Cementless Spotorno tapered titanium stems

Excellent 10–15-year survival in 141 young patients

Peter R Aldinger, Marc Thomsen, Hans Mau, Volker Ewerbeck and Steffen J Breusch

Stiftung Orthopädische Universitätsklinik Heidelberg, Schlierbacher Landstrasse 200a, DE-69118 Heidelberg, Germany.
Correspondence: steffen.breusch@urz.uni-heidelberg.de
Submitted 02-03-23. Accepted 02-09-28

ABSTRACT **We evaluated the clinical and radiographic results of the first consecutive 154 implantations of a cementless, double-tapered straight femoral stem (cementless Spotorno (CLS), Sulzer Orthopedics) in 141 patients under the age of 55 (mean 47 (13–55)) years. After a mean follow-up of 12 (10–15) years, 11 patients (11 hips) had died and 7 (7 hips) could not be located. 5 patients (5 hips) underwent femoral revision—1 for infection, 1 for periprosthetic fracture and 3 for aseptic loosening of the stem. The overall survival rate of the stem was 97% at 12 years (95% confidence limits, 93%–100%), and survival with femoral revision for aseptic loosening as an end point 98 (95–100)%. The survival rate of the acetabular components was 78 (71–85)% after 12 years. The median Harris hip score at follow-up was 84 points. None of the patients had thigh pain. Radiolucent lines in Gruen regions 1 and 7 were present in 21 hips (17%). 2 hips had radiolucent lines in regions 2–6 on anteroposterior (AP) radiographs. No femoral osteolysis was detected.**

The mid- to long-term survival with this type of femoral component is excellent and compares favorably with cemented stems in this age group. However, the high rate of cup loosening and the low Harris hip scores are a concern in this subgroup of young patients.

Despite improvements in cementing techniques, the survival of total hip implants in younger patients has been disappointing (Smith et al. 2000). Consequently, cementless components have been developed. Longer implant survival, preservation of bone stock and "easier" revisions have been advocated as potential advantages of cementless stems (Engh et al. 1987, Morscher 1987). The early findings using cementless femoral components in young patients have been reported (Mont et al. 1993, Dowdy et al. 1997), but only a few have included data on more than a 10-year follow-up (McLaughlin and Lee 2000, Duffy et al. 2001, Nercessian et al. 2001). We evaluated implant survival, clinical and radiographic results with a cementless, double-tapered, grit-blasted titanium stem in patients under the age of 55 years with a minimum follow-up of 10 years.

Patients and methods

A consecutive series of 354 cementless THAs in 326 patients received a cementless Spotorno CLS stem between January 1985 and December 1989 (Sulzer Orthopedics). 141 patients with 154 hips, under the age of 55 years, were selected for the present study (Table 1). The 10–15-year follow-up was 88% for the entire group and 96% for the patients still alive at the time of the follow-up evaluation. The average time of follow-up was 12 (10–15) years. During this period, 11 patients (11 hips) had died, and 7 (7 hips) could not be located (Figure 1). In all patients who died, the prosthesis was in situ at the time of death. The follow-up data were obtained about 131 hips, 96 of which were collected directly by the first author. The rest were seen by their local orthopedic surgeon. Standard radiographs were taken and sent to our institution for evaluation.

In all patients, a cementless, straight, collarless CLS Spotorno stem (Sulzer Orthopedics) (Figure 2) with a CCD angle of 145° was implanted, using

Table 1. Patient demographics

Diagnoses, number of hips	
CDH	51 (33%)
Osteoarthrosis	47 (30%)
Avascular necrosis (AVN)	29 (19%)
Congenital hip dislocation	11 (7%)
Posttraumatic osteoarthritis	8 (5%)
Rheumatoid arthritis	2 (2%)
Other	6 (4%)
Previous osteotomies	23 (15%)
Median age, years (range)	
Male	47 (13–55)
Female	47 (13–55)
Gender, patients (hips)	
Male	69 (73)
Female	72 (81)
Body mass index (FU), median (quartile)	
Male	28 (24-31)
Female	25 (24-28)
Charnley class (FU), number of hips	
A	61 (48%)
B	46 (37%)
C	17 (15%)
Radiolucent lines (< 2 mm), number of hips	
Region 1	21 (17%)
Region 2	1 (1%)
Region 3	2 (2%)
Region 4	2 (2%)
Region 5	2 (2%)
Region 6	0 (0%)
Region 7	21 (17%)
Stem position, number of hips	
Neutral	115 (91%)
Varus	7 (6%)
Valgus	4 (3%)
Heterotopic ossification, number of hips	
Grade I	52 (41%)
Grade II	15 (12%)
Grade III	3 (2%)
Grade IV	0 (0%)

