R.J.K. Khan · A. MacDowell · P. Crossman · A. Datta
N. Jallali · B.N. Arch · G.S. Keene

Cemented or uncemented hemiarthroplasty for displaced intracapsular femoral neck fractures

Accepted: 19 March 2002 / Published online: 27 April 2002
© Springer-Verlag 2002

Abstract The aim of this study was to establish whether or not to cement the hemiarthroplasty for displaced intracapsular femoral neck fractures in the elderly. Consecutive patients treated by hemiarthroplasty in adjacent hospitals were reviewed. The same monoblock prosthesis was used; in hospital A they were uncemented (121 patients), and in hospital B they were cemented (123 patients). Notes were reviewed retrospectively. Surviving patients (50 and 56 respectively) were assessed prospectively for pain and functional ability using validated scoring systems. Follow-up was 32–36 months. Patient demographics were similar. Fewer of the cemented group had been revised or were awaiting revision ($P=0.036$). There was no difference in general complication or mortality rates. There was a highly statistically significant greater deterioration in pain ($P=0.003$), walking ability ($P=0.002$), use of walking aids ($P=0.003$) and activities of daily living ($P=0.009$) in the uncemented group. Our findings support the use of cemented hemiarthroplasty in the elderly.

Résumé Le but de cette étude était établir l'intérêt ou non de cimenter l'hémiarthroplastie pour les fractures déplacées intracapsulaires du col fémorales chez les personnes âgées. Les malades consécutifs traités par hémiarthroplastie dans des hôpitaux voisins ont été examinés. La même prothèse monobloc a été utilisée; dans

l'hôpital A elles étaient non cimentées (121 malades), et dans l'hôpital B elles étaient cimentées (123 malades). L'étude a été rétrospective avec un suivi de 32 à 36 mois. Les patients survivant (50 et 56 respectivement) a été réparti selon les douleurs et la capacité fonctionnelle en utilisant un système de score validé. La démographie des patients était semblable. Moins de patients du groupe cimenté avaient été révisés ou attendaient une révision ($P=0.036$). Il n'y avait aucune différence dans les complications générales ou le taux de mortalité. Dans le groupe non cimenté il y avait une plus grande détérioration statistiquement significative pour les douleurs ($P=0.003$), la capacité de marche ($P=0.002$), l'usage de déambulateurs ($P=0.003$) et les activités de la vie courante ($P=0.009$). Nos conclusions sont en faveur de l'hémiarthroplastie cimentée chez les personnes âgées.

Introduction

Despite the frequency with which displaced intracapsular femoral neck fractures occur, best management remains undecided. It is accepted that surgery is the mainstay of treatment, but debate continues on the role of internal fixation versus hemiarthroplasty, unipolar versus bipolar hemiarthroplasty and whether or not the prosthesis should be cemented [19].

The two most commonly performed procedures in the UK for these fractures in the frail or elderly are the uncemented Austin-Moore and the cemented Thompson hemiarthroplasty [1]. The choice of implant appears to be influenced by the surgeon's opinion on the use of cement. Concerns about the possible effects of cement on the cardiopulmonary system, and technically more difficult revision, may lead one surgeon to use an uncemented implant; others may worry about early loosening associated with pain and poor function, and choose a cemented implant. Whether or not to cement the hemiarthroplasty is an issue that divides orthopaedic surgeons. The aim of this study was to establish whether the advantages of cement outweigh the disadvantages.

R.J.K. Khan (✉)
Green End House, 318 High Street, Cottenham,
Cambridge CB4 8TX, UK
e-mail: riazkhan@aol.com
Tel.: +44-7787505613, Fax: +44-17338745024

R.J.K. Khan · A. MacDowell · A. Datta
Department of Trauma and Orthopaedics, Bedford Hospital,
Bedford, MK42 9DU, UK

P. Crossman · N. Jallali · G.S. Keene
Department of Trauma and Orthopaedics,
Addenbrooke's Hospital, Cambridge, CB2 2QQ, UK

B.N. Arch
Centre for Applied Medical Statistics, Institute of Public Health,
Forvie Site, Robinson Way, Cambridge, CB2 2SR, UK

