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## Ten-year results of uncemented hip stems for failed intertrochanteric osteotomy

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**Abstract** *Introduction* Inferior survival of cemented total hip arthroplasty has been reported after previous femoral osteotomy. The purpose of this study was to evaluate the long-term survival of uncemented stems after femoral osteotomy. *Materials and methods* Forty-eight hips in 45 patients had undergone conversion THA for a failed intertrochanteric osteotomy of the hip after a mean of 12 years (2–33 years). Mean time of follow-up was 11 years (5–15 years). *Results* At follow-up, two patients (three hips) had died, and one patient (one hip) was not located. Three patients (three hips) underwent femoral revision—one for infection and two for aseptic loosening of the stem. Survival of the stem was 94% at 10 years, and survival with femoral revision for aseptic loosening as an end point was 96%. The median Harris Hip Score at follow-up was 80 points. Radiolucent lines in Gruen zones 1 and 7 were present in 14 and 18% of hips, respectively. Radiolucencies in other zones were not detected. There was no radiographic evidence of femoral osteolysis, stress-shielding or loosening. *Conclusion* The results with this type of uncemented tapered titanium femoral component after proximal femoral osteotomy are encouraging and compare to those achieved in patients with regular femoral anatomy.

**Keywords** Osteotomy · THA · Primary · Uncemented · Titanium · Straight · Stem · Long-term follow-up

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### Introduction

Intertrochanteric femoral osteotomy remains an important operative treatment option in young patients with early symptomatic degenerative hip disease (DHD) [8, 30]. Apart from relief of symptoms, the main purpose of osteotomy is to delay the natural course of DHD by realignment of the articular surfaces and redistributing joint forces. With failure rates of 18 to 30% after 10 years and 60% after 15 years [20, 21, 11, 16], conversion to primary THA usually becomes necessary eventually. The proximal femoral anatomy is then frequently distorted by malalignment, residual deformity and/or significant sclerosis in the metaphyseal region. As a consequence, preparation of the femoral canal can be challenging, and higher intraoperative complication rates have to be anticipated [12, 28]. Interestingly, there are only a few reports on long-term results of cemented THA after proximal femoral osteotomy [6, 11, 16, 25]. Data on uncemented THA after this condition are even more limited at present, which is particularly intriguing as cementless designs are favored by most surgeons and commonly offered to young patients. Iwase et al. suggested cemented stems are preferable to cementless stems after failed femoral valgus osteotomy [16]. We have therefore evaluated the clinical and radiographic outcome of a consecutive series of 48 hips from January 1985 until December 1994 using the uncemented CLS Spotorno femoral component after proximal femoral osteotomy with a mean of 11 years follow-up.

### Materials and methods

A consecutive series of 48 cementless THAs in 45 patients received a cementless Spotorno CLS stem between 1985 and 1995 (Sulzer Orthopedics). In all hips previous proximal intertrochanteric osteotomy had been performed with an average of 12 years (2–33 years)

before conversion to THA. The 5- to 15-year follow-up rate was 98% for the entire group. The mean time of follow-up was 11 years (5–15 years). During the follow-up period, three patients (three hips) had died, and one patient (one hip) was lost to follow-up (Fig. 1). In all patients who died, the prosthesis was in situ at the time of death. Follow-up data were obtained for 41 hips, of which 35 were collected directly by the senior author. The remainder was seen by their local orthopedic surgeon. Standard radiographs were taken and sent to our institution for evaluation. Diagnoses and patient demographics are listed in Table 1. In all patients a cementless, straight, collarless CLS Spotorno stem (Sulzer Orthopedics) (Fig. 2) with a CCD angle of 145° was implanted using the press-fit technique. The implant was made from Ti6Al7Nb alloy (Protasul 64) with a microporous surface treatment ( $R_a=4.4\ \mu\text{m}$ ). This stem is wedge-shaped and tapered in all three planes with proximal, anterior and posterior ribs/flutes. The femoral component was combined with differing acetabular implants. In 94% of the cases, smooth cementless threaded cups were used; 83% received threaded spherical cementless Mecron cups (Mecron medizinische Produkte GmbH), and 11% threaded conical cementless Weill rings (Sulzer Orthopedics). In 6% of cases, cemented cups (Aesculap) were implanted. In all cases 32-mm Biolox ceramic heads (Ceramtec) and polyethylene liners were used.