the press-fit technique. The implant was made from Ti6Al7Nb alloy (Protasul 64) with microporous surface treatment (Ra = 4.4 µm). This stem is wedge-shaped, tapers in all three planes, and has proximally, anteriorly and posteriorly located ribs/flutes. The femoral component was combined with various acetabular implants. In 98% of cases, smooth, cementless, threaded cups were used. 63% received threaded, spherical, cementless, Mecron cups (Mecron medizinische Produkte GmbH), and 35% threaded, conical, cementless, Weill rings (Sulzer Orthopedics). In 2% 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 20 surgeons. A modified Watson-Jones or a transgluteal lateral Bauer approach with the patient in supine position was used. Preparation of the femoral canal was done with a canal finder and a series of chipped tooth broaches of increasing size. No attempt was made to obtain 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) was given to prevent heterotopic ossification.

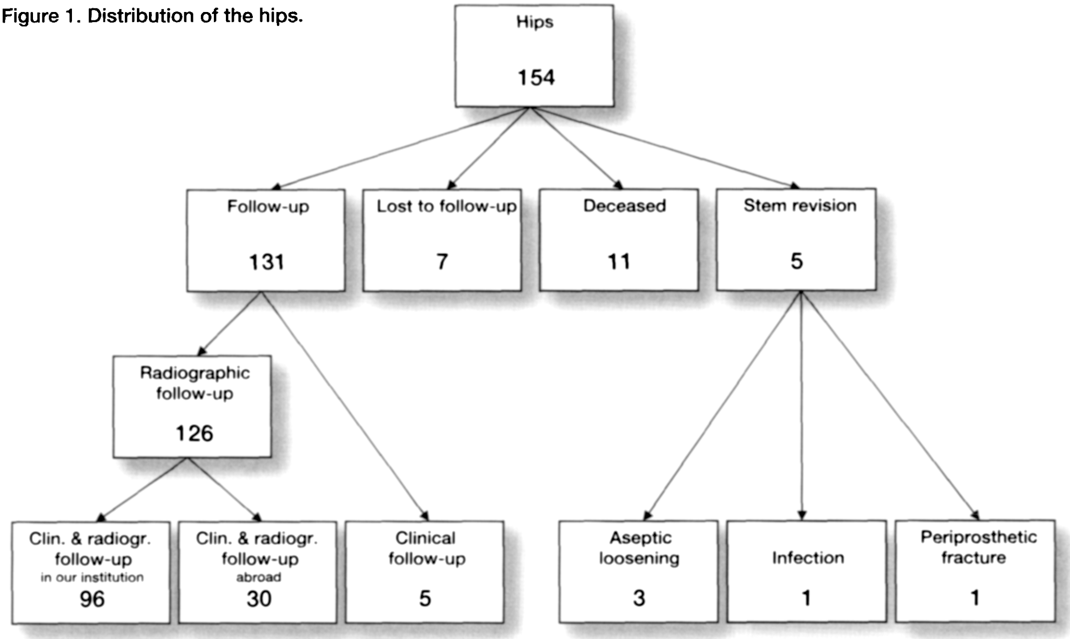
At follow-up, a standardized questionnaire including items on the Harris (1969) hip score, was filled in by each patient/hip. The clinical assessment included limp, range of motion and pain. Patients assessed their pain in the operated hip at the time of follow-up on a visual analog scale (VAS: 0–10).

The radiographs were examined by two experienced independent orthopedic surgeons for stem alignment, subsidence, radiolucent lines, bone hypertrophy, osteolysis, stress shielding, pedestal formation at the stem 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°. Radiolucent lines were allocated to Gruen regions 1–7 (Gruen et al. 1979) 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 by Engh et al.'s method (1987): only second, third and fourth degree stress shielding with resorption of cortical bone medially, anteriorly or laterally was regarded as stress shielding, while rounding of the medial femoral neck was termed calcar rounding and not considered a sign of stress shielding. Pedestal formation was defined as a shelf of new endosteal bone at the stem tip partly or completely bridging the intramedullary canal. A femoral stem was regarded as 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°, as compared with baseline anteroposterior radiographs.

Using revision of the stem for aseptic loosening and revision of the stem for any cause as the end

Figure 1. Distribution of the hips.