Patients and methods

Two consecutive series of patients with displaced intracapsular femoral neck fractures treated with hemiarthroplasty between January 1997 and May 1998 in two hospitals within the same Deanery were compared. The same monoblock prosthesis was used in both hospitals (Austin-Moore), but in hospital A they were uncemented and in hospital B they were cemented. Modern cementing techniques were used – thorough evacuation of canal contents, cement restrictor, venting of the canal and retrograde cementation. Post-operative management was the same, including early mobilisation. There were 121 patients in the uncemented group and 123 in the cemented group, of which 50 and 56 respectively were alive at follow-up. Two patients were lost to follow-up in each group. Advice and approval was obtained from the local ethics committee.

Hospital records were examined in detail by the authors to obtain demographic, operative, post-operative and follow-up data. Anaesthetic charts were analysed for a fall in diastolic blood pressure (DBP) of 20 mmHg or more or oxygen saturation below 95% during surgery, as an indication of the effect of cement on the cardiopulmonary system [22]. Anaesthetic times were measured as an indication of operative time.

On all surviving patients two authors (AD and NJ) blinded to treatment method carried out a telephone interview. Pre-fracture and current scores for pain, walking ability, use of walking aids, activities of daily living and residential status were obtained using validated scoring systems, and relative deterioration was determined. Pain was assessed using the Charnley pain score [6]. Walking ability, use of walking aids and residential status were scored using codes from the Standardised Audit of Hip Fracture in Europe [20]. Activities of daily living (ADL) were assessed according to Katz et al. [12]. Mean follow-up was 34 months (SD 4.7).

A pilot study performed by the authors on 24 patients confirmed no significant inter- or intra-observer error. The same patients were re-interviewed a year later: the high reproducibility of scores confirmed no significant recall bias.

Statistical methods

Logistic regression was used to investigate the effect of cement on whether patients became more dependent in their accommodation, while adjusting for the effect of confounders. The chi-square test was used to compare proportions of non-fatal complications in the two groups. The Mann-Whitney *U* test was used to compare the relative change in score data for the two hospitals. The effect of cement on risk of death over the follow-up period, adjusted for potential confounders, was investigated using Cox regression.

To minimise the effects of multiple testing, *P*-values were calculated for comparisons of prime interest only. A *P*-value less than 0.05 was considered statistically significant.

Results

Patient demographics were similar (Table 1); however, there were fewer people in hospital A (uncemented) with a positive history of cardiopulmonary disease, and the men in hospital B (cemented) tended to be younger than the women. Pre-fracture pain, walking ability, use of walking aids and ADL scores were available only for surviving patients; importantly, there was marked similarity between the groups. Type of accommodation for all patients pre-fracture was also similar.

Operative details are listed in Table 2. Mean pre-operative delay was the same in both hospitals (1.7 days). All patients received prophylactic antibiotics. The ratio of spinal to general anaesthetics was higher in the un-

Table 1 Patient demographics

	Uncemented group (hospital A)	Cemented group (hospital B)
Number of patients	121	123
Mean age in years (SD)	82 (7.0)	84 (6.0)
Women (%)	98 (81.0)	98 (79.7)
Left sided (%)	60 (49.6)	61 (49.6)
Positive history of cardiac or lung disease (%)	57 (47.1)	80 (65.0)

Table 2 Operative details. *DBP* diastolic blood pressure

	Uncemented group (hospital A) <i>n</i> =121	Cemented group (hospital B) <i>n</i> =123
Anaesthetic Spinal (%)	48 (39.7)	8.1 (8.1)
GA +/- regional (%)	73 (60.3)	113 (91.9)
Fall in O ₂ saturations <95% (%)	15 (12.4)	19 (15.4)
Fall in DBP ≥20 mmHg (%)	61 (50.5)	21 (17.1)
Mean anaesthetic time in minutes (SD)	73.4 (24.2)	89.11 (22.6)

mented group. Middle grade surgeons performed the procedure in almost 90% of cases. The anterolateral approach was used for all patients. There was no difference in fall in oxygen saturation between groups; however, more than twice as many patients in the uncemented group sustained a drop in diastolic blood pressure (≥20 mmHg) compared with the cemented group. There was no association found between fall in either oxygen saturation or blood pressure and a history of cardiopulmonary disease. Anaesthetic time was, on average, 15 min longer in the cemented group for all types of anaesthesia. Blood loss was poorly documented in both hospitals.

