Cementless primary total hip replacement

Four to eight year results with the Zweymüller-Alloclassic® prosthesis

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Summary. *One hundred and twenty-nine consecutive cementless primary total hip arthroplasties with Zweymüller-Alloclassic® grit-blasted titanium components were evaluated prospectively at an average follow-up of 5.9 years. The clinical results were graded as excellent or good in 116 hips (90%), fair in 12, and poor in one due to a fracture of the femoral shaft at operation leading to early stem loosening and delayed ring loosening. Failure was defined as definite aseptic loosening, and the final survivorship at 8 years was 99.3% for the SL-stem, and 99.1% for the CSF-threaded cup. These early results compare favourably with those of total hip arthroplasties using new cementing techniques.*

Résumé. *129 arthroplasties totales consécutives non cimentées de hanche avec les implants Alloclassic® en titane grenailé de Zweymüller ont été prospectivement étudiées après un recul moyen de 5,9 ans (de 4 à 8 ans). Les résultats cliniques ont été excellents et bons dans 116 hanches (90%), passables dans 12 hanches, et mauvais dans un cas du fait d'une fracture per-opératoire de la diaphyse fémorale responsable d'une instabilité précoce de la tige et d'une migration retardée de l'anneau. Au recul final de 8 ans, la survie avec comme évènement d'exclusion le déscollement aseptique est de 99,3% pour la tige, et de 99.1% pour l'anneau vissé. A recul équivalent, ces résultats précoces sont favorablement comparables à ceux des arthroplasties totales avec nouvelles techniques de cimentage.*

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Introduction

The designs of a grit-blasted titanium alloy cementless femoral tapered stem and a threaded acetabular ring have been progressively improved by Zweymüller, Semlitsch and their co-workers since 1973. The mid-term results with the first generation Zweymüller components in primary total hip replacement (THR) were encouraging [5].

These devices were modified in the mid-1980s to the Zweymüller-Alloclassic® stepless (SL) femoral stem and the second generation Alloclassic® conical self-taping cement free (CSF) screw ring with a 28 mm ceramic-on-polyethylene (PE) bearing surface (AlloPro AG, Baar, Switzerland) (Fig. 1).

Since then we have carried out a prospective clinical and radiological study of these new components in primary THRs.

Patients and methods

Between May 1988 and December 1991, 147 consecutive primary THRs were performed on 139 patients (8 were bilateral). The median age at operation of the 77 males and 62 females was 65 years (range 32 to 91 years), and their mean weight was 70 kg (range: 42 to 111 kg). According to Charnley's classification, 51 patients were graded as A, 39 patients as B (46 hips) and 49 patients as C (50 hips). The primary diagnoses are listed in Table 1.

The operation was carried out under general or spinal anaesthesia in a horizontal laminar air flow theatre. An antero-lateral approach was used in 83 cases and a posterolateral in 64 cases. Bulk grafts of the femoral head, fixed with cortical screws, were used in 7 cases with acetabular dysplasia.

Antibiotic prophylaxis with a second-generation cephalosporin was maintained for 48 hours. Thromboembolic prophylaxis using elastic stockings and administration of a low

Table 1. Preoperative diagnosis (147 hips)

Osteoarthritis	125
Primary	92
Dysplasia	30
Post-trauma	3
Avascular necrosis	21
Rheumatoid arthritis	1

Table 2. Postoperative complications (147 THRs)

Phlebitis	6	4%
Pulmonary embolus	1	
Peroneal nerve palsy	2	
Dislocation	8	5.4%
Deep infection	1	

molecular weight heparin was maintained for one month. Weight bearing was allowed immediately, initially with two crutches, and then full weight bearing as soon as possible.

