Femoral shaft fracture after hip arthroplasty

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Femoral shaft fractures after hip arthroplasties were treated in 74 noncemented hemiarthroplasties and 65 cemented arthroplasties.

In loose prostheses the best clinical results and the least number of operations were achieved with revision arthroplasty with a long-stem prosthesis, combined with simple internal fixation methods when applicable. In firmly fixed prostheses the results of revision arthroplasty and traction treatment were similar. Cemented revision arthroplasty did not interfere with fracture union. Internal fixation with the prosthesis in situ cannot be recommended because of a large number of secondary revision arthroplasties and nonunions. Removal of the femoral stem prosthesis and internal fixation nearly always require a secondary revision and cannot be recommended.

Femoral fracture after arthroplasty is rare; only small materials have been reported (Johansson et al. 1981, Bethea et al. 1982), and the outcome seems rather poor (Johansson et al. 1981).

This multicenter investigation attempts to point out the preferable principle of treatment as based on a retrospective study.

Patients and methods

Our material was compiled retrospectively from five major departments of orthopedics (Rigshospitalet, Gentofte Hospital and Hvidovre Hospital, Copenhagen; Frederiksberg County Hospital, Hillerød; and Orthopedic Hospital, Aarhus). In all, 131 patients were treated for 139 ipsilateral femoral shaft fractures in topographic relation to a femoral endoprosthesis during the years 1974 through 1983. The series included 84 Moore or Monk hemiarthroplasties, 10 being primarily cemented, and 55 cemented total hip arthroplasties (Stanmore 27, Mueller-Charnley 7, Lubinus 7, Charnley 8, and miscellaneous designs 6).

The median age of the patients was 76 (37–97) years and 77 per cent were males. The fractures were classified radiographically according to the location (Figure 1) and to spiral, transverse, or comminuted. The radiographic material from the time of the primary hip arthroplasty until the time

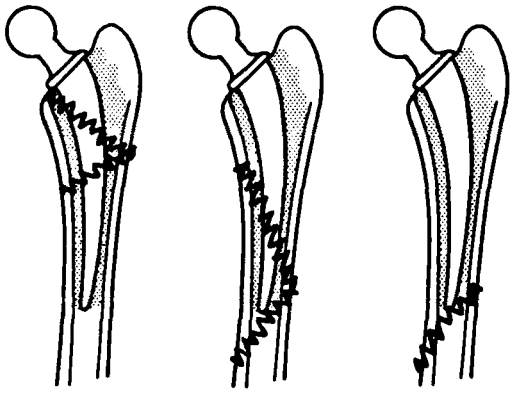

Figure 1. Fracture types.
1, located around the proximal two thirds of the prosthetic femoral stem,
2, extending proximally and distally from the area of the femoral stem tip,
3, extending distally from the area of the femoral stem tip.

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of fracture was evaluated for signs of loosening of the prosthetic stem, i.e., progressive osteolysis exceeding 2 mm between cement and bone or between stem and cement, or in noncemented cases progressive osteolysis exceeding 2 mm between stem and bone.

The methods of treatment were 1) traction, 2) removal of the femoral component and internal fixation of the fracture, 3) internal fixation with the prosthetic stem in situ, using AO plate, cerclage wires, or screws, and 4) revision arthroplasty, usually a long-stem prosthesis, with or without cementation, combined with internal fixation with wire, nylon straps, or screws when appropriate. No infections were observed in any of the operated on cases.

The patients were followed clinically and radiographically until the fracture had united or a permanent clinical situation had been obtained. Pain, limitation in walking, time to fracture union, and the need of further surgery were recorded. The clinical result was classified as good if the fracture had united and deterioration of pain and walking ability were not experienced as compared with the prefracture condition. Note that pain and walking limitations due to loosening of the prosthesis may have occurred in some patients prior to the fracture. Unsatisfactory results were defined as clinical deterioration and/or need of further treatment, i.e, revision arthroplasty, further internal fixation, or prolonged conservative treatment due to secondary fracture dislocation. The clinical and radiographic data were analyzed by the chi-square test and contingency tables. Calculations of hospitalization time were not carried out because the series was collected from departments with varying routines for postoperative care.

Results

In a multivariate analysis, an association was found between fracture location, primary cementation, and radiographic signs of loosening (Table 1). Fracture extending distally from the prosthesis was usually observed in firmly fixed prostheses, whereas proximal fracture around the stem predominantly occurred with firmly fixed noncemented stems or in loose cemented prostheses. The fracture (spiral 98, transverse 15, comminuted 26) was not related to these parameters.

Removal of the femoral stem and internal fixation was mainly applied to loose cemented stems ($P < 0.07$), but otherwise the pattern of treatment did not differ between prostheses with loose and firm stems (Table 2).

