Unsatisfactory results after repeated revision of hip arthroplasty,

61 cases followed for 5 (1–10) years

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61 cemented second revision total hip arthroplasties and 18 cemented third revision total hip arthroplasties were studied with emphasis on causes of failure, complications, risk of further revision, and clinical and radiographic results of surviving, not further revised patients. Aseptic loosening was the major reason for both second and third revisions followed by recurrent dislocations. Of 61 second revisions, 21 failed again. Postoperative dislocation was the major complication, encountered in 10/61 after second revisions and in 4/18 third revisions. 10 second revisions were reoperated on without exchange of components, but for causes related to the implant.

The clinical and radiographic outcome of surviving, not further revised patients was favorable, but must be seen in the light of the high rate of further revisions.

In 33 of 53 second revisions and in 5 of 13 third revisions left for evaluation, the outcome was considered unsatisfactory. We conclude that reoperations for failed arthroplasties should be the prerogative of highly experienced centers.

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The rate of failure requiring further surgery is higher after revision arthroplasty than after primary arthroplasty (Callaghan et al. 1985, Kavanagh et al 1985, Pellichi et al. 1985, Retpen el al. 1989). Patients with potential indications for repetitive surgery represent complexities considering type of operation and operative techniques. In advising these patients adequately, knowledge is required concerning the outcome of a second or further revision with major emphasis on the risk of further failure, intraoperative and postoperative complications, and the clinical results related to pain and function.

The results after repeated revisions have been scarcely described (Kavanagh and Fitzgerald 1987). We report our experience in hip arthroplasties revised two or three times.

Material and methods

400 cemented first revision total hip arthroplasties were performed in our department from 1977 through 1990. By January 1991, 61 were revised a second time and 18 a third time using cemented techniques. These two series of second and third revisions constitute the material of this study.

The second revision series constituted 42 women and 18 men aged 66 (33–85) years, whereas 1 patient was revised bilaterally. Primary diagnoses were primary osteoarthrosis 37, osteoarthrosis secondary to congenital dislocation of the hip 10, fracture of femoral neck 8, rheumatoid arthritis 2, and miscellaneous 4. The primary arthroplasties were 5 uncemented hemiarthroplasties and 56 cemented total arthroplasties, which had all been revised with cemented arthroplasties. The mean follow-up time for the total series was 61 (1–130) months.

The third revision series constituted 14 women and 4 men aged 64 (34–84) years. All the previous revisions were performed using cemented techniques. The mean follow-up time of the total series was 41 (1–110) months.

The types of prostheses used in the two series are shown in Table 2.

Definitions

Failure. Need of further revision surgery with exchange of components, resection arthroplasty, and acetabular augmentation (Olerud 1985).

Time of failure. The time when revision was decided upon.

Aseptic loosening. Combination of radiographic signs of migration of components and/or progressive radiolucency and recurrence of pain and malfunction.

Malposition or malorientation. Perforation of the

Table 1. Observations in 61 cases of cemented second revisions of hip arthroplasties

ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1[a]	2	46	4	1	2	2	4	0	0	1	0	0	116	1	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2[b]	2	83	1	1	2	2	4	0	0	1	0	0	11	2	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
3[b]	2	54	2	1	1	1	1	0	4	1	0	0	51	2	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4	2	67	4	1	2	2	4	0	0	1	0	0	75	1	0	.	.	.	.	0	.	.	.	0	6	0	0	0	1	43	1	0	.	5	0	0
5	1	71	1	1	3	3	2	0	0	1	0	0	3	2	0	.	.	.	.	0	.	.	.	2	2	0	0	0	1	43	1	0	.	5	0	0
6	2	72	1	1	8	2	5	2	0	1	0	0	5	5	0	.	.	.	.	0	.	.	.	5	5	0	0	0	1	60	1	1	4	4	0	0
7	2	40	3	1	3	3	5	2	0	1	0	0	15	5	0	.	.	.	.	0	.	.	.	5	5	2	0	0	1	30	1	1	4	4	0	0
8	2	36	3	1	4	1	6	0	0	1	0	0	95	1	0	.	.	.	.	0	.	.	.	1	6	0	0	0	1	24	1	1	4	5	0	0
9	2	50	3	1	4	1	2	0	0	1	0	0	79	3	0	.	.	.	.	0	.	.	.	3	2	2	0	0	1	82	1	1	4	4	2	1
10	2	83	4	2	3	3	1	0	0	1	0	0	17	3	0	.	.	.	.	0	.	.	.	3	2	0	0	0	1	64	1	0	.	4	0	1
11	2	79	1	1	2	2	2	0	1	1	0	0	46	2	0	.	.	.	.	0	.	.	.	2	3	1	0	0	1	16	0	.	.	.	.	.
12	1	77	1	1	3	3	6	0	0	1	0	0	1	3	0	.	.	.	.	0	.	.	.	3	6	0	0	1	0	61	0	.	.	.	.	.
13	2	74	1	1	7	2	4	0	0	1	0	0	8	2	0	.	.	.	.	0	.	.	.	4	.	0	0	1	0	.	0	.	.	.	.	.
14	2	51	1	1	3	3	4	3	0	1	0	0	11	3	0	.	.	.	.	0	.	.	.	3	4	3	1	0	0	40	0	.	.	.	.	.
15	2	33	5	1	2	1	4	2	0	1	0	0	7	6	0	.	.	.	.	0	.	.	.	1	2	2	0	1	0	49	0	.	.	.	.	.
16	1	58	1	1	7	1	6	1	0	1	0	0	26	2	0	.	.	.	.	0	.	.	.	1	5	2	0	1	0	12	0	.	.	.	.	.
17	2	76	1	1	2	2	1	1	0	1	0	0	41	1	0	.	.	.	.	0	.	.	.	1	3	0	0	1	0	1	0	.	.	.	.	.
18	2	68	1	1	2	2	1	1	0	1	0	0	22	2	0	.	.	.	.	0	.	.	.	2	3	0	0	0	1	2	0	.	.	.	.	.
19	2	59	1	1	2	2	3	0	0	1	0	0	26	10	0	.	.	.	.	0	.	.	.	1	6	0	0	0	1	11	0	.	.	.	.	.
20	1	44	5	1	1	1	3	2	0	1	0	0	1	6	0	.	.	.	.	0	.	.	.	1	3	0	0	0	1	5	0	.	.	.	.	.
21	2	60	3	1	5	5	6	2	0	1	0	0	2	6	0	.	.	.	.	0	.	.	.	1	5	3	1	0	0	22	0	.	.	.	.	.
22	2	68	1	1	1	1	1	0	0	0	0	1	91	.	1	91	1	3	3	1	91	3	0	.	.	.	.	.	.	.	.	.	.	.	.	.
23	1	72	1	1	2	2	1	0	0	0	0	1	50	.	1	50	2	1	1	1	50	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
24	1	73	1	1	9	2	1	0	0	0	0	1	87	.	1	87	0	.	4	1	87	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
25	2	70	1	1	10	1	1	3	5	0	0	1	63	.	1	63	0	.	1	1	63	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
26	2	72	3	1	1	1	4	0	0	0	0	1	96	.	1	96	0	.	1	1	32	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
27	1	75	1	1	1	1	1	0	0	0	0	1	77	.	1	77	0	.	4	1	77	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
28	2	78	1	1	2	2	2	0	0	0	0	1	64	.	1	64	0	.	4	1	64	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
29	2	75	5	1	10	1	1	0	0	0	0	1	69	.	1	69	0	.	4	1	25	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
30	2	73	1	1	2	2	4	0	0	0	0	1	95	.	1	95	0	.	5	1	95	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
31	1	64	1	1	1	1	1	0	0	0	0	1	63	.	1	63	0	.	5	1	63	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