After operation radiographic and clinical follow up was undertaken at 2, 6 and 12 months, and then once a year. Clinically, pain and function (walking and stability) were graded according to Merle d'Aubigné's rating system with the mobility score taking into account Charnley's modifications. Subsidence of the femoral implant was defined by the distance measured between tip of the stem and the tip of the greater trochanter. The bone implant interface and bone remodeling were assessed in the femur using the method of Gruen et al. [11] and for the acetabular side using that of DeLee and Charnley [6]. Femoral fixation and stem stability were assessed by the scales proposed by Engh and Massin [9]. Periprosthetic heterotopic ossification was described by the classification of Brooker et al [2]. Polyethylene wear and annual linear rates have been estimated by measuring the progress of the PE-cranial protrusion between the first weight-bearing radiograph and the last control. Measurements in millimetres were calculated after correction of radiographic magnification. All serial radiographs have been double-reviewed by two of us with one independent examiner (CC) who was blinded to the clinical results. Survivorship analysis included actuarial calculation of annual cumulative rates with 95% confidence intervals (95% CI) according to the Wilson quadratic method.

Eighteen hips have been excluded from the study; eleven patients (11 hips) died before the 4 year minimum follow-up, three refused to attend or were unable to do so and 4 (2.9%) have been lost to follow-up. Thus, 129 THRs in 131 patients have been fully reviewed at an average follow-up of 5.9 years (range 4 to 8 years).

Results

Complications and failures

During the 147 operations there were 9 fractures of the greater trochanter (6.4%) and 5 of the proximal femoral shaft (3.4%), 7 of which required cerclage wiring. On the acetabular side, one perforation of the central wall needed supplementary grafting. The postoperative complications are listed in Table 2. Stem subsidence of more than 20 mm occurred in an 81 year old man (Charnley C grade) and was due to a poorly fixed fracture of the femoral shaft. Failure in achieving primary stability was rapidly confirmed; the femoral component was revised 2 years later and replaced using cement. The corresponding screw ring was revised 3 years later because of recurring groin pain and radiographic confirmation of delayed acetabular loosening.

At the 8 year final follow-up, the survivorship, with the component revision as the end point, was 98.4% (95% CI, 83.4 to 99.8%).

Clinical results

The Merle D'Aubigné and Charnley scores are shown in Tables 3 and 4. At the last follow-up, excellent and good results were achieved in 90% of hips, including those with operative fractures, except for the only failure which has been described. Only one patient (0.7%) reported slight thigh pain which was graded 5.

Radiographic results

Thirty-nine (30%) SL stems have been implanted in slight, but not progressive varus with no adverse clinical effect. Twenty-one SL stems subsided more than 2 mm within the first 2 years after operation. After the second year, no progressive subsidence was detected, except for the loose femoral component previously described. The

Table 3. Clinical results according to age at operation and Charnley grading (121 patients)

	No. hips	Clinical results		
		Excellent & good	Fair	Poor
> 75 ys.	29	21	7	1
55–75 ys.	79	74	5	
<55 ys.	21	21		
A	46	46		
B	42	40	2	
C	41	30	10	1
Total	129	116 (90%)	12	1

Table 4. Average Merle d'Aubigné – Charnley scores (129 THRs)

	Pre-operative	Last follow-up
Pain	2.9	5.7
Motion	4.1	5.6
Function	3.6	5.5
Overall	10.7	16.9 (max: 18 points)

Table 5. Femoral lucent lines and cortical thickening at last follow-up (129 SL stems)

Gruen zone	Reactive-lucent lines (%)	Cortical thickening (%)
1	13	0
2	0.8	6.1
3	0	25.8
4	0	19.7
5	0	39.4
6	0.8	19.7
7	13	0

Table 6. Acetabular gaps and lucencies (129 CSF rings)

DeLee & Charnley zone	Postoperative gaps (%)	Lucencies at last follow-up (%)
I	37.8	4.7
II	40.5	0.8
III	0	0.8
Total	78.3	6.3

8 year survivorship with the SL stem, using definite aseptic loosening as the end point, is 99.3% (95%, CI – 85.2 to 99.9%).

