Rescue of failed inter- and subtrochanteric osteosynthesis with a joint replacement
Technique and results of a series of 61 cases

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Abstract
Introduction: The aim of this study was to review technical issues of hip arthroplasty after a failed proximal femur fixation, as well as to evaluate results and complications associated with this procedure.
Methods: Sixty-one hip arthroplasties after a failed intertrochanteric or subtrochanteric fixation were performed. Average age of patients was 76 years (range 50-93). Thirty-four patients (56%) were originally treated with a dynamic hip screw, 8 (13%) with a DCS, 2 (3%) with Ender nail and 17 (28%) with proximal femoral nail. Fifty-five patients (90%) were treated with total hip arthroplasty and 6 (10%) with hemiarthroplasty. Uncemented stem was used in 17 patients (28%) and a cemented stem in 44 (72%). A standard length stem was used in 12 patients, and a long stem in 49 cases.
Results: The HHS improved from 47 (range 32-54) before surgery to 84 (range 67-93) at one-year follow-up. Seven patients (11.5%) had complications: 3 (4.9%) periprosthetic femoral fractures, 2 (3.2%) dislocations, one (1.6%) wound hematoma, and one (1.6%) deep infection.
Conclusions: Hip arthroplasty after a failed fixation of an intertrochanteric or subtrochanteric fracture is an effective method. Pain and functional outcomes improve significantly in most patients. However, it is a more technically challenging procedure and causes more complications than primary hip replacement.

Key words: Failed osteosynthesis; proximal femur; hip arthroplasty.
Level of Evidence: IV

Rescate de osteosíntesis intertrocantéricas y subtrocantéricas fallidas con un reemplazo articular. Técnica y resultados de una serie de 61 casos

Resumen
Introducción: El objetivo de este estudio fue revisar los aspectos técnicos de la artroplastia de cadera como rescate de una osteosíntesis fallida de una fractura intertrocantérica o subtrocantérica, y evaluar los resultados funcionales y las complicaciones en una serie consecutiva de 61 casos.
Materiales y Métodos: Sesenta y un pacientes fueron sometidos a una artroplastia de cadera como rescate de una osteosíntesis fallida de una fractura intertrocantérica o subtrocantérica. La edad promedio era de 76 años (rango 50-93). Treinta y cuatro casos (56%) fueron tratados inicialmente con un tornillo deslizante de cadera; 8 (13%), con un DCS; 2 (3%), con clavos de Ender y 17 (28%), con un clavo de fémur proximal (corto o largo). Cincuenta y cinco (90%) fueron rescatadas

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con una artroplastia total y 6 (10%), con una hemiartroplastia. Se utilizaron tallos no cementados en 17 casos (28%) y cementados en 44 (72%). El largo del tallo fue estándar en 12 pacientes y de revisión en 49 casos.
Resultados: El HHS mejoró de 47 (rango 32-54) antes de la cirugía a 84 (rango 67-93) al año posoperatorio. Siete pacientes (11,5%) presentaron complicaciones: 3 (4,9%) fracturas femorales periprotésicas, 2 (3,2%) luxaciones, 1 (1,6%) infección y 1 (1,6%) hematoma de la herida.
Conclusiones: La artroplastia de cadera se presenta como un método eficaz para el rescate de las osteosíntesis fallidas de fracturas intertrocantéricas y subtrocantéricas. El dolor y la capacidad funcional mejoran significativamente en la mayoría de los pacientes. Sin embargo, es un procedimiento más demandante y con más complicaciones asociadas que el de una artroplastia de cadera primaria.

Palabras clave: Fracaso de osteosíntesis; fémur proximal; artroplastia de cadera.
Nivel de Evidencia: IV

Introduction

Proximal femoral fractures, both intertrochanteric and subtrochanteric ones, are most frequent. Nine out of 10 fractures occur in >65 year-old patients, and their incidence is on the increase.[1,2] In most cases treatment is satisfactory with osteosynthesis. However, due to their extremely high frequency, even small percentages of failure represent a significant number of patients who require reoperation. Reported failure rates range from 3% to 12%, and contributing factors are the unstable pattern of the fracture, comminution, poor bone quality, infection and mistakes in the surgical technique.[3,4]

