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ORIGINAL STUDY

Ten-year survival of the cemented MS-30 femoral stem Increased revision rate in male patients

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This retrospective study evaluated the clinical and radiographic results of 337 consecutive matte surfaced, straight cemented MS-30 femoral stems implanted with first -to second-generation cementing technique. The median age of the patients at time of surgery was 72 (27-91) years. The median duration of follow-up was 10 (0.1-14) years. A Kaplan Meier survival analysis was performed.

At follow-up, 113 patients (120 stems) had died and 13 (13 hips) were lost to follow-up. Twenty-one hips had undergone femoral revision, 13 for aseptic loosening, five for infection, two for dislocation and one for periprosthetic fracture. Survival analysis with revision of the femoral component for any reason as the end point was 91% (95% CI : 87-96) and for aseptic loosening 94% (95% CI : 90-97) at 12 years. Females (n = 245) with 99% (95% CI : 97-100) had significantly better survival compared to males (n = 92) showing 80% stem survival (95% CI : 67-91) at 12 years (p < 0.001). Median Harris Hip score (HHS) was 82 (25 -100) points. Male patients had a higher activity score than female patients (p = 0.04). Femoral Dorr type A was associated with a higher risk of failure.

THA with the MS-30 stem revealed satisfactory mid-term results despite relatively crude cementing techniques. However, the higher revision rate in males and Dorr Type A is of concern.

Keywords : cemented ; straight stem ; cementing technique ; aseptic loosening.

INTRODUCTION

Cemented total hip arthroplasty (THA) first introduced by Charnley in the 1960`s remains one of the most cost-effective and successful surgical interventions owing to pain-relief and patient satisfaction (*9,23,24*). Aseptic loosening of a well-cemented femoral stem in the first decade is a rare event if modern cementing techniques are implemented (*6,7,16,23,24,29,33*). National THA registries

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Table I. — Diagnosis of 337 hips (322 patients)

Diagnosis	Number of hips (%)
Osteoarthritis (OA)	259 (76.9)
Fracture of the femoral neck (Fx)	31 (9.2)
Hip Dysplasia (CDH)	14 (4.2)
Rheumatoid Arthritis (RA)	12 (3.6)
Avascular Necrosis (AVN)	12 (3.6)
Other	9 (2.7)

in Sweden and other studies revealed demographic factors to have an effect on cemented stem survival (*3,23,24,28*). Male gender, younger age and underlying diagnosis were found to be risk factors for aseptic stem loosening.

The Morscher-Spotorno stem (MS 30) is a cemented straight, collarless, conical three-dimensionally tapered stem. It was designed to transfer loads to the proximal femur. The stem was included into scandinavian hip replacement registration but so far there is only published long term data from the designing surgeon's centres available (*2,27*), which revealed excellent stem survival rates for aseptic loosening of 98.5% to 100% after 10 years. We retrospectively evaluated the clinical and radiological outcome of the MS-30 femoral component with matte surface finish in 322 patients after 9 to 14 years postoperatively.

PATIENTS AND METHODS

Between March 1992 und December 1996, 322 consecutive patients (337 hips) underwent THA with a cemented MS 30 femoral component. All patients were registered prospectively in a diagnosis- and procedure-based electronic data registry. The distribution of diagnoses is shown in table I.

The median age at the time of surgery in females (245 hips, 72.2%) was 72 (41-91) years ; the age of the males (92 hips, 27.3%) was 71 (27-87) years. Informed consent was given by all patients. Ethical approval was obtained from the local ethics committee.

We retrospectively reviewed the results of these 322 consecutive patients receiving primary total hip arthroplasty (THA) using a matte cemented MS 30-stem (fig 1).

At a median follow-up of 10 years (0.1-14) thirteen patients (13 hips, 3.9%) were lost to follow-up, four of them with foreign residence (fig 2). The remaining

Fig. 1. — Photograph, of the MS-30 stem, Zimmer, Switzerland, AP view of the right hip in a 73-year-old female patient, 10 years postoperatively.

patients were followed for a mean of ten years or until death or removal of the femoral component. One hundred and thirteen patients (120 hips) died (35.6%) unrelated to the arthroplasty ; none of these patients had required hip revision surgery. One hundred and seventy-six patients (183 hips, 54.3%) were followed clinically and radiographically for a mean of 11 (9-14) years. Seventy-three patients (74 hips, 22%) were unable to attend for radiographic review, but the clinical outcome scores were generated by a telephone interview. The clinical details of the reviewed patients are given in table II.