32	2	67	4	2	10	1	1	0	0	0	1	0	60	.	1	60	0	.	1	1	58	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
33	2	72	4	2	1	1	2	0	0	0	0	1	132	.	1	124	1	4	3	1	124	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
34	2	39	5	1	8	1	1	0	2	0	0	1	64	.	1	64	0	.	5	1	64	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
35	1	80	4	2	2	2	1	0	2	0	0	1	54	.	1	54	0	.	4	1	54	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
36	2	69	1	2	2	1	1	0	2	0	0	1	68	.	1	68	2	4	5	1	68	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
37	2	77	1	1	8	2	3	1	2	0	0	1	28	.	1	28	0	.	4	1	24	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
38	2	72	1	1	3	3	3	0	0	0	0	1	24	.	1	24	0	.	2	1	24	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
39	2	38	3	1	1	1	6	2	0	0	0	1	34	.	1	34	0	.	5	1	31	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
40	2	47	3	1	3	3	4	2	0	0	0	1	40	.	1	40	0	.	2	1	35	0	1	.	.	.	.	.	.	.	.	.	.	.	.	.
41	2	69	1	1	8	2	3	0	0	0	0	1	38	.	1	38	0	.	5	1	38	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
42	2	60	3	1	2	2	3	2	0	0	0	1	24	.	1	24	0	.	5	1	24	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
43	2	85	1	1	1	1	1	0	0	0	0	1	61	.	1	61	1	4	4	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
44	1	76	1	1	2	2	4	1	0	0	1	0	70	.	1	58	2	4	4	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
45	1	79	1	1	7	2	2	0	0	0	1	0	109	.	1	80	2	2	3	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
46	2	70	1	1	9	2	6	0	0	0	0	1	115	.	1	115	1	4	3	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
47	2	79	4	1	5	3	2	0	0	0	1	0	42	.	1	35	2	2	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
48	1	63	1	1	10	1	2	2	3	0	1	0	120	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
49	1	67	1	1	5	1	2	0	0	0	1	0	125	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
50	1	71	3	1	1	1	1	0	0	0	1	0	45	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
51	2	77	2	1	7	2	1	0	0	0	1	0	25	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
52	2	74	1	1	7	2	4	0	0	0	1	0	57	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
53	2	74	3	1	3	3	6	0	0	0	1	0	27	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
54	2	67	1	1	9	1	6	0	0	0	1	0	117	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
55	1	70	1	1	2	2	3	0	0	0	1	0	10	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
56	2	70	1	1	2	2	1	0	0	0	0	1	15	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
57	1	78	1	1	10	1	3	2	6	0	0	1	16	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
58	2	82	1	1	5	3	2	0	0	0	0	1	17	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
59	1	42	4	1	2	2	3	0	0	0	0	1	1	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
60	1	76	1	1	2	2	3	1	6	0	0	1	1	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
61	2	64	1	1	1	1	3	0	0	0	0	1	1	.	0	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

