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■ **TRAUMA**

Reoperation and revision rates at ten years after 1,312 cemented Thompson's hemiarthroplasties

ANY NEED TO CHANGE TO A DIFFERENT IMPLANT?

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Aims

Despite multiple trials and case series on hip hemiarthroplasty designs, guidance is still lacking on which implant to use. One particularly deficient area is long-term outcomes. We present over 1,000 consecutive cemented Thompson's hemiarthroplasties over a ten-year period, recording all accessible patient and implant outcomes.

Methods

Patient identifiers for a consecutive cohort treated between 1 January 2003 and 31 December 2011 were linked to radiographs, surgical notes, clinic letters, and mortality data from a national dataset. This allowed charting of their postoperative course, complications, readmissions, returns to theatre, revisions, and deaths. We also identified all postoperative attendances at the Emergency and Outpatient Departments, and recorded any subsequent skeletal injuries.

Results

In total, 1,312 Thompson's hemiarthroplasties were analyzed (mean age at surgery 82.8 years); 125 complications were recorded, necessitating 82 returns to theatre. These included 14 patients undergoing aspiration or manipulation under anaesthesia, 68 reoperations (5.2%) for debridement and implant retention (n = 12), haematoma evacuation (n = 2), open reduction for dislocation (n = 1), fixation of periprosthetic fracture (n = 5), and 48 revised stems (3.7%), for infection (n = 13), dislocation (n = 12), aseptic loosening (n = 9), persistent pain (n = 6), periprosthetic fracture (n = 4), acetabular erosion (n = 3), and metastatic bone disease (n = 1). Their status at ten years is summarized as follows: 1,180 (89.9%) dead without revision, 34 (2.6%) dead having had revision, 84 (6.6%) alive with the stem unrevised, and 14 (1.1%) alive having had revision. Cumulative implant survivorship was 90.3% at ten years; patient survivorship was 7.4%.

Conclusion

The Thompson's stem demonstrates very low rates of complications requiring reoperation and revision, up to ten years after the index procedure. Fewer than one in ten patients live for ten years after fracture. This study supports the use of a cemented Thompson's implant as a cost-effective option for frail hip fracture patients.

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Introduction

The Thompson's stem is a generic design of a hemiarthroplasty stem entering its seventh decade of worldwide use for the treatment of intracapsular hip fractures.[1,2] The National Institute for Health and Care Excellence (NICE) 2011 guidance recommended against the use of Austin Moore or Thompson's

stems for hemiarthroplasty, suggesting the use of a femoral component with an Orthopaedic Data Evaluation Panel (ODEP)[3] rating of at least 3B when used in a total hip arthroplasty (THA). Two randomized controlled trials published since the NICE guidance did not demonstrate any difference in health outcomes or complication rates between a cemented Thompson's stem and the Exeter trauma stem, a universal-offset monoblock stem based on (but with a different surface finish to) the Exeter V40 stem (Stryker, USA).[4,5] The more recent World Hip Trauma Evaluation (WHiTE3) multicentre trial found no difference in mobility, mortality, and four-month postoperative EuroQol five-dimension questionnaire (EQ-5D) scores between Thompson's and the Exeter V40 arthroplasty stem combined with a large modular unipolar head.[6] A clarification from the ODEP committee (which does not rate femoral stems when used as hemiarthroplasties only) in November 2019 resulted in an update from NICE which removed advice regarding ODEP rating for hemiarthroplasties.[3] The guidance in this area therefore remains unclear.

Survivorship analysis after hemiarthroplasties is more nuanced than after THAs. These patients are generally older than those undergoing elective THA, with a significant comorbidity profile and a varying degree of cognitive and capacity impairment at the time of presentation. One-third of patients have usually died before the one-year anniversary of their surgery, let alone reach the ten-year time metric used by ODEP.[7] Even in the short to medium term, patients suffering complications may not be able to seek specialist help, and the majority of those who do get seen by orthopaedic teams may still be unsuitable or deemed too frail for surgical intervention. An ideal outcome analysis after hemiarthroplasty should therefore differentiate between implant and patient survivorship, and analyze all the possible recorded outcomes, for as long a period as possible. Such an intuitive approach is lacking in literature published to date.[8-11]

We have previously demonstrated 95% implant survivorship at five years after cemented Thompson's hemiarthroplasty in a large consecutive series, from a Trust which caters to the largest geographical catchment areas within England (5,100 square kilometres) and has a robust system for data collection and outcomes monitoring.[12] We now present our findings of ten-year survivorship in this cohort, separately analyzed for both implants and patients. We also present all recorded complications, return to theatre episodes, and reoperations, aiming to put forth a more holistic picture of all outcomes for this large contemporaneous cohort.

