

Mid-term results of 155 patients treated with a collum femoris preserving (CFP) short stem prosthesis

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Abstract Short stem prostheses that preserve the femoral neck are becoming more and more popular. The CFP (collum femoris preserving) has been introduced especially for the treatment of younger patients. However, information about remodelling, complications and learning curve are thus far rare. We present a retrospective study of 155 patients (average age 59.3 ± 9.9 years) who underwent total hip replacement with the CFP prosthesis. Follow-up was obtained 74.3 ± 9.4 months postoperatively. The Harris hip score revealed excellent and good results in 96%. One stem had to be exchanged due to aseptic loosening revealing a survival rate of 99% and 100% for stem and cup, respectively. Radiological analysis showed typical patterns of remodelling with appearance of cortical thickening predominantly in the distal part of the prosthesis. Implant related revision rate was <1%, with further complication rate independent of the surgeon's individual experience. With regard to outcome, survivorship and complication rate, the medium-term results of the CFP prosthesis are promising.

Introduction

The concept of femoral neck preserving hip replacement was introduced in the mid 1990s [1]. Preservation of the neck retains the trabecular systems of the metaphyseal cancellous bone, and thus allows for a more physiological load

distribution along the diaphysis and the greater trochanter [2]. Retention of the neck further permits an increased bone ingrowth, probably due to the protection of blood supply [1].

Accordingly, the mineral density of the proximal femur is retained after implantation [3]. At present, there is a huge variety of neck preserving implants available on the market including the Mayo prosthesis, the CUT prosthesis, the thrust plate prosthesis, and many others [2, 4]. The CFP (collum femoris preserving) short stem prosthesis has been introduced as a cementless implant especially for younger patients and provides the possibility of less invasive implantation.

Until now, there have been no standardised data available after implantation of the CFP prosthesis reflecting patterns of bone remodelling and success and complication rate, especially with regard to the surgeon's individual experience with this specific type of implant. In order to address these issues a consecutive series of patients undergoing cementless hip replacement with the CFP prosthesis was studied in a retrospective clinical trial.

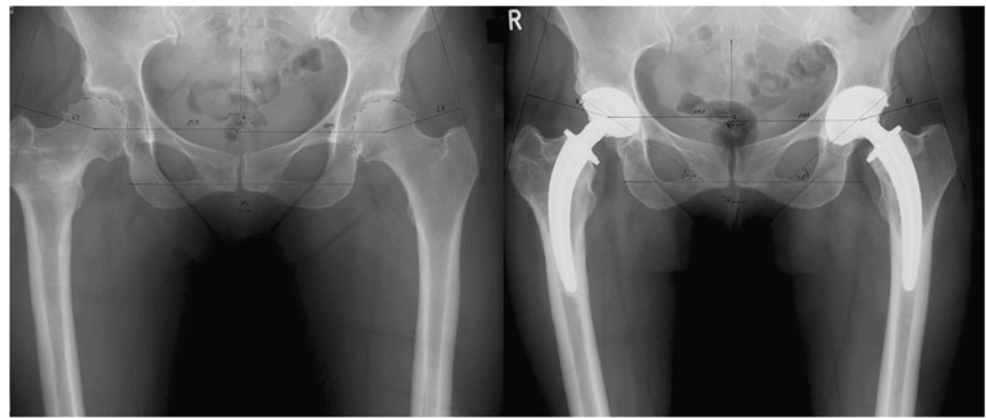
Methods

Study design

Patients from a consecutive series who underwent total hip replacement with a cementless short stem prosthesis in our institution in the years 1999 and 2000 were investigated in a retrospective study (evidence level IVa). Only patients presenting with radiographic diagnosis of joint destruction types III and IV according to Kellgren's classification were included. Functional outcome was assessed using the Harris hip score (HHS) on admission and at the time of follow-up. Results were grouped as being excellent (≥ 90 points), good

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Fig. 1 Radiographs of a 58-year-old female patient with dysplasia arthrosis of the right hip and correction osteotomy in adolescence: preoperative (*left*) and 79 months after surgery (*right*)



(89–80), fair (79–70), and poor (<70). Patients' opinion was assessed by using four subjective categories (very satisfied, satisfied, unsatisfied, very unsatisfied).

