-36) physical component score, or the European quality of life instrument 5D (EQ-5D) visual analogue scale. We reversed the polarity of inverse scores (those producing higher values with poorer function, such as the Oxford hip score) by subtracting the maximum possible score from the observed score. In case authors provided ranges instead of standard deviations of possible scores, we approximated the standard deviation by providing both P values and ratios of relative risks with 95% confidence intervals. For all calculations we used Stata 10.0 statistical software, incorporating the updated metan meta-analysis package.

**RESULTS**

The electronic search strategy revealed 3821 papers, 160 of which were potentially relevant to the analysis. An additional search of the reference lists yielded 42 citations not covered by the electronic search. A shortlist of 24 papers was compiled from the set of 202 full text articles retrieved. At this stage, the reviewers omitted another nine manuscripts. Two studies, one of which was published in German and later duplicated in English, included patients with trochanteric fractures only, as did a study from Belgium.

Another two studies enrolled patients with femoral neck and trochanteric fractures but did not provide sufficient information to enable separate analyses on both factors. One study that compared primary joint replacement with internal fixation did not distinguish between the results from randomised trials and retrospective cohort studies, enrolling a total of 1890 patients.

**Study characteristics**

Tables 1-3 summarise the key characteristics of the included studies, and table 4 the criteria of methodological quality. In seven studies (n=776) patients were randomly allocated to hemiarthroplasty or to total hip arthroplasty. Concealed randomisation (sealed envelopes or a central automated telephone system) was guaranteed by four trials, all of which system) was guaranteed by four trials, all of which

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For studies available in duplicate, references to the most recent publication were provided. This left 15 original reports (fig 1) of four randomised trials, three quasi-randomised trials, and eight retrospective cohort studies, enrolling a total of 1890 patients.

We carried out stratified analyses for differences between the results from randomised trials and retrospective cohort studies and further differentiated between randomised trials with and without proper concealment of treatment allocation. To examine the impact of individual patient and study criteria we planned the following additional two way sensitivity analyses a priori: balanced patient profile given published information on personal details, comorbidity and ambulation (yes or no); inclusion of mobile and oriented patients only (yes or heterogeneous sample/unclear); cementation of stems in the hemiarthroplasty group (100% or <100%, or unclear); follow-up interval less than or more than 24 months; intention to treat analysis specified (yes or no); specification of surgeon grades in the study (yes or no); less than 5% loss to follow-up (yes or no, or not specified); and postoperative care specified (yes or no). We compared treatment effects between independent subgroups using the test for interaction proposed by Altman and Bland, providing both P values and ratios of relative risks with 95% confidence intervals. For all calculations we used Stata 10.0 statistical software, incorporating the updated metan meta-analysis package.

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Experimental evidence was supplemented by data from eight retrospective cohort studies (n=1114) of low methodological quality.52-59 The number of fulfilled quality criteria ranged from one to seven of a maximum 12. However, two of these observational studies together included 584 patients, or one third of the entire sample of participants.52,55

Most studies showed balanced patient baseline characteristics (n=12), included mobile and oriented patients only (n=10), attempted a minimum follow-up of more than 24 months (n=12), and specified post-operative care (n=9). Loss to follow-up was less than 5% in seven of the 15 studies, and hemiarthroplasty stems were cemented in six. Information on intention to treat analysis was provided in four studies: either all the patients were analysed according to the allocated intervention,43,49 or the paper confirmed that all patients had undergone the assigned procedure.43,51

According to seven studies,43,45,48,49,52,57,59 total hip replacement lengthened the duration of surgery by an average of 11 minutes (95% confidence interval 4 to 19 minutes). Heterogeneity was significant for the reported lengths of surgery (P=0.001). Reoperation rates

The seven randomised trials and seven of eight retrospective cohort studies, totalling 1669 patients and 123 events, provided data on reoperation rates. Overall, primary total hip arthroplasty was associated with a lower risk of subsequent reoperation compared with hemiarthroplasty (fig 2). The pooled relative risk was 0.57 (95% confidence interval 0.34 to 0.96), equalling a risk difference of 4.4% (95% confidence interval 0.2% to 8.5%) in favour of total hip replacement. Heterogeneity across studies was low (I²=27%, P=0.16). Publication bias was not evident (intercept 0.79, P=0.36).

Table 5 shows the influence of the study design and other prespecified variables on relative risks of reoperation. Studies with follow-up intervals of two years or longer were associated with bigger treatment effects in favour of total hip replacement (ratio of relative risks 0.44, 95% confidence interval 0.15 to 1.26, test for interaction, P=0.13). Treatment effects were comparable between retrospective cohort and experimental studies (1.26, 0.42 to 3.79, test for interaction, P=0.67) but seemed to be overestimated by studies with

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**Table 4 | Methodological quality of included studies**