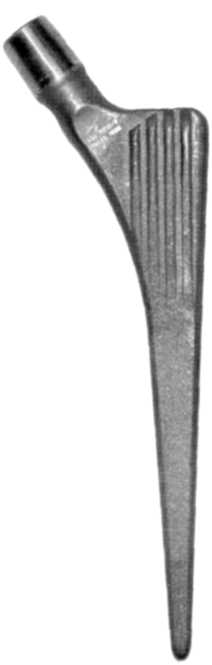


Figure 2. Cementless double-tapered titanium CLS Spotorno stem.

point, we did a Kaplan-Meier survival analysis to calculate the cumulative survival rate.

Results

Revisions

Stem revisions. In 129 patients with 142 hips (97%), the stem remained in situ until follow-up or death. In 5 patients (5 hips), the stem had been revised. 1 hip was revised for a deep infection, 1 for periprosthetic fracture. 3 stems were revised for other causes: 1 during revision of the cup with no signs of radiographic loosening. In 1 case, an intraoperative fracture of the proximal femur occurred. In this case, the stem did not stabilize and it had to be revised after 3 years. In 1 stem, the femoral component was undersized; this lead to stem subsidence and revision.

Acetabular revisions. 42 acetabular cups (27%) (33 Mecron and 9 Weill) were revised before the most recent follow-up. Of the remaining hips, 21 cups (14%) showed continuous migration and are scheduled for revision (17 Mecron and 4 Weill).

Clinical results. The median Harris hip score (HHS) of the 126 hips that were radiographically followed was 84 (30–100) points. Low Charnley class and acetabular loosening/revision affected the HHS (Table 2). 4 hips had a Harris pain score of 10 or less (of a possible 44). All of these had a loose acetabular component or suffered from other diseases that were unrelated to the operated hip joint (Charnley class C). None of the patients complained of thigh pain.

Radiographic evaluation. We found no evidence of radiographic loosening or osteolysis. Early subsidence (> 5 mm) was seen in 1 stem (1%), which stabilized at 12 months without further clinical or radiological signs of stem loosening at follow-up. Mild rounding of the calcar was found in most patients (76 %). No distal cortical hypertrophy or stress shielding (2–4 degrees) with atrophy of the proximal femur was detected. Pedestal formation at the tip of the prosthesis was noted in 18% of cases.

Table 2. Clinical and radiographic results

Harris hip score, median (range)	
All hips	84 (30–100)
Stable cup	86 (45–100)
Loose cup	79 (30–99)
Revised cup	73 (41–99)
Charnley A	92 (52–100)
Charnley B	78 (30–99)
Charnley C	68 (32–89)
Harris pain score, median (quartile)	
All hips	44 (30–44)
Stable cup	44 (40–44)
Loose cup	40 (20–44)
Revised cup	40 (20–44)
VAS pain, number of hips (%)	
No pain	67 (53%)
Slight pain	25 (20%)
Mild pain	8 (6%)
Moderate pain	22 (18%)
Severe pain	2 (2%)
Thigh pain	0 (0%)

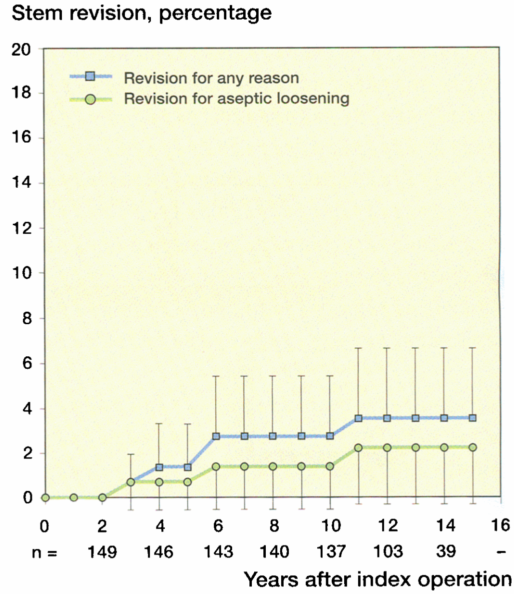


Figure 3. Survival rates of all revisions/revision for aseptic loosening of the femoral component as end point.

Survival analyses

Stem. Kaplan-Meier analysis (Figure 3) was used to assess 154 hips and showed a survival rate of 97% after 12 years (95% confidence limits 93%–100%) on the basis of revision for any reason. Survival with femoral revision for aseptic loosening as the end point was 98 (95–100)% after 12 years. The survival rate remained unchanged until the 15th year. Since many patients were lost to follow-up 14–15 years after surgery, the confidence limits are wide (Figure 2). At the time of follow-up, no patient was on the waiting list for a stem revision.