Implants

The cemented MS 30 stem is designed as a cemented straight, collarless, conical three dimensionally tapered stem (Zimmer, Winterthur, CH). It was designed to transfer loads to the proximal femur. It is available in six different stem sizes and two offset versions with CCD-angle of 130° and 136°. The acetabular component was a cemented all-polyethylene cup (Aesculap, Tuttlingen, Germany) in 320 cases (95%), 6 of them were augmented with a Mueller reinforcement ring (Zimmer, Winterthur, Switzerland). Seventeen stems (5%) were combined with uncemented acetabular components (8 Ultima, DePuy, Johnson & Johnson, 7 Mecring Type B, Mecron Medical, 2 Fitek, Zimmer).

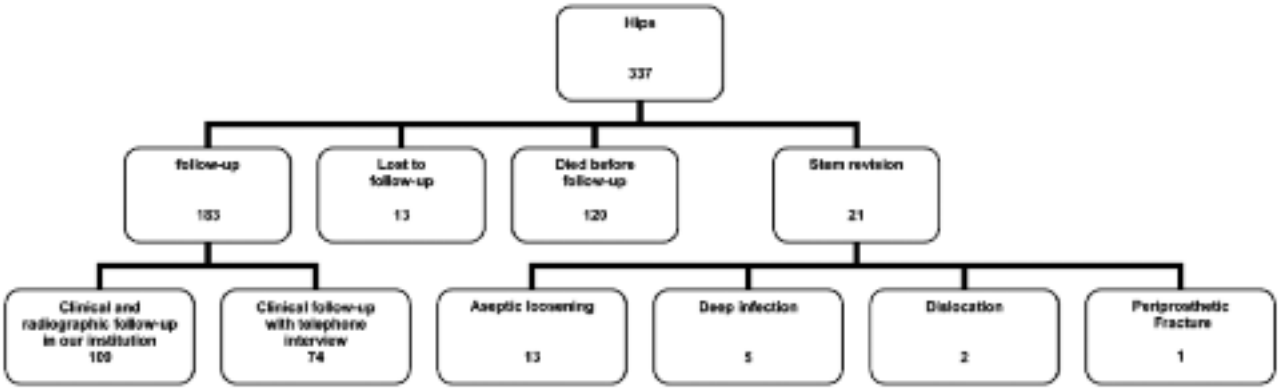


Fig. 2. — Distribution of hips at follow-up after implantation of a matte MS-30 stem

Table II. — Clinical details of 337 hips (322 patients)

	Male	Female
Number of hips		
Postoperative	92	245
At follow-up	44 (48%)	139 (57%)
Operated side		
Right	49 (53%)	139 (57%)
Left	43	106
Mean age in years (range)		
At time of surgery	71 (27-87)	72 (41-91)
At follow-up	78 (38-94)	81 (49-98)
Median Follow-up in years (range)		
Of all 322 patients	9.8 (0.1-14.2)	
Median Follow-up in years (range)	Male	Female
	9.7 (0.1-14.2)	9.8 (0.2-14.2)
Of 183 patients at follow-up	10.7 (8.8-14.2)	
Median Follow-up in years (range)	Male	Female
	10 (9.3-14.2)	10 (8.8-14.2)

Surgery was performed by 36 surgeons with different levels of experience including many residents. THA was performed using a modified Watson-Jones or transgluteal approach according to Bauer in a supine position. The cementing technique included syringe bone lavage, retrograde cement gun application, but no formal proximal pressurization with a femoral seal. A stem centralizer was applied in 90% and a distal cement restrictor was used in 59% of the cases upon surgeon's preference. Palacos bone cement (Biomet/Merck, Darmstadt, Germany) with gentamicin was used in all cases. Postoperatively full weight bearing was allowed. Ossification prophylaxis was implemented for two weeks with a non-steroidal anti-inflammatory drug (diclofenac).

Clinical assessment

Clinical evaluation was made using the Harris-Hip-Score (HHS) (*15*) and the Merle d`Aubigné and Postel score (*11*). The Charnley classification (*10*) and the Devane score (*12*) were used for grading the patients` activity and co morbidities. Pain was evaluated using a visual analogue scale (VAS) from 0 to 10 points, wherein 0 means no pain.