Radiographs were evaluated using Gruen and Charnley zones. Further, relation of the stem to the femoral shaft with regard to size (too small/too large) and angulation (varus/valgus) were assessed by the author's consensus. Patients that could not be investigated at our institution personally were interviewed on the phone. All items of the HHS except ROM and radiological aspects were inquired about. Further, any complications related to the prosthesis such as infection, luxation and operative revision after primary surgery were requested. Finally, the patient's contentedness was queried.

Surgical procedure

The CFP (collum femoris preserving) prosthesis stem and the TOP (trabeculae oriented pattern) acetabular cup were used as cementless components for total hip replacement (Waldemar Link GmbH, Hamburg, Germany; Fig. 1). Stems used in this study consisted of titanium (Tilastan®) and calcium phosphate coating (HX®). Either slightly ("A") or strongly ("B") curved stems with a CCD-angle of 126° were implanted. Length of the stems varied according to their widths (five sizes from x-small to x-large).

All procedures were performed by an experienced orthopaedic consultant through a posterior standard approach with the patient in lateral position either under general or regional anaesthesia. An autotransfusion system was applied to collect the patient's blood intraoperatively and immediately after the operation. Postoperatively, Ibuprofen was orally administered for 14 days as analgesic and prophylaxis against periarticular soft tissue ossification. Patients were allowed to apply partial load bearing of 30 kg for the first three weeks after the operation followed by a quick progression to full weight bearing afterwards. Patients were regularly seen in our outpatient institution

six, 12 and 24 months postoperatively for clinical and radiological assessment.

Statistical analysis

Study data are presented as mean value \pm standard deviation and range. Differences between pre- and postoperative data were evaluated by a paired *t*-test, between ipsi- and contralateral hip by *t*-test. If the sample data were not normally distributed, the Wilcoxon signed rank test and the Mann-Whitney rank sum test were used respectively. Frequency distributions including 95% confidence intervals (CI) were compared by using the Chi-square test. All tests were calculated with a desired power of $1-\beta=0.8$ and a significance level of $\alpha=0.05$. Statistical analysis was performed with SigmaStat (version 2.03) by SPSS (SPSS Inc., Chicago, IL, USA).

Results

A total population of 155 patients was included in the study consisting of 80 male and 75 female patients with an average age of 59.3 ± 9.9 years (range 27–77). Reasons for hip

Table 1 Distribution of the Harris hip score (HHS) according to categories excellent (≥ 90 points), good (89–80), fair (79–70), and poor (<70)

Rating	HHS preoperative	HHS postoperative
Excellent	0/155 (0%)	99/115 (86.1%)
Good	26/155 (16.8%)	11/115 (9.6%)
Fair	7/155 (4.5%)	3/155 (2.6%)
Poor	122/155 (78.7%)	2/115 (1.7%)
Overall	65.5 \pm 15.3	96.3 \pm 7.4*

* $p<0.001$ vs. preoperative

Table 2 Relevant postoperative complications requiring revision surgery ($n=8$)

Revision	Pathology	Treatment
Implant associated	Early aseptic stem loosening ($n=1$)	Stem exchange
	Recurrent luxation due to cup malalignment ($n=1$)	Cup exchange
Non-implant associated	Periarticular ossification ($n=3$)	PO resection
	Luxation due to deep osteotomy ($n=1$)	Head extension
	Secondary posterior luxation due to scar tissue ($n=1$)	Scar tissue resection
	Bursitis trochanterica ($n=1$)	Bursa resection

replacement were osteoarthritis ($n=85$), dysplasia ($n=23$), avascular necrosis ($n=22$), post-traumatic necrosis ($n=8$), coxa vara ($n=8$), coxa valga ($n=5$), rheumatoid arthritis ($n=3$), and Perthes disease ($n=1$). The BMI of the total population was 26.5 ± 3.7 kg/m² (range 18.5–35) with an average ASA score of 1.9 ± 0.3 (range 1–2).

Procedures were performed by nine surgeons, although two surgeons performed the majority of the implantations ($n=113$, 72.9%). Stems with an A-curvature were used in 100 cases, stems with a B-curvature were applied in the remaining cases. The average procedure time was 99.5 ± 18.5 minutes (range 48–165). An average amount of 679.3 ± 243.1 (0–1200) ml erythrocyte concentrate was transfused postoperatively.