[a] Third revision performed using uncemented technique.
[b] Third revision not yet performed.

Legend to Table 1

ID Case
A Sex
  1 male
  2 female
B Age at second revision
C Primary diagnosis
  1 primary osteoarthrosis
  2 rheumatoid arthritis
  3 osteoarthrosis secundary to congenital dislocation of the hip
  4 fracture of the femoral neck
  5 other
D Primary prosthesis
  1 cemented total arthroplasty
  2 uncemented hemi-arthroplasty
E Cause of failure necessitating second revision
  1 aseptic loosening of both components
  2 aseptic loosening of femoral component
  3 aseptic loosening of acetabular component
  4 recurrent dislocations caused by anteversion of femoral component
  5 recurrent dislocations caused by malposition of acetabular component
  6 recurrent dislocations caused by malposition of both components
  7 stem perforating femoral shaft
  8 fracture of stem
  9 fracture of femoral shaft
  10 deep infection
F Type of surgery at second revision
  1 both components exchanged
  2 femoral component alone exchanged
  3 acetabular component alone exchanged
  4 resection arthroplasty
  5 acetabular augmentation
G Type of prosthesis at second revision
  1 Lubinus, long stem
  2 Lubinus, short stem
  3 Bimetric, long stem
  4 Stanmore, short stem
  5 Arnoldi, short stem
  6 other
H Intra- and postoperative complications at second revision
  1 intraoperative fracture of femoral shaft
  2 postoperative dislocation
  3 deep infection
I Reoperation other than revision surgery after second revision
  0 none
  1 excision of para-articular calcification
  2 osteosynthesis of fracture around the stem
  3 open reduction of dislocated hip
  4 fasciotomy
  5 debridement and drainage due to deep infection
  6 reoperation due to excessive bleeding
J Failure after second revision necessitating a third revision
  0 no
  1 yes
K Death (or emigration, 1 patient) before follow-up examination after second revision
  0 no
  1 yes
L Prosthesis still at risk of failure after second revision
  0 no
  1 yes
M Known time of survival of prosthesis after second revision in months
N Cause of failure after second revision Same identification as E
O Clinical evaluation after second revision
  0 no
  1 yes
P Time to clinical follow-up examination after second revision in months
Q Pain at follow-up examination after second revision
  0 none
  1 pain associated with activity
  2 pain at rest
R Grade of persistent pain at follow-up after second revision
  1 worse
  2 unchanged
  3 some relief
  4 substantial relief
S Functional outcome score at follow-up examination after second revision, 0–5 points, see text
T Radiographic evaluation after second revision
  0 no
  1 yes
U Time to radiographic follow-up examination after second revision in months
V Radiographic assessment of femoral component
  0 stable
  1 possibly loose
  2 probably loose
  3 definite loose
W Radiographic assessment of acetabular component
  0 stable
  1 loose
X Type of surgery at third revision. Same identification as F
Y Type of prosthesis at third revision. Same identification as G
AA Intra- and postoperative complications at third revision. Same identification as H
AB Failure after third revision necessitating a fourth revision
  0 no
  1 yes
AC Death before follow-up examination after third revision
  0 no
  1 yes
AD Prosthesis still at risk of failure after third revision
  0 no
  1 yes
AE Known time of survival of prosthesis/time to clinical and radiographic follow-up examination after third revision in months
AF Clinical and radiographic evaluation after third revision
  0 no
  1 yes
AG Pain at follow-up examination after third revision. Same identification as Q
AH Grade of persistent pain after third revision. Same identification as R
AI Functional outcome score at follow-up examination after third revision. Same identification as S
AJ Radiographic assessment of femoral component after third revision. Same identification as V
AK Radiographic assessment of acetabular component after third revision. Same identification as W

Table 2. Type of prostheses used at second and third revisions

	Second (n 61)	Third (n 18)
Lubinus, long stem	19	–
Lubinus, short stem	10	4
Bimetric, long stem	11	4
Stanmore, short stem	11	1
Arnoldi, short stem	2	4
Miscellaneous	8	4

Table 3. Cause of failure necessitating the second and third revisions and type of surgery at revision

	Second (n 61)	Third (n 18)
Cause of failure		
Aseptic loosening	38	12
Femoral component	19	5
Acetabular component	8	4
Both components	11	3
Recurrent dislocation	6	5
Anteversion of femoral component	2	0
Malposition of acetabular component	4	2
Malposition of both components	0	3
Stem perforating femoral shaft	5	0
Fracture of stem	4	0
Fracture of femoral shaft	3	0
Deep infection	5	1
Type of surgery at revision		
Both components exchanged	24	8
Femoral component alone exchanged	26	3
Acetabular component alone exchanged	10	4
Acetabular augmentation	1	2
Resection arthroplasty	0	1

femoral shaft or malorientation resulting in recurrent dislocations, i.e., anteversion of the femoral component, steep inclination, or retroversion of the acetabular component.

Deep infection. Diagnosis based on a combination of an elevated ESR and clinical, radiographic, and scintigraphic findings suggestive of infection, supported by intraoperative findings and confirmed by positive intraoperatively obtained cultures.

Complications. Intraoperative fracture of the femoral shaft, deep infection, postoperative dislocation, or the need of a reoperation other than revision surgery for causes related to the implant.

Risk of further failure after the second revision was estimated through survivorship analysis.

Of the second revisions, 21 hips were revised again, 7 patients (seven hips) had died and 1 (one hip) patient had emigrated before follow-up. Of the remaining 32 revisions, 26 were followed for more than 2 years and clinically evaluated, with a mean follow-up time of 5 (2–10) years. Radiographic evaluation was performed in only 21 of 26 hips, because transportation was unacceptable owing to poor general health in 5 patients.

Of the third revisions, 2 hips were revised again and 5 patients (5 hips) had died before follow-up. Of the remaining 11 patients (11 hips), 7 were followed for more than 2 years, and clinical and radiographic results were evaluated, with a mean follow-up time of 4 (2–7) years. Because the patients were admitted from different parts of Denmark, the clinical evaluation was based on questionnaires and/or telephone interviews (Galante 1985), and radiographs were performed at the local hospital and sent to us for evaluation.