The implantations were performed by three different senior surgeons. Either a modified Watson-Jones or a transgluteal lateral Bauer approach with the patient in a supine position was used. Preparation of the femoral

**Table 1** Distribution of diagnoses and patient demographics

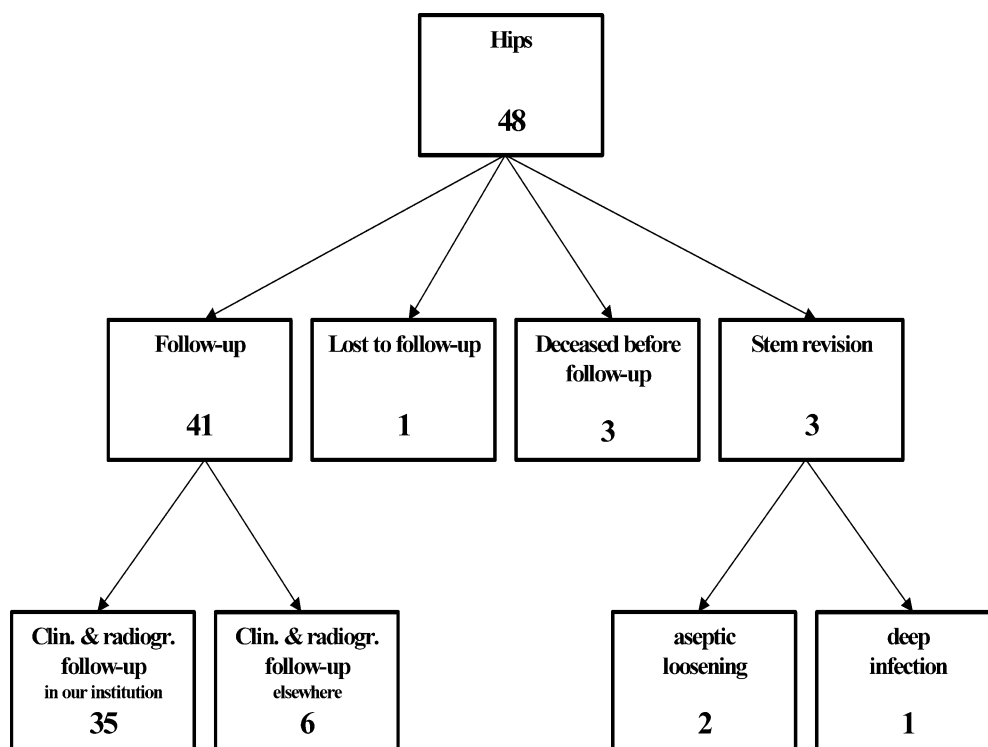
Diagnoses	<i>n</i> (%)
CDH	34 (69%)
AVN	7 (15%)
Idiopathic OA	5 (11%)
Posttraumatic OA	2 (5%)
Demographics	
Median age (years)	50 (26–67)
BMI	27 (24–30)
Female ( <i>n</i> )	33 (73%)
Male ( <i>n</i> )	12 (27%)
Left ( <i>n</i> )	22 (46%)
Right ( <i>n</i> )	26 (54%)

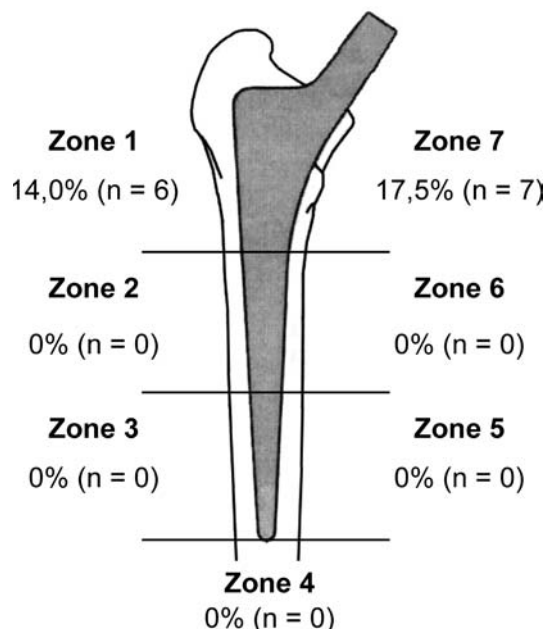
canal was performed using a canal finder and a series of chipped tooth broaches with increasing size. No attempt was made to achieve cortical fixation. Postoperative partial weight bearing was encouraged for 6 weeks, and weight bearing as tolerated for the first 3 months. No regular prophylaxis (irradiation or NSAIDs) for prevention of heterotopic ossification was given.

At follow-up, a standardized questionnaire including the items of the Harris Hip Score was administered for each patient/hip. Clinical assessment included limp, range of motion and pain. Patients assessed their pain in the operated hip at the time of follow-up on a visual analog scale (VAS: 0–10). In addition, the pain score according to Harris was used [15].