Although the procedure of choice in young patients is rescue with new osteosynthesis and the preservation of the hip, in the elderly or in those patients with femoral head injury, acetabular disorders, scarce bone remains or significant lower limb shortening, rescue with arthroplasty comes as the most predictable option.[5-7] Hip arthroplasty in the scenario of osteosynthesis rescue is a complex and demanding procedure; however, it can improve functional results in most patients.[5-9]

The aim of this study was to revise the technical aspects of hip arthroplasty as a rescue procedure in the failed osteosynthesis of an intertrochanteric or a subtrochanteric fracture, as well as assess patients' functional results and associated complications in a consecutive series of 61 patients.

Materials and Methods

Between February 1996 and February 2013, we carried out 61 hip arthroplasties in 61 patients as rescue of failed osteosynthesis in intertrochanteric or subtrochanteric fractures. Patients averaged 76 years of age (ranging from 50 to 93) and the affected hip was the right one in 34 patients (56%) and the left one in 27 (44%). Fifteen fractures (24.5%) were subtrochanteric fractures whereas 46 fractures (75.5%) were intertrochanteric fractures. Thirty-four cases (56%) were initially treated with dynamic hip screw; eight (13%), with DCS (dynamic condylar screw); two (3%), with Ender nailing and 17 (28%), with a (short or long) proximal femoral nail. Osteosynthesis failure was due to proximal migration of the cervicocephalic screw (cut-out) (29 cases, 47.5%) (Figure 1), non-union (10 cases, 16.4%), avascular necrosis of the femoral head (5 cases, 8.1%), infected non-union (7 cases, 11.5%), osteoarthritis (7 cases, 11.5%) and non-union in an associated hip neck fracture (3 cases, 5%). On average, patients were operated on 21 months (ranging from 4 to 140 months) after osteosynthesis. Functional assessment was carried out using the Harris Hip Score (Figures 1 and 2).[10] We ruled out infection in all cases by ESR and RCP. In seven patients (11.5%) with diagnosis or suspicions of infection, it was necessary to carry out a two-time procedure—at first we removed osteosynthesis and carried out surgical toilet and tissues sampling. We inserted a cement hip spacer with antibiotics. We administered antibiotic treatment and carried out the second or reconstructive surgical time once the patient was discharged from Infectology (Figure 3).

We always used the posterior-lateral approach, which can be widened distally as required. Osteosynthesis was removed after hip dislocation. Only in one case did we keep the plate and removed only the required screws to insert the femoral stem. In three patients it was necessary to carry out extended trochanteric osteotomy due to varus deformity in the proximal femur.[11]

The selection of total arthroplasty or hemiarthroplasty was based on either the presence of chondral injury or the patient's functional demand. We carried out 55 (90%) total arthroplasties and six (10%) hemiarthroplasties. The type of fixation was decided on the grounds of patients' bone quality, functional demand, age and socio-economic background. In 17 cases (28%), we used uncemented stems and, in 44 (72%), cemented stems. In 12 patients, the length of the stem was standard and, in 49, which were revision stems, we systematically aimed at the stem outreaching at least two femoral diaphysis diameters the most distal hole in the previous osteosynthesis, thus decreasing the risk of periprosthetic fracture. In the 55 total

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▲ **Figure 1.** Eighty-four year-old patient with history of hip osteosynthesis treated with DHS seven months ago. After a while the patient consults for groin pain and gait impairment. The patient undergoes bipolar arthroplasty with long cemented stem.

Figure 2. Eighty-nine year-old male patient, active lifestyle, with mild Parkinson disease. Intertrochanteric fracture treated by reduction and osteosynthesis with proximal femur nail five months ago. X-ray showing cut-out failure. Rescue with uncemented arthroplasty with modular conic stem.

Figure 3. Sixty-four year-old male patient, ASA 2. Subtrochanteric fracture treated with DHS two years ago. Removal of implant at first surgery-stage. Reconstructive surgery 10 months afterwards with modular conic uncemented prosthesis.

arthroplasties that we carried out, in 28 (51%) cases there were uncemented cotyles and in 27 (49%), cemented cotyles. The diameter of the heads we used was 28 mm (34 cases), 32 mm (15 cases), 36 mm (8 cases) and we also used bipolar cups (4 cases). We always aimed at implanting the highest-diameter head to get the greatest possible stability. In three patients we used constrained inserts to decrease the risk of instability given their remarkable abductor deficiency, muscle deficit or other associated risk factors. We did our best to get adequate vastus muscle-gluteus muscle continuity; only in two cases did we resort to some fixation method for the greater trochanter. Average follow-up was 6.5 years (ranging from 2 to 14 years) (Table).