Radiographic assessment

Radiographic outcome was evaluated using standardized anterior-posterior (AP) radiographs of the pelvis and lateral views of the hip, and were compared to the first postoperative films by two independent specialist orthopaedic surgeons. Radiolucent lines at the bone-cement interface (≤ 2/ > 2 mm), osteolysis (progressive bone loss > 3 mm) and cortical hypertrophy were measured using the 14 radiological zones of Gruen *et al* (*14*) extended by Johnston *et al* (*19*). The quality of the cement mantle was assessed on the direct postoperative film according to the classification proposed by Barrack (*1*). The stem alignment was measured as described by Iwase *et al* on the AP view (*17*), whereas a varus or valgus malalignment was defined as a deviation of more than 3° from the longitudinal axis. Subsidence was assessed according to the method of Loudon and Charnley (*22*). Heterotopic ossification was evaluated according to Brooker *et al* (*5*). Stems were considered "cases at risk" for aseptic failure when showing progressive debonding ≥ 2 mm, progressive osteolysis, cement mantle or stem fracture and/ or progressive subsidence > 5 mm compared with postoperative radiographs (*14,18,26,30,32*). The anatomical patterns of femoral bone structure were identified from the AP and lateral radiographs in type A, B and C proposed by Dorr *et al* (*13*).

Statistics

The Kaplan-Meier method (*20*) was used for survival analysis of the implant with regard to stem loosening or revision with 95% confidence intervals (CI). The following end points were defined : (1) revision of the femoral component for any reason, (2) revision of the stem due to aseptic loosening. Association between Harris Hip Score and radiological and clinical parameters was tested by Spearman's rank correlation. Differences between groups and survival analysis were statistically significant if p-values were less than 0.05 in a chi square test. Data analysis was performed with SPSS for Windows, version 15.0.

RESULTS

Revisions

Stem

The stem had been revised in twenty patients (21 hips, i.e. 6.2%). Thirteen stems (3.8%) were revised for aseptic loosening (10 males, 3 females), five stems (1.5%) for deep infection, two stems (0.6%) for recurrent dislocation and one stem (0.3%) for a periprosthetic fracture.

Cup

A total of 314 hips received cemented cups ; 25 cups had been revised (8%) during the follow-up period : 17 (5.4%) for aseptic loosening (10 males, 7 females), five (1.6%) for deep infection and three (1%) for recurrent dislocations.

Survival analysis

Stem

Survival was calculated for stem revision for any reason and for aseptic loosening. The overall survival rate with revision for any reason as the endpoint was 93.5% (95%-CI : 90-96) at 10 years and 91.2% (95%-CI : 87-95) at 12 years. The survival rate with aseptic stem loosening as the endpoint was 95.5% after 10 years (95%-CI : 92-98) and 93.8% after 12 years (95%-CI : 90-97) (fig 3). There was a significantly better survival (p = 0.0001) in female patients (98.7% [95% CI : 97-100] at 10 years and 12 years) than in male patients (89.1%, [95% CI : 80-96] at 10 years and 80.3%, [95%-CI : 67-91] at 12 years) (fig 4).

Cup

The overall survival rate of the cemented all-polyethylene cups (n = 314) was 92.9% after 10 years (95% CI : 89-96). The survival rate with revision for aseptic loosening as the endpoint was 95.3% at 10 years (95% CI : 92-98).

Clinical results

The median follow-up time of the 183 surviving femoral components in patients who were alive at the time of the last examination was 11 (9-14) years. The median Harris Hip score (HHS) was 82 (25-100) points. Clinical results were excellent in 26.1% of the patients, good in 29.5% , moderate in 20.0% and poor in 24.4% according to Harris.

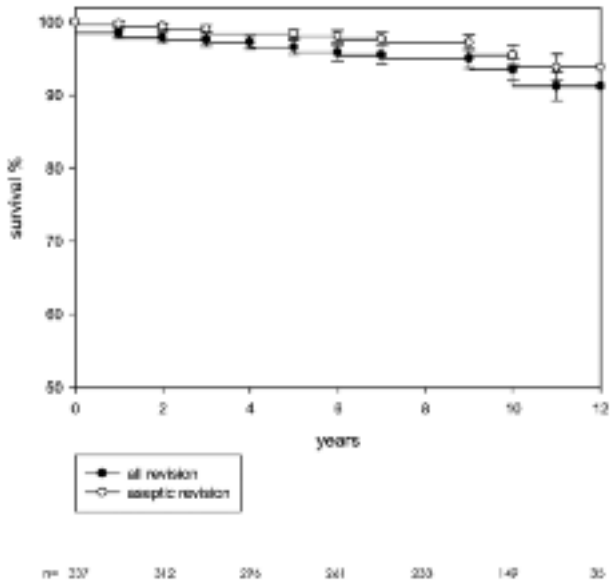


Fig. 3. — Kaplan Meier analysis showing survival of the femoral component with revision for any reason and for aseptic loosening as the endpoint.