At the last follow-up, the incidence of reactive and lucent lines, which were always less than 2 mm thick, and diaphyseal cortical hypertrophy (1 to 10 mm thickness), are shown in Table 5. A decrease in proximal cortical density (Gruen zones 1 and 7) has been noted in 20 hips (15.5%), but more extensive femoral stress-shielding has been observed in 3 hips (2.3%). Good implant cortical contact in at least 2 Gruen zones, calcar atrophy and spot welds at any level, were observed in 99.3%, 96% and 93% of hips respectively, including most of the components showing proximal lucent lines or stress shielding.

In the acetabulum, 2 rings exhibited early migration with medial tilting of 3° and 8° within the first 6 months after operation. Both hips had a good clinical score at 6 and 5 years respectively. Review of immediate postoperative gaps due to lack of perfect bone-implant contact, and bone-implant lucencies at the last follow-up, are shown in Table 6. At the final follow-up, the bone-implant

Fig. 1. Radiograph with a superimposed photograph showing the Zweymüller-Alloclassic® SL femoral and CSF acetabular components (by permission of Allo-Pro AG)

interface looked perfect in 93.7% of hips. The 8 year survivorship with definite CSF ring aseptic loosening as the end point, is 99.1% (95%, CI – 85 to 99.9%).

Heterotopic ossification of Brooker grade I was seen in 31 hips (24%), grade II in 22 (17%) and grade III in 14 (11%). The annual linear PE-wear rate of 0.2 mm or more a year could only be detected in one hip with an annual wear rate of 0.32 mm with corresponding osteolysis in femoral Gruen zone 13.

Discussion

Our unacceptable 6.5% rate of fractures of the greater trochanter during operation was mainly due to the early experience of both surgeons with the technically demanding stem implantation technique. Careful deep rasping of the greater trochanter is the key to avoiding cortical-bone damage. This also allows a better axial preparation of the femoral canal and decreases the risk of varus implantation. Our 3.4% rate of femoral shaft fracture is comparable to those reported with either cementless [27] or cemented [22] femoral components. Patient selection, careful preoperative planning and improvement in surgical technique have dramatically reduced our operative fracture rate.

Pain in the thigh and stem subsidence are worrying features commonly reported in series of cementless femoral prostheses. Haddad et al. [12] reported thigh pain and subsidence rates of 22% and 9% respectively with the AML prosthesis (De Puy, Warsaw, Indiana, USA); 8% and 6% with the

LSF prosthesis (Long-Term Stable Fixation, Implant Technology Inc, Secaucus, New Jersey, USA), and 20% and 15% with the PCA prosthesis (Porous-Coated Anatomic Prosthesis, Howmedica, Rutherford, New Jersey, USA). In the our study, we have recorded thigh pain in 4.6% (6 hips), and a subsidence rate of more than 2 mm in 16.3% (21 hips) at the end of the first year. At last follow-up, the incidence of thigh pain was 0.8%.

Proximal stress-shielding is a common feature of the femoral replacement, either with or without cement fixation. Dual-energy X-ray absorptiometry studies by Cohen and Rushton [3] showed a 6.7% reduction in femoral bone mineral density (BMD) as early as one year after cemented Charnley total hip replacement. With a longer follow up, McCarthy et al. [21] found a 40% loss in average bone mineral content proximally around cemented femoral stems at 7 to 14 years after operation. Korovessis et al. [18] have shown that the proximal bone mineral density measured immediately after operation around Zweymüller-Alloclassic®-SL stem remained unchanged after 4 years. Retrieval studies by Lintner et al. [20] have shown excellent biological fixation of press-fit grit-blasted titanium endoprostheses and this has been confirmed experimentally by Feighan et al. [10].