There was no difference in overall non-fatal complication rate (including chest infection, deep vein thrombosis, pulmonary embolism, wound infection, haematoma, urinary tract infection or heart failure) between groups. There were three iatrogenic periprosthetic fractures, all occurring in the uncemented group; one was lost to follow-up, one died in hospital, and the third has been revised. There were no dislocations in the cemented group and three in the uncemented group, two of whom have since died and the third has undergone revision. There was no statistically significant difference in absolute revision rates despite a six-fold difference in favour of cement; however, the difference became significant (*P*=0.036) when those awaiting revision were included in the analysis.

There was no statistically significant effect of cementing on survival (*P*=0.77) over the entire follow-up period. One-year mortality was just over 33% in both groups; three-year mortality was 57% in the uncemented group and 51% in the cemented group.

Table 3 Prospective scores: median (and mean) relative deterioration

Measurement	Uncemented group (hospital A) <i>n</i> =50	Cemented group (hospital B) <i>n</i> =56	Significance
Pain	-1 (-1.32)	0 (-0.60)	<i>P</i> =0.003*
Walking ability	-2 (-1.76)	-1 (-0.95)	<i>P</i> =0.002*
Walking aids	-2 (-2.00)	-1 (-1.31)	<i>P</i> =0.003*
ADL	-2 (-2.92)	-1 (-1.72)	<i>P</i> =0.009*

*Statistically significant

Prospective assessment (Table 3) revealed a highly statistically significant greater deterioration in pain (*P*=0.003), walking ability (*P*=0.002), use of walking aids (*P*=0.004) and activities of daily living (*P*=0.009) in the uncemented group. Fifty-six percent of the uncemented group were in more dependent accommodation at follow-up compared with 40% in the cemented group, a difference that failed to reach statistical significance (*P*=0.14).

Discussion

Despite the known physiological effect of cement upon the cardiopulmonary system [5, 7, 21, 22], we found no clinically significant evidence of this in our study as measured by a fall in blood pressure or oxygen saturation. Modern cementing techniques were used, reducing the incidence of cement-associated complications [4, 17]. In view of these potential complications, and a finding of increased mortality in the cemented group within 48 h of surgery, Lennox and McLauchlan [15] concluded that cement should not be used in the frail elderly patient. Our findings are not consistent with this argument: there was neither an association between cardiac or chest disease and fall in blood pressure or oxygen saturation; nor was there an increased mortality rate in the cemented group at any time after surgery. Interestingly, there was a greater incidence of fall in diastolic blood pressure in the uncemented group, despite a lower incidence of cardiopulmonary disease; this cannot be accounted for by the greater number of spinal anaesthetics in this group since the difference is still present with correction for type of anaesthetic. A potential confounding variable that was not reviewed was the grade of anaesthetist.

Age, sex and medical history adjusted analysis indicates there is no significant difference in survival between groups, a finding that contradicts those of Anderson et al. [2], Muirhead-Allwood et al. [18], and Lennox and McLauchlan [15]. The only sudden intra-operative death occurred in the uncemented group in this study. The period of "primary mortality", when the hip fracture together with associated diseases must be regarded as the decisive mortality factor, was described originally as being 30 days after surgery [23]. Findings in our study, however, support comments by Todd et al. [26] who noted that most deaths

occur within 4 months. Increasing age and male gender were found to be the most significant predictors of poor prognosis, a finding supported by Dahl [8].

In common with other studies, there was no difference in overall non-fatal complication rates between the two groups, either as in-patients or after discharge [13]. Our findings of increased revision rate in the uncemented group concur with those of most other studies [3, 10, 15, 16], but contradict those of Muirhead-Allwood et al. [18]. The main argument against the use of the Austin-Moore as a cemented prosthesis is that it has fenestrations in its stem that make revision more difficult. Although we do not necessarily advocate its routine use with cement, it has served to compare identical prostheses in this study and therefore removed potential confounding variables. Interestingly, the operation note of the only cemented Austin-Moore that was revised remarked on its ease of removal.