| Study             | Concealment of allocation | Entry criteria specified | Intention to treat analysis | Interventions groups characterised | Surgeon grade specified | Postoperative care defined | Outcome measures defined | Outcome assessor blinded | Follow-up period of ≥ 1 year | Missing information on ≥5% of patients |
|-------------------|---------------------------|--------------------------|-----------------------------|-----------------------------------|------------------------|---------------------------|-------------------------|---------------------------|-------------------------------|-------------------------------------|
| Baker 200648       | Yes                       | Yes                      | No                          | Yes                               | Yes                    | Yes                       | Yes                     | No                        | Yes                           | No                                  |
| Keating 200655     | Yes                       | Yes                      | Yes                         | Yes                               | Yes                    | No                        | Yes                     | No                        | Yes                           | Yes                                 |
| Blomfeldt 200749   | Yes                       | Yes                      | Yes                         | Yes                               | Yes                    | Yes                       | Yes                     | Yes                       | Yes                           | No                                  |
| Macaulay 200842,43 | Yes                       | Yes                      | Yes                         | Yes                               | Yes                    | No                        | Yes                     | No                        | Yes                           | No                                  |
| Dorr 198650        | No                        | Yes                      | No                          | Yes                               | No                     | Yes                       | No                      | No                        | Yes                           | No                                  |
| Ravikumar 200046   | No                        | Yes                      | Yes                         | Yes                               | Yes                    | Yes                       | Yes                     | Yes                       | Yes                           | Yes                                  |
| Mouzopoulos 200851 | No                        | Yes                      | Yes                         | Yes                               | No                     | Yes                       | Yes                     | No                        | Yes                           | Yes                                  |
| Gebhard 199253     | No                        | No                       | No                          | Yes                               | No                     | No                        | Yes                     | No                        | Yes                           | No                                  |
| Eysel 199452       | No                        | No                       | No                          | Yes                               | No                     | Yes                       | Yes                     | Yes                       | No                           | No                                  |
| Levi 199655        | No                        | No                       | No                          | Yes                               | No                     | Yes                       | Yes                     | Yes                       | No                           | No                                  |
| Squires 199954     | No                        | Yes                      | Yes                         | No                               | Yes                    | Yes                       | Yes                     | No                        | Yes                           | No                                  |
| Xu 200257          | No                        | No                       | No                          | No                               | No                     | No                        | No                      | No                        | No                           | No                                  |
| Schleicher 200357  | No                        | No                       | No                          | Yes                               | No                     | Yes                       | Yes                     | Yes                       | Yes                           | No                                  |
| Healy 200454       | No                        | No                       | No                          | Yes                               | No                     | Yes                       | Yes                     | Yes                       | Yes                           | No                                  |
| Narayan 200656     | No                        | Yes                      | No                          | No                               | No                     | No                        | Yes                     | Yes                       | Yes                           | No                                  |

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**Fig 4 | Random effects meta-analysis comparing relative risk of deep infections after total hip arthroplasty and hemiarthroplasty for displaced intracapsular hip fractures**
inadequate or unclear concealment of allocation (2.59, 0.83 to 8.07, test for interaction, P = 0.10).

The observed benefit in reoperation rates with total hip replacement mitigated in studies that had enrolled only oriented and ambulatory patients, used only cemented stems for hemiarthroplasty, and respected the intention to treat principle (table 5).

Local and general complications

Dislocation rates were reported in 12 studies (1517 patients, 73 events). Effect sizes were homogeneous (I²=4%, P=0.40) and publication bias was not evident (intercept 1.43, P=0.24). The pooled analysis (fig 3) showed no significant difference in the risk for dislocation between total hip arthroplasty and hemiarthroplasty (relative risk 1.48, 95% confidence interval 0.89 to 2.46, risk difference 1.0%, 95% confidence interval −1.2% to 3.2%). A tendency was, however, noted towards a higher risk for dislocation after total hip arthroplasty among randomised and quasirandomised trials. This trend was most pronounced in studies with balanced patient baseline profiles and follow-up intervals of two or more years (table 6).

Table 5 | Sensitivity analysis showing influence of prespecified variables on relative risks of reoperation

| Variables                        | No of trials/ No of patients | Relative risk (95% CI) | Relative risk ratio (95% CI) | z       | P value* |
|---------------------------------|------------------------------|------------------------|-----------------------------|--------|---------|
| Design:                         |                              |                        |                             |        |         |
| Randomised or quasi-randomised  | 7/776 0.63 (0.29 to 1.40)    | 1.26 (0.42 to 3.79)    | 0.42                        | 0.67   |         |
| Retrospective cohort            | 7/893 0.50 (0.23 to 1.08)    |                        |                             |        |         |
| Concealment:                    |                              |                        |                             |        |         |
| Appropriate                     | 4/421 1.08 (0.39 to 3.03)    | 2.59 (0.83 to 8.07)    | 1.65                        | 0.10   |         |
| Unclear                         | 10/1248 0.41 (0.25 to 0.68)  |                        |                             |        |         |
| Baseline characteristics:       |                              |                        |                             |        |         |
| Balanced                        | 12/1240 0.55 (0.30 to 1.01)  | 0.98 (0.15 to 6.09)    | −0.01                       | 0.99   |         |
| Unbalanced                      | 2/429 0.56 (0.10 to 3.15)    |                        |                             |        |         |
| Patient sample:                 |                              |                        |                             |        |         |
| Oriented and ambulatory         | 10/1201 0.75 (0.41 to 1.38)  | 2.80 (1.09 to 7.22)    | 2.14                        | 0.03   |         |
| Mixed                           | 4/468 0.27 (0.13 to 0.56)    |                        |                             |        |         |
| Hemiarthroplasty type:          |                              |                        |                             |        |         |
| All cemented stems              | 6/866 0.88 (0.44 to 1.73)    | 2.35 (0.95 to 5.82)    | 1.86                        | 0.06   |         |
| Mixed                           | 8/803 0.37 (0.20 to 0.68)    |                        |                             |        |         |
| Follow-up:                      |                              |                        |                             |        |         |
| ≥2 years                        | 12/1186 0.47 (0.26 to 0.86)  | 0.44 (0.15 to 1.26)    | −1.51                       | 0.13   |         |
| <2 years                        | 2/483 1.05 (0.45 to 2.45)    |                        |                             |        |         |
| Surgeon grade:                  |                              |                        |                             |        |         |
| Specified                       | 7/1039 0.59 (0.26 to 1.33)   | 1.13 (0.35 to 3.57)    | 0.21                        | 0.83   |         |
| Not specified                   | 7/630 0.52 (0.23 to 1.21)    |                        |                             |        |         |
| Intention to treat:             |                              |                        |                             |        |         |
| Respected                       | 4/426 1.32 (0.60 to 2.90)    | 3.26 (1.27 to 8.33)    | 2.47                        | 0.01   |         |
| Not specified                   | 10/1243 0.40 (0.24 to 0.67)  |                        |                             |        |         |
| Losses to follow-up:            |                              |                        |                             |        |         |
| <5%                             | 7/737 0.60 (0.28 to 1.30)    | 1.17 (0.39 to 3.48)    | 0.29                        | 0.77   |         |
| Not specified                   | 7/932 0.51 (0.24 to 1.11)    |                        |                             |        |         |
| Postoperative care:             |                              |                        |                             |        |         |
| Specified                       | 8/1036 0.54 (0.30 to 0.96)   | 0.98 (0.28 to 3.37)    | −0.02                       | 0.98   |         |
| Not specified                   | 6/633 0.55 (0.18 to 1.64)    |                        |                             |        |         |

*Derived from test of interaction.34

**Fig 5** | Random effects meta-analysis comparing relative risk of general complications after total hip arthroplasty and hemiarthroplasty for displaced intracapsular hip fractures

inadequate or unclear concealment of allocation (2.59, 0.83 to 8.07, test for interaction, P = 0.10).