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Table. Patients' characteristics

Patient	Sex	Age	Hip	Fracture	Initial treatment	Failure	Surgery	Interval	Follow-up	Preoperative HHS	Posteoperative HHS
1	M	74	Left	ITF	Ender	Osteoarthritis	hTHR	54	174	42	78
2	F	80	Right	STF	DHS	Non-union	cTHR	4	156	39	79
3	M	73	Left	ITF	DHS	Cut-out	hTHR	9	129	45	73
4	F	78	Right	ITF	DHS	Cut-out	cTHR	6	109	33	80
5	F	81	Right	ITF	DHS	Associated hip neck fracture	PHR	5	95	41	82
6	F	82	Left	ITF	DHS	Cut-out	cTHR	4	87	54	84
7	F	79	Left	ITF	DHS	Cut-out	PHR	3	86	42	87
8	F	72	Right	ITF	DHS	Cut-out	hTHR	12	69	23	71
9	F	84	Right	ITF	DHS	Cut-out	cTHR	4	79	34	80
10	M	64	Left	STF	DHS	Infected non-union	2-time cTHR	9	58	54	86
11	F	62	Right	ITF	DHS	Infected non-union	2-time cTHR	4	89	43	81
12	F	72	Left	ITF	PFN	Infected non-union	2-time cTHR	11	68	32	89
13	F	60	Left	STF	PFN	Non-union	Bipolar RHR	9	56	51	86
14	M	89	Right	ITF	DHS	Infected non-union	2-time cTHR	12	86	44	83
15	F	72	Right	STF	DCS	Cut-out	cTHR	10	46	43	90
16	M	79	Right	ITF	DHS	Cut-out	cTHR	4	45	57	82
17	M	50	Right	STF	DCS	Osteoarthritis	uTHR	12	38	50	79
18	M	69	Left	ITF	DCS	Osteoarthritis	hTHR	52	34	51	77
19	M	69	Right	ITF	PFN	Cut-out	uTHR	1	28	49	67
20	F	78	Right	STF	DCS	Osteoarthritis	cTHR	12	26	47	73
21	F	75	Right	ITF	DHS	"Cut-out"	cTHR	7	58	41	69
22	F	92	Right	ITF	DHS	Infected non-union	2-time cTHR	14	44	41	79
23	F	82	Left	ITF	DHS		cTHR	39	71	48	80
24	F	79	Right	ITF	DHS	Non-union	uTHR	24	60	43	83
25	F	60	Left	ITF	DHS	Necrosis	(constrained) hTHR	24	62	38	86
26	M	81	Right	ITF	PFN	Necrosis	cTHR	7	59	53	92
27	F	84	Left	ITF	PFN	Cut-out	bipolar PHR	26	46	47	77
28	F	84	Left	ITF	DHS	Non-union	bipolar PHR	7	50	49	82
29	F	77	Left	STF	PFN	Non-union	uTHR	11	61	54	89
30	F	81	Left	ITF	DHS	Cut-out	cTHR	12	58	61	87
31	F	80	Left	ITF	DHS	Cut-out	uTHR	24	40	53	88
32	F	64	Left	ITF	PFN	Cut-out	cTHR	9	39	49	74

Table. (Cont.)