Follow-up was obtained 74.3 ± 9.4 months (range 51–94) postoperatively. Patients included in the study were from all

over Germany. Thus, only 115 of them could be investigated clinically and radiologically. Results of the HHS were analysed in these patients only. Thirty-six patients were interviewed on the phone, the remaining three patients whose hips worked well anamnesticly had died, and one patient was lost to follow-up.

Functional outcome assessment revealed good and excellent results in 96% according to the Harris hip score. At the time of follow-up, scores showed significant improvement compared to the preoperative measurements (Table 1). After hip replacement, 99% of the patients felt very satisfied or satisfied. No patient complained about thigh pain initially or at the time of follow-up. Eight patients were surgically revised (revision rate 5.1%, CI 2.1–9.7), predominantly due to recurrent dislocation and periarticular ossification ($n=3$ each, 1.9%, CI 0.4–5.4,

Fig. 2 Hip replacement after acetabular fracture care (a) with early postoperative luxation (b, left hand side) due to relatively deep femoral neck osteotomy leading to revision and exchange of the head component (medium to extra long, b, right hand side)

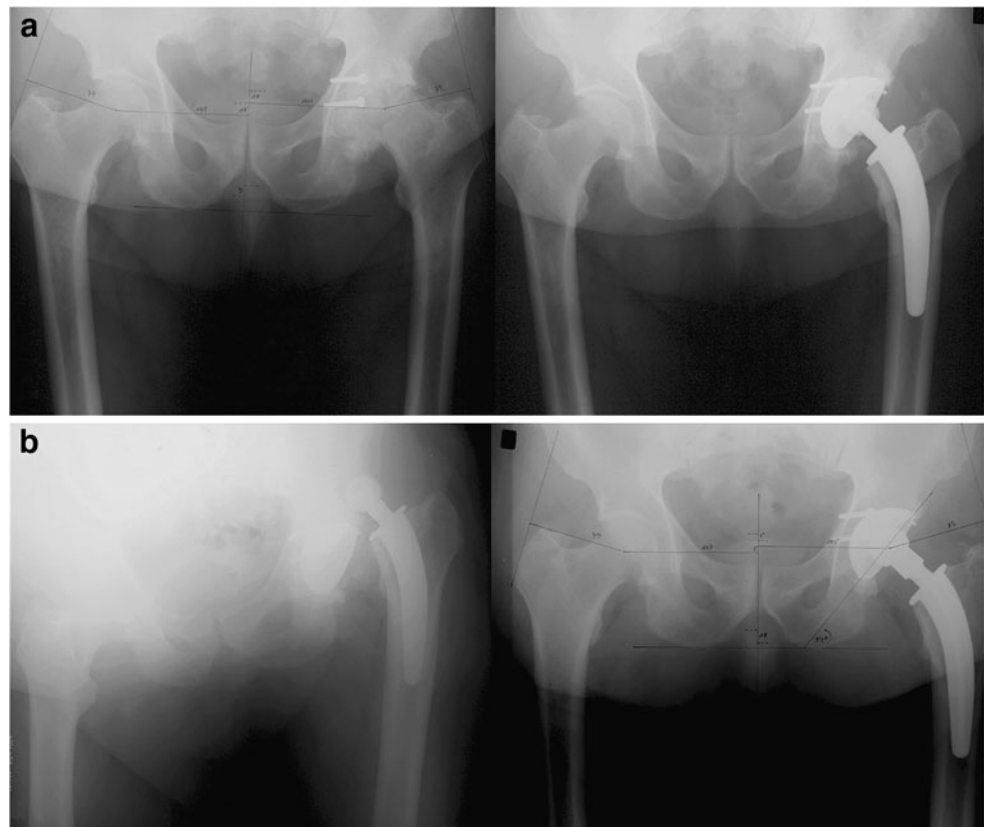


Table 2). Luxation was caused by malpositioning of the cup, relatively deep osteotomy of the femoral neck (Fig. 2), and scar tissue development anterior to the cup ($n=1$ each). There was one early aseptic loosening of the stem (0.6%, CI 0.02–3.4) leading to its exchange one year after primary surgery.

