Hemiarthroplasty *versus* internal fixation for displaced intracapsular hip fractures in the elderly

A RANDOMISED TRIAL OF 455 PATIENTS

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A total of 455 patients aged over 70 years with a displaced intracapsular fracture of the proximal femur was randomised to be treated either by hemiarthroplasty or internal fixation. The preoperative characteristics of the patients in both groups were similar.

Internal fixation has a shorter length of anaesthesia (36 minutes *versus* 57 minutes, $p < 0.0001$), lower operative blood loss (28 ml *versus* 177 ml, $p < 0.0001$) and lower transfusion requirements (0.04 units *versus* 0.39 units, $p < 0.0001$). In the internal fixation group 90 patients required 111 additional surgical procedures while only 15 additional operations on the hip were needed in 12 patients in the arthroplasty group. There was no statistically significant difference in mortality between the groups at one year (61/226 *versus* 63/229, $p = 0.91$), but there was a tendency for an improved survival in the older less mobile patients treated by internal fixation. For the survivors assessed at one, two and three years from injury there were no differences with regard to the outcome for pain and mobility. Limb shortening was more common after internal fixation (7.0 mm *versus* 3.6 mm, $p = 0.004$).

We recommend that displaced intracapsular fractures in the elderly should generally be treated by arthroplasty but that internal fixation may be appropriate for those who are very frail.

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There is still controversy about the choice of treatment of displaced intracapsular fractures in elderly patients. Internal fixation is associated with less operative trauma but later

complications such as displacement of the fracture, nonunion and avascular necrosis may require revision.¹⁻³ This has led most surgeons to treat this fracture by arthroplasty, although internal fixation is still favoured in a few countries. There have been only a few randomised trials which have addressed this issue in the elderly patient, and they have generally been on small numbers of patients from which no definite conclusions could be made.¹ We have previously reported our results for a randomised trial,⁴ but because they were inconclusive we increased the number of patients within the study to see if there were definite advantages of one particular form of treatment for specific subgroups of patients.

Patients and Methods

All patients presenting to one hospital with a displaced intracapsular fracture of the hip between July 1991 and February 2001 were considered for inclusion in the study. The fracture had to be clearly displaced on both the anteroposterior and lateral radiographs and the patient had to be over 70 years old and fit for either surgical procedure. To standardise treatment all operations were undertaken or directly supervised by one surgeon (MP). The exclusion criteria were undisplaced or minimally displaced fractures, age less than 71 years, rheumatoid arthritis, chronic renal failure, significant arthritis of the hip, a delay from the fracture to surgery of more than 48 hours, and fractures secondary to tumour, Paget's disease or metabolic bone disease. Randomisation was undertaken at the time of assessment using sealed opaque identical envelopes. Once randomised, all patients remained within the group to which they had been allocated. The study was approved by the local Ethical Committee and written consent was obtained from the patient, or in the case of those with mental impairment, from the next of kin.

The patients were assessed before operation to record their mobility score (0 to 9),⁵ associated medical conditions, American Society of Anaesthesiologists grade (ASA),⁶ residential status (own home or institutional care) and mental test score (0 to 10).⁷ The Garden⁸ grading of the fracture was noted. The pre- and postoperative protocols for care were the same for all patients and included perioperative antibiotic cover and thromboembolic prophylaxis with

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Table I. Details of the patients in both groups