Pain was recorded as pain at rest, pain only associated with activity, and no pain. Pain at follow-up was related to preoperative pain and graded as worse, unchanged, some relief, or substantial relief.

Function was measured as Functional Outcome Score (FOS; Retpen et al. 1989), using a 0–5-point scale based on evaluation of walking distance, walking aid, stair climbing, limp, and ability to sit. Five points indicated excellent function.

Through radiographic analyses, assessing migration of components and progressive radiolucency at the cement-bone interface, the femoral component was classified as stable, possibly loose, probably loose, or definitely loose (Harris and McGann 1986). The acetabular component was classified as loose only if it had migrated; otherwise, it was classified as stable.

Results

Second revision

Causes of revision (Table 3)

38 revisions were performed because of aseptic loosening of one or both components. 21 of 30 femoral components and 12 of 19 acetabular components demonstrated recurrent loosening, for they were revised the first time for the same reason. In 14 of the remaining 23 cases, failure was related to the femoral component, in 4 cases to the acetabular component, and in 5 cases to deep infection.

One nonfailed femoral component and 6 nonfailed acetabular components were exchanged because of a mismatching of components. In 4 of 50 revisions of femoral components and in 14 of 34 revisions of acetabular components, the components had not been revised before.

Table 4. Complications

	Second (n 61)	Third (n 18)
Intraoperative fracture of femoral shaft	6	1
Postoperative dislocations	10	4
Deep infection	2	2

Complications (Table 4)

6 patients sustained an intraoperative fracture of the femoral shaft requiring stabilization with Partridge bands and restricted weight bearing for 6 weeks. In 1 case, there was an increasing displacement of the fracture around the tip of a long stem resulting in operative restabilization after 1 year. In the 5 remaining cases, the fracture healed without further surgery. In 3 of these cases, a third revision was required because of loosening of the femoral component.

There were 10 postoperative dislocations of which only one had been revised a second time because of a previous recurrent dislocation. 4 were single dislocations, whereas 6 became recurrent dislocations. One patient with a recurrent dislocation would not accept further surgery, but the hip has been stable during the last 18 months. The remaining 5 patients were revised a third time—3 with exchange of both components because of combined malorientation of the components and 2 with acetabular augmentation because of malorientation of the cup. All but 1 case, where both components were exchanged, became stable after the third revision.

Two deep infections occurred. In 1 case, a revision was performed after 11 months, with exchange of a loose acetabular component. The well-fixed femoral component was left in situ; but after 40 months, a fourth revision was performed because of recurrence of the infection. In the other case, debridement and implantation of beads containing gentamycin were performed. The well-fixed components were not exchanged, and there have been no signs of infection after 5 years.

In 2 cases, a reoperation within the first 24 hours was necessary because of excessive bleeding. In 1 case, excision of paraarticular calcifications was performed after 30 months; in 1 case, open reduction of a dislocated hip was necessary because of interposition of soft tissue after 16 months; and in 1 case, a fasciotomy was performed because of a snapping-hip phenomenon after 12 months. Three patients sustained a fracture around a long-stemmed prosthesis 2, 4, and 5 months after the second revision. They were all treated successfully with internal fixation without exchange of the component.

Table 5. Clinical outcome

	Second	Third
Pain	(n 26)	(n 7)
None	17	3
Pain associated with activity	4	4
Pain at rest	5	0
Grade of persistent pain	(n 9)	(n 4)
Worse	1	0
Unchanged	2	0
Some relief	1	0
Substantial relief	5	4
Functional outcome score	(n 26)	(n 7)
5	7	3
4	8	4
3	4	0
2	2	0
1	4	0
0	1	0

Rate of failure

21 second revisions failed, and 18 of these constituted the series of third revisions. Three cases of aseptic loosening are still awaiting the third revision. 15 of 21 second revisions failed because of loosening after an average of 40 (1–116) months.

The overall survival curve for prostheses after the second revision is shown in Figure 1.

11 of 46 femoral components revised both at the first and the second revision failed again because of aseptic loosening.