Acetabular components. The Kaplan-Meier analysis of the acetabular components showed a survival rate of 84% after 10 years (95% confidence limits 78%–90%), 78 (71–85)% after 12 years and 69 (58–80)% after 15 years. When the pending revisions were included in the analysis, the survival rate dropped to 81 (75–87)% at 10 years, 70 (63–77)% at 12 years and 29 (3–55)% at 15 years.

Discussion

The survival rate we found for the cementless tapered stem is particularly impressive considering the young age of the population, and the inclusion of patients who underwent implantation during the "learning curve" using this device. We achieved a high clinical follow-up rate with only 7 patients (5%) lost to follow-up (Britton et al. 1995).

There are several reasons for the good fixation of the Spotorno stem. One of the likeliest is the combination of a double taper with a grit-blasted surface treatment that permits osseointegration of the titanium alloy (Spotorno et al. 1993). The advantageous distribution of load may have prevented severe stress shielding and distal cortical hypertrophy on radiographic examination. This finding differs from the results of other cementless implants with a tight distal fit, which show high rates of cortical hypertrophy due to more distal fixation (Engh and Culpepper 1997, Kim et al. 1999, Grubl et al. 2002). Thigh pain occurs in association with distal canal reaming and a tight fit (Engh and Hopper 1998). In our series, no patient reported thigh pain. We ascribe this to the more flexible titanium alloy, the lack of tight filling of the distal canal and the more proximal meta-diaphyseal loading of the CLS stem. This does not entirely accord with the hypothesis of pure metaphyseal load transfer suggested by the designers of this stem (Spotorno et al. 1993). We found radiolucent lines that were limited to the proximal regions of the stem (Gruen zones 1 and 7) in more than 15% of cases, which were probably due to mild stress shielding. They appeared not to affect clinical outcome, but should be monitored carefully for progression.

Although the rate of acetabular loosening was high in this group, we found no evidence of excessive wear in most of the polyethylene inserts at the time of acetabular revision or of femoral osteolysis in this group of young and active patients. This contrasts with other studies in which high rates of osteolysis have been reported with cementless implants in young patients, even after a short to intermediate follow-up (Brinker et al. 1994, Kim et al. 1995, Kronick et al. 1997).

Despite excellent survival and radiographic findings, the clinical results with a median Harris hip score of 84 points were only moderately good. About one quarter of the patients complained of moderate to severe pain. Some of the low scores are due to the high number of cases in low Charnley classes (B/C) (Charnley 1972). More than a quarter of the patients had undergone acetabular revision, usually with major reconstruction. The high failure rate of these threaded cups has been reported by others (Simank et al. 1997). However, the association of pain and migration/loosening of the cup was uncertain. We can not blame only the acetabular changes for the moderate clinical scores. Similar HHS (mean 88 points) have been reported with this stem type and threaded sockets (Schramm et al. 2000). In combination with a press-fit acetabular cup higher scores (mean 94 points) have been found (Siebold et al. 2001), which would suggest that acetabular failure is partly responsible for the lower scores.

The scarcity of long-term follow-ups (> 15 years) of cementless femoral implants makes it difficult to predict the long-term outcome in younger patients. After 12 years, we found a low revision rate due to aseptic loosening of the stem, no femoral osteolysis and better results than with most cemented stems in young patients (Ballard et al. 1994, Dorr et al. 1994, Torchia et al. 1996, Devitt et al. 1997).

We think that the insertion of this cementless femoral stem is less demanding than that of a cemented THA, because of its design. Even in a multi-surgeon series, the medium- to long-term results were entirely consistent. In our opinion, this grit-blasted cementless tapered stem can be recommended for use in young patients.

Ballard W T, Callaghan J J, Sullivan P M, Johnston R C. The results of improved cementing techniques for total hip arthroplasty in patients less than fifty years old. A ten-year follow-up study. J Bone Joint Surg (Am) 1994; 76 (7): 959-64.

Brinker M R, Rosenberg A G, Kull L, Galante J O. Primary total hip arthroplasty using noncemented porous-coated femoral components in patients with osteonecrosis of the femoral head. J Arthroplasty 1994; 9 (5): 457-68.

Britton A, Murray D, Bulstrode C, McPherson K, Denham R. Loss to follow-up: does it matter? Lancet 1995; 345 (8963): 1511-2.

Charnley J. The long-term results of low-friction arthroplasty of the hip performed as a primary intervention. J Bone Joint Surg (Br) 1972; 54 (1): 61-76.

Devitt A, O'Sullivan T, Quinlan W. 16- to 25-year follow-up study of cemented arthroplasty of the hip in patients aged 50 years or younger. J Arthroplasty 1997; 12 (5): 479-89.