Postoperative complications included deep vein thrombosis in three patients (1.9%) and temporary motor palsy of the sciatic nerve in one case with spontaneous complete recovery (0.6%). Deep infections, periprosthetic fractures or muscle damage resulting in Trendelenburg limping did not occur in any case. Out of 115 patients who had a full radiographic follow-up investigation, 114 revealed stable bony ingrowth of cup and stem. One stem was revised for aseptic loosening one year after primary surgery, while none of the cups required revision. Thus, survival rate was 99.4% and 100% at follow-up for the femoral and the acetabular components respectively (Fig. 3).

The proximal part of the femur became relatively osteopenic, while osteosclerotic transformation of the cortical bone occurred more frequently in the distal areas of the prosthesis (Fig. 4). Signs of significant periprosthetic bone loss or osteolyses distal to the prosthesis were not observed in any case. Though digital analysis of the radiographs was not available, no signs of secondary migration of stem and cup could be detected.

Radiological assessment further revealed no loss of offset after surgery (64.5 ± 7.3 mm pre-vs. 68.6 ± 8.3 mm postoperatively, $p < 0.001$, $\beta = 0$). Preoperative shortening of the leg due to arthrosis of the hip was significantly improved after surgery (-1.7 ± 7.8 pre-vs. 0.8 ± 9.3 mm postoperatively, $p < 0.001$, $\beta = 0.1$). Of the stems, 87.0% ($n = 100/115$) were placed correctly regarding size and CCD

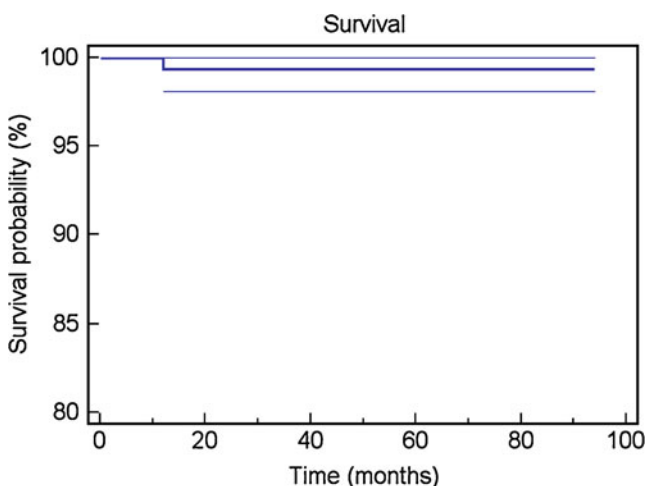


Fig. 3 Kaplan-Meier survival curve including 95% confidence interval with time and probability of survivorship regarding the CFP (collum femoris preserving) stem

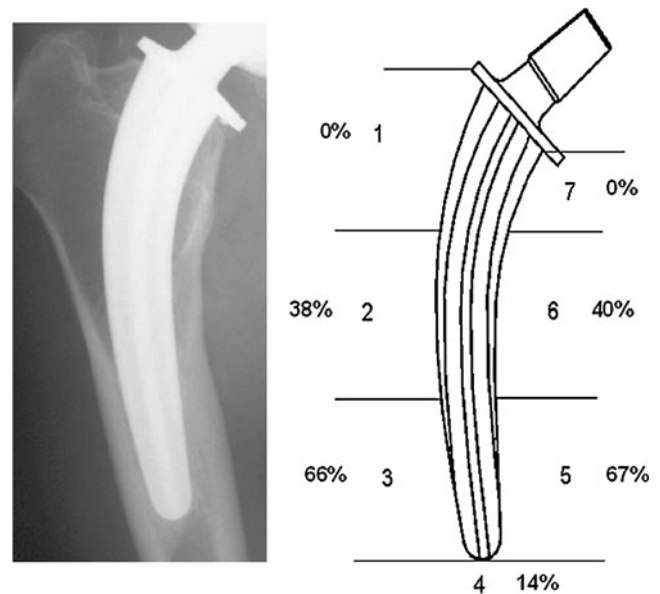


Fig. 4 Occurrence of osteosclerotic femoral bone transformation distributed along Gruen zones

angle. Six stems were implanted in a varus position, while nine stems seemed to be inadequate (too small) in relation to the cortical diameter. However, none of these stems required revision or presented with clinical or radiographic abnormalities. Finally, there was no significant difference between high and low volume surgeons with regard to failure and complication rate (Table 3).