	Hemiarthroplasty	Internal fixation
Number of patients	229	226
Mean age in years (range)	82.4 (71 to 101)	82.2 (71 to 103)
Number of men (%)	46 (20)	45 (20)
Mean mobility score	5.2	5.3
Prefracture use of walking aids (%)		
None	141 (62)	139 (62)
Walking stick	59 (26)	54 (24)
Zimmer or other walking frame	26 (11)	31 (14)
Immobile	3 (1)	2 (1)
Mean mental test score	5.5	5.4
Mean ASA score	2.7	2.7
Living in own home (%)	164 (72)	151 (67)
Pre-existing cardiovascular disease (%)	78 (34)	70 (31)
Pre-existing respiratory disease (%)	23 (10)	24 (11)
Mean preoperative haemoglobin (g/l)	128	128
Garden ⁷ grade 3 (%)	113 (49)	117 (52)
Garden ⁷ grade 4 (%)	116 (51)	109 (48)
Mean time from injury to admission (hours)	4.8	4.9
Mean time from injury to surgery (hours)	27.5	25.0
Operation with spinal anaesthesia (%)	91 (40)	87 (38)

heparin for five days. Internal fixation was undertaken percutaneously after closed reduction of the fracture using three parallel cannulated AO cancellous screws (Stratec Ltd).⁹ For hemiarthroplasty an uncemented Austin Moore (Stryker Howmedica Osteonics Ltd, Newbury, UK) implant was inserted by an anterolateral surgical approach with preservation of the joint capsule.⁹ After operation, there were no restrictions on movement of the hip or weight-bearing in either group with all patients being encouraged to walk as soon as they were able.

The patients were followed up by the first author (MJP) in a hip fracture clinic, which included an assessment at one year from injury. For those patients unable to attend assessment at one year this was undertaken by telephone and patients were thereafter contacted annually by telephone. Those who complained of considerable pain in the hip were asked to re-attend the clinic and pain was assessed using the six-point scale of Charnley.¹⁰ Mobility and residential status were also noted. Shortening and loss of flexion compared with the contralateral hip were determined for all except those with contralateral disease. All surviving patients had a minimum follow-up of one year with 330 being assessed at one year, 217 at two years and 151 at three years. No patient was lost to follow-up.

Statistical analysis. Between groups this was calculated using the unpaired *t*-test for continuous variables, Fisher's exact test for binary outcomes and the log-rank test for mortality using GraphPad InStat version 3.00 for Windows 95 (GraphPad Software, San Diego, California).

Table II. Mortality related to age, mobility score and mental test score, by number and *percentage*

	Hemiarthroplasty	Internal fixation	p value
Age in years			
All ages	63/229 (27.5)	61/226 (27.0)	0.91
71 to 79	12/83 (14.5)	17/85 (20.0)	0.42
80 to 89	36/110 (32.7)	35/117 (29.9)	0.67
90 and above	15/36 (41.7)	8/24 (33.3)	0.59
Mobility score			
0 to 3	38/72 (52.8)	35/81 (43.2)	0.26
4 to 6	20/79 (25.3)	19/64 (29.7)	0.58
7 to 9	5/78 (6.4)	7/81 (8.6)	0.77
Mental test score			
0 to 3	35/67 (52.2)	31/64 (48.4)	0.73
4 to 6	8/21 (38.1)	13/26 (50.0)	0.56
7 to 10	20/137 (14.6)	13/125 (10.4)	0.35

Fig. 1

Flow diagram for patients in both groups.

Fig. 2

Survival curve for both groups with mortality as the endpoint.

Fig. 3

Survival curve for patients aged 70 to 79 years in both groups.

Fig. 4

Survival curve for patients aged 80 to 89 years in both groups.

Fig. 5

Survival curve for patients aged 90 years and over in both groups.

Results

Over the period of study 1581 patients with an intracapsular fracture were admitted. Figure 1 shows the number of patients who were excluded and the reasons for this; some were excluded for more than one reason. Table I gives the details of the 455 patients randomised. There were no statistically significant differences between the two groups for any of the measures listed. For these patients, 49 deviations

from the trial protocol occurred in 36 patients as listed in Figure 1. All results other than those for the operative details (*see* Table IV) were presented by intention to treat.