Methods

A retrospective cohort was identified, comprising consecutive patients who underwent cemented Thompson's hemiarthroplasty from 1 January 2003 to 31 December 2011, as identified by a patient administration system. A supplemental search was performed on the Trust's online radiology repository (CareStream, USA) for all imaging descriptors for pelvis and hip radiographs used across the Trust between these two dates. We excluded delayed hemiarthoplasties for failed nonoperative management, salvage procedures for failed fixations (e.g. after cannulated screws), revision procedures for failed hemiarthroplasties, procedures done without cement, procedures not followed by postoperative radiographs, and patients repatriated to other countries after surgery.

The final dataset of hemiarthroplasties was then linked to: surgical notes and clinical letters available online; data collected by the Surgical Site Infection Surveillance Service (SSISS) team; and mortality data from the Office of National Statistics (ONS). This allowed charting of the following events: postoperative course; date of discharge from the ward and hospital; complications, readmissions, and return to theatre; revisions and causes; later attendances at the emergency department (ED) with fall-related injuries (e.g. contralateral hip fractures, pubic rami fractures, acetabular fractures); clinic appointments requested by the patients' general practitioners or elderly care teams; and dates and places of death.

For implant outcomes, the unit of analysis was the implant, rather than the patient. Returns to theatres included all recorded postoperative visits to theatre, including procedures like aspirations and manipulations under anaesthesia. The chronology, cause, and outcome for each return was recorded. A reoperation was defined as any procedure in which a new incision was placed to expose the tissues overlying the hip joint. Finally, a revision was defined as any procedure in which the originally implanted Thompson's stem was explanted (e.g. revised to a different stem such as a bipolar stem, revised to a THA, excised in a Girdlestone's arthroplasty etc.). If a return to theatre resulted in a revision in the same spell, it was counted as a revision and not a return. Subsequent procedures for contralateral hip fractures or distal femoral fractures were recorded but not included in returns to theatre. Life tables were produced with numbers of implants entering each year and yearly revisions and deaths, to give annual and cumulative survival rates (Table I).[13] Kaplan-Meier survival curves were then produced for both implants and patients (Figure 1).

Results

Overall, 1,312 patients underwent cemented Thompson's hemiarthroplasties, all through lateral trans-gluteal approach.[14] Females accounted for 1,029 cases (78.4%). The mean age at surgery was 82.8 years (52 to 102). A total of 125 stems (9.5%) encountered complications over the ten-year period. These included infection (n = 37, 29.6%), dislocation (n = 24, 19.2%), persistent pain (n = 22, 17.6%), aseptic loosening (n = 19, 15.2%),

Table I. Reasons for revision.