Patient	Sex	Age	Hip	Fracture	Initial treatment	Failure	Surgery	Interval	Follow-up	Preoperative HHS	Posteoperative HHS
33	F	52	Right	ITF	DHS	Cut-out	uTHR	6	41	46	87
34	F	84	Left	ITF	DHS	Cut-out	(constrained) hTHR	6	36	42	84
35	F	70	Right	ITF	DCS	Cut-out	uTHR	10	40	44	87
36	F	85	Left	ITF	DHS	Cut-out	cTHR	6	28	40	93
37	F	76	Left	ITF	DHS	Cut-out	uTHR	13	30	43	76
38	F	87	Left	ITF	DHS	Associated hip neck fracture	cTHR	8	32	45	79
39	F	71	Left	ITF	DHS	Cut-out	uTHR	12	25	54	90
40	F	79	Right	ITF	DHS	Cut-out	hTHR	9	27	55	85
41	F	81	Right	STF	PFN	Non-union	hTHR	8	33	56	89
42	M	74	Left	ITF	DHS	Infected non-union	2-time uTHR	12	30	55	88
43	F	79	Right	STF	DCS		bipolar PHR	10	31	61	93
44	F	89	Right	ITF	DHS	Associated hip neck fracture	cTHR	12	24	55	91
45	F	82	Right	ITF	DCS	Non-union	uTHR	9	27	45	90
46	F	81	Right	ITF	DHS	Cut-out	cTHR	6	21	44	89
47	M	74	Left	STF	PFN	Cut-out	hTHR	12	23	54	88
48	F	77	Right	ITF	PFN	Non-union	(constrained) uTHR	5	50	45	79
49	F	87	Right	STF	PFN	Cut-out	cTHR	9	49	49	89
50	M	58	Left	STF	PFN	Necrosis	uTHR	16	43	45	90
51	M	51	Left	STF	DCS	Osteoarthritis	uTHR	140	50	54	93
52	M	85	Right	ITF	DHS	Cut-out	cTHR	1	46	54	88
53	M	68	Right	ITF	Ender		hTHR	360	43	42	89
54	M	89	Right	STF	PFN	Cut-out	uTHR	4	30	51	88
55	F	84	Right	ITF	PFN	Cut-out	cTHR	1	26	44	83
56	F	87	Left	ITF	PFN	Infected non-union	2-time hTHR	12	26	52	78
57	F	93	Right	ITF	PFN	Cut-out	cTHR	3	26	47	84
58	F	55	Right	ITF	DHS	Osteoarthritis	uTHR	120	25	49	89
59	M	62	Left	STF	PFN	Non-union	uTHR	14	29	48	94
60	F	73	Right	ITF	DHS	Necrosis	uTHR	24	26	43	91
61	M	76	Right	STF	DHS	Cut-out	hTHR	22	28	55	90

ITF = Intertrochanteric Fracture; STF= Subtrochanteric fracture; DHS = *Dynamic Hip Screw*; PFN = Proximal Femur Nail; DCS = *Dynamic Condylar Screw;* hTHR = hybrid Total Hip Replacement; cTHR = cemented Total Hip Replacement; PHR = Partial Hip Replacement; uTHR = uncemented Total Hip Replacement.

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Results

One year after the surgery, the Harris Hip Score had improved from preoperative average 47 (ranging from 32 to 54) to average 84 (ranging from 67 to 93). Seven patients (11.5%) suffered complications. Three (4.9%) were peri-prosthetic femoral fractures. Two of them occurred during the surgery, while preparing the femoral canal. In the first case, there was a false pathway in the proximal femoral third on its lateral aspect and, by inserting a long stem we avoided any need for surgical treatment. The second patient suffered a mid-diaphyseal fracture which required open reduction, cerclage wiring and the insertion of a long stem. The third case occurred at long-term postoperative stages and was all about a diaphyseal fracture distal to the implant which, while not compromising implant fixation (Vancouver C)[12], required reduction and osteosynthesis with plate. Two patients (3.2%) suffered dislocation episodes—one of them was satisfactorily treated by closed reduction whereas the other one required revision, where we cemented a polyethylene insert within the osseointegrated cotyle, what improved the device orientation.[13] One patient (1.6%) developed hematoma with persistent leaking through the wound, because of which this patient was subject to surgical toilet with negative bacterial culturing. The remaining patient (1.6%) suffered acute deep infection and, in spite of multiple surgical toilets, this patient did not do well and was subject to implant removal with spacer insertion. Up to the patient's last checkup, infection outcomes were all right. There were no cases of implant loosening up to the latest checkups. Survival free from revision at postoperative year 4.6 was 96.5%. Reoperation rates were 6.5%.