Table 1. Relations between fracture type (Figure 1), radiographic loosening and presence of cement

	Type			
	1	2	3	Total
No loosening	23	16	52	91
Cemented	9		29	38
Non-cemented	30		23	53*
Loose prostheses	21	10	17	48
Cemented	17		10	27
Non-cemented	14		7	21

* $P < 0.002$.

Table 2. Method of treatment, occurrence of loosening, presence of cement and type of fracture around hip arthroplasties

	Traction	Removal of stem +osteosynthesis	Internal fixation prosthesis in situ	Revision arthroplasty +/−osteosynthesis
No loosening	26	2	46	17
Type 1, 2	13	1	18	7
Type 3	13	1	28	10
Cemented	13	1	19	5
Non-cemented	13	1	27	12
Loose prostheses	12	7	12	17
Type 1, 2	9	6	5	11
Type 3	3	1	7	6
Cemented	7	7	5	8
Non-cemented	5	0	7	9

Table 3. Method of treatment, complications, type of fracture and clinical results in fractures around hip arthroplasties

	Traction	Removal of stem +osteosynthesis	Internal fixation prosthesis in situ	Revision arthroplasty +/−osteosynthesis
No loosening	26	2	46	17
Secondary Revision	1	2	8	1
Non-union	0	0	6	1
Good clinical results:	13/24	0/2	16/44	11/16
Type 1, 2	5/12	0/1	6/17	5/ 6
Type 3	8/12	0/1	10/27	6/10
Loose prostheses	12	7	12	17
Secondary Revision	2	6	4	1
Non-union	1	0	0	1
Good clinical results:	4/11	1/7	4/11	12/16
Type 1, 2	2/ 8	1/6	3/ 4	8/11
Type 3	2/ 3	0/1	1/ 7	4/ 5

Firmly fixed prosthetic stems were observed in 91 cases (33 cemented total arthroplasties, 5 cemented and 53 noncemented hemiarthroplasties)

Traction was applied in 26 cases (Table 3), including 13 noncemented and two cemented hemiarthroplasties. Two patients died. Fracture union was achieved in all the other cases. Secondary revision arthroplasty was needed in one cemented prosthesis for loosening, following a proximal spiral fracture. Good clinical results were obtained in six noncemented and seven cemented cases.

Removal of the prosthetic stem and internal fixation was performed in 2 patients, both of whom had secondary revision arthroplasty after union of the fracture.

Internal fixation with the prosthesis in situ (Table 3) was performed in 19 cemented and 27 noncemented cases. An AO plate was used in 14 cases of each group, whereas the remainders were fixed with cerclage wires, screws, or Partridge nylon straps. Two patients died before fracture union. Secondary revision arthroplasty was needed for refracture in 4 cases (2 AO plate, 2 cerclage wiring), for symptomatic nonunion in 3 (1 AO plate, 2 straps or screws), and for secondary loosening in 1 case (cerclage wiring). Further nonunions occurred in 3 cases fixed with cerclage wires and in 3 with AO plates. Unsatisfactory results were thus encountered in 14/44 cases. No difference between cemented and noncemented prostheses was observed.

In primary revision arthroplasty a cemented long-stem prosthesis was used in 4 previously cemented cases. Revision with a prosthesis of equal length was performed in 1 case, which was further revised because of a refracture. The fractures associated with cemented stems were fixed with an AO plate in 1 case and wires, straps, or screws in the other cases. Fractures related to noncemented stems were revised with noncemented long-stem Moore hemiarthroplasties in 8 cases, 1 of which was followed by asymptomatic nonunion; AO plating was necessary in 1 case, whereas 5 could be fixed by simple procedures. A further 4 cases were uneventfully treated by cemented long-stem total replacements in combination with simple fracture fixation methods. The clinical results were not related to cementation or not, neither primarily nor secondarily.

In firm prosthetic stems the highest complication rate ($P < 0.001$) and the poorest clinical results ($P < 0.03$) were observed after internal fixation with the prosthesis in situ or with the stem removed when compared with traction and primary revision arthroplasty. No difference was found between traction and revision arthroplasty. The location or comminution of the fracture did not influence the results.

Loose prosthetic stems were observed in 48 cases, including 21 noncemented hemiarthroplasties, 4 cemented hemiarthroplasties, and 23 cemented total arthroplasties.

Removal of the stem with internal fixation was applied in cemented cases only (Table 2), but

otherwise the choice of treatment was not related to the presence of cement.

Traction was followed by nonunion in 1 noncemented case (Table 3). Owing to symptomatic loosening, secondary revision arthroplasty was undertaken in 2 of 7 cemented cases.

Removal of the stem and internal fixation, including two AO platings, were followed by secondary revision arthroplasty in 6/7 cases; only 1 was rated clinically good (Table 3).

Internal fixation (1 AO plate, 6 other procedures) with the prosthesis in situ was performed in 7 noncemented cases, only 1 of which needed a secondary revision arthroplasty for symptomatic loosening. When applied to cemented cases (2 AO, 3 other fixations), secondary revisions were needed in 3 cases (1 AO, 2 other fixations) for refracture, nonunion, or symptomatic union.

