INTERNAL FIXATION VERSUS HEMIARTHROPLASTY FOR THE DISPLACED SUBCAPITAL FRACTURE OF THE FEMUR

A PROSPECTIVE RANDOMISED STUDY

J. M. SIKORSKI, R. BARRINGTON

From the Bristol Royal Infirmary, Bristol

A prospective randomised trial of surgical treatment for the displaced subcapital femoral fracture in patients of 70 years or more is presented. Two hundred and eighteen patients were randomly allocated into one of three treatment groups: manipulative reduction and internal fixation using Garden screws; Thompson hemiarthroplasty through a posterior (Moore) approach; and Thompson hemiarthroplasty through an anterolateral (McKee) approach.

There is no significant difference in the mortality of the internal fixation and posterior arthroplasty groups. Both groups showed a significantly higher mortality than patients operated on through the anterior approach. The technical results of operation were worse in the internally fixed group, with only 40 per cent being satisfactory. Mobilisation was best achieved after the posterior approach. It is concluded that Thompson hemiarthroplasty, using an anterolateral approach, is the safest operation in this group of patients.

Patients sustaining a subcapital fracture of the femoral neck are currently treated either by a replacement hemiarthroplasty or by manipulative reduction and internal fixation of the fracture. On empirical grounds, a well-aligned and united proximal section of femur is preferable to an implant. However, achieving this goal can be a formidable task. Manipulative reduction of the fracture may be difficult. If the fracture is reduced, then adequate fixation is not always achieved. Even when both reduction and fixation seem satisfactory, late failure of fixation, failure of union and avascular necrosis of the femoral head may all occur (Barnes *et al.* 1976). Thus many patients in whom an attempt at obtaining union is made ultimately require prosthetic replacement. In this group of patients the primary failure gives prolonged disability, and they run the risks of long periods of pain, immobility and repeated operations. For this reason, primary prosthetic replacement has been advocated for all elderly patients with displaced fractures of the femoral neck (D'Arcy and Devas 1976). However, this solution has been opposed on the basis that replacement arthroplasty was inherently more hazardous and therefore it was considered unreasonable to expose all patients to increased risk for the sake of the few who would require revision operations.

Comparisons of internal fixation and hemiarthroplasty have been reported. Initial reports favoured

internal fixation as the safer alternative (Hunter 1969, 1974), but these were based on retrospective analyses. Two prospective trials (Riley 1978; Soreide, Mølster and Raugstad 1979) have shown quite different results. They found no difference between the mortality of internal fixation and hemiarthroplasty when done as a primary procedure. The discrepancy between the two types of study is probably explained by the fact that the retrospective studies did not compare like groups. However, there is a suggestion (Chan and Hoskinson 1975) that there may be other important variables. Thus, not all arthroplasties carry the same risks, and the anterior approach to the hip seems to be associated with fewer problems than the posterior.

The present, prospective, study seeks to answer the following questions. Is internal fixation inherently less hazardous than hemiarthroplasty, and does it lead to equally good rehabilitation? Is there a price to pay for attempting to reduce a fracture, failing, and only then proceeding to the arthroplasty? Does the surgical approach affect the outcome?

PATIENTS AND METHODS

Patients admitted to the Bristol Royal Infirmary between January 1977 and January 1980 with subcapital fractures of the femoral neck were included in a randomised trial of surgical treatment if the fracture was displaced (conforming to Stage III or IV of Garden 1964), and the patient was aged 70 or more in the year of presentation. Patients were

J. M. Sikorski, FRCS, Senior Lecturer in Orthopaedic Surgery, The University of Western Australia, Queen Elizabeth II Medical Centre, Nedlands, Western Australia 6009.

R. Barrington, FRCS, Senior Orthopaedic Registrar, The General Infirmary, Great George Street, Leeds LS1 3EX, England.

Requests for reprints should be sent to Mr J. M. Sikorski.

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excluded if the consultant in charge felt that a particular form of treatment was strongly indicated in that patient. The numbers excluded were a relatively small proportion and the most common grounds for exclusion were a long-standing fracture, rheumatoid arthritis, the suspicion of a malignant deposit in the hip and where the distinction between a Stage II and Stage III fracture could not be made confidently.