Clinical outcome (Table 5)

17 of the 26 patients, followed for more than 2 years, who were still alive and had not undergone further revision surgery had no pain. Of the 9 patients with persistent pain, 3 were worse or unchanged, and 6 experienced some or substantial relief.

7 of 26 patients had a maximum FOS. Twenty-one patients suffered from concomitant disabling conditions, but 15 patients with impaired function according to their FOS stated that the revised hip was the major cause of the functional disability.

Radiographic outcome

In 18 of the 21 patients without further revision surgery, there were no signs of loosening. In 2 cases, progressive radiolucency was noted around the proximal part of the stem, but not exceeding half the interface. In 1 case, 100 percent progressive radiolucency and migration of the stem was observed, and a third revision is being considered. Thus, 20 femoral components were found to be stable and one was found to be definitely loose.

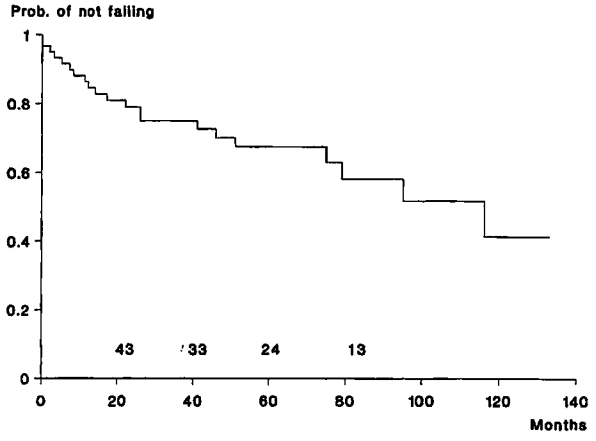

Figure 1. Kaplan-Meier survival curve demonstrating overall risk of failure leading to further revision after the second revision. Number of patients left to follow-up are stated above the X-axis.

In 5 of 21 cases, progressive radiolucency was found in the cement-bone interface around the acetabular component, but only one cup had migrated; the loosening was not associated with pain.

Third revision series

Causes of failure (Table 3)
12 third revisions were caused by loosening of one or both components. 7 of the 8 loose femoral components demonstrated recurrent loosening, as 4 and 3, respectively, had been revised once and twice before for the same reason. Only 2 of the acetabular components manifested recurrent loosening. In 1 of 12 third revisions of failed femoral components and in 2 of 13 third revisions of failed acetabular components, the components had not been revised before, and in 2 and 7 hips, respectively, the components had been revised only once before.

Complications (Table 4)
One intraoperative fracture of the femoral shaft was treated with Partridge bands and restricted weight bearing. The fracture healed, and the femoral component was stable at the follow-up examination (16 months).

There were 4 postoperative dislocations of which 2 underwent recurrent dislocations. One of these had been revised a third time because of previous recurrent dislocations. Two immediate deep infections were treated primarily with debridement and installation of gentamycin-containing beads, and both needed later revisions.

Rate of failure
Two hips were revised a fourth time after 22 and 40 months because of deep infection.

Clinical outcome (Table 5)
4 of 7 patients, followed for more than 2 years, who were still alive and who had not undergone a fourth revision, had pain at the follow-up examination, but all 4 had experienced substantial relief. All 7 patients had a FOS exceeding 3.

Radiographic outcome
In 5 of the 7 patients, followed for more than 2 years, who had not undergone a fourth revision, radiographic evaluations revealed no signs of loosening. A probably loose femoral component and a definitely loose acetabular component (migration) was found in 1 patient, and a definitely loose acetabular component was found in another, but this was not associated with pain or malfunction in any of the cases.

Discussion

74 to 86 percent of first revisions are caused by aseptic loosening (Pellici et al. 1982, Callaghan et al. 1985, Ahnfelt et al. 1990, Engelbrecht et al. 1990). This was still the major reason for second and third revisions in our study, although reduced to about two thirds, whereas recurrent dislocation was the second most important factor. These findings are consistent with results in a study of multiple revisions by Kavanagh and Fitzgerald (1987).

In previous studies of first revisions (Pellici et al. 1982, Callaghan et al. 1985, Kavanagh et al. 1985, Retpen et al. 1989), the femoral component was most frequently involved. Kavanagh and Fitzgerald (1987) found at the second and the third revision an equal engagement of the two components, and the same tendency towards an increasing risk for the acetabular component was seen in this study.

