

FRACTURED STEM IN TOTAL HIP REPLACEMENT

A Clinical Review of 120 Cases

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Clinical review of 120 cases of fractured stem of the now obsolete Charnley "flat back" has shown an incidence of 1.15 per cent. The period of risk was the 11 years from the time of surgery and 97.5 per cent fractured during that time. Before the fracture occurred 87.8 per cent had normal hip function.

There was a linear relationship between the patients' weight and the time of the fracture. Patients of comparable weight, and referred from other units, fractured the stem earlier than patients from our unit. Radiographic evidence of failure of the femoral stem fixation, within 1 year of surgery, was found in 77.2 per cent of the hips where serial radiographs were available. This group fractured the stem, on average, 17.3 months earlier. Loss of calcar height was present in 73.3 per cent and was a technical problem at revision. Study of varus/valgus orientation of the stem did not bear out the commonly held opinion; in patients of comparable weight valgus stems fractured earlier than varus stems. Mechanical loosening of the socket in the group was 12.9 per cent. Detachment of the trochanter following revision was 12.1 per cent and the dislocation rate 5.2 per cent.

The findings suggest that the surgical technique, as regards preparation of the medullary canal and the cement injection, and the patients' weight, are the most important factors in the complication under study.

Key words: arthroplasty; femoral component; fracture

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The mechanism of fracture of the stem in total hip replacement was postulated from the examination of the fragments (Wroblewski 1979a) and confirmed experimentally (Charnley 1979).

In a previous study (Charnley 1975) the male:female ratio, the importance of body weight and the varus placement of the stem have been discussed. The varus-valgus orientation of the stem within the medullary canal has received frequent attention since (Galante et al. 1975, Nicholson 1976 and Collis 1977). The level of the fracture of the stem (Wroblewski 1979a) and the method of operative management have also been recorded (Wroblewski 1979b).

This paper is a retrospective study of 120 cases undertaken to highlight clinical and radiographic

aspects of the complication. Seventeen of the fractures have been reported previously (Charnley 1975).

The stem under review (Charnley "flat back") has been made obsolete by a new generation of designs and the technique improved to prevent this complication.

PATIENTS AND METHODS

Review of case notes and radiographs of patients with a fractured stem was carried out.

A total of 120 fractures occurred in 115 patients. The sex distribution and the fracture side are shown in Table 1, and the patients' age at the time of fracture in Figure 1.

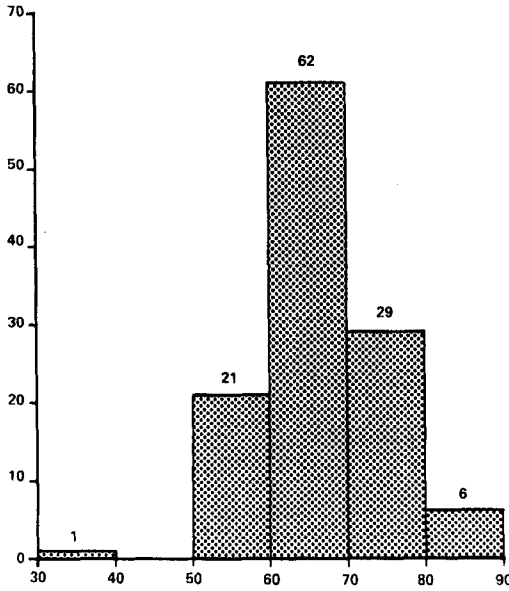


Figure 1. Patients' age at the time of fracture of the stem.

Hip pathology leading up to low friction arthroplasty is presented in Table 2 and the state of the opposite hip in Table 3.

Only 3 patients – one with bilateral stem fractures and 2 with arthritis had markedly reduced function.

RESULTS

The onset of discomfort or pain, usually referred to the thigh and knee, at times sudden, when weight-bearing, was the typical presentation. Four patients presented as an emergency; in 3 the fracture was discovered accidentally. Excluding these 7, all the others were aware of deterioration of function, often retrospectively.

Eight fractures had occurred within 2 years of surgery; 7 were in males and one in a female. Five followed primary hip replacement (one had had an osteotomy). Two of them fractured the stem within 2 years and fractured the stem again within 2 years after the revision. The only female in this group had had a revision for a fractured stem of a metal to metal prosthesis and fractured the stem again following revision.

A total of 109 stems (90.8 per cent) fractured

Table 1. Fractured stem – sex and side.

	Right	Left	Total
Male	46	46	92
Female	20	8	28
Total	66	54	120

Table 2. Hip pathology leading to total hip replacement.