As soon as the patient was admitted to the trial, a card was drawn from a box in the operating theatre. These cards randomly allocated patients to one of three groups: internal fixation, Thompson hemiarthroplasty through a McKee anterolateral approach (anterior Thompson), or Thompson hemiarthroplasty through a Moore

internal fixation but the fracture was irreducible by manipulation and a hemiarthroplasty was therefore performed; 57 patients had anterior Thompson arthroplasty; and 57 patients had posterior Thompson arthroplasty. Patients were retrospectively excluded if a card was drawn out of sequence or if the instructions on the card were not followed. When the treatment allocation was made, each patient was allotted a printed proforma on which progress was recorded. A total of 218 patients fulfilled the selection criteria. Their mean age was 80.37 ± 6.21 years, and 35 were men.

The operations were almost invariably performed by trainees of varying degrees of experience. Manipulative reduction was controlled using an image intensifier, and internal fixation was by two Garden

Fig. 1

Fig. 2

Fig. 3

Figure 1—Good fixation with Garden screws. Figure 2—Poor fixation with Garden screws. Figure 3—Incomplete resection of femoral neck indicating an undesirable result of Thompson hemiarthroplasty.

posterior approach (posterior Thompson). The ratio of the three groups was predetermined as 2 : 1 : 1. Cards allocating patients to the internal fixation group carried an alternative of either anterior or posterior arthroplasty should a satisfactory manipulative reduction not be obtained. Thus, four separate groups of patients were generated: 76 patients had internal fixation; 28 patients were initially allocated to

Table I. Grades of pain and mobility

<i>Pain</i>
1. No pain at all.
2. Pain occasional and mild, not requiring analgesics.
3. Pain either constant or occasional but severe, requiring occasional analgesics.
4. Pain constant and severe, requiring regular analgesics.
<i>Mobility</i>
1. Independent, walks without aids and does own shopping. Capable of using public transport.
2. As above, but uses walking aids.
3. Limited to the house unless accompanied. Walking aids not used indoors.
4. Requires walking aids indoors.
5. Chair-bound.
6. Bed-bound.

screws. A standard Thompson prosthesis was used for both approaches and was cemented in. The following radiological criteria of technical adequacy were used: reduction had to be within 15 degrees in both the anteroposterior and lateral planes, with no step in the calcar femorale; fixation had to involve three out of four quadrants of the femoral head (anterior, posterior, superior and inferior) irrespective of whether the screws were crossed or not; the screws had to engage the subchondral bone and not penetrate the cortex; and Thompson prostheses had to be contained in an unfractured shaft, with no residual neck in the anteroposterior radiograph, and with no varus angulation (Figs 1 to 3). The decision on technical adequacy was made by one of the authors on the basis of the first radiograph after operation.

All patients were nursed in a general orthopaedic trauma unit and were mobilised, fully weight-bearing, on the second day after operation. Patients who had had a posterior Thompson arthroplasty were not allowed to sit and were nursed flat for two weeks. Otherwise no restrictions were imposed.

After discharge from hospital, patients were reviewed at a special clinic at intervals of three months or less. They were followed-up for two years, or until death, or until two weeks after the first revision operation, whichever was the sooner. Patients failing to attend clinics were recalled when possible, or their fate was ascertained from general practitioners, institutions, relatives or friends. At each attendance, estimates of pain and mobility were made on the scale shown in Table I. Patients were examined clinically, the range of movements of their hips recorded, and anteroposterior and lateral radiographs taken at each attendance.

Statistical analysis. Results are presented as percentages, or means $\pm$ standard deviations. Statistical significance has been assessed using the χ^2 test.

RESULTS

The mean ages of the three groups were comparable. The sex distribution showed a higher proportion of men in the internally fixed (21 per cent) and posterior Thompson (16 per cent) groups than in the anterior Thompson (nine per cent) group.

Mortality. Patient mortality was expressed either as the number of patients known to have died (simple mortality) or the sum of patients known to have died plus those lost to follow-up (maximum mortality). The true mortality lies between the two figures. Trends for the two are identical, however, and all statistics were based on simple mortality (Fig. 4).

There was no significant difference between the mortality of men and women. The ratio of male to

Fig. 4

Total mortality of patients aged 70 years or more after surgical treatment for the displaced subcapital fracture. The curves join the points representing simple mortality. The maximum mortality is represented as the upper limit for each point.

female patients entered into the trial was 1:5.2 and the ratio for those dying was 1:4.5. The mortality of posterior Thompson arthroplasty was marginally higher than that of internal fixation at all stages, but these differences were not statistically significant. Anterior Thompson arthroplasty was associated with lower mortality. When compared with internal fixation, the difference was significant at six months ($P<0.05$) and thereafter. Compared to posterior Thompson arthroplasty, there was a significant advantage by three months ($P<0.05$).