The primary outcome was mortality for which there was no statistically significant difference between the groups (Fig. 2). There was a tendency for an improved survival after internal fixation in those aged 90 years and over (Figs 3 to 5) and in those with a lower mobility score (Table II), although none of these results reached statistical signifi-

Table III. Pain and function for the surviving patients at one, two and three years

	Hemiarthroplasty	Internal fixation	p value
One year			
Number of patients	163	160	
Number with little, if any, pain (%)	91/163 (55.8)	102/160 (63.8)	0.17
Mean pain score	2.41	2.22	0.91
Mean reduction in mobility score	1.92	1.71	0.27
Number using same walking aids (%)	61/166 (36.8)	66/164 (40.2)	0.57
Number at same residential status (%)	135/162 (83.3)	134/164 (84.8)	0.76
Mean shortening in mm	3.6	7.0	0.004
Mean loss of flexion (degrees)	9.2	8.8	0.83
Two years			
Number of patients	105	123	
Mean pain score	1.87	2.03	0.82
Number with little, if any pain (%)	83/105 (79.1)	88/123 (71.5)	0.22
Mean reduction in mobility score	2.26	2.08	0.45
Three years			
Number of patients	74	91	
Mean pain score	1.79	1.92	0.93
Number with little, if any pain (%)	54/74 (77.1)	67/91 (73.6)	0.71
Mean reduction in mobility score	2.72	2.65	0.82

cance. Table III gives details of pain and functional assessment of the survivors. Other than the degree of shortening none of the outcome measures showed any statistically significant difference between groups.

The operative details are shown in Table IV and relate only to those patients who received the operation to which they had been allocated. A decrease in blood pressure during the operation was defined as a reduction of systolic pressure of more than 40 mmHg for more than five minutes. Superficial wound infection, defined as infection requiring antibiotics and/or debridement, but not involving the prosthesis, occurred in five patients in the hemiarthroplasty group and in three in the internal fixation group. Deep wound infection, defined as infection around the implant, occurred in six patients in the hemiarthroplasty group and in none in the internal fixation group. Table V gives details of postoperative complications. None of the differences between the two groups was statistically significant other than that of deep wound infection ($p = 0.03$).

Twelve patients in the hemiarthroplasty group required secondary procedures, 15 reoperations in total. Seven were revised to total hip replacement (THR) for loosening. One of these THRs dislocated twice and had a later acetabular cup support. One fracture below the implant was plated and two patients with sepsis were treated by a Girdlestone excision arthroplasty. Two patients allocated to the arthroplasty group but treated by internal fixation developed nonunion and were revised to a hemiarthroplasty. In addition, in one patient a fracture below the implant was treated conservatively by traction.

In 77 (34.5%) of those allocated to internal fixation the fracture redisplaced after fixation or showed radiological evidence of nonunion at the final follow-up. In addition, 11 (4.9%) patients had radiological evidence of avascular necrosis. A total of 111 surgical procedures was undertaken on 90 patients. These secondary operations were hemi-

arthroplasty (61), total hip replacement (THR) (5), removal of the screws followed by hemiarthroplasty (7), removal of the screws followed by THR (2), hemiarthroplasty which later required revision arthroplasty (7), removal of the screws alone (8), drainage of a haematoma (2) and reduction of dislocation (twice) in one patient (2). In addition, there was one case of fracture below the screws which was treated by hemiarthroplasty.

The mean length of hospital stay was 20.5 days for the arthroplasty and 20.8 days for the internal fixation group ($p = 0.91$). This stay included any time spent on outlying wards or in rehabilitation facilities until discharge from hospital. The mean hospital stay including days for any re-admissions related to the fracture of the hip was 22.7 days and 27.9 days, respectively for the two groups ($p = 0.087$).

Discussion

A meta-analysis¹ of over 100 reports of displaced fractures of the neck of the femur reported a mean rate of nonunion of 33%, avascular necrosis of 16% and a reoperation rate of 20% to 36% after internal fixation compared with 6% to 18% after hemiarthroplasty. These findings are comparable with our rate of reoperation of 40% (92/231) for patients in this study treated by internal fixation and 4.5% (10/226) for those treated by arthroplasty.