Discussion

Most intertrochanteric fractures are treated satisfactorily with current osteosynthesis implants (dynamic hip screw or proximal femoral screw).[14-19] When treatment fails, osteosynthesis rescue results necessary for pain relief and physical impairment. In young patients and the elderly with high demand and good bone stock, rescue with new osteosynthesis seems to be the best option of all.[20-21] On the other hand, in old patients with low demand or in those with poor bone stock or acetabular conditions, rescue with arthroplasty offers more predictable results.[5-7]

In our series, the reoperation rates of 6.5% —what includes closed reduction— provide evidence of the greatest complexity associated with hip arthroplasty in the scenario of rescue of failed osteosynthesis in intertrochanteric or subtrochanteric fractures, as compared with primary arthroplasty. In 2003, Haidukewych and Berry in their series of 60 patients reported reoperation rates of 8% and one dislocation.[20] In 2012, Mortazavi et al., in a series of 154 arthroplasties in 152 patients reported reoperation rates of 7.2% and no dislocation at all.[22] The same year, Enocson et al. reported that 11 out of the 88 patients (16%) in their series required reoperation, what included closed reduction. All in all, there were six peri-prosthetic fractures, five deep infections and three dislocations.[21]

Hip arthroplasty in the scenario of failed osteosynthesis is associated with good or excellent results in more than 70% of the cases;[5-7] however, it challenges surgeons with some technical drawbacks that make out of this one a more demanding procedure than that in primary arthroplasty.[23] The surgeon should carry out adequate preoperative planning, evaluating the need for specific tools for osteosynthesis material removal, the occurrence of deformities or bone defects in the proximal femur which require trochanteric osteotomy, and the need for a revision implant, as well as the management of the greater trochanter and the abductor apparatus.

Dislocation is one the most frequent complications. The alteration of hip anatomy with potential risk of bad components insertion, plus the alteration of the abductor apparatus, may be one of the main reasons for dislocation. Therefore, the use of modular stems is one of the alternatives surgeons should bear in mind for restoration of better stability and hip biomechanics.[8,24] Likewise, greater trochanter joining or its fixation with a system of any kind could decrease the risk of instability.[25] Fortunately, in most cases despite the poor bone stock in the greater trochanter, vastus muscle-gluteus muscle continuity is respected and the abductor apparatus is functional. Nevertheless, in some cases seriously affected, it is necessary to resort to constrained implants. In our series, two patients (3.2%) developed instability episodes: one of them required a revision surgery in which a new polyethylene insert was cemented within the osseointegrated cotyle, whereas the other one was satisfactorily treated by closed reduction. This percentage is similar to that of 1.6% reported by Haidukewych and Berry, and significantly smaller than that reported in some series, which can reach up to 23%-rates.[26]

Another one of the most frequently reported complications is peri-prosthetic fracture. Poor bone quality and the presence of femoral holes remaining from the previous osteosynthesis screws can trigger the fracture. We believe it is important to carry out hip dislocation before removing the osteosynthesis so as to decrease femoral stress and thus avoid intraoperative fracture. Along these lines, the use of stems long enough so as to outreach the most distal screw-hole helps decrease the risk of fracture.[23] Notwithstanding, three patients (4.9%) in our series suffered peri-prosthetic fracture (2 intraoperative fractures and one at long-term postoperative stages).

The functional results gotten in the diverse series were satisfactory in spite of the high percentages of complications. In the Haidukewych and Berry's series, 89% of the patients did not suffer pain and 91% were able to walk at patients' last checkup—59% of them with or without cane.[5] In 2010, D'Arrigo et al. reported 21 cases of rescue in interthrocanteric fracture by means of hip arthroplasty, with significant improvement in the average Harris Hip Score, which went from preoperative 37 to 81 at last follow-up.[8] In 2015, Karampinas et al. reported a significant increase in the Harris Hip Score in their series of 25 patients and they highlight that, before revision, all patients had a poor Harris Hip Score, and more than 73% of the patients got good or excellent results at revision two-year follow-up.[9] In our series, results coincide with those that have been reported.

Conclusions

Hip arthroplasty comes as an effective method for the rescue of failed osteosynthesis in intertrochanteric and subtrochanteric fractures. Patients' pain and function improve significantly in most patients. However, it is a more demanding procedure which is associated with more complications than those in primary hip arthroplasty.

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