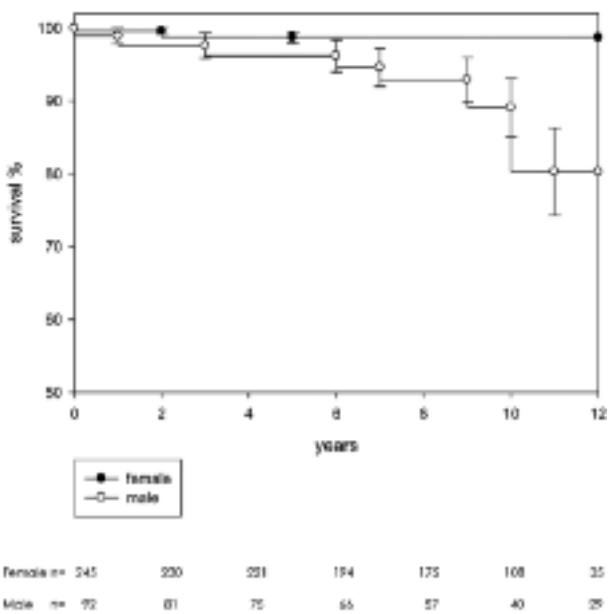


Fig. 4. — Kaplan Meier analysis for males and females showing femoral stem survival with revision for aseptic loosening of the femoral component as the endpoint.

There was a strong correlation between a low Harris Hip Score and a poor Charnley class ($p = 0.04$, Spearman rank correlation coefficient, $r = -0.230$) (table III). Male patients in Charnley class B and C showed better HHS than those in Charnley class A, but this was not significant.

The score according to Merle d`Aubigné and Postel showed good and excellent results in 34.5%, moderate results in 26.7% and poor results in 38.8%.

The Devane score showed predominantly activity level 2 (68% of the patients) (table III). These patients were able to perform simple indoor work and sitting occupation. Male patients showed a better activity level according to the Devane score than did female patients ($p = 0.04$).

The average pain level of the 183 patients was 1.2 points (range 0 to 10) on a VAS, with 73.3% achieving 0 points (no pain).

Radiographic results

One hundred and one hips with surviving femoral components were examined clinically and radiologically. Radiolucent lines ≤ 2 mm were seen in 33 cases (30.3%) with predominance in Gruen zones 1, 7 and 8, whereas lines > 2 mm appeared in four cases (3.7%). Osteolysis was found predominantly in Gruen zones 5 and 7, cortical hypertrophy was apparent in two cases (1.8%). Thin cement mantles (< 2 mm) were seen in Gruen zones 8 (84%) and 12 (46%) on the lateral view and in Gruen zone 1 (73%), 5 (63%) and 6 (67%) on the anterior-posterior radiographs (table IV).

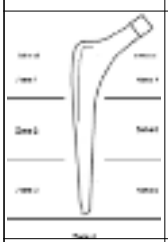
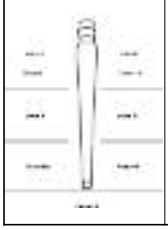
Subsidence more than 2 mm was seen in 3 cases (2.8%) and more than 5 mm in 7 (6.4%) cases. The cement mantle quality of the 109 reviewed hips showed Barrack grade A in 6 (5.5%), grade B in 61 (56%), grade C in 26 (23.8%) and grade D in 16 cases (14.7%). Twenty stems (13 females and 7 males) were found to be at risk for aseptic failure according to radiographic criteria. Inferior cementing technique according to the Barrack classification (Barrack C and D) showed a weak correlation to the occurrence of a risk for aseptic loosening ($p = 0.06$).