The observed benefit in reoperation rates with total hip replacement mitigated in studies that had enrolled only oriented and ambulatory patients, used only cemented stems for hemiarthroplasty, and respected the intention to treat principle (table 5).

Local and general complications

Dislocation rates were reported in 12 studies (1517 patients, 73 events). Effect sizes were homogeneous (I²=4%, P=0.40) and publication bias was not evident (intercept 1.43, P=0.24). The pooled analysis (fig 3) showed no significant difference in the risk for dislocation between total hip arthroplasty and hemiarthroplasty (relative risk 1.48, 95% confidence interval 0.89 to 2.46, risk difference 1.0%, 95% confidence interval −1.2% to 3.2%). A tendency was, however, noted towards a higher risk for dislocation after total hip arthroplasty among randomised and quasirandomised trials. This trend was most pronounced in studies with balanced patient baseline profiles and follow-up intervals of two or more years (table 6).
Deep infections occurred in 33 of 1264 patients enrolled in 11 studies. There was no heterogeneity ($I^2=0\%$, $P=0.89$) but evidence of funnel plot asymmetry (intercept 2.81, $P=0.027$) for this end point. The pooled relative risk of infection after total hip arthroplasty compared with hemiarthroplasty was 1.27 (95% confidence interval 0.64 to 2.51), translating into a risk difference of 0.4% (95% confidence interval $-0.7\%$ to $1.6\%$). Results were virtually similar among experimental, quasiexperimental, and retrospective cohort studies (fig 4). Also, no substantial interaction was noted between all investigated subgroups for this end point (table 7).

General complications were observed slightly more often after total hip arthroplasty than after hemiarthroplasty (relative risk $1.14$, 95% confidence interval 0.87 to 1.48, risk difference $3.7\%$, 95% confidence interval $-3.7\%$ to $11.1\%$). This trend was consistently observed in randomised trials (fig 5) as well as in studies with balanced patient baseline profiles and follow-up intervals of two or more years (table 8). Results were prone to publication bias (intercept 4.09, $P=0.033$).

One year mortality
Nine studies (1023 patients, 178 events) provided data on one year mortality. There was no evidence of heterogeneity ($I^2=0\%$, $P=0.85$) and publication bias (intercept 0.22, $P=0.76$). Altogether, mortality did not differ between patients undergoing total hip arthroplasty and hemiarthroplasty (relative risk $0.92$, 95% confidence interval $0.70$ to $1.21$, risk difference $1.4\%$, 95% confidence interval $-2.6\%$ to $5.4\%$). Notable benefits were observed in randomised trials (fig 6); however, the test for interaction did not reveal significant differences between subgroups (table 9).

Function and health related quality of life
The Harris hip score was used for outcome assessment in three randomised trials and in 246 patients, with follow-up intervals ranging from 12 to 48 months.43 49 51 This score contains the subscales pain, function, deformity, and range of motion, and may achieve values from 0 to 100 points, with higher scores indicating better function.60 Total hip replacement was consistently associated with better function in all studies ($I^2=4\%$,
P=0.35) (fig 7), and without evidence of publication bias (intercept −0.18, P=0.95). The weighted mean difference in favour of total hip replacement was 5.4 (95% confidence interval 2.7 to 8.2).

Another trial had utilised the hip rating questionnaire, an instrument consisting of the four subscales arthritis, pain, walking, and daily function. Scores may range from 16 to 100 points. At final follow-up after 24 months, the weighted mean difference was 6.1 (95% confidence interval 0.4 to 11.8) in favour of total hip replacement.

The Oxford hip score was used for functional outcome measurement in another trial. This score ranges from 12 to 60 points, with higher values indicating poorer function. After three years of follow-up, hip function after total hip arthroplasty was rated slightly better than after hemiarthroplasty, by 3.5 points (95% confidence interval −0.7 to 7.7 points).

The standardised mean difference from all trials was estimated at 0.42 (95% confidence interval 0.24 to 0.61), indicating a medium functional benefit of total hip replacement.

**DISCUSSION**

The purpose of this review was to provide additional insight into the options for treating intracapsular hip fractures, focusing on the role of total hip replacement now that there is a significant body of evidence indicating that older patients treated with arthroplasty of all types have fewer complication rates and better health outcomes than those treated with internal fixation. Total hip arthroplasty compared with hemiarthroplasty was found to be beneficial for reoperation rates and functional outcomes. It is unclear whether patients