The radiographs were examined by two independent experienced orthopedic surgeons for stem alignment, subsidence, radiolucent lines, bone hypertrophy, osteolysis, stress shielding, pedestal formation at the stem

**Fig. 1** Distribution of hips evaluated





**Fig. 2** Radiographic findings divided by Gruen-zones of 41 hips with radiographic follow-up

tip, heterotopic ossifications and femoral and acetabular loosening (see below).

Varus or valgus stem malalignment was defined as deviation from the longitudinal femoral axis of more than  $2^\circ$ . Radiolucent lines were allocated to Gruen regions 1–7 [14], and bone hypertrophy was defined as thickening of the distal periprosthetic diaphyseal bone. Osteolysis was defined as areas of localized bone resorption or endosteal erosion. Stress shielding was defined according to Engh [9]: only second, third and fourth degree stress shielding with resorption of cortical bone medially, anteriorly or laterally was regarded as stress shielding, whereas rounding of the medial femoral

neck was noted as calcar rounding and not considered a sign of stress shielding. Pedestal formation was defined as a shelf of endosteal new bone at the stem tip partially or completely bridging the intramedullary canal. A femoral stem was regarded loose if radiolucent lines  $>2$  mm were present around the entire implant. Acetabular loosening was defined as continuous migration  $>5$  mm or tilting of  $>5^\circ$  compared with baseline radiographs on anteroposterior radiographs. Using revision of the stem for any cause and revision for aseptic loosening as endpoint, a life-table was constructed, and the 1- to 15-year survival rates were calculated.

## Results

### Revisions

#### *Stem revisions*

In 41 patients with 44 hips (94%), the femoral prosthesis had not been revised. In three patients (three hips), the stem had been revised. One hip was revised for deep infection, and two stems for aseptic loosening.

#### *Cup revisions*

Eleven acetabular cups (23%), all of them Mecron components, had been revised prior to follow-up. From the remaining hips, six Mecrons had migrated and are awaiting revision.

#### *Complications*

In two hips femoral fissures occurred during stem preparation; none of them required further treatment.

**Fig. 3** Preoperative, postoperative and 14-year follow-up films of a 53-year-old male patient, HHS: 96 points. Calcar rounding can be observed



One early dislocation occurred, which was successfully treated by closed reduction.

### Clinical results

The median Harris Hip Score of the 41 radiographically followed hips at the time of follow-up evaluation was 80 (24–100) points (out of 100). No pain was reported in 46% (19 hips) of the hips, in 17% (7 hips) slight hip pain, in 12% (5 hips) mild pain, in 17% (7 hips) moderate pain, and in 7% (3 hips) severe pain was reported. In three hips a Harris pain score of 10 or less (of a possible 44) points was reported; all three of them had a loose acetabular component. No thigh pain was reported.

### Radiographic evaluation

There was no evidence of radiographic loosening, osteolysis or subsidence. The position of the femoral prosthesis at the time of follow-up was neutral in 36 hips (88%); 2 hips (5%) had a varus position, and 3 hips (7%) had a valgus position.

Radiolucent lines were limited to Gruen zones 1 and 7 in 15% (six hips) and 17% (seven hips), respectively. Other Gruen zones were not affected (Figs. 2, 3, 4). Mild rounding of the calcar was found in most patients (88%). Severe stress shielding (2–4 degrees) or distal femoral hypertrophy was not observed. The radiographic analysis showed only mild bone loss and stress shielding in all patients. Pedestal formation at the tip of the prosthesis was observed in 12% of cases.

### Survival analysis

The life-table analysis (Table 2) shows a low annual failure rate and the calculation of the survival of 94% of

femoral components after 10 years without revision (for any reason). The figures for lost to follow-up were high in postoperative years 10–15 due to a limited number of observations in that time period. Survival with femoral revision for aseptic loosening as an end point was 96% at 10 years.

### Discussion

Total hip arthroplasty remains the most effective treatment for osteoarthritis of the hip in the elderly [7]. However, in the young patient with dysplasia, longevity of this procedure has been greatly compromised by failure due to aseptic component loosening, (activity induced) wear and osteolysis, necessitating revision surgery [5, 18]. Intertrochanteric osteotomy is a valuable alternative treatment option in younger patients, especially for dysplastic hips to improve joint congruency, relieve pain and restore function of the hip [8, 27, 30]. However, the results of osteotomy are often impaired by progression of disease necessitating conversion to total hip arthroplasty. Results of cemented THA with the use of first generation cementing techniques after failed proximal femoral osteotomy have shown inferior results in the long term compared to standard THA [6, 11, 16]. Femoral revision rates of 18% after 5 [11] and 10 years [6] have been reported. The use of second generation cementing techniques significantly improved survivorship of stems after osteotomy, and most failures were due to an insufficient cement mantle supposedly caused by irregular femoral anatomy [25]. However, residual cortical holes may compromise cement pressurization and thus penetration into cancellous bone, and may even predispose to earlier failure [11]. Cementless stems, in theory, do not pose this problem, but have not