The evaluation of the femoral canal shape according to Dorr showed a Dorr type A in 15% of

Table III. — Clinical results of (183 hips) at follow-up

Harris hip score (HHS)	Median (range) post-op	Male n = 44	Female n = 139
All hips (n = 183)	82 (25-100)	85.5 (46-99)	81 (25-100)
Charnley class A (n = 45)	87 (25-100)	80 (46-99)	87 (25-100)
Charnley class B (n = 67)	81 (25-100)	87 (55-97)	81 (25-100)
Charnley class C (n = 71)	79 (31-98)	85.5 (60-97)	78 (31-98)
Devane activity score	Number of hips (%) n = 183	Male n = 44 (%)	Female n = 139 (%)
Grade 1	12 (6%)	2 (4.5%)	10 (7.2%)
Grade 2	124 (68%)	23 (52.3%)	101 (72.6%)
Grade 3	38 (21%)	13 (29.5%)	25 (18%)
Grade 4	9 (5%)	6 (13.6%)	3 (2.2%)
Grade 5	0 (0%)	0 (0%)	0 (0%)
Satisfaction	Number of hips (%)	Male n = 44 (%)	Female n = 139 (%)
very satisfied	125 (68%)	27 (61.4%)	98 (70.5%)
satisfied	54 (30%)	16 (36.3)	38 (27.3%)
unsatisfied	4 (2%)	1 (2.3%)	3 (2.2%)

Table IV. — Radiological assessment of 109 hips (103 patients)

Gruen zones	Gruen zones	Radio-lucent lines ≤ 2 mm (n)	Radio-lucent lines > 2mm (n)	Osteo lysis (n)	Cortical hyper-throphy (n)	Cement mantle < 2 mm (n)	Cement mantle ≥ 2 mm (n)
	1	7	1	4	0	79	30
	2	3	0	2	0	53	56
	3	0	0	4	0	55	54
	4	0	0	2	0	26	83
	5	1	0	5	1	69	40
	6	2	0	3	0	73	36
	7	6	0	7	0	65	44
	8	7	0	1	0	92	17
	9	0	1	0	0	24	85
	10	0	1	0	0	12	97
	11	0	0	0	0	14	95
	12	0	0	2	1	50	59
	13	2	1	2	0	33	76
	14	5	0	2	0	35	74

cases (champagne flute), more frequently in males than in females, a Dorr type B in 53% and a Type C (stove pipe) in 35%, predominantly in women. Among the 13 hips revised for aseptic loosening (10 males, 3 females), there was a significantly higher prevalence of Dorr type A compared to all 109 hips reviewed ($p < 0.0001$) (table V).

The stem alignment was found to be neutral in 85 hips (78%) ; a valgus position was found in 10 (9.2%) and a varus position in 14 cases (12.8%). No ectopic ossifications according to Brooker *et al* were seen in 60 cases (55%), grade I ossification was noted in 25 patients (22.9%), grade II with a distance between the ossifications more than 1 cm

Table V. — Femoral canal shape according to Dorr of 109 hips (103 patients) reviewed and 13 hips with aseptic femoral loosening

Dorr Type (n = 109)	Males (n = 33) n (%)	Females (n = 76) n (%)
Type A (n = 16, 15%)	13 (39%)	3 (4%)
Type B (n = 58, 53%)	16 (48%)	42 (55%)
Type C (n = 35, 32%)	4 (12%)	31 (41%)
Dorr Type (n = 13)	Males (n = 10) n	Females (n = 3) n
Type A (n = 8)	7	1
Type B (n = 5)	2	3
Type C (n = 0)	0	0

in 13 (12%) and grade III with a distance less than 1 cm in 11 cases (10.1%). There was no correlation between HHS and ectopic ossification ($p = 0.19$, Spearman correlation coefficient 0.14).

DISCUSSION

Our results with the matte cemented MS-30 stem with a survival free of aseptic loosening of 95.5% after 10 years were inferior to those achieved by the designing surgeons. Berli *et al* presented 10-year results of 121 patients after THA with the MS-30 matte femoral component (*2*) *;* six hips showed osteolysis, mostly in Gruen zone 7. Survival rates of 98.5 to 100% were achieved with modern cementing techniques predominantly used by the designing authors (*2,27*).

The Swedish national hip register showed that the overall rate of implant survival after 10 years has improved from 89.4% to 92.5% between the 1980's and 1990's due to advances in implant design and patient related factors but mainly due to improved surgical and cementing techniques (*23*). Contemporary cementing techniques of the second and third generation have been associated with increased femoral survival rates (*6,7,16,23,24,29,33*) even in young patients (*21*). In contrast to the modern techniques of the third generation that we routinely use today, the patients in this series were treated with crude cementing techniques including non-pressurized bone lavage, retrograde cement gun application and no routine and formal proximal pressurization. Furthermore, a stem centralizer and a distal cement restrictor were not applied in all cases. Even though the cementing technique was not standardized and 37 surgeons (most of them still in training) contributed to this series, the survival of 95.5% at 10 years is remarkable. However the 80% survival in the male population was significantly inferior compared to females (99%) in this cohort ($p < 0.0001$). One of the reasons might be the lower age at follow-up of the male patients (mean 78 versus 81 years). Demographic studies and national THA registers revealed young patients and male gender to have a negative prognostic impact on the survival of cemented femoral stems due to aseptic loosening (*3,23,24,28*). In our study we found a higher activity level of males than of females ($p = 0.04$) at follow-up examination.