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**Table 7 | Sensitivity analysis showing influence of prespecified variables on relative risks of deep infection**

| Variables                          | No of trials/No of patients | Relative risk (95% CI) | Relative risk ratio (95% CI) | z     | P value* |
|-----------------------------------|----------------------------|------------------------|----------------------------|-------|---------|
| **Design:**                       |                            |                        |                            |       |         |
| Randomised or quasi-randomised    | 6/690                      | 1.37 (0.59 to 3.18)    | 1.28 (0.29 to 5.47)        | 0.33  | 0.74    |
| Retrospective cohort              | 5/912                      | 1.07 (0.32 to 3.51)    |                            |       |         |
| Concealment:                      |                            |                        |                            |       |         |
| Appropriate                       | 4/421                      | 1.71 (0.65 to 4.44)    | 1.86 (0.47 to 7.34)        | 0.89  | 0.38    |
| Unclear                           | 7/1181                     | 0.91 (0.34 to 2.46)    |                            |       |         |
| **Baseline characteristics:**     |                            |                        |                            |       |         |
| Balanced                           | 9/1018                     | 1.52 (0.69 to 3.31)    | 2.25 (0.43 to 11.63)       | 0.97  | 0.33    |
| Unbalanced                         | 2/584                      | 0.67 (0.15 to 2.85)    |                            |       |         |
| **Patient sample:**               |                            |                        |                            |       |         |
| Oriented and ambulatory           | 7/979                      | 1.81 (0.75 to 4.36)    | 2.48 (0.61 to 10.11)       | 1.27  | 0.20    |
| Mixed                              | 4/623                      | 0.72 (0.24 to 2.17)    |                            |       |         |
| **Hemiarthroplasty type:**        |                            |                        |                            |       |         |
| All cemented stems                | 5/800                      | 1.61 (0.61 to 4.19)    | 1.64 (0.41 to 6.47)        | 0.71  | 0.48    |
| Mixed                              | 6/802                      | 0.98 (0.36 to 2.62)    |                            |       |         |
| Follow-up:                        |                            |                        |                            |       |         |
| ≥2 years                          | 8/898                      | 1.52 (0.63 to 3.64)    | 1.63 (0.39 to 6.74)        | 0.69  | 0.49    |
| <2 years                          | 3/704                      | 0.93 (0.30 to 2.83)    |                            |       |         |
| Surgeon grade:                    |                            |                        |                            |       |         |
| Specified                          | 7/1185                     | 1.14 (0.55 to 2.37)    | 0.40 (0.04 to 3.67)        | −0.80 | 0.42    |
| Not specified                      | 4/417                      | 2.82 (0.35 to 22.5)    |                            |       |         |
| Intention to treat:               |                            |                        |                            |       |         |
| Respected                          | 3/340                      | 1.49 (0.51 to 4.31)    | 1.33 (0.33 to 5.36)        | 0.41  | 0.68    |
| Not specified                      | 8/1262                     | 1.12 (0.45 to 2.75)    |                            |       |         |
| Losses to follow-up:              |                            |                        |                            |       |         |
| <5%                               | 5/576                      | 1.65 (0.63 to 4.31)    | 1.74 (0.44 to 6.87)        | 0.79  | 0.43    |
| Not specified                      | 6/1026                     | 0.95 (0.35 to 2.54)    |                            |       |         |
| Postoperative care:               |                            |                        |                            |       |         |
| Specified                          | 7/1110                     | 1.02 (0.43 to 2.44)    | 0.57 (0.13 to 2.35)        | −0.78 | 0.44    |
| Not specified                      | 4/492                      | 1.79 (0.58 to 5.50)    |                            |       |         |

*Derived from test of interaction.34

SF-36 physical component scores were available from two trials totalling 121 patients, with no differences between total hip arthroplasty and hemiarthroplasty (weighted mean difference 1.9, 95% confidence interval −2.2 to 6.0). Another trial had used EQ-5D utility scores, which were rated significantly better in the total hip arthroplasty group compared with the hemiarthroplasty group after two years of follow-up (mean difference 0.16, 95% confidence interval 0.05 to 0.27).45

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undergoing total hip replacement may also benefit from a small survival advantage after one year. The potential advantages must be traded off against a possible higher risk of dislocation and general complications, higher invasiveness, and longer theatre times.

Strengths and weaknesses of this review
This is the first review to compile all available head to head investigations of total hip arthroplasty compared with hemiarthroplasty for femoral neck fractures. By including both experimental and non-experimental studies, the sample size and robustness of estimates was enhanced compared with previous reviews. Yet, the number of available studies was small, and with an overall sample size of fewer than 2000 patients our results do not allow for conclusive statements on the effectiveness of total hip arthroplasty and hemiarthroplasty for treating femoral neck fractures. Some might argue about the inclusion of retrospective cohort studies because of their inherent risk of bias. However, such studies enrolled a significant number of patients and, despite methodological limitations, ignoring this source of data might have affected the external validity of our findings. The researchers were diligent about extracting as much information as possible from the available papers. We tried to control our computations for confounding, carried out various sensitivity analyses, and explored the interaction between subgroups.

There is no doubt that only randomisation creates biologically similar patient cohorts, in which unknown confounders are equally distributed, and allows for inferences on causal relations between exposure and outcome. It might be assumed that in non-randomised studies, patients with poorer prognosis were more likely to undergo the faster, less invasive procedure of hemiarthroplasty, thereby introducing selection and differential indication bias.

Although the published information on patient profiles was limited in quantity and quality, participants enrolled in the retrospective cohort studies were not entirely different from those enrolled in the randomised trials. This is not surprising, since the typical patient presenting with a femoral neck fracture to an emergency department in an industrial country (thus being a potential candidate for a clinical study) is a