Complication	Stems suffering complication, n	Stems returning to theatre, n	Stems reoperated, n	Stems revised, n	% of all revisions
Infection	37	28	25	13	27.1
Dislocation	24	20	13	12	25
Persistent pain	22	9	6	6	12.5
Aseptic loosening	19	10	9	9	18.7
Periprosthetic fracture	10	9	9	4	8.3
Acetabular erosion	7	3	3	3	6.25
Bleeding/haematomas	5	2	2	0	0
Metastatic bone disease	1	1	1	1	2.1
Total	125	82	68	48	100
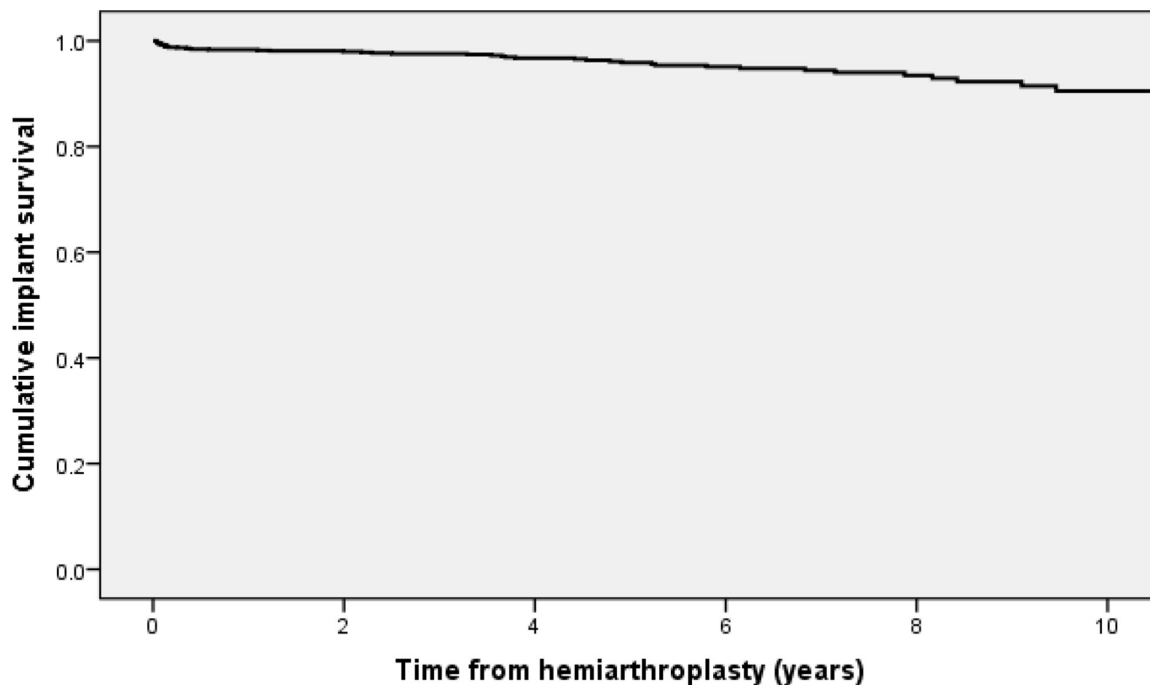
Fig. 1

Kaplan-Meier curve for implant survival (see Table II for numbers at risk).

periprosthetic fracture (n = 10, 8%), acetabular erosion (n = 7, 5.6%), haematoma and/or wound bleeding (n = 5, 4%), and failure due to metastatic bone disease (n = 1, 0.8%) (Table I). Of these, 82 stems (6.2%) were linked to returns to theatre, including 68 reoperations (5.2%), and 14 procedures not involving surgical incision (seven aspirations, seven manipulations under anaesthesia). A total of 48 (3.7%) of the reoperated stems were revised. Stems revised in the first year after the index procedure (n = 22) were all revised for either dislocation (n = 12; median 48 days, IQR 18 to 75.7) or infection (n = 10; median 36 days, IQR 22 to 79.5). Those revised after the first year were revised predominantly for aseptic loosening (n = 9; median 4.9 years, IQR 3.7 to 5.3), pain (n = 6; median 5.2 years, IQR 4.0 to 7.8), periprosthetic fracture (n = 4;

median 5.5 years, IQR 4.5 to 6.9), and acetabular erosion (n = 3, median 7.1 years, IQR 4.8 to 7.5).

Five procedures were complicated by haematoma causing prolonged wound ooze. Three settled with dressing changes or aspiration in clinic, leaving two cases requiring washout and debridement in theatre. The 37 infections (2.8% infection rate) included six superficial infections treated with antibiotics alone, while three patients were too frail or ill to have any surgery. Of the remaining 28 infections returning to theatre, three had negative aspirations and were treated with antibiotics, 12 underwent washout and debridement retaining the implant, nine had Girdlestone's type excisions, and the remaining four underwent two-stage revisions to THAs. The 24 dislocations (1.8% dislocation rate) were linked to

Table II. Life table for implant survivorship.

