THE HASTINGS BIPOLAR HEMIARTHROPLASTY FOR SUBCAPITAL FRACTURES OF THE FEMORAL NECK

A 10-YEAR PROSPECTIVE STUDY

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In a 10-year prospective study, 561 displaced subcapital fractures of the femoral neck in 546 patients were treated with the Hastings bipolar hemiarthroplasty. Within six months of their operations, 148 patients had died. In 322 hips followed up, 243 with adequate serial radiographs separated by more than one year, only 14 (5.6%) showed acetabular erosion.

A group of 91 had been reviewed for between three and nine years (mean, 4 years 10 months) and of these, 95% had no pain or slight pain only.

Comparison with an earlier series of conventional hemiarthroplasties reported from this institution showed that the clinical results were similar, but that the erosion rate had been halved.

Biarticular prostheses were developed in the hope that they would lessen the incidence of acetabular erosion and hip pain, complications often associated with the use of single component prostheses for subcapital fractures of the femur (Table Ia). Whether or not biarticular prostheses achieve this aim remains uncertain. Several authors have reported that erosions do not occur, and have claimed that biarticular designs were associated with less postoperative pain (Langan 1979; Long and Knight 1980; Devas and Hinves 1983). However, Leyshon and Matthews (1984) found erosion in 9% and Van Demark, Cabanela and Henderson (1980) in 21%. A recent prospective study of the Bateman and Osteonics prostheses, in which there was a subgroup of 90 cases with a minimum follow-up of two years (mean 38 months), revealed measurable erosion in 21%, though 90% of patients had no significant pain (Bochner, Pellicci and Lyden 1988). All previous reports have reviewed less than 150 cases; only one study has a mean follow-up longer than three years (Table Ib).

We now report the results of a prospective study

carried out over 10 years during which 561 Hastings hips were implanted.

MATERIALS AND METHODS

The Hastings hip is a biarticular hemiarthroplasty. The femoral component has a curved stem and a 22.25 mm diameter head. If preferred, a standard straight-stem Charnley femoral component can be used. The head unit is constructed of ultra-high molecular weight polyethylene (UHMWP) bonded to a stainless steel outer shell. Since the UHMWP is slightly thinner centrally than peripherally, the centres of rotation of the inner and outer surfaces of the head unit are eccentric. It therefore tends to assume a perpendicular position along the vector of the weight-bearing force.

In all, 561 Hastings hemiarthroplasties were performed for subcapital fractures of the femoral neck in 546 patients between 1976 and 1986. Of these, 460 were female and 86 male; 261 operations were in right hips, and 300 in left; 87 (16%) were performed by a consultant, 233 (41%) by a senior trainee and 241 (43%) by a junior. The mean age of the patients was 79.8 years (range 43 to 102).

Less than six months after the operation 147 (26.5%) patients had died. A further 80 (14%) failed to attend for review. This was due to advanced infirmity (57), moving from the district (20), or for unknown reasons (3). Twelve patients (2%) had their hips revised within six months of surgery. These are fully discussed under the heading 'revisions'. The remaining 322 (57.5%) were reviewed at

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Table Ia. Results from previous published series of single component hemiarthroplasties

Authors	Prosthesis	Number	Dislocation (per cent)	Deep infection (per cent)	Follow-up					
					Years (mean)	Reviewed (per cent)	Loose (per cent)	Acetabular erosion (per cent)	Good/ excellent (per cent)	No pain/ slight (per cent)
Whittaker et al (1972)	Moore/ Thompson	160	4.4	3	4 to 18	34	—	64	57	58
Jensen and Holstein (1975)	Moore	169	0.6	3	4.9	36	—	16.7	—	70
D'Arcy and Devas (1976)	Thompson (cemented)	354	2	1.1	3	45	—	11	82	—
Tillberg (1976)	Moore	163	1.2	3	3.5	18	—	—	—	93
Beckenbaugh, Tressler and Johnson (1977)	Thompson (cemented)	51	0.9	4.6	3	67	—	15	—	85
Montgomery and Lawson (1981)	Thompson (uncemented)	250	1	2.4	4.8	38	—	—	57	85
Browett (1981)	Thompson (uncemented)	324	0.6	4.9	3.3	26	56	35	47	—
Johnston et al (1982)	Moore	150	0.6	2	1.8	83	4	—	—	83