Hip Pathology	No.	Per cent
Osteoarthritis		
Primary	95	82.6
Secondary –		
Paget's disease	5	4.3
Quadrantic head necrosis	4	3.5
Slipped femoral epiphysis	1	3.5
Fractured acetabulum	1	
Fractured femoral neck	1	
Congenital coxa valga	1	
Rheumatoid arthritis	4	3.5
Primary protrusio	2	1.7
Ankylosing spondylitis	1	0.9
	115	100

Table 3. Condition of the contralateral hip.

Contralateral hip	No.	Per cent
Normal	47	40.9
L.F.A.	54	47.0
O.A.	10	8.7
Hip fusion	2	3.4
Infected LFA	1	
Fractured stem	1	
Total	115	100

in the 9-year period between the second and the eleventh year after surgery.

Three fractures, all in females, occurred after the eleventh year. Two had had a Teflon arthroplasty originally which was revised without changing the stem. The progressive loss of calcar and thus of proximal support of the stem was an obvious feature. The fractures occurred at 177 and 154 months. The third fracture was found

Table 4. The three groups of fractures: early, typical and late.

Fractures	No.	Per cent of total	Average weight	
			lb	kg
Within 2 years	8	6.7	201.6	91.6
2-11 years	109	90.8	185.6	84.4
After 11 years	3	2.5	137.7	62.3

Table 5. Comparison of the Hip Centre patients and referred patients.

	No.	Average weight		Time between surgery and fracture (months)
		lb	kg	
Other units	24	183.6	83.5	56.6
Hip Centre	96	187	85	77.7

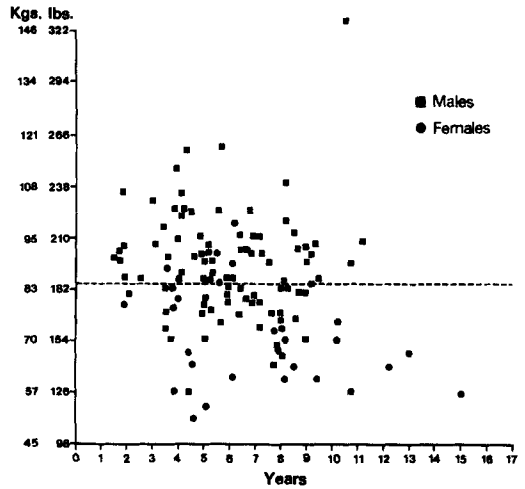


Figure 2. A total of 120 fractured stems recorded over 17 years. Relative absence of fractures after the eleventh year (dotted line-average weight).

accidentally. It was very low, caused no symptoms and was thought to have occurred around the twelfth year. The time interval be-

tween surgery and the fracture and the average weight in the three groups is presented in Table 4.

Males weighed 194.3 lb (88.3 kg) on average. Females were lighter, their average weight was 158 lb (71.9 kg). Fifty-three patients (46.1 per cent) gained weight, 19.1 lb (8.7 kg) on average, between hip replacement and the fracture. The

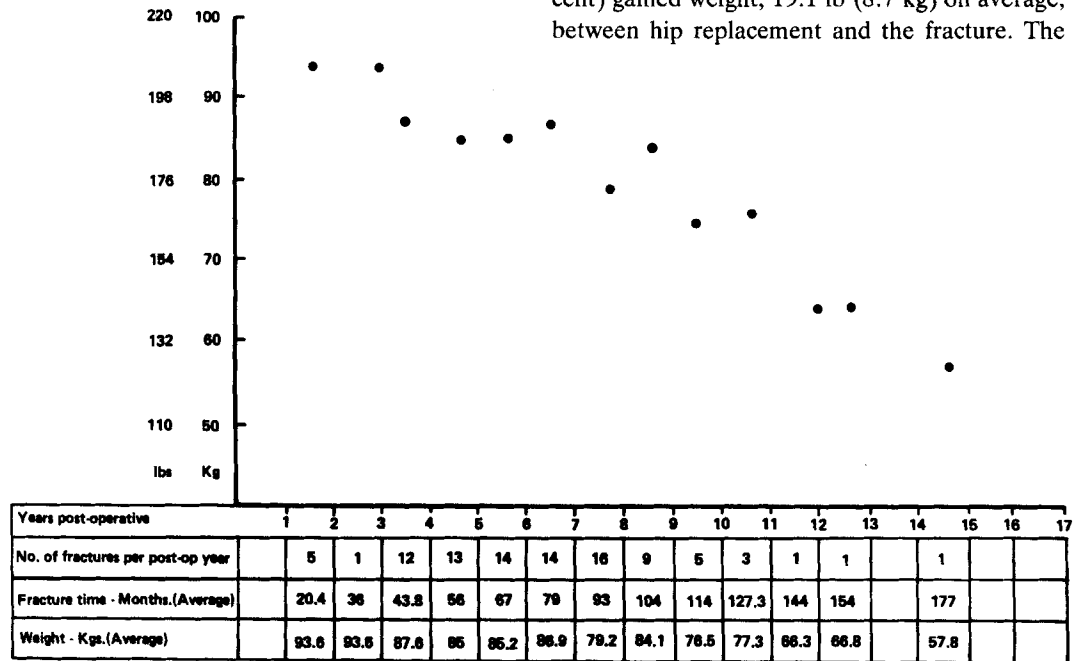


Figure 3. Ninety-five fractures showing their distribution and the linear relationship between the weight of the patient and the time of the fracture of the stem.