The presence of two components with possibilities of a separate failure increases the risk of repeated operations, and it has been suggested that a nonfailed component should be exchanged at revision (Engelbrecht 1990) along with the failed component. We agree with Kavanagh et al. (1985), who recommended revision of the failed component only. The further outcome of the nonfailed component cannot be predicted, and there are considerable disadvantages associated with removal of a firmly fixed cemented component.

Two survivorship analyses of failure after first revisions performed because of loosening by Marti et al. (1990) and by Kershaw et al. (1991) revealed rates of failure within 14 years of 15 percent and within 10 years of 13 percent, respectively.

Based on a study of first revisions, including all the causes of primary failure, Retpen et al. (1989) reported a rate of further failure of 18 percent within 5 years compared with 33 percent within 5 years after second revisions found in the present study. The pattern of failure after first revisions demonstrated a late failure period related to loosening and an early failure period related to other causes of failure (Retpen et al. 1989). This was not encountered after second revisions in the present study, as 11 of the 15 aseptic loosenings occurred within 5 years.

The increased failure risk after second revisions is only partly explained by the occurrence of alternating revisions of the two components. The twice before revised femoral component had a risk of loosening of 22 percent within 5 years compared with 6 percent for femoral components revised only once before (Retpen et al. 1989).

This increase in overall failure risk from first to second revisions and the increase in risk of loosening of femoral components with the number of previous revisions are consistent with the findings of Kavanagh and Fitzgerald (1987) and with the results in an experimental study by Dohmae et al. (1988), examining cement-bone interlocking in bone prepared as for primary and first and second revisions, as they found inferior fixation in the latter cases. The risk of early loosening of the previously revised femoral component has also been demonstrated in a roentgen stereophotogrammetric analysis of migration of cemented components by Snorrason and Kärrholm (1990).

The high incidence of complications after revision arthroplasty is of major concern, and especially the increasing risk of dislocation after each revision must be emphasized. Marti et al. (1990), Retpen et al. (1989), Callaghan et al. (1985), and Kavanagh et al. (1985) reported respectively 2, 6, 8, and 9 percent dislocations after the first revision. Kavanagh and Fitzgerald (1987) reported 26 percent dislocations after second revisions, and the present study revealed 16 percent dislocations after second revisions and 22 percent after third revisions.

Malorientation of components is a major cause of dislocation, whereas increased laxity and decreased muscle power is probably the cause of instability of an arthroplasty with correct orientation of components (Kavanagh and Fitzgerald 1987). This multifactorial etiology should be borne in mind when considering revision, and a thorough evaluation of the instability should be performed (Lidgren 1991). Even in cases with obvious malorientation of components, an arthroplasty might become stable after protecting it for a period of 6 weeks because of capsular healing (McCollum and Gray 1990), and this should be tried before revision.

Clinical results with regard to pain were equal to those after first revisions (Retpen et al. 1989) using the same evaluation system, whereas functional outcome was inferior after second revisions.

Long-term results of uncemented revisions in combination with bone grafting are still not available, but short-medium-term results are promising (Engh et al. 1988, Harris et al. 1988, Hedley et al. 1988). We believe that these results and the unsatisfactory results of cemented multiple revisions justify the use of uncemented techniques in revision arthroplasties in selected cases.

The results after resection arthroplasty were, in general, found to be unsatisfactory (Bittar and Petty 1982, Kantor et al. 1986, Marchetty et al. 1987, Grauer et al. 1989), especially in young patients. However, a resection arthroplasty may be the salvage procedure of choice in selected cases of elderly patients with low demands of mobility.

Revisions should be performed only by experienced and skilled surgeons, and centralization of this type of surgery is advocated. Operative techniques facilitating careful removal of cement and components must be applied to preserve bone, thus reducing the risk of intraoperative and postoperative fractures and increasing the possibilities of firm fixation of revision components. In cemented revisions, modern techniques including pressurizing and plugging should be applied (Rubash and Harris 1988).

Attention must be paid to correct orientation of components and correct tension of soft tissue, and bone grafting must be performed if necessary to secure this.

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