Primary revision arthroplasty was performed in nine noncemented hemiarthroplasties. A noncemented long-stem prosthesis was used in 6 cases; 1 needing an additional AO plate. A cemented long-stem total arthroplasty was performed in 3 cases. All but 2 cases had a good clinical result. Moreover, 7 cemented cases were revised with cemented long-stem arthroplasties, and 5 of them obtained good results. In 1 additional case revised with a stem of unchanged length, a further revision was needed because of a refracture. Good clinical results were recorded in 8/10 cemented and 4/6 noncemented long-stem revision arthroplasties.

In loose prostheses the best results were achieved with primary revision arthroplasty ($P = 0.03$). In noncemented cases, it was better than traction ($P < 0.004$), and in cemented cases superior to internal fixation with the prosthesis in situ ($P < 0.02$). Traction was found superior to internal fixation in cemented cases ($P < 0.04$), but inferior in noncemented cases ($P < 0.04$). Three patients with loose prostheses died from causes unrelated to the treatment. No significance of fracture location or comminution could be proved.

The most applicable method for general use was the primary revision arthroplasty ($P < 0.006$), whereas internal fixation with the prosthesis in situ ($P = 0.08$) or with the stem removed showed the highest failure rate and the poorest clinical results ($P = 0.003$). The subdivision of the series, however, identified traction as a possible method in firm cemented prostheses.

Discussion

The majority of fractures in firmly fixed cases originated in the area around the prosthetic tip, which accords with the load transmission being predominant in this area. Proximal fractures were sustained in loose cemented arthroplasties or firmly fixed noncemented designs. Subdivision according to the fracture comminution was found of no significance, the vast majority (98/139) being spiral fractures. The fracture location and the degree of comminution did not, however, influence the choice of treatment or the clinical results of this series. It is obviously more relevant to consider the presence of prosthetic loosening. Classification based on the relationship between the prosthetic tip and the medullary cavity (Johansson et al. 1981) does not seem justified for clinical use; neither does the system used in other series (Bethea et al. 1982).

Our series was analyzed in relation to prosthetic loosening more than to the presence of cement, because the technical difficulties in revision arthroplasty with firm prostheses are rather comparable whether cement or proximal bone plugs have to be removed. The hemiarthroplasties were nearly all performed for femoral neck fractures, but subdivision in relation to osteoporosis was omitted in this retrospective series because of the uncertainty of determining the bone density and also because this will not influence the recommendations gained from the study. The clinical result can, however, be affected by painful acetabular wear in hemiarthroplasties.

In firm prostheses the results of traction and primary revision arthroplasty were similar; both were superior to the other methods. The choice of revision arthroplasty should consequently be based solely on reduced hospitalization time. Our study cannot provide such evidence because of variations in postoperative care and facilities for discharge at the participating departments. The results with long-stem prostheses were similar whether cemented or not, but application of a long-stem prosthesis seems a prerequisite for good results. A well-functioning hemiarthroplasty does not need to be converted into a cemented total hip arthroplasty. A striking feature was that internal fixation with the prosthesis in situ revealed a very high complication rate and rather depressing clinical results. Internal fixation with the AO plate causes the same operative trauma

as revision arthroplasty and difficulties in obtaining exact reduction favors the development of nonunion. Consequently, we cannot recommend this method.

In loose prostheses the aim is either to achieve fracture union or a final solution for both the fracture and the loosening. Common to all our methods was a low rate of nonunion. Symptomatic loosening, however, warranted a large number of secondary revision arthroplasties or was followed by poor clinical results if the loose prosthesis was not primarily treated. Argumentation for a reduction in the complication rate by delaying the revision arthroplasty does not seem justified from this series, because only one nonunion was observed and the only secondary arthroplasty was performed after application of a stem with a length equal to the first one. Cemented long-stem total revision arthroplasty was successful in 8/10 cases and noncemented long stems in 4/6 cases after Moore hemiarthroplasties. The fracture union was not affected by the theoretical risk of cement interposition between the fracture ends. Moreover, a combination of intramedullary fixation with the long-stem prosthesis and simple fixation across the fracture lines gave sufficient stability for mobilization with immediate weight bearing.

Revision arthroplasty with a long-stem prosthesis consequently seems to be the method of choice in loose prostheses and a resource-saving alternative to traction in firm prostheses. A high technical skill is required because removal of the prosthesis might add further fractures, especially in firmly fixed stems. By meticulous technique, this has not turned out to be a problem that could not be solved by simple fixation methods in this series. The application of nylon straps (Partridge and Evans 1982, Larsen et al. 1984) has improved the results further, possibly because of less interruption of the blood circulation of the bone. The major requirements are a full range of revision prostheses with long stems and different neck lengths. The size of the inventory suggests centralization of the treatment.

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