correlation between the patients' weight and the time of the fracture is shown in Figures 2 and 3.

Comparison between patients from the Hip Centre and other units is made in Table 5.

Radiographic study

In 7 cases radiolucent cement was used. In 21 no postoperative radiographs were available except for the one showing the fractured stem. Fracture of the femoral cement was seen in 58 (51.3 per cent) of the 113 cases. In 33 (29.2 per cent) this was near the tip of the stem, in 17 (15 per cent) at the calcar, and in 8 (7.1 per cent) at the tip of the stem *and* at the calcar.

Cystic cavitation of the endosteum of the femur was present in 28 cases (24.8 per cent). In 15 it was above the lesser trochanter, while in 10 it also extended below the lesser trochanter. In 3 it occurred around the tip of the stem. In 26 cases cystic cavitation was found later than 1 year after surgery.

In 92 cases serial radiographs were available to allow the time of the failure of the femoral cement and subsidence of the stem to be studied. The failure was defined as (1) separation of the stem from the lateral aspect of the cement, (2) fracture of the cement about the tip of the stem (3) fracture of the cement at the calcar, (4) extensive cavitation of the calcar or any combination of (1) to (4).

Using the above criteria, in 71 cases (77.2 per cent) the fixation had failed by about 1 year from the time of the operation. Based on the first three criteria, 2 had failed within 2 weeks of surgery, 26 (28.3 per cent) around the sixth post-operative month and 41 (44.6 per cent) around the twelfth month.

Table 6. Comparison of cases with femoral cement failure and those showing intact femoral cement at 12 months.

Femoral cement	No.	Average weight		Time of fracture of the stem (months)
		lb	kg	
Failed at 12 months	71	186	84.5	67.5
Intact at 12 months	21	184	83.6	84.8

In the 2 patients with extensive cavitation of the calcar the changes were found at 7 and 12 months, respectively. In 21 cases the femoral cement appeared normal at 12 months. The two groups are compared in Table 6.

Cortical thickening in the region of the tip of the stem was present in 31 cases (25.8 per cent).

The quality of the femoral cortex below the lesser trochanter, excluding localised cystic cavitation, was normal in all but two cases; one had had an osteotomy some years previously and the femoral shaft always appeared porotic. The second patient had "limped" on the fractured stem for 2 years.

Loss of the calcar height before total hip replacement or as a result of the technique of hip replacement or because of fracture of the stem, was found in 88 cases (73.3 per cent). In 32 (26.7 per cent) it extended to the level of the lesser trochanter. This presented a technical problem at revision surgery; use of a femoral stem with an extended neck was often indicated.

The position of the stem within the medullary canal was studied according to criteria suggested by Charnley (1975) and the results are shown in

Table 7. Position of the stem, time of fracture and patients' weight.

Position of the stem	No. of cases	Per cent	Average time between surgery and fracture (months)		Average weight	
			lb	kg		
Valgus	23	19.2	60.5	204.6	93	
Neutral	23	19.2	69.7	177.8	80.8	
Varus	67	55.8	77.1	185	84.1	
Proud	7	5.8	86.0	160.7	73	

Table 8. Comparison of "varus" and "valgus" patients weighing 80 kg or more

Position of the stem	No.	Average weight		Average time between surgery and fracture (months)
		lb	kg	
Varus	38	206.9	94.0	72.8
Valgus	23	204.6	93.0	60.5

Table 7. A comparison between "valgus" and "varus" patients weighing 80 kg or more is presented in Table 8.

Fracture of the radiographic wire marker of the socket was found in 23 cases (18.3 per cent). In 16 it was on the same side, in 6 on the opposite side, and on both sides in one case.

A study of the socket in cases of fractured stem has not been reported before. Of the 116 cases undergoing revision the socket was changed because of loosening in 13 (11.2 per cent). Three other sockets migrated following changing of the stem alone. (One was associated with deep sepsis.) Thus the total rate of *mechanical* loosening of the socket was 12.9 per cent. Two other sockets were changed – one for malposition, the other for suspected loosening.