| Variables | No of trials/ No of patients | Relative risk (95% CI) | Relative risk ratio (95% CI) | z | P value* |
|-----------|-------------------------------|------------------------|-------------------------------|---|--------|
| Design:   |                               |                        |                               |   |        |
| Randomised or quasi-randomised | 4/421 | 1.35 (1.04 to 1.75) | 1.41 (0.91 to 2.19) | 1.54 | 0.12 |
| Retrospective cohort | 4/710 | 0.95 (0.67 to 1.36) |                       |   |        |
| Concealment: |                               |                        |                               |   |        |
| Appropriate | 4/421 | 1.35 (1.04 to 1.75) | 1.41 (0.91 to 2.19) | 1.54 | 0.12 |
| Unclear | 4/710 | 0.95 (0.67 to 1.36) |                       |   |        |
| Baseline characteristics: |                               |                        |                               |   |        |
| Balanced | 7/768 | 1.24 (1.02 to 1.51) | 1.68 (1.24 to 2.27) | 3.37 | <0.01 |
| Unbalanced | 1/363 | 0.74 (0.58 to 0.93) |                       |   |        |
| Patient sample: |                               |                        |                               |   |        |
| Oriented and ambulatory | 7/965 | 1.16 (0.86 to 1.56) | 1.20 (0.51 to 2.78) | 0.43 | 0.67 |
| Mixed | 1/166 | 0.97 (0.44 to 2.13) |                       |   |        |
| Hemiarthroplasty type: |                               |                        |                               |   |        |
| All cemented stems | 4/744 | 1.14 (0.68 to 1.93) | 0.96 (0.55 to 1.70) | −0.11 | 0.92 |
| Mixed | 4/387 | 1.18 (0.95 to 1.47) |                       |   |        |
| Follow-up: |                               |                        |                               |   |        |
| ≥2 years | 6/648 | 1.24 (1.02 to 1.51) | 1.65 (1.22 to 2.23) | 3.27 | <0.01 |
| <2 years | 2/483 | 0.75 (0.60 to 0.94) |                       |   |        |
| Surgeon grade: |                               |                        |                               |   |        |
| Specified | 6/859 | 1.22 (0.83 to 1.80) | 1.13 (0.69 to 1.85) | 0.52 | 0.60 |
| Not specified | 2/272 | 1.07 (0.79 to 1.45) |                       |   |        |
| Intention to treat: |                               |                        |                               |   |        |
| Respected | 3/340 | 1.28 (0.97 to 1.70) | 1.18 (0.73 to 1.89) | 0.70 | 0.48 |
| Not specified | 5/791 | 1.08 (0.74 to 1.58) |                       |   |        |
| Losses to follow-up: |                               |                        |                               |   |        |
| <5% | 5/562 | 1.26 (0.97 to 1.63) | 1.31 (0.79 to 2.18) | 1.07 | 0.28 |
| Not specified | 3/569 | 0.95 (0.62 to 1.48) |                       |   |        |
| Postoperative care: |                               |                        |                               |   |        |
| Specified | 3/564 | 1.09 (0.56 to 2.11) | 0.90 (0.45 to 1.80) | −0.28 | 0.78 |
| Not specified | 5/567 | 1.20 (0.98 to 1.48) |                       |   |        |

*Derived from test of interaction.34
woman in her mid-70s with osteoporosis, cardiovascular comorbidity, and associated drugs. The available information did not support the thesis that different treatment assignment in non-randomised studies was mainly based on preoperative risk assessment. Although we do not discount this, we suspect that in these studies surgeons’ preferences, as well as disposability of teams, hardware, and theatre time slots, contributed to the decision to implant a total hip or a bipolar prosthesis. This does, however, resemble clinical reality.

We noted further interesting patterns of treatment effects that may be useful for planning future trials. Random assignment to interventions in itself had little influence on the reported reoperation rates. In fact, the observed advantage with total hip replacement disappeared with adequate concealment of allocation, which may be an important surrogate of higher methodological quality. Other features such as the recruitment of physically and mentally fit patients and routine cementation of stems in the hemiarthroplasty control group mitigated (but still did not exclude) favourable reoperation risks after total hip arthroplasty.

Upcoming trial protocols should respect these important variables that may distort effect sizes. They must also aim for minimum follow-up intervals of two years to confirm or refute potential gains of total hip arthroplasty over hemiarthroplasty in the fracture scenario.

It is noteworthy that, although derived from a small subset of studies, the findings of better hip function after total hip replacement were highly consistent. A reliable trade-off of the possible benefits and harms with total hip replacement also requires large scale data on health related quality of life.

Other studies
A recent meta-analysis of randomised trials identified three studies, all included in this review. The meta-analysis reported similar findings to this review, with higher reoperation rates and a trend for lower dislocation rates with hemiarthroplasty. Patients who had undergone total hip replacement were more likely to become mobile and less likely to require a second analgesic at 1, 2, 4, and 13 years, although this was not statistically significant at any assessment time. The greater proportion of mobile patients who had

| Table 9 | Sensitivity analysis showing influence of prespecified variables on relative risks of one year mortality |
|----------|---------------------------------------------------------------|
| Variables | No of trials/No of patients | Relative risk (95% CI) | Relative risk ratio (95% CI) | z     | P value* |
| Design: | | | | | | |
| Randomised or quasi-randomised | 6/695 | 0.8 (0.56 to 1.14) | 0.71 (0.41 to 1.24) | −1.19 | 0.24 |
| Retrospective cohort | 3/328 | 1.11 (0.73 to 1.71) | | | |
| Concealment: | | | | | | |
| Appropriate | 3/340 | 0.67 (0.29 to 1.50) | 0.70 (0.29 to 1.65) | −0.81 | 0.42 |
| Unclear | 6/683 | 0.95 (0.71 to 1.27) | | | |
| Baseline characteristics: | | | | | | |
| Balanced | 9/1023 | 0.91 (0.69 to 1.20) | | | |
| Unbalanced | 0 | | | | |
| Patient sample: | | | | | | |
| Oriented and ambulatory | 6/621 | 0.88 (0.57 to 1.37) | 0.94 (0.53 to 1.66) | −0.20 | 0.84 |
| Mixed | 3/402 | 0.93 (0.66 to 1.32) | | | |
| Hemiarthroplasty type: | | | | | | |
| All cemented stems | 3/356 | 0.84 (0.40 to 1.77) | 0.90 (0.40 to 2.02) | −0.24 | 0.81 |
| Mixed | 6/667 | 0.93 (0.69 to 1.24) | | | |
| Follow-up: | | | | | | |
| ≥2 years | 8/903 | 0.90 (0.68 to 1.19) | 0.67 (0.15 to 2.98) | −0.51 | 0.61 |
| <2 years | 1/120 | 1.33 (0.31 to 5.70) | | | |
| Surgeon grade: | | | | | | |
| Specified | 4/520 | 0.79 (0.51 to 1.22) | 0.79 (0.45 to 1.37) | −0.83 | 0.41 |
| Not specified | 5/503 | 1.01 (0.70 to 1.43) | | | |
| Intention to treat: | | | | | | |
| Respected | 4/426 | 0.72 (0.42 to 1.23) | 0.72 (0.38 to 1.34) | −1.02 | 0.31 |
| Not specified | 5/597 | 1 (0.72 to 1.37) | | | |
| Losses to follow-up: | | | | | | |
| <5% | 5/581 | 0.93 (0.59 to 1.47) | 1.03 (0.58 to 1.82) | 0.12 | 0.90 |
| Not specified | 4/442 | 0.90 (0.64 to 1.27) | | | |
| Postoperative care: | | | | | | |
| Specified | 5/531 | 0.87 (0.60 to 1.26) | 0.90 (0.49 to 1.65) | −0.32 | 0.75 |
| Not specified | 4/492 | 0.96 (0.59 to 1.54) | | | |