Early clinical results with the Alloclassic-SL stem in primary THR have been promising. Kutschera et al. [19] and Huo et al. [16] have reported no loosening at 5 years and at 3 to 6 years respectively. Baumgartner et al. have reported a 98.9% survival rate in their series of 533 primary Alloclassic THRs at 6 to 7 years [1]. In the Norwegian arthroplasty register at 4.5 years 99.1% of the Zweymüller Alloclassic-SL stems had not been revised [14].

These early results of primary THRs with the Alloclassic-SL cementless femoral component are as good as the best results of both the early cementing techniques and when the latest developments in cemented femoral fixation have been used. With femoral plug occlusion, the use of a cement gun and stems of improved design, Harris and McGann found radiographic signs of definite femoral loosening at 6 years in 1.7% of hips [13]. The Mayo Clinic experience with contemporary cementing techniques using the Harris Design II component (HD-II, Howmedica, Rutherford, New Jersey) showed a rate of 1.6% of definite or probably loose stems at 5 to 7 years [25]. With the improved cementing techniques using the Harris precoat femoral component (Zimmer, Warsaw, Indiana, USA), no loosening was reported in

96.6% at 6 to 7 years [22]. Our own statistical study with failure defined as definite SL-stem loosening indicated a 8 year survivorship of 99.3%.

Compared to the Alloclassic-SL stem implantation, insertion of the Zweymüller Alloclassic-CSF screw ring is technically easy. The extreme weakness or apparent absence of one acetabular wall represents the only absolute contraindication for the use of this threaded component.

In the present study, demarcation at the implant bone interface decreased from 78.3% post-operatively to 6.3% at the 5.9 year average follow up. Such an improvement has never been described around the more commonly used cemented polyethylene cups [15], metal backed cemented cups [23, 24], or cementless cups [22, 26].

The use of smooth acetabular threaded components is no longer recommended, and we agree with this. Since the 1980s, other screw rings have been available with creation of the same grit-blasted surface like that on the Alloclassic-CSF cup. Weill and Scarlat observed that the 22.4% lucencies and 13.8% migration rates with the CLW titanium screw ring (Protek AG, Bern, CH) when polished decreased to 3.3% and 0.4% respectively when rough [28]. Of 841 acetabular replacements with the same CLW component, Decoulx et al. reported annual cumulative rates of 88.3%, 90.9% and 87.4% respectively using hip pain, radiographic stability and revision as end points, for the smooth component versus 96.4%, 100% and 99.8%, respectively, for the grit-blasted [7].

Early clinical results with the Alloclassic-CSF cup in primary THR showed loosening rates of 1% at 5 to 6 years [19] and 1.7% at 4 to 8 years [8]. Our review of 300 consecutive primary acetabular replacements mixing Zweymüller grit-blasted screw rings of first and second generation showed, with loosening as the endpoint, a 99.1% survival rate at the 7 to 8 year follow-up [4].

We have not seen breakage of a ceramic head or separation between the polyethylene liner and the metal backing. Although the low friction arthroplasty is often considered as the gold standard in terms of polyethylene wear, Isaac et al. demonstrated that stainless steel femoral heads became roughened in vivo, mainly by particles of radiographic contrast medium, and assumed that the harder ceramic femoral heads would give a bearing surface which would not be damaged so easily [17]. Clinical trials published by Zichner and Willert favour 32 mm ceramic Biolox® rather than 32 mm CoCrMo alloy heads [29]. Among the

109 28 mm-ceramic-PE bearing surfaces available for measurements of radiographic wear after a minimum of 5 years in vivo, only one hip has shown a cranial PE-protrusion rate of more than 0.2 mm a year.

Primary cementless total hip arthroplasty with the Zweymüller-Alloclassic® prosthesis failed in the short term because of insufficient postoperative primary stability. Once operative difficulties, mainly on the femoral side, had been successfully overcome, the solid primary fit of both components is impressive even in poor acetabular bone stock. Osteointegration of the grit-blasted titanium surface is excellent and provides rapid secondary stability. Longer follow-up is necessary to confirm this early favourable outcome.

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