Four patients did not undergo revision surgery; 3 were not fit while in the fourth the fractured stem presented no problems.

Over 50 per cent of the revisions were carried out by the author by the technique described (Wroblewski 1979b).

Three patients died in the postoperative period, 2 with pulmonary embolism, one with cerebral haemorrhage. Three had paralytic ileus and one intestinal obstruction. Seven had a delayed wound healing and one had deep sepsis. There were 14 cases (12.2 per cent) of trochanteric non-union and one of delayed union. Six (5.2 per cent) had a subluxation or dislocation; 5 were treated conservatively and one required open reduction.

Excluding the 4 patients who did not undergo surgery, the 3 that died and the one that was infected, all others returned to normal activities following the revision.

The incidence of fractured stem was studied in a group of 3,983 hips which at the time of writing have passed the 11-year mark from the time of the operation (see Figure 2); 255 were still being followed as part of the long-term study. The original group had 46 fractures – an incidence of 1.15 per cent.

DISCUSSION

The Charnley low friction arthroplasty has been a developmental procedure and fracture of the stem has turned out to be a rare complication. The male/female ratio is less than previously reported (Charnley 1975). A proportion of patients had gained weight following surgery. This was usually attributed to "well being" but the effects of withdrawal of some of the analgesics/anti-inflammatory drugs must be seriously considered. Patients must be discouraged from gaining weight.

Normal function of the opposite hip and thus of the patient has not been commented upon before. A fractured stem may be considered a back-handed compliment to the excellent quality of the functional results of the operation.

The importance of the surgical technique and the patients' weight is highlighted when analysing the patients from the Hip Centre and the referred patients (Table 5); although the average weights of the two groups are comparable, fractures occurred 21.1 months earlier in the referred patients. Statistical analysis showed that for the patients whose average weight was 176–187 lb (80–85 kg) the time difference between the two groups was significant at the $P < 0.005$ level.

In the 95 fractures from the Hip Centre (Figure 3), where the surgical technique could be judged to be uniform there was a linear relationship between the patients' weight and the time of the fracture which could be expressed in an equation: months to fracture = 5.6 (97 – weight in kg).

The correlation coefficient between weight (kg) and the time of the fracture (months) was -0.405 and was highly significant ($P < 0.001$).

The study of the two groups (with and without cement failure) (Table 6) shows that their weights are comparable – and the time difference be-

tween surgery and the fracture is probably significant ($P < 0.05$). On average, cement failure within 1 year of surgery meant a fractured stem 17.3 months earlier than if the cement was intact at 1 year. Therefore in patients of comparable weight, the surgical technique of preparation of the medullary canal and of injection of the cement plays a very important part.

The 11-year "at risk" period has several implications. No total hip replacement using a stainless steel stem can be considered free from the risk of fracture until an 11-year follow-up is available. The apparent lack of fractures after that period cannot be interpreted by suggesting that the patients are elderly and inactive. At the time of writing a group of 255 was being followed up as a part of a long-term study, because of the excellence of their results. There are no fractures appearing in this group. It is suggested that in a patient with normal function the stem is unlikely to fracture having once passed the critical period, *barring accidents affecting the cement-bone bond*. This would be in keeping with the fatigue limit of the stainless steel stressed in a non-corrosive environment and would thus vindicate the use of stainless steel – even in the original EN58J form.

It may be of long-term interest to record that 99 patients (107 hips) with the longest follow-up at the time of writing (average 15.4 years) still attending, weigh on average 145 lb (65.9 kg) range 90–215 lb (41–97.7 kg). This would suggest that the weight limit for the stem under discussion was 145 lb (65.9 kg).

Varus/valgus orientation of the stem within the medullary canal has received frequent attention – largely unwarranted. Statistical analysis has shown that (i) on average the patients with the "valgus" stem were significantly heavier than patients with a "varus" stem ($P < 0.005$). (ii) On average the "valgus" patients probably did fracture the stem significantly earlier than the "varus" patients ($P < 0.05$). (iii) If patients of 176 lb (80 kg) or more are considered (Table 7) their weights are comparable yet the time difference between the two groups is significant at the

$P < 0.005$ level – the "valgus" stems fracturing earlier than the "varus" stems. The term varus/valgus is of descriptive value only; it cannot be used to judge the quality of the cement technique or the long-term results.

The low incidence of stem fracture must be a reflection on the surgical technique of the exposure, preparation of the medullary canal and the cement injection, all of which have been improved in the light of past experience. Comparison with other stem designs cannot be made as the information is sadly lacking. Fracture of the stem is but a dramatic presentation of the end result of loosening of the proximal part of the stem in the presence of distal fixation. Careful attention to the details of the cementing technique is essential to avoid the complication.

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