*Derived from test of interaction.
undergone total hip replacement seems to correspond to the better hip function found with total hip replacement in this review. An earlier Cochrane review\textsuperscript{48} that compared cemented and cementless arthroplasty and internal fixation also carried out a meta-analysis of total hip arthroplasty compared with hemiarthroplasty based on three studies used in this review.\textsuperscript{45,47,50} The Cochrane review found no significant differences between the interventions, although there was a trend for higher dislocation rates and lower reoperation rates with total hip replacement. Also, total hip arthroplasty was found to take about 20 minutes longer than hemiarthroplasty.

Meaning of our review

The optimal treatment strategy for hip fractures matters to healthcare professionals, policy makers, and payers of healthcare services, and should avoid costly reoperations, secondary hospital admissions, loss of independence, and physical disability. The noted 43\% relative or 4\% absolute reduction in the risk of reoperation with total hip arthroplasty is clinically important, given reported baseline risks of revision with hemiarthroplasty ranging from 6\% to 18\%.\textsuperscript{21,23} It must be kept in mind, however, that this is an aggregated effect mainly driven by data from trials with inadequate concealment. In contrast, total hip replacement was associated with a 48\% relative or 1\% absolute increase in the risk of dislocation. Avoiding further major surgical procedures is particularly relevant to patients with hip fractures, who are generally older and less healthy than the general population.

Unanswered questions and future research

The results from this review cannot be considered conclusive owing to various interactions between strata. Furthermore, the improvement in function and health outcomes with total hip replacement was modest and only reported by a small number of studies. Therefore large scale clinical research to study the potential effects of total hip replacement on mobility and regain of independent living after displaced fractures of the femoral neck is merited. The quantitative findings from this review may allow for a better planning of those trials, selection of trial end points, and sample size estimation.

Patients are currently being recruited to the Hip Fracture Evaluation with Alternatives of Total Hip Arthroplasty versus Hemi-Arthroplasty trial, an initiative of the International Hip Fracture Research Collaborative. With a target sample size of 2500 patients for this study, the results from this trial, expected to be published in 2011, may allow for more conclusive inferences on this matter, but still must be interpreted in the light of current best evidence and the prior probability of effectiveness with either type of joint replacement. Additionally, a formal health economic analysis would be useful for providing greater clarity in decision making.

Patients with greater levels of activity treated with hemiarthroplasty may induce osteoarthritis more rapidly than in less active patients and, as they are likely to have a higher life expectancy, will be exposed to the risk of acetabular erosion for a longer period. Factors contributing to dislocation rates may be the...
Conclusions

Although this review was limited to a small number of randomised controlled trials and retrospective cohort studies, some evidence suggested that patients treated with total hip arthroplasty for intracapsular hip fractures may have better outcomes than those treated with hemiarthroplasty.

The data currently available, however, do not yet allow for definitive conclusions about the scale and existence of some of the identified treatment effects, owing to varying interactions between subgroups, particularly those concerning random allocation of patients. Considering that a more frequent use of total hip replacement in oriented and mobile patients with displaced intracapsular hip fractures may be appropriate and save costs in the long run, an adequately powered trial is urgently needed to dispel these remaining doubts of the benefit to risk ratio with total hip replacement in the fracture setting.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Arthroplasty is associated with lower reoperation rates and better function than internal fixation for patients with displaced intracapsular hip fractures.

Total hip arthroplasty may be associated with better function than hemiarthroplasty in this setting and may also avoid secondary conversion surgery.

A sample of randomised trials comparing both interventions was included in a recent systematic review, but an overview of the entire body of evidence is lacking.

WHAT THIS STUDY ADDS

Data from 15 studies suggest that total hip arthroplasty is associated with lower reoperation rates and slightly better functional outcomes than hemiarthroplasty.

Advantages with total hip arthroplasty must be traded off against a slightly higher risk of dislocations and general complications.

Large well designed clinical trials comparing the two interventions are required before a definitive conclusion on their risk-benefit ratio can be reached.

Contributors: CH conceived the study. CH and MW did the first data analyses, and DS did the final analyses. CH wrote the first draft of the protocol and the paper. CH, MW, and DS wrote the final draft of the paper and did the literature searches. All authors contributed to extracting and interpreting data and to revising the protocol and manuscript. CH and DS are the guarantors.

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Competing interests: All authors have completed the Unified Competing Interests form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that (1) CH has support from DePuy International a Johnson & Johnson company for the submitted work; (2) DS, AE, and MW have no relationships with DePuy International a Johnson & Johnson Company that might have an interest in the submitted work in the previous three years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) CH, DS, AE, and MW have no non-financial interests that may be relevant to the submitted work.

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Data sharing: The technical appendix, and datasets extracted from individual papers and meta-analyses are available from the corresponding author at chopley@pts.jnj.com.