The classification of the femoral canal shape according to Dorr (*13*) showed a type A femur predominantly in male patients. Dorr type A was associated with a higher risk for aseptic loosening ($p < 0.0001$). The narrow canal shape in males carries a risk for thin cement mantles (*4*) especially with the MS-30 stem which has a relatively bulky distal end compared with the Exeter stem design.

The main weakness of this study is its retrospective cohort design that limits the comparability to other cohorts. However, we believe that an independent series is still worth reporting to validate the results of the designing authors (*2*). The number of cases lost to follow-up was relatively low in this series (3.9%), so that the results allow for valuable conclusions (*31*).

The analysis of the cement mantle showed thin mantles of less than 2 mm in Gruen zone 8 (anterior-proximal) in 84% of the cases and in zone 12

(posterior-distal) in 46% of the stems predominantly according to the well-known pattern of a straight stem design (*4*). Thin cement mantles in zone 8 and 12 were associated with osteolysis in three stems ; these should be closely monitored in the longer term follow-up. We found osteolysis most frequently in Gruen zone 7 at the femoral calcar in seven stems (6.4%) and in zone 1 in 4 stems (3.7%) showing a significant correlation with polyethylene wear more than 1 mm in the AP view ($p = 0.0002$). As reported by Schmalzried *et al* (*34*) the proximal part of the femoral cement-bone interface often shows debris-loaded macrophages, and active bone resorption histologically did not generally result in implant failure when the cement-bone interface more distally was intact.

The system of grading the cement mantle quality according to Barrack has been shown to be associated with implant failure for grades C and/or D (*8,25*) in Charnley cemented femoral components. This seems to be true even with contemporary design implants in our series. We detected a poor cement mantle in 40% of the reviewed stems (Barrack C and D) and a slight correlation with the occurrence of a stem "at risk" for failure through aseptic loosening ($p = 0.06$).

Clinical results were only moderate in our series. However, we were able to show that a higher proportion of Charnley C patients had a lower median HHS of 82 points. Higher Charnley classes (A/B) appeared to have better Harris Hip Scores ($p = 0.04$). Berli *et al* (*2*) described a mean Harris Hip score of 96 points in their series of younger patients, but the Charnley class is not given in their paper.

Nowadays, pain reduction has become one of the most important goals of THA. Therefore the visual analogue scale is often used for continuous measurements (*23*). The mean pain level (VAS) of our 183 reviewed patients was 1.2 points (range 0 to 10), similar to the results of Malchau (*23*) and showed a considerable discrepancy between moderate HHS and patient perceived pain. With respect to indications and age (77% of primary OA) our study presented similar demographics compared to other studies (*2,6,7,16,24,29,33*).

The Exeter stem with a matte surface introduced in the late 1970s to achieve a stronger cement-implant bond in order to increase the longevity of cemented THA showed a higher revision rate than for polished stems with the same design (*24*). The reason may be an increased cement and metal abrasion by micromovement especially when using inferior cementing techniques. Although the results of the designing authors of the matte and polished MS-30 stem showed similar results (*2,27*) the manufacturer changed the design from a matte to a polished surface of the MS-30 stems. The matte stem in our study subsided more than 2 mm in 10% of cases, but we were not able to show a correlation to failure or worse cement mantle quality according to Barrack. In the meantime the matte MS-30 version has been withdrawn from the market without customer communication.

In summary our mid-term results with the matte cemented MS-30 stem at 10 years were comparable to the published data showing the limitations of straight stem design regarding the cement mantle thickness. A survival rate of 95.5% at 10 years with aseptic stem loosening as the endpoint was acceptable in the light of a multi surgeon teaching institution setting. However the inferior survival in males especially with Dorr type A femora gives rise to concern in the longer term. We expect that the long-term outcome will improve with contemporary 3rd generation cementing techniques and the polished stem design.

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