Interval start time (start year)	Number at start	Withdrawn	Number at risk	Number revised	Cumulative number revised	Annual failure rate, %	Annual survival rate, %	Cumulative survival rate, %	Overall survival rate, %
0	1,312	359	1,133	20	20	1.8	98.2	98.2	98.5
1	933	146	860	3	23	0.3	99.7	97.9	98.2
2	784	138	715	3	26	0.4	99.6	97.5	98.0
3	643	105	591	5	31	0.8	99.2	96.7	97.6
4	533	115	476	4	35	0.8	99.2	95.8	97.3
5	414	94	367	3	38	0.8	99.2	95.1	97.1
6	317	81	277	2	40	0.7	99.3	94.4	97.0
7	234	60	204	2	42	1.0	99.0	93.4	96.8
8	172	53	146	2	44	1.4	98.6	92.2	96.6
9	117	34	100	2	46	2.0	98.0	90.3	96.5
10	81	81	41	0	46	0.0	100.0	90.3	96.5

20 returns to theatre, including eight closed/open reductions, eight Girdlestone's excisions, one revision to other hemiarthroplasty, and three revisions to THAs. One stem was successfully reduced in the ED without requiring a trip to theatre; the remaining three were chronic by the time they were assessed and were either not offered surgery (n = 2) or themselves refused to have surgery (n = 1). Ten of the 19 stems presenting with aseptic loosening (1.4% loosening rate) returned to theatre; these included one negative aspiration, one revision to another hemiarthroplasty, and eight revisions to THA.

The ten periprosthetic fractures (0.8% fracture rate) occurred from within three months to nine years of the index procedure. One fracture was an avulsion of the lesser trochanter (Vancouver type A_L) not requiring surgery.[15] The remaining nine fractures underwent five open reduction and internal fixations (two type B_1 and three type C), three revisions to other hemiarthroplasty (one B_1, two B_3 fractures), and one revision to THA (type B_3). Surgery was considered for symptomatic acetabular erosion in seven cases. Only three of these were revised to THAs; the others were either unsuitable (n = 1) for revision surgery, or simply refused to have it (n = 3). One patient was diagnosed with metastatic cancer a long time after the index hemiarthroplasty, with symptomatic lesions around the stem and in the acetabulum, requiring a revision to THA.

Persistent pain was identified in 22 patients. Nine were referred by their family doctors to either ED (n = 6) or directly to the orthopaedic service (n = 3). Clinical examination, haematological investigations, and systematic appraisals of serial radiographs were unremarkable for these, and they were discharged back to primary care. There were 13 who remained under clinical surveillance for varying times; six of them eventually undergoing revision to THA, with time to revision ranging from 1.9 to 9.5 years. Five patients were not offered surgery for various reasons, and two refused surgery when offered.

We were able to link nine patients with subsequent ED attendances, with radiographs confirming pubic rami or acetabular fractures (n = 7) and ipsilateral distal femoral fractures (n = 2, one of which had surgery to fix the fracture). We also identified heterotopic ossification in 16 patients' radiographs who had attended ED for a variety of reasons and at varying times after their index surgery. Finally, 103 patients (7.8%) returned with contralateral hip fractures within ten years of their index procedure, undergoing 71 Thompson's hemiarthroplasties, seven other hemiarthroplasties, 17 dynamic hip screws, and five intramedullary nails, while three were managed nonoperatively.[16]

At ten years, the cohort's status included: 1,180 (89.9%) dead without revision, 34 (2.6%) dead having had revision, 84 (6.4%) alive with the stem unrevised, and 14 (1.1%) alive having had revision. Overall, actual implant survival at ten years was 96.5%. This equated to a cumulative implant survival rate of 90.3% (Table II, Figure 1). In contrast, 30-day patient survival was 93.6%, dropping to 72.0% at one year, and only 7.4% (n = 97) of patients were alive at ten years (Figure 2).