1. Dorner T, Weichselbaum E, Lawrence K, Viktoria SK, Rieder A, Austrian osteoporosis report: epidemiology, lifestyle factors, public health strategies. Wien Med Wochenschr 2009;159:221-9.
2. Nieves JW, Bilezikian JP, Lane JM, Einhorn TA, Wang Y, Steinbuch M, et al. Fragility fractures of the hip and femur: incidence and patient characteristics. Osteoporos Int 2010;21:399-408.
3. Eklund F, Nordstrom A, Neovius M, Svensson O, Nordstrom P. Variation in fracture rates by country may not be explained by differences in bone mass. Calcif Tissue Int 2009;85:10-6.
4. Abrahamsen B, Vestergaard P. Declining incidence of hip fractures and the extent of use of anti-osteoporotic therapy in Denmark 1997-2006. Osteoporos Int 2010;21:373-80.
5. Sirosi MJ, Cole M, Pfeit S. The burden of hospitalized hip fractures: patterns of admissions in a level I trauma center over 20 years. J Trauma 2009;66:1402-10.
6. Holt G, Smith R, Duncan K, Hutchinson JD, Reid D. Changes in population demographics and the future incidence of hip fracture. Injury 2009;40:722-6.
7. Icks A, Haasbott B, Wildner M, Becker C, Rapp Dr, Dragano N, et al. Hip fractures and area level socioeconomic conditions: a population-based study. BMC Public Health 2009;9:114.
8. Dodds MK, Cold MB, Looney A, Mulhall KG. Incidence of hip fracture in the Republic of Ireland and future projections: a population-based study. Osteoporos Int 2009;20:2105-10.
9. Tsang SW, Kung AW, Kanis JA, Johansson H, Oden A. Ten-year fracture probability in Hong Kong southern Chinese according to age and BMD femoral neck T-scores. Osteoporos Int 2009;20:1939-45.
10. Fisher AA, O’Brien ED, Davis MW. Trends in hip fracture epidemiology in Australia: possible impact of bisphosphonates and hormone replacement therapy. Bone 2009;45:246-53.
11. Oliver D, Connelly JB, Victor CR, Shaw FE, Whitehead A, Genc Y, et al. Strategies to prevent falls and fractures in hospitals and care homes and effect of cognitive impairment: systematic review and meta-analyses. BMJ 2007;334:82-5.
12. Bischoff-Ferrari HA, Willett WC, Wong JB, Giovannucci E, Dietrich T, Dawson-Hughes B. Fracture prevention with vitamin D supplementation: a meta-analysis of randomized controlled trials. JAMA 2005;293:2257-64.
13. Bischoff-Ferrari HA, Dawson-Hughes B, Willett WC, Staehelin HB, Bazemore MG, Zee RF, et al. Effect of Vitamin D on falls: a meta-analysis. JAMA 2004;291:1999-2006.
14. Iwamoto J, Sato Y, Takeda T, Matsumoto H. Hip fracture protection by alendronate treatment in postmenopausal women with osteoporosis: a review of the literature. Clin Interv Aging 2008;3:483-9.
15. Wilels G, Crane N, Peterson L, Boucher M, Shea B, Robinson V, et al. Risedronate for the primary and secondary prevention of osteoporotic fractures in postmenopausal women. Cochrane Database Syst Rev 2008;1:CD005423.
16. Wells GA, Crane N, Peterson L, Boucher M, Shea B, Robinson V, et al. Etidronate for the primary and secondary prevention of osteoporotic fractures in postmenopausal women. Cochrane Database Syst Rev 2008;1:CD003736.
17. Reid IR, Bolland MJ, Grey A. Effect of calcium supplementation on hip fractures. Osteoporos Int 2008;19:1119-23.
18. MacLean C, Newberry S, Maglione M, McMahon M, Ranganath V, Suttop M, et al. Systematic review: comparative effectiveness of
treatments to prevent fractures in men and women with low bone density or osteoporosis. Ann Intern Med 2008;148:197-213.

19 Jackson C, Gaugris S, Sen SS, Hosking D. The effect of cholecalciferol (vitamin D3) on the risk of fall and fracture: a meta-analysis. Q J Med 2007;100:181-92.

20 Sahni S, Hannan MT, Gagnon D, Blumberg J, Cupples LA, Kiel DP, et al. Protective effect of total and supplemental vitamin C intake on the risk of hip fracture—a 17-year follow-up from the Framingham Osteoporosis Study. Osteoporos Int 2009;20:1853-61.

21 Kromm A, Johnell O. Primary arthroplasty is better than internal fixation of displaced femoral neck fractures: a meta-analysis of 14 randomized studies with 2,289 patients. Acta Orthop 2006;77:359-67.

22 Frihagen F, Nordsletten L, Madsen JE. Hip hemiarthroplasty or internal fixation for intracapsular displaced femoral neck fractures: randomised controlled trial. BMJ 2007;335:1251-4.

23 Bhandari M, Devereaux PJ, Swiontkowski MF, Tornetta P III, O'Brien W, Koval K, et al. Technical fixation with spongiosa for displaced hip fractures in elderly patients: a multi-centre study. J Orthop Trauma 2007;21:436-41.

24 Scottish Intercollegiate Guidelines Network. Management of hip fracture in older people: a national clinical guideline. Scottish Intercollegiate Guidelines Network, 2005.

25 Kakar S, Tornetta P III, Schmitz EH, Swiontkowski MF, Koval K, Hanson BP, et al. Technical considerations in the operative management of femoral neck fractures in elderly patients: a multinational study. J Trauma 2007;63:641-6.

26 Bhandari M, Devereaux PJ, Tornetta P III, Swiontkowski MF, Beny D, Haidukewych G, et al. Operative management of displaced femoral neck fractures in elderly patients: an international survey. J Bone Joint Surg Am 2005;87:2122-30.

27 Sayana MK, Lakshmanan P, Peehal JP, Wynn-Jones C, Maffulli N. Total hip replacement for acute femoral neck fracture: a survey of National Joint Registers. Acta Orthop Belg 2008;74:54-8.

28 Parker MJ, Gurusamy K. Arthroplasties (with and without bone cement) for proximal femoral fractures in adults. Cochrane Database Syst Rev 2006;3:CD001706.

29 Parker MJ, Handoll HH. Replacement arthroplasty versus internal fixation for extra-articular hip fractures in adults. Cochrane Database Syst Rev 2006;2:CD000086.