The Cochrane review group has identified previous quasi-randomised and randomised trials which have compared internal fixation with arthroplasty.¹¹ Our study is the largest trial to date on this topic and also used much stricter methodology, which included blinded randomisation, analysis of intention to treat, defined inclusion and exclusion criteria, supervision by one surgeon and a comprehensive follow-up of patients. Jensen et al¹² undertook a similar study using parallel screws and a Moore hemiarthroplasty in 102 patients aged between 70 and 94 years. Mortality was

Table IV. Operative details for both groups

	Hemiarthroplasty	Internal fixation	p value
Number of patients	223	223	
Mean (SD) length of operation in minutes	46.4 (11.8)	24.2 (9.2)	<0.0001
Mean length (SD) of anaesthesia in minutes	56.9 (11.5)	36.0 (10.3)	<0.0001
Mean (SD) units of blood transfused	0.39 (0.82)	0.04 (0.31)	<0.0001
Number of patients transfused	44	4	<0.0001
Mean (SD) operative blood loss in ml	177 (114.3)	28 (18.0)	<0.0001
Number with operative fall in blood pressure (see text)	32	18	0.05

less after internal fixation (11/50 *versus* 19/52 at one year) with a rate of nonunion of 26% and of avascular necrosis of 6%. Wound sepsis and medical complications were more common after arthroplasty.

Our study suggests that internal fixation is associated with less initial surgical trauma (Table IV) and a tendency to reduced mortality in patients aged 90 years and over and in those with a reduced mental test or mobility score. The number of patients studied, however, was insufficient to show statistical significance. Our findings are supported by those of Davison et al¹³ who reported mortality at one year of 8% after internal fixation and of 12% after arthroplasty. Other studies have failed to find any difference in mortality between fixation or arthroplasty,¹⁴⁻²² possibly because of the selection of younger patients^{15,17} or those who satisfied specific mental or physical abilities.^{15,16,18,22} In a small randomised study of only 60 patients with dementia no difference in mortality between internal fixation or arthroplasty was found.²³

In our study the short-term outcome was similar for both methods of treatment. The long-term outcome for these procedures has not been evaluated, although this is planned with a follow-up of patients for the remainder of their lives. Our study agreed with the findings of all previous studies that internal fixation has the major disadvantage of an increased rate of reoperation in comparison with arthroplasty. This complication, however, although undesirable, can generally be effectively treated by revision to an arthroplasty. We believe that for the displaced intracapsular fracture internal fixation is appropriate for the younger patients (aged less than about 70 years) with a good life expectancy. Internal fixation may also be appropriate for the very elderly with impaired mobility, but further studies are required on this group of patients before definite conclusions can be made. For the remaining patients aged over 70 years with a displaced intracapsular fracture, hemiarthroplasty has a lower risk of secondary surgery.

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Table V. Postoperative complications. The numbers in parentheses are those complications which occurred after secondary surgical operations

	Hemiarthroplasty	Internal fixation
Superficial wound infection	5	3 (6)
Deep wound infection	6	0
Confusional state	14	13 (3)
Pneumonia	14	16
Retention of urine	13	5
Pressure sores	6	7
Gastrointestinal bleeding	6	4 (1)
Congestive cardiac failure	6	6
Cerebrovascular accident	2	1 (1)
Deep-vein thrombosis	2	4
Pulmonary embolism	1	3
Gastric aspiration	1	0
Renal failure	1	4
<i>Clostridia</i> diarrhoea	2	1
Amputation of leg	1	1
Wound haematoma requiring drainage	1	0
Perforated ulcer/GI tract	1	1
Acute cardiac arrhythmia	1	2
Myocardial infarction	0	0 (2)
Arterial embolus	0	1
Liver failure	0	1

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