Table Ib. Results from previously published series of biarticular prostheses

Authors	Prosthesis	Number	Dislocation (per cent)	Deep infection (per cent)	Follow-up					
					Years (mean)	Reviewed (per cent)	Loose (per cent)	Acetabular erosion (per cent)	Good/ excellent (per cent)	No pain/ slight (per cent)
Langan (1979)	Giliberty	90	4.4	1.1	1.6	72	0	0	—	93
Long and Knight (1980)	Bateman	225	1.7	—	2.5	69	0	0	—	97
Van Demark et al (1980)	Bateman	59	3.4	1.7	2.2	72	5.8	21	94	—
Devas and Hinves (1983)	Hastings	161	5.1	—	2.3	60	—	0	70	—
Franklin and Gallanaugh (1983)	Bateman	101	0	0	6 mth	52	0	0	—	30
Leyshon and Matthews (1984)	Monk	182	—	—	2.1	—	—	4.9	—	—
Bochner et al (1988)	Osteonics	120	2.5	0.8	3.2	75	2.2	19	—	91
Wetherell et al (1989)	Hastings	561	2.9	1.1	2.9	57	7	5.4	83	95

six months, one year, and annually thereafter. For those patients who died, or defaulted from review during the study, the last attendance was used to calculate the final length of follow-up. The mean length of follow-up for the study was 29 months (range 6 to 100). If the 91 patients followed up for over three years are considered as a separate subgroup, they have a mean follow-up of 48 months (range 36 to 100).

The majority of operations (96%) were performed by an anterolateral approach in an orthopaedic theatre with conventional ventilation. The femoral components were cemented in all cases. Since 1983, cement restrictors have been used routinely to permit cement pressurisation. Antibiotic prophylaxis was given at induction of anaesthesia, and continued for five days. Apart from early mobilisation and anti-embolism stockings, no prophylaxis was employed against venous thrombosis. Within a week of surgery, 46% of the patients had been transferred to an orthogeriatric unit, and 88% had left the acute surgical unit within a fortnight.

Clinical assessment. At each review, pain, function and range of movement were scored using the Charnley (1972) grading system. To assess whether the quality of the results diminished with time, the overall grade for each patient was calculated using the system described by Hansen, Kromann and Baekgaard (1986), in which

the grades in Charnley's three categories are added together to produce a total score.

Radiological assessment. At each review, anteroposterior pelvic radiographs were taken. Of the 289 cases followed for a minimum of one year, 243 had complete sets of films allowing comparison of radiographs separated by at least a year. These serial films were examined for acetabular erosion, using the lateral lip of the acetabulum on each side to provide a consistent landmark for measuring superior migration. A line tangential to the pelvic brim and passing through the mid-point of the obturator foramen provided a consistent marker for medial migration. If pelvic rotation did not exceed 10° between successive films, this method of analysis was found to be accurate with a margin of error of only 2.0 mm (Wetherell, Amis and Heatley 1989). To allow for minor differences in magnification and positioning, a change of 3 mm or more was taken as evidence of true erosion.

On the femoral side, the bone-cement interface was examined for lucent lines which would suggest loosening, and any distal migration of the component was measured. Earlier workers have taken measured sinkage of greater than 2 mm as evidence of significant loosening (Griffith et al 1978; Stauffer 1982), and the same measurement was adopted in this study.

Survivorship. The whole series was subjected to survivorship analysis by the method of Dobbs (1980).

RESULTS

Peri-operative complications. (Table II).

Of the 561 prostheses, 16 (2.9%) dislocated; on all but three occasions this occurred during the patients' period in hospital. Of the three late dislocations, one was at four weeks as a result of a fall, one at four months while the patient was rising from a chair, and the third at some time between leaving hospital and the first review at six months.