30 Dawson J, Fitzpatrick R, Frost S, Gundale R, McLardy-Smith P, Murray D. Evidence for the validity of a patient-based instrument for assessment of outcome after revision hip replacement. J Bone Joint Surg Br 2001;83:1125-9.

31 DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials 1986;7:177-88.

32 Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ 2003;327:557-60.

33 Egger M, Davey SG, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ 1997;315:629-34.

34 Altman DG, Bland JM. Measurement error revisited: the difference between two estimates. BMJ 2003;326:219.

35 Harris RB, Bradburn MJ, Deeks JJ, Harbord RM, Altman DG, Sterne JA. Meta-analysis: fixed- and random-effects meta-analysis. Stata J 2008;8:3-28.

36 Geiger F, Schneiter K, Schneider S, Pauschert R, Thomsen M. [Proximal fracture of the femur in elderly patients. The influence of surgical care and patient characteristics on post-operative mortality.] Orthopade 2006;35:651-7.

37 van der Tol S, Bleken R, Bleken A, Thomsen M, van der Tol G, Heun R, et al. The four-year functional result after a displaced subcapital hip fracture treated with three different surgical options. Int Orthop 2008;32:367-73.

38 Eysel MM, Schwenk W, Badke A, Krebs S, Stock W. [Total endoprosthesis or dual head prosthesis in endoprosthetic management of femoral neck fractures?] Unfallchirurg 1994;97:347-52.

39 Gedibhard JS, Amstutz HC, Zinar DM, Dorey FJ. A comparison of total hip arthroplasty and hemiarthroplasty for treatment of acute fracture of the femoral neck. Clin Orthop Relat Res 1992;123-31.

40 Healy WL, Iorio R. Total hip arthroplasty: optimal treatment for displaced femoral neck fractures in elderly patients. Clin Orthop Relat Res 2004;423:8-20.

41 Levi N. Early mortality after cervical hip fractures. Injury 1996;27:565-7.

42 Narayan KN, George T. Functional outcome of fracture neck of femur treated with total hip replacement versus bipolar arthroplasty in a South Asian population. Arch Orthop Trauma Surg 2006;126:545-58.

43 Schleicher J, Kordelle J, Jungersen L, Haas H, Melzer C. [Femoral neck fractures in the elderly—bipolar hemi-arthroplasty in total hip replacement.] Unfallchirurg 2003;106:467-71.

44 Squires B, Bannister G. Displaced intracapsular neck of femur fractures in mobile independent patients: total hip replacement or hemiarthroplasty? Injury 1999;30:345-8.

45 Xiu X, Liu Y, Liu J, Li Y. Prosthetic replacement in treatment of subcapital femoral neck fractures in the elderly. Chin J Traumatol 2002;5:28-31.

46 Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 1969;51:73-85.

47 Johanson NA, Charleston ME, Szatrowski TP, Ranawat CS. A self-administered hip-rating questionnaire for the assessment of outcome after total hip replacement. J Bone Joint Surg Am 1997;79:587-97.

48 Dawson J, Fitzpatrick R, Murray D, Carr A. Comparison of measures to assess outcomes in total hip replacement surgery. J Bone Joint Surg Br 1997;79:587-97.

49 Blomfeldt R, Tornkvist H, Eriksson K, Soderqvist A, Panzer S, Tidemar K. A randomised controlled trial comparing bipolar hemi-arthroplasty with total hip replacement for displaced intracapsular fractures of the femoral neck in elderly patients. J Bone Joint Surg Br 2007;89:160-5.

50 von Dörse R, Mayr R, Hauschildt H, Hahn P, Wolf HG, Härtert V. Displaced subcapital fractures of the femur: a prospective randomised controlled comparison of internal fixation, hemi-arthroplasty and total hip replacement. Injury 1989;20:291-3.

51 Skoumal P, Roständ M, Lassen J, Skjodek M, Sorensen O. Cemented versus non-cemented hip prostheses. Acta Orthop Scand Suppl 1981;170:1-11.

52 Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 1969;51:73-85.

53 Johanson NA, Charleston ME, Szatrowski TP, Ranawat CS. A self-administered hip-rating questionnaire for the assessment of outcome after total hip replacement. J Bone Joint Surg Am 1997;79:587-97.

54 Dawson J, Fitzpatrick R, Murray D, Carr A. Comparison of measures to assess outcomes in total hip replacement surgery. J Bone Joint Surg Br 1997;79:587-97.

55 Squires B, Bannister G. Displaced intracapsular neck of femur fractures in mobile independent patients: total hip replacement or hemiarthroplasty? Injury 1999;30:345-8.

56 Xiu X, Liu Y, Liu J, Li Y. Prosthetic replacement in treatment of subcapital femoral neck fractures in the elderly. Chin J Traumatol 2002;5:28-31.

57 Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 1969;51:73-85.

58 Johanson NA, Charleston ME, Szatrowski TP, Ranawat CS. A self-administered hip-rating questionnaire for the assessment of outcome after total hip replacement. J Bone Joint Surg Am 1997;79:587-97.

59 Xu X, Liu Y, Liu J, Li Y. Prosthetic replacement in treatment of subcapital femoral neck fractures in the elderly. Chin J Traumatol 2002;5:28-31.

60 Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 1969;51:73-85.

61 Johanson NA, Charleston ME, Szatrowski TP, Ranawat CS. A self-administered hip-rating questionnaire for the assessment of outcome after total hip replacement. J Bone Joint Surg Am 1997;79:587-97.

62 Dawson J, Fitzpatrick R, Murray D, Carr A. Comparison of measures to assess outcomes in total hip replacement surgery. J Bone Joint Surg Br 1997;79:587-97.

63 Squires B, Bannister G. Displaced intracapsular neck of femur fractures in mobile independent patients: total hip replacement or hemiarthroplasty? Injury 1999;30:345-8.

64 Xiu X, Liu Y, Liu J, Li Y. Prosthetic replacement in treatment of subcapital femoral neck fractures in the elderly. Chin J Traumatol 2002;5:28-31.