Radiographic changes were not assessed: they are frequently reported as not correlating with clinical findings [11, 16, 25]. Also, because of the commonly held policy of limited follow-up for patients with a fractured neck of femur there were too few radiographs to allow a meaningful review.

The most significant and important differences between the cemented and uncemented groups were found at prospective follow-up. (It should be noted that scores were analysed on surviving patients only, and pre-fracture scores were obtained retrospectively; however, the high reproducibility of pre-fracture scores found in the pilot group when re-interviewed a year later suggests their accuracy.) The interviewers (AD and NJ) were blinded to treatment type, and it was clear the patients were oblivious as to whether the prosthesis was cemented or not; therefore, the interview was considered to be double blind. Despite the trend towards more dependent accommodation in the uncemented group failing to reach statistical significance, there was a marked difference in terms of pain, walking ability, use of walking aids and ADL. The relative changes in these scores amounted to a difference in magnitude of 1 unit. Clinically this is significant and may, for example, represent a change from "tolerable pain, permitting limited activity" to "severe pain on attempting to walk, preventing all activity" [6]; and from "able to walk outdoors alone" to "only able to walk outdoors accompanied" [20]. Sonne-Holm et al. [25] reported similar findings at 3 and 6 months follow-up; however, at 12 months the significance was lost. Our findings suggest that the benefits are in fact more prolonged. The importance of these findings are illustrated by Salkeld [24] who reported that "80% of women would rather be dead than experience loss of independence and quality of life that results from a bad hip fracture..."

Our findings have implications for management and resources. There will be an increase in initial costs caused by the purchase of cement and associated equipment, and operative time will be increased by approximately 15 min per case. Senior house officers will per-

form fewer operations, and all surgeons, including junior registrars, will be required to be competent with modern cementing techniques. The move away from more junior staff performing such procedures will, however, conform to the UK guidelines set out in the National Confidential Enquiry into Peri-operative Deaths (CEPOD) [9]. A prospective randomised study comparing overall costs of cemented versus uncemented total hip arthroplasty at 1 year post-operation found no significant difference when quality of life was included in the assessment; the study concluded that cost would only differ if there was a subsequent difference in revision rate [14]. Our study found not only a lower revision rate in the cemented group, but also that there was a less pronounced deterioration relating to pain, walking ability, use of walking aids and ADL, suggesting that, although initial costs may be greater, long-term costs may be reduced.

In summary, the cemented group fared significantly better than the uncemented group in terms of pain, walking ability, use of walking aids, ADL and revision rate. There was no difference in general complication or mortality rates. Our findings suggest that for the displaced intracapsular femoral neck fracture in the elderly patient, when hemiarthroplasty is the treatment of choice, cemented fixation is preferable.

Acknowledgements We would like to thank the staff of Bedford Hospital Library for their help in finding articles, Helen Knowles of the research and development department of Bedford Hospital for her guidance, and the audit departments of Bedford and Addenbrooke's Hospitals for retrieving patients' notes