Patients in the irreducible group had the highest mortality. Their operative mortality was 21 per cent compared to one per cent for internal fixation, and four per cent for hemiarthroplasty, the difference being significant ($P<0.001$). By two years the simple mortality of these patients (70 per cent) was significantly higher than either the internal fixation ($P<0.05$) or the anterior hemiarthroplasty ($P<0.001$).

Systemic complications. Patients with irreducible fractures had the highest incidence of cardiac failure, respiratory infections and urinary infections (Table II). Posterior arthroplasty was associated with an identical incidence of complications except that cardiac failure

occurred less often. Anterior Thompson arthroplasty resulted in a greater number of wound infections than any of the other forms of treatment. This was 14 per cent for those diagnosed clinically and nine per cent for the bacteriologically proven, and was significantly higher than that occurring after internal fixation ($P<0.01$).

Technical results. On radiological criteria, all groups showed a very high rate of technical inadequacy, varying from 33 per cent for a posterior Thompson arthroplasty, to 46 per cent in the internally fixed group despite the fact that the latter group was already pre-selected in that the patients had been judged as having a good manipulative reduction (Table III). Thus, of the original 104 patients allocated to internal fixation, only 42 (40 per cent) had a technically successful manipulative reduction and internal fixation. This was significantly ($P<0.01$) worse than the success rate of posterior Thompson arthroplasty (67 per cent), or of anterior Thompson arthroplasty (64 per cent). Of 74 patients who were judged to be well reduced at the time of operation, only 54 per cent were subsequently accepted as having both adequate reduction and fixation.

Table II. The percentage incidence of complications after internal fixation or Thompson hemiarthroplasty

Complications	Internal fixation	Anterior Thompson	Posterior Thompson	Irreducible *
Cardiac failure	7	9	14	29
Respiratory infection	25	14	30	29
Urinary infection	17	12	21	21
Wound infection	4	14	7	4
(proven)	(1)	(9)	(5)	(14)
Number of patients	76	57	57	28

Figures in italics are percentages.

* For definition, see text.

Table III. Relative incidence of failure of primary treatment, as judged radiologically (technical), by persistence of symptoms and by the necessity to revise the original operation

	Internal fixation		Anterior Thompson		Posterior Thompson		Irreducible	
	n	%	n	%	n	%	n	%
Technically unsatisfactory	74	46	55	36	55	33	22	50
Pain after 1 month	53	28	55	11	55	4	19	5
Revision before 3 months	52	6	48	6	37	5	15	13
Revision between 3 and 24 months	44	32	41	7	28	1	8	13

n refers to the number of patients considered after exclusion of deaths and those for whom the relevant information could not be obtained because of inadequate radiographs, refusal to attend clinics or dementia.

The technical failures of the internal fixation group were reflected in both subjective complaints of persistent pain (of Stage III or worse for more than a month) in 28 per cent and in the rate of revision. Thirty-eight per

operative mobility or deteriorated by one grade, while 15 per cent deteriorated by more than one grade. After anterior arthroplasty, deterioration by two grades or more occurred in 37 per cent, and after internal fixation

Table IV. Principal causes of operative failure with internal fixation

Cause of early failure	Failures (per cent)	Cause of late failure	Failures (per cent)
Inadequate reduction *	26	Failure of union	2
Inadequate fixation	32	Avascular necrosis	18
Screw penetration	20		
Infection	15		
Number of patients surviving operation	74	Number of patients followed up for 24 months	44

For definition of early and late failures, see text.

*This was recognised late, so these patients were not transferred to the "irreducible" group.

cent of these patients required revision operations, more ($P<0.01$) than either of the arthroplasty groups.

Failures of internal fixation. Failures were divided into early, where the patient failed to regain full mobility, and late, where the initial mobility deteriorated (Table IV). The principal causes of early failure were inadequate reduction, inadequate fixation, screw penetration of the femoral head, and local infection about the screws. The majority of the screw infections were not associated with an overt wound infection immediately after operation but presented later. Late failure occurred in 20 per cent: in one patient union did not occur and the screws broke, and eight patients developed avascular necrosis of the femoral head.