Dislocation in a biarticular prosthesis may be intraprosthetic (involving separation of the components), or extraprosthetic (the assembled prosthesis dislocates intact). The first two of the three late dislocations described above were the only intraprosthetic dislocations to occur, and both required open reduction. Slight imperfections in the manufacture of some early head units may have been responsible (Devas and Hinves 1983).

therapy occurred in 10 cases (1.8%). Four patients developed primary deep infections, one developing acute renal failure and dying. The other three eventually had

Table II. Major surgical complications

Complication	Number	Requiring further surgery	Procedure
Peri-operative shaft fracture	3	—	—
Prosthesis perforated shaft	4	4	Revised to long stem femoral components
Dislocation	16	9	(see text for details)
Primary deep infection*	4	3	Girdlestone pseudarthrosis
Loose femoral component	3	3	Revision of femoral component
Fracture below prosthesis	1	1	Revised to long stem femoral component
	31 (5.5%)	20 (3.6%)	

*one patient died of renal failure secondary to sepsis

Table III. Survivorship table, where failure is the need for operative revision

Follow-up (years)	Number at start	Withdrawn	Revised	Number at risk	Annual failure (per cent)	Annual success (per cent)	Cumulative success (per cent)
0 to 1	561	259	13	431.5	3.0	97.0	97.0
1 to 2	289	121	2	228.5	0.9	99.1	96.1
2 to 3	166	74	1	129	0.8	99.2	95.4
3 to 4	91	34	1	74	1.4	98.6	94.1
4 to 5	56	19	1	46.5	2.2	97.8	92.0
5 to 6	36	14	2	29	6.8	93.2	82.5
6 to 7	20	14	0	13	0	100	82.5
7 to 8	6	2	0	5	0	100	82.5
8 to 9	4	0	0	4	0	100	82.5

The other 14 dislocations were extraprosthetic. Three were successfully reduced by closed manipulation. Of seven cases where open reduction was performed, only two were successful. Two patients developed deep infection and three had recurrent dislocations; all five were converted to Girdlestone pseudarthroses. Three further cases were revised directly to total hip replacements. The dislocation discovered at the six-month review had a relatively pain-free pseudarthrosis and was therefore left untreated.

Wound dehiscence occurred in one case, requiring resuturing, but no organism was isolated from the wound. Superficial wound infections which resolved on antibiotic

Table IV. Analysis of 91 patients followed up for three to nine years and graded by the method of Hansen, Kroman and Baekgaard (1986) by number and percentage of the group

Charnley grade (points)	Follow-up (years)			
	0.5 to 1	1 to 2	2 to 3	3 to 9
Excellent (17 to 18)	35 38	34 37	29 32	29 32
Good (13 to 16)	46 51	46 51	51 56	45 49
Fair (8 to 12)	7 8	8 9	8 9	10 11
Poor (<8)	3 3	3 3	3 3	7 8

Girdlestone pseudarthroses. If the two cases with infection following open reduction of a dislocation are included, there was a total of six cases of deep infection (1.1%).

The complication rate was found to be independent of the experience of the operating surgeon.

is shown in Table IV. Cases with follow-up greater than three years have been grouped together and their results at six months, one year, two years and the final review have been tabulated. These results have been analysed by McNemar's χ^2 test, studying the excellent/good and the fair/poor groups and the changes between them over

Table V. Radiographic analysis of acetabular erosion in 243 patients with comparable films followed up for one year or longer (number and *percentage* with erosion)

Erosion (mm)	Follow-up (years)								Total
	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	
<3	103	45	26	24	16	8	2	5	229
>3	6 5.5	2 4.3	2 7	2 7.7		1 11	1 33		14

Revisions. A total of 20 hips (3.6%) were revised. The reasons for revision and the procedure performed are shown in Table II. The times of the revisions are included in Table III. To date, no revisions have been performed for acetabular erosion. All the revised hips have been counted as failures, regardless of their subsequent progress.

the period of the study. There was a deterioration in the results in later years which is statistically significant ($p < 0.05$).

Radiographic analysis. Of the 243 cases which had a complete set of radiographs after one year, 14 (5.8%) showed a change in the position of the head unit of 3 mm or more (Table V). Nine of the 10 patients with erosions

Table VI. Radiographic analysis of sinking of the femoral component in 243 patients (number and *percentage* with sinking)

Sinking (mm)	Follow-up (years)								Total
	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	
<2	107	42	25	25	16	5	3	3	226
>2	2 1.8	5 10.6	3 10.7	1 3.8		4 44.4		2 40	17

Survivorship. Survivorship analysis for the series is shown in Table III. From these figures, it can be seen that the great majority of revisions were performed in the first year and that the number revised in each subsequent year has remained low. One patient required further surgery at five years following a fracture around the femoral prosthesis. All the other revisions after three years were for loosening of the femoral component.