Discussion

Hip hemiarthroplasty is a high-volume procedure in trauma surgery, with nearly 50,000 stems implanted in 2019, amounting to £10.6 million in implant cost alone.[17] Evidence favours the use of cemented over uncemented hemiarthroplasty, with lower residual pain, better quality of life, and lower incidence of periprosthetic fractures;[18,19] 95% of NHS hospitals have also reported cemented implants as their prosthesis of choice.[20] There is, however, considerable variation in the designs used, with considerable differences in cost between the cheapest monoblock and the most expensive modular stem.[20] Citing this, alongside the clinical evidence from WHiTE3,[6] the National Hip Fracture Database (NHFD) encourages
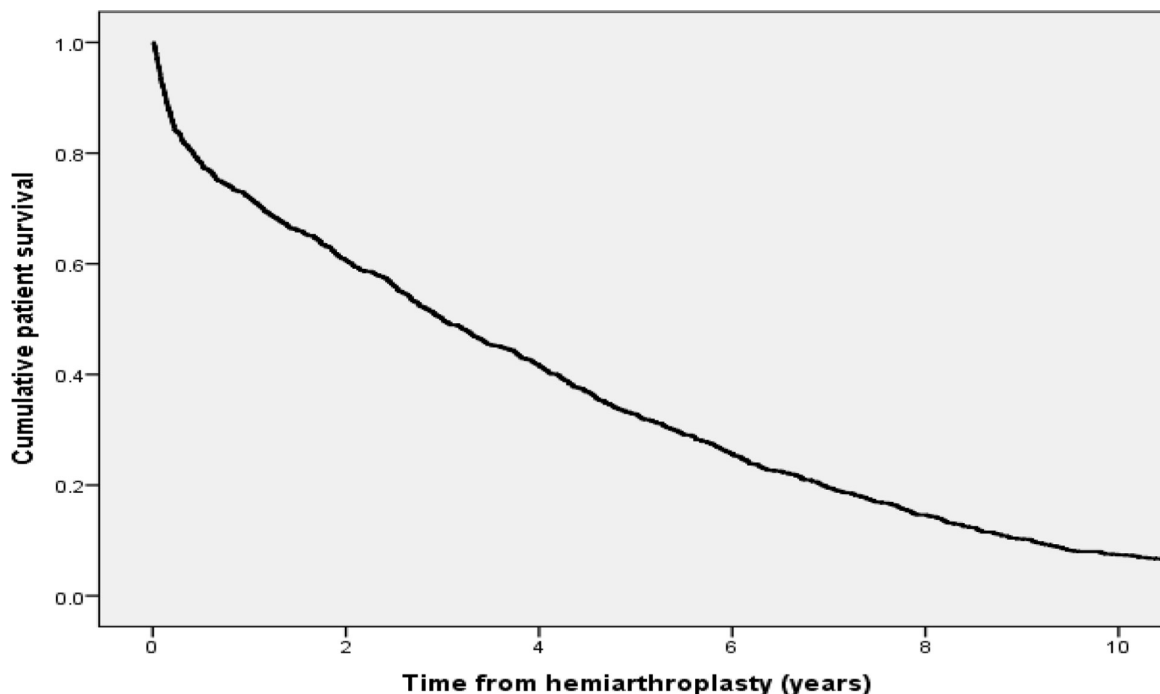
Fig. 2

Kaplan-Meier curve for patient survival (see Table II for numbers at risk).

hospitals to "review their hemiarthroplasty implant inventory accordingly".[20]

The perceived advantages of using a modern (but more expensive) cemented stem include the benefits of modularity, with expected optimization of femoral neck offset, anteversion and restoration of leg length, ease of implantation, and cement-in-cement revision to a THA. It also familiarizes trainees with the techniques for THA surgery. However, these surgical issues are secondary concerns, given that there is no difference in the outcome for patients,[6] and that the patient population is presenting in increasing numbers, at an increasingly older age, and with a worsening comorbidity burden, year by year.[21-23]

Another opined benefit is a lower risk of periprosthetic fracture with modern stems.[24] This probably comes from an unintentional conflation of two unrelated phenomena: the historical fracture rate with old hemiarthroplasty stems, and the fracture rates in polished taper-slip (PTS) versus composite beam (CB) stems used in elective THAs. Phillips et al[25] reported a 2.1% fracture rate in their series of 3,611 hemiarthroplasties, but 77% of these occurred around uncemented Austin-Moores prostheses. There is no published literature comparing Thompson's versus PTS stems specifically for late periprosthetic fractures or aseptic loosening, nor the ease of revision to a THA for these complications. PTS stems (e.g. Exeter) in THAs have been reported to have lower all-cause revision rates compared to CB stems (e.g. Charnley; DePuy Orthopaedics, USA), but their rate

of periprosthetic fractures is higher.[26,27] This difference in fracture rates has also been observed after hemiarthroplasty, with both straight (Spectron, Charnley) and anatomical (Lubinus SP2, Waldemar Link, Germany) CB stems, showing a significantly lower fracture rate than PTS stems (Exeter, CPT).[28] The Thompson's is a CB stem despite its curved design, and our low rate of 0.8% can be expected to decline further as the presenting age increases yearly.