**Fig. 4** Preoperative, postoperative and 15 year follow-up films of right hip of a 61-year-old female patient, HHS: 89 points. Calcar rounding is present at 15 years, the osteotomy site is still visible



**Table 2** Life table analysis of the 48 hip stems after proximal femoral osteotomy

Years since operation	Number at start	Number at risk	Drop-out (n)	Revision (aseptic) (n)	Revision (infection) (n)	Deceased (n)	Lost to follow-up (n)	Annual failure rate (%)	Annual success rate (%)	Survival rate (%)	Survival rate (aseptic) (%)
0 to 1	48	48	0	0	0	0	0	0	100	100	100
1 to 2	48	48	0	0	0	0	0	0	100	100	100
2 to 3	48	46.5	3	1	1	1	0	4.3	95.7	95.7	97.8
3 to 4	45	44.5	1	1	0	0	0	2.2	97.8	93.5	95.7
4 to 5	44	43.5	1	0	0	1	0	0	100	93.5	95.7
5 to 6	43	42.5	1	0	0	0	0	0	100	93.5	95.7
6 to 7	42	41.5	1	0	0	0	1	0	100	93.5	95.7
7 to 8	41	38.5	5	0	0	1	0	0	100	93.5	95.7
8 to 9	36	34	4	0	0	0	0	0	100	93.5	95.7
9 to 10	32	30.5	3	0	0	0	0	0	100	93.5	95.7
10 to 11	29	24	10	0	0	0	0	0	100	93.5	95.7
11 to 12	19	15.5	7	0	0	0	0	0	100	93.5	95.7
12 to 13	12	10	4	0	0	0	0	0	100	93.5	95.7
13 to 14	8	6.5	3	0	0	0	0	0	100	93.5	95.7
14 to 15	5	3	4	0	0	0	0	0	100	93.5	95.7
15 to 16	1	0.5	1	0	0	0	0	0	100	93.5	95.7

performed equally well in this context so far. Iwase et al. found a high failure rate with 18 cementless stems (Ominiflex, Ominifit) after an average follow-up of 5 years [16] and suggested that it is unreasonable to use standard cementless stems, which are designed for normal femoral canals [22].

In contrast, the long-term results of the grit-blasted tapered uncemented stem used in our study with a survival rate of 94% after 10 and 15 years are comparable to those achieved in patients without previous femoral osteotomy managed with this specific stem [1, 3, 24, 26]. As no more failures occurred after the 4th postoperative year, failure due to mechanical loosening over time is unlikely. Even though predominantly uncemented polished threaded cups, which have been reported with a high rate of migration and failure, had been implanted in our study [4], survival of the stem was not affected regardless of its intramedullary alignment [17, 23]. Radiologically, no case of severe stress shielding and no distal cortical hypertrophy were found in the patients investigated. This finding is in contrast to the results of other uncemented implants [10, 13, 19]. The tapered design in combination with a very slim diaphyseal part of the stem seems to provide proximal metadiaphyseal load transfer over 10–15 years [2], as suggested by the authors [29], even in the presence of disturbed proximal femoral anatomy with sclerotic host bone. Radiolucent lines limited to the proximal regions of the stem (Gruen zones 1 and 7) were seen in almost 1/5. Although these radiolucent lines did not affect clinical outcome, they have to be observed carefully in the future for progression. Surprisingly, there was no radiographic evidence of femoral osteolysis. Although we did not measure wear in this study, the ceramic femoral heads might have contributed to the absence of osteolysis after up to 15 years.

After 10 to 15 years, we found a very low revision rate due to aseptic loosening with the CLS stem after proximal intertrochanteric osteotomy, no femoral osteolysis and favorable results on radiographic examination. Even though the acetabular revision rate was high in this study, the survival rate of the femoral component was excellent.

In our opinion, the insertion of this tapered uncemented femoral stem is less demanding than cemented THA, in particular under unusual anatomic conditions, due to the forgiving design of this tapered stem. It can provide good long-term success with fewer possible pitfalls. Even in a multi-surgeon series, the long-term results were very consistent in this previously operated group of patients. Our results suggest that grit-blasted uncemented tapered stems can be recommended in the management of patients after failed intertrochanteric osteotomy.

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