Clinical results. The mean score for pain was 5.7; 307 cases (95%) had no pain at all, or only slight pain in the hip when last reviewed. Only 15 (4.5%) had moderate or worse pain.

The mean score for range of movement was 5.7, and for function it was 4.0; 220 patients (69%) walked unaided or with one stick only; those using one stick slightly outnumber those who managed without. These results emphasise the disproportionate loss of confidence suffered by these elderly patients despite good pain relief.

The effect of time on the quality of the clinical results

of 5 mm or less were asymptomatic or had slight pain only, while three of the four in which there had been erosion of more than 5 mm had moderate or severe pain. One of the most severe erosions was secondary to deep infection and another occurred in a patient with Paget's disease of the pelvis.

Seventeen femoral prostheses showed sinkage of 2 mm or more (Table VI). The correlation of pain with subsidence and with acetabular erosion is shown in Tables VII and VIII. A partial or complete radiolucent line more than 1 mm wide was seen at the bone-cement interface in 69 of the cases examined.

DISCUSSION

This study is the largest so far reported for any biarticular prosthesis and the subgroup of 91 cases has, at 4.8 years, the longest follow-up. Pain relief is the criterion which allows the most direct comparison with other studies.

Only 5% of our patients had more than slight pain at review, a figure which is similar to that reported by Bochner et al (1988). The average scores for function and range of hip movement in the Hastings hip are also similar to those found by those authors in a study of Bateman and Osteonic prostheses. As in their study and many others, the score for function was lowered by the patients' frequent use of a stick.

Table VII. Correlation of femoral component sinking with symptoms

Sinkage (mm)	Pain			
	None	Slight	Moderate	Severe
> 10		1		
7 to 10		1	1*	2*†
4 to 6	2	1	1*	1*
0 to 3	5	2		

*also had acetabular erosion
†also had infection

The main reason for the use of a biarticular prosthesis is to lessen the incidence of acetabular erosion; but it is difficult to compare erosion rates between series, because no standard method of measurement has been generally adopted. The most accurate method available is X-ray stereophotogrammetry (Lippert et al 1982; Mogensen et al 1982), but this is a research tool requiring the implantation of markers at operation. We have depended upon the measurement of clinical radiographs, a method accurate to within 3 mm (Wetherell et al 1989). Our series has demonstrated no tendency for the incidence of erosion to rise with increasing follow-up. However, once it begins, erosion appears to progress at a steady rate. In our series, the erosion rate (5.6%) was lower than that reported in most studies of single component prostheses. In particular, a study of Thompson prostheses in our own institution (D'Arcy and Devas 1976) found an erosion rate of 11%.

Sinkage of the femoral component occurred in 17 cases (7%), and gave rise to symptoms requiring revision in three. Curved femoral stems are known to be associated with a high incidence of loosening (Reikeras 1982; Sutherland et al 1982; Lindberg and Carlsson 1983), and the curved stem of the Hastings hip is shortly to be replaced with a straight stem.

Statistical analysis, using Fisher's exact test, failed to show any association between pain and either acetabular erosion or femoral component sinkage, perhaps because the numbers involved were too few.

Rae and Paton (1988) recently reported three cases of interprosthetic dislocation of the Hastings hip. Two

occurred during attempts at closed reduction of extra-prosthetic dislocations. Separation of the components is a well-recognised but uncommon complication of biarticular hip replacement and is not confined to the Hastings prosthesis (Anderson and Milgram 1978; Barmada and Siegel 1979). Our incidence of interprosthetic dislocation was 0.4%. Stewart and Papagiannopoulos (1986) reported interprosthetic dislocation in one Hastings hip out of 100

Table VIII. Correlation of acetabular erosion with symptoms

Erosion (mm)	Pain			
	None	Slight	Moderate	Severe
> 10			1	1*†
7 to 10	1		1*	
4 to 6	3	1	1*	
2 to 3	3	1		1*

*also had femoral loosening
†also had infection

(1%), and Bochner et al (1988) had one case in 120 (0.8%). While closed manipulation may result in disassembly of the components, this is very uncommon in normal use.

Our results offer some support for the concept behind the Hastings prosthesis, but there is a clear need for a controlled prospective trial to compare its performance with that of a single component hemiarthroplasty. For statistical significance such a trial will need to include at least 120 patients in each group.

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