We acknowledge that this analysis has certain shortcomings. Hip fractures do not get routine clinic follow-ups in the NHS.[29] Even data collection by phone or post is poor beyond a few months of discharge from hospital, as shown by annual reports from the NHFD.[20] Survival curves in the presence of competing risks (e.g. the significant competing risk of death) may overestimate the risk of revision;[30] therefore, the true revision risk for these patients may be smaller than we report here. In addition, while mortality data used for this study are linked to ONS national data, data for implant revision are only sourced locally. It is possible that a small number of patients may have been revised elsewhere in the country. However, given our large catchment area, we suspect this number would be very small and unlikely to significantly influence the findings.

In conclusion, this series demonstrates cumulative implant survivorship of 90.3% at ten years in Thompson's hip hemiarthroplasty. In contrast, patient survivorship at ten years was only 7.4%. Our large cohort study reports previously lacking information on ten-year

survivorship for the Thompson's implant, strengthening the argument for continuing with its use. Given these results, and the evidence from the WHiTE3 trial and suggestions from Getting It Right First Time[17] and NHFD, we feel it apt for NICE to also consider recommending in its favour.

Take home message

- This series demonstrates cumulative implant survivorship of 90.3% at ten years in Thompson's hip hemiarthroplasty.
- Our large cohort study reports previously lacking information on ten-year survivorship for the Thompson's implant, strengthening the argument for continuing with its use.

References

1. **THOMPSON FR**. Two and a half years' experience with a vitallium intramedullary hip prosthesis. *J Bone Joint Surg Am*. 1954;36-A(3):489–502.

2. **Hernigou P**, **Quiennec S**, **Guissou I**. Hip hemiarthroplasty: from Venable and Bohlman to Moore and Thompson. *Int Orthop*. 2014;38(3):655–661.

3. **No authors listed**. Hip fracture: management. National Institute for Health and Care Excellence. https://www.nice.org.uk/guidance/cg124 (date last accessed 7 July 2022).

4. **Parker MJ**. Cemented Thompson hemiarthroplasty versus cemented Exeter Trauma Stem (ETS) hemiarthroplasty for intracapsular hip fractures: a randomised trial of 200 patients. *Injury*. 2012;43(6):807–810.

5. **Bidwai ASC**, **Willett KM**. Comparison of the Exeter Trauma Stem and the Thompson hemiarthroplasty for intracapsular hip fractures. *Hip Int*. 2012;22(6):655–660.

6. **Sims AL**, **Parsons N**, **Achten J**, **et al**. A randomized controlled trial comparing the Thompson hemiarthroplasty with the Exeter polished tapered stem and Unitrax modular head in the treatment of displaced intracapsular fractures of the hip: the WHiTE 3: HEMI Trial. *Bone Joint J*. 2018;100-B(3):352–360.

7. Orthopaedic Data Evaluation Panel. https://www.odep.org.uk/wp-content/uploads/2022/07/ODEP_Criteria_Hips_2021.pdf (date last accessed 8 August 2022).

8. **Ruiz-Ibán MA**, **Crespo-Hernández P**, **Fernández-Roldán S**, **et al**. Cemented hemiarthroplasty after a femoral neck fracture. Survivorship analysis. *Revista Española de Cirugía Ortopédica y Traumatología (English Edition)*. 2008;52(4):206–212.

9. **Jameson SS**, **Khan SK**, **Baker P**, **et al**. A national analysis of complications following hemiarthroplasty for hip fracture in older patients. *QJM*. 2012;105(5):455–460.

10. **Manoharan G**, **Morley D**, **Chatterton BD**, **Moores TS**, **Roberts PJ**. Uncemented Thompson's hemiarthroplasty: safe, palliative and cost-effective surgery in the infirm patient-a consecutive series of 1445 cases. *Eur J Orthop Surg Traumatol*. 2018;28(6):1103–1109.

11. **Kassam A-A**, **Griffiths S**, **Higgins G**. Historical implant or current best standard? Minimum five year follow-up outcomes of cemented Thompson hemiarthroplasties. *J Arthroplasty*. 2014;29(9):1745–1748.

12. **Khan SK**, **Jameson SS**, **Sims A**, **et al**. Cemented Thompson's hemiarthroplasty in patients with intracapsular neck of femur fractures: survival analysis of 1,670 procedures. *Eur J Orthop Surg Traumatol*. 2015;25(4):655–660.