Dorr L D, Kane T J, 3rd, Conaty J P. Long-term results of cemented total hip arthroplasty in patients 45 years old or younger. A 16-year follow-up study. J Arthroplasty 1994; 9 (5): 453-6.

Dowdy P A, Rorabeck C H, Bourne R B. Uncemented total hip arthroplasty in patients 50 years of age or younger. J Arthroplasty 1997; 12 (8): 853-62.

Duffy G P, Berry D J, Rowland C, Cabanela M E. Primary uncemented total hip arthroplasty in patients <40 years old: 10- to 14-year results using first-generation proximally porous-coated implants. J Arthroplasty (8 Suppl 1) 2001; 16: 140-4.

Engh C A, Culpepper W J. Long-term results of use of the anatomic medullary locking prosthesis in total hip arthroplasty. J Bone Joint Surg (Am) 1997; 79 (2): 177-84.

Engh C A, Hopper R H, Jr. Porous-coated total hip arthroplasty in the young. Orthopedics 1998; 21 (9): 953-6.

Engh C A, Bobyn J D, Glassman A H. Porous-coated hip replacement. The factors governing bone ingrowth, stress shielding, and clinical results. J Bone Joint Surg (Br) 1987; 69 (1): 45-55.

Grubl A, Chiari C, Gruber M, Kaider A, Gottsauner-Wolf F. Cementless total hip arthroplasty with a tapered, rectangular titanium stem and a threaded cup: a minimum ten-year follow-up. J Bone Joint Surg (Am) 2002; 84 (3): 425-31.

Gruen T A, McNeice G M, Amstutz H C. "Modes of failure" of cemented stem-type femoral components: a radiographic analysis of loosening. Clin Orthop 1979; 141: 17-27.

Harris W H. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg (Am) 1969; 51 (4): 737-55.

Kim Y H, Oh J H, Oh S H. Cementless total hip arthroplasty in patients with osteonecrosis of the femoral head. Clin Orthop 1995; 320: 73-84.

Kim Y H, Kim J S, Cho S H. Primary total hip arthroplasty with a cementless porous-coated anatomic total hip prosthesis: 10- to 12-year results of prospective and consecutive series. J Arthroplasty 1999; 14 (5): 538-48.

Kronick J L, Barba M L, Paprosky W G. Extensively coated femoral components in young patients. Clin Orthop 1997; 344: 263-74.

McLaughlin J R, Lee K R. Total hip arthroplasty in young patients. 8- to 13-year results using an uncemented stem. Clin Orthop 2000; 373: 153-63.

Mont M A, Maar D C, Krackow K A, Jacobs M A, Jones L C, Hungerford D S. Total hip replacement without cement for non-inflammatory osteoarthrosis in patients who are less than forty-five years old. J Bone Joint Surg (Am) 1993; 75 (5): 740-51.

Morscher E. Experiences, requirements and development of cement-free hip endoprostheses. Orthopade 1987; 16 (3): 185-96.

Nercessian O A, Wu W H, Sarkissian H. Clinical and radiographic results of cementless AML total hip arthroplasty in young patients. J Arthroplasty 2001; 16 (3): 312-6.

Schramm M, Keck F, Hohmann D, Pitto R P. Total hip arthroplasty using an uncemented femoral component with taper design: outcome at 10-year follow-up. Arch Orthop Trauma Surg 2000; 120 (7-8): 407-12.

Siebold R, Scheller G, Schreiner U, Jani L. Long-term results with the cement-free Spotorno CLS shaft. Orthopade 2001; 30 (5): 317-22.

Simank H G, Brocai D R, Reiser D, Thomsen M, Sabo D, Lukoschek M. Middle-term results of threaded acetabular cups. High failure rates five years after surgery. J Bone Joint Surg (Br) 1997; 79 (3): 366-70.

Smith S E, Estok D M, 2nd, Harris W H. 20-year experience with cemented primary and conversion total hip arthroplasty using so-called second-generation cementing techniques in patients aged 50 years or younger. J Arthroplasty 2000; 15 (3): 263-73.

Spotorno L, Romagnoli S, Ivaldo N, Grappiolo G, Bibbiani E, Blaha D J, Guen T A. The CLS system. Theoretical concept and results. Acta Orthop Belg (Suppl 1) 1993; 59: 144-8.

Torchia M E, Klassen R A, Bianco A J. Total hip arthroplasty with cement in patients less than twenty years old. Long-term results. J Bone Joint Surg (Am) 1996; 78 (7): 995-1003.