Failure of arthroplasty. The principal technical inadequacy of the hemiarthroplasty group was failure to resect the femoral neck completely (Table V). This did not invariably cause symptoms. Dislocation was rare, with only two cases occurring, one in each arthroplasty group. The distribution of complications was equivalent in the two groups. Late problems were common (Table VI), the most frequent being para-articular ossification, loosening of the prosthesis and protrusio acetabuli which became apparent at about two years. As this was the limit of our follow-up period, this latter complication has almost certainly been underestimated. Protrusio developed very rapidly in two patients, and was associated with infection of the prosthesis.

Patient mobility. The ability of patients to walk deteriorated after operation compared with their state before. The deterioration was greatest after anterior Thompson arthroplasty and least after the posterior approach (Table VII). After anterior Thompson arthroplasty a number of patients remained either chair-bound or bed-bound. Eighty-five per cent of patients who had a posterior arthroplasty either maintained their pre-

Table V. Principal causes of technical inadequacy of Thompson hemiarthroplasty

Technical faults	Anterior Thompson (per cent)	Posterior Thompson (per cent)
Neck remnant	27	22
Varus stem	9	9
Dislocation	2	2
Infection	7	4
Others	4	—
Number of patients surviving operation	55	55

Table VI. Relative incidence of technical complications in the two forms of hemiarthroplasty

Complications	Anterior Thompson		Posterior Thompson	
	n	Per cent	n	Per cent
Para-articular ossification	48	13	28	7
Loosening of prosthesis	41	12	28	11
Protrusio acetabuli	41	7	28	11

Table VII. Relative effect of the different forms of surgical intervention on patient mobility when compared with their pre-operative state. Assessment at six months (measured as percentage of patients in each group)

Impairment of mobility	Internal fixation	Anterior Thompson	Posterior Thompson
No impairment	27	24	33
By 1 grade	43	39	52
By 2 grades	16	15	12
By 3 grades	8	17	3
By 4 grades	6	5	—
Number of patients assessed	37	41	34

in 29 per cent. The difference between the two forms of arthroplasty was significant ($P<0.02$).

DISCUSSION

In common with the other prospective controlled studies, we found that internal fixation offered no advantage over hemiarthroplasty in the treatment of the displaced subcapital fracture in the elderly patient. The

mortality associated with surgical treatment in these patients was high, irrespective of the procedure. Overall, our mortality figures were comparable to the other series (Riley 1978; Soreide *et al.* 1979; Dahl 1980). Our figure of 36 per cent at one year is slightly higher, but this is compatible with the higher age qualification for entry into this trial.

The morbidity of internal fixation was also awesome. These patients were not immune from general systemic complications, and the only significant advantage they had was in the lower incidence of wound infection. They had a very high rate of technical failure, and over one-third of all the internally fixed fractures required revision. Persistent pain was a major problem. These poor results are not unique to our centre, and Soreide *et al.* (1979) report a revision rate of 22 per cent. What is even more disturbing, however, is the high price that is paid for embarking on internal fixation and then changing course. The operative mortality of this group is simply unacceptable (21 per cent). The process of attempting reduction, then changing the patient's position, changing instruments and undertaking a hemiarthroplasty, resulted in a fivefold increase in mortality. If these patients survived, then subsequently they had the highest incidence of systemic complications. By two years, their maximum mortality was 71 per cent.

Comparison of internal fixation with hemiarthroplasty as a group disguises the fact that not all

hemiarthroplasties represent an equivalent hazard to the patient. The advantage of using an anterior approach to the hip joint rather than a posterior has been hinted at before, both on grounds of empirical observation (D'Arcy and Devas 1976), and retrospective analysis (Chan and Hoskinson 1975). This, however, is the first controlled validation of their suspicions. The anterolateral approach has a definite advantage in terms of lower mortality and lower incidence of systemic complications. We are unsure as to the mechanism of this. It could be a reflection of the position of the patient on the table, or of the nursing regimen. The advantages of the anterior approach do not extend to the technical quality of the result. The two approaches are indistinguishable, except that the posterior group gain better mobility. This, we believe, is simply a matter of "natural" selection: the posterior arthroplasty selects out the most frail patients, whose ultimate mobility would have been poor. Once again, internal fixation gives poor ultimate mobility.

Thus we have concluded that the anterior hemiarthroplasty is the safest primary mode of treatment in the elderly patient with the displaced subcapital fracture. Manipulative reduction and internal fixation is not indicated, as it has no advantage in terms of systemic morbidity and mortality, and has considerable disadvantages in obtaining adequate mobility. Since the policy at the Bristol Royal Infirmary for displaced subcapital fractures has been to use internal fixation wherever possible these results have been unexpected.

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