References

- Anderson GH, Harper WM, Gregg PJ (1991) Management of the intracapsular fractures of the proximal femur in 1990: a cause for concern? *J Bone Joint Surg [Br]* 73 (Supp I): 70
- Anderson GH, Dias JJ, Hoskinson J, Harper WM (1992) A randomized study of the use of bone cement with Thompson's prosthesis in the treatment of intracapsular fractures of the femoral neck. *J Bone Joint Surg [Br]* 74 (Supp II): 132–133
- Browett JP (1981) The uncemented Thompson prosthesis. *J Bone Joint Surg [Br]* 63: 634–635
- Burwell RG, Dennis CN, Ross AF, Barnes JM, Barnes R, Braden M et al (1974) Acrylic cement and the cardiovascular system. *Lancet* 2: 1002–1004
- Byrick RJ, Bell RS, Kay JC, Waddell JP, Mullen JB (1989) High-volume, high-pressure pulsatile lavage during cemented arthroplasty. *J Bone Joint Surg [Am]* 71: 1331–1336
- Charnley J (1972) The long-term results of low-friction arthroplasty of the hip performed as a primary intervention. *J Bone Joint Surg [Br]* 54: 61–76
- Christie J, Robinson CM, Pell ACH, McBirnie J, Burnett R (1995) Transcardiac echocardiography during invasive intramedullary procedures. *J Bone Joint Surg [Br]* 77: 450–455
- Dahl E (1980) Mortality and life expectancy after hip fractures. *Acta Orthop Scand* 51: 163–170
- Department of Health (2000) Then and now: the 2000 report of the National Confidential Enquiry into Peri-operative Deaths. The NCEPD, London
- Gebhard JS, Amstutz HC, Zinar DM, Dorey FJ (1992) A comparison of total hip arthroplasty and hemiarthroplasty for treatment of acute fracture of the femoral neck. *Clin Orthop* 282: 123–131
- Gingras MB, Clarke J, McCollister Evarts C (1980) Prosthetic replacement in femoral neck fractures. *Clin Orthop* 152: 147–157
- Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW (1963) Studies of illness in the aged. *JAMA* 185: 914–919
- Khan RJK, MacDowell A, Crossman P, Keene GS (2002) Cemented or uncemented hemiarthroplasty for displaced intracapsular fractures of the hip – a systematic review. *Injury* 33: 13–17
- Laupacis A, Bourne R, Rorabeck C, Feeny D, Wong C, Tugwell P et al (1994) Costs of elective total hip arthroplasty during the first year: cemented versus noncemented. *J Arthroplasty* 9: 481–487
- Lennox IAC, McLauchlan J (1993) Comparing the mortality and morbidity of cemented and uncemented hemiarthroplasties. *Injury* 24: 185–186
- Lo W-H, Chen W-M, Huang C-K, Chen T-H, Chiu F-Y, Chen C-M (1994) Bateman bipolar hemiarthroplasty for displaced intracapsular femoral neck fractures. *Clin Orthop* 302: 75–82
- McCaskie AW, Barnes MR, Lin E, Harper WM, Gregg PJ (1997) Cement pressurisation during hip replacement. *J Bone Joint Surg [Br]* 79: 379–384
- Muirhead-Allwood W, Hutton P, Glasgow MMS (1983) A comparative study of cemented and uncemented Thompson prostheses. *J Bone Joint Surg [Br]* 65: 218–219
- Parker MJ (2000) The management of intracapsular fractures of the proximal femur. *J Bone Joint Surg [Br]* 82: 937–941
- Parker MJ, Currie CT, Mountain JA, Thorngren K-G (1998) Standardised audit of hip fracture in Europe (SAHFE). *Hip International* 8: 10–15
- Parvizi J, Holiday AD, Ereth MH, Lewallen DG (1999) Sudden death during hip arthroplasty. *Clin Orthop* 369: 39–48
- Pitto RP, Koessler M, Kuehle JW (1999) Comparison of fixation of the femoral component without cement and fixation with use of a bone-vacuum cementing technique for the prevention of fat embolism during total hip arthroplasty. *J Bone Joint Surg [Am]* 81: 831–843
- Riska EB (1970) Factors influencing the primary mortality in the treatment of hip fractures. *Injury* 2: 107–115
- Salkeld G, Cameron ID, Cumming RG, Easter S, Seymour J, Kurrle SE, Quine S (2000) Quality of life related to fear of falling and hip fracture in older women: a time trade off study. *BMJ* 320: 341–346
- Sonne-Holm S, Walter S, Steen Jensen J (1982) Moore hemiarthroplasty with and without bone cement in femoral neck fractures. *Acta Orthop Scand* 53: 953–956
- Todd CJ, Freeman CJ, Camilleri-Ferrante C, Palmer CR, Hyder A, Laxton CE et al (1995) Differences in mortality after fracture of hip: the East Anglian audit. *BMJ* 310: 904–908