13. **Murray DW**, **Carr AJ**, **Bulstrode C**. Survival analysis of joint replacements. *J Bone Joint Surg Br*. 1993;75-B(5):697–704.

14. **Abram SGF**, **Murray JB**. Outcomes of 807 Thompson hip hemiarthroplasty procedures and the effect of surgical approach on dislocation rates. *Injury*. 2015;46(6):1013–1017.

15. **Masri BA**, **Meek RMD**, **Duncan CP**. Periprosthetic fractures evaluation and treatment. *Clin Orthop Relat Res*. 2004;420:80–95.

16. **Ryg J**, **Rejnmark L**, **Overgaard S**, **Brixen K**, **Vestergaard P**. Hip fracture patients at risk of second hip fracture: a nationwide population-based cohort study of 169,145 cases during 1977-2001. *J Bone Miner Res*. 2009;24(7):1299–1307.

17. **No authors listed**. Getting It Right in Orthopaedics. Getting It Right First Time. February 2020. https://gettingitrightfirsttime.co.uk/wp-content/uploads/2020/02/GIRFT-orthopaedics-follow-up-report-February-2020.pdf (date last accessed 7 July 2022).

18. **Parker MI**, **Pryor G**, **Gurusamy K**. Cemented versus uncemented hemiarthroplasty for intracapsular hip fractures: A randomised controlled trial in 400 patients. *J Bone Joint Surg Br*. 2010;92-B(1):116–122.

19. **Fernandez MA**, **Achten J**, **Parsons N**, **et al**. Cemented or uncemented hemiarthroplasty for intracapsular hip fracture. *N Engl J Med*. 2022;386(6):521–530.

20. **No authors listed**. The National Hip Fracture Database (2019) Annual Report. Royal College of Physicians. https://www.nhfd.co.uk/files/2019ReportFiles/NHFD-Facilities-Survey-2019.pdf (date last accessed 7 July 2022).

21. **White SM**, **Griffiths R**. Projected incidence of proximal femoral fracture in England: a report from the NHS Hip Fracture Anaesthesia Network (HIPFAN. *Injury*. 2011;42(11):1230–1233.

22. **Veronese N**, **Maggi S**. Epidemiology and social costs of hip fracture. *Injury*. 2018;49(8):1458–1460.

23. **Bekeris J**, **Wilson LA**, **Bekere D**, **et al**. Trends in comorbidities and complications among patients undergoing hip fracture repair. *Anesth Analg*. 2021;132(2):475–484.

24. **Hammouche SA**, **Phillips J**, **Massoumi A**, **Scammell BE**, **Moran CG**. Implant and patient survival rates using Exeter Trauma Stem hemiarthroplasty in fracture neck of femur patients: The largest study to date. *Injury*. 2022;53(6):2199–2206.

25. **Phillips JRA**, **Moran CG**, **Manktelow ARJ**. Periprosthetic fractures around hip hemiarthroplasty performed for hip fracture. *Injury*. 2013;44(6):757–762.

26. **Kazi HA**, **Whitehouse SL**, **Howell JR**, **Timperley AJ**. Not all cemented hips are the same: a register-based (NJR) comparison of taper-slip and composite beam femoral stems. *Acta Orthop*. 2019;90(3):214–219.

27. **Scott T**, **Salvatore A**, **Woo P**, **Lee Y-Y**, **Salvati EA**, **Gonzalez Della Valle A**. Polished, collarless, tapered, cemented stems for primary hip arthroplasty may exhibit high rate of periprosthetic fracture at short-term follow-up. *J Arthroplasty*. 2018;33(4):1120–1125.

28. **Kristensen TB**, **Dybvik E**, **Furnes O**, **Engesæter LB**, **Gjertsen J-E**. More reoperations for periprosthetic fracture after cemented hemiarthroplasty with polished taper-slip stems than after anatomical and straight stems in the treatment of hip fractures: a study from the Norwegian Hip Fracture Register 2005 to 2016. *Bone Joint J*. 2018;100-B(12):1565–1571.

29. **British Orthopaedic Association**. *The Care of Patients with Fragility Fracture*. BOA, 2007.

30. **Gillam MH**, **Salter A**, **Ryan P**, **Graves SE**. Different competing risks models applied to data from the Australian Orthopaedic Association National Joint Replacement Registry. *Acta Orthop*. 2011;82(5):513–520.

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