Discussion

Our data obtained from 155 patients treated with the CFP prosthesis revealed good results with regard to implant survival rate, functional outcome and complication rate. These findings have recently been confirmed by Gill et al., who described survival rates of 97% of the cup and 100% of the stem also after a medium-term follow-up [5]. In general, the clinical outcome after cementless hip replacement can be significantly affected by the occurrence of thigh pain which is mainly caused by micromotion of the stem accompanied by radiolucent lines [6, 7]. In our study we did not observe radiological signs of migration, and no patient complained about thigh pain at the time of follow-up. Other study groups found some early retroversion of the CFP stem that stabilised one year after surgery [8].

Thus, the CFP stem seems to provide sufficient rotational stability in a short- and mid-term clinical follow-up. There was one early aseptic loosening of the stem in our study, leading to surgical revision and exchange of the stem. However, this loosening was not related to

Table 3 Distribution of prosthesis failure and perioperative complications (deep vein thrombosis, nerve palsy) in high and low volume surgeons contributing to the study series

Failure and complications	High volume surgeons ($n=2$) Procedures ranging from 48 to 65	Low volume surgeons ($n=7$) Procedures ranging from 2 to 16
Revision rate	3.5% (4/113)*	9.8% (4/41)
Failure rate	0.9% (1/113)*	0% (0/41)
Complication rate	2.6% (3/113)*	2.4% (1/41)

* $p > 0.05$ vs. low volume surgeons

radiological undersizing of the stem which might have led to insufficient anchoring and increasing micromotion [9]. In line with other study groups we found typical remodelling patterns with relative loss of bone in the region of the proximal femur and cortical hypertrophy at the distal stem. This basic pattern of bone remodelling seems to be largely regulated by the load distribution which is determined by design and stiffness of the stem [10–14].

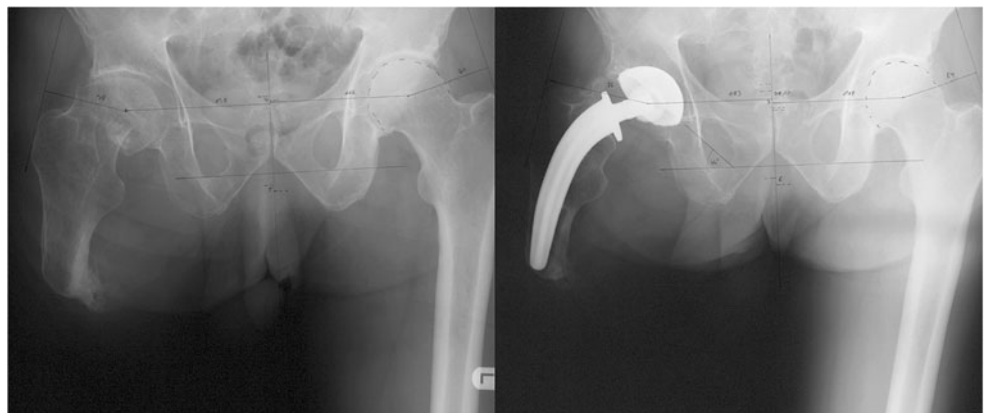
Overall, bony ingrowth and fixation of the stem was excellent at the time of follow-up. The improved integration may have been promoted by the HA-coating of the stem which seems to reduce the phenomenon of stress shielding [15, 16]. There are further factors that may influence remodelling and stress shielding such as bone density at the time of surgery which has however not been addressed in our study. Significant complications that may be related to the implantation of the CFP stem include nerve palsy and periprosthetic fracture. There are several risk factors that are associated with a higher incidence of a motor nerve palsy for example a preoperative diagnosis of dysplasia or lengthening of the leg. In our series, reversible motor palsy of the sciatic nerve was <1%, and thus, comparable to that of cemented stems [17].

The incidence of intraoperative fractures is related to the use of minimally invasive approaches, the use of cementless implants, female gender, poor bone quality, obesity and

technical errors during the operation [18, 19]. However, data from an experimental setup indicate that curved short-stemmed prostheses do not constitute a higher fracture risk, which is in line with our findings [20]. A further point of interest was the influence of individual experience. With regard to this, we did not find a statistical correlation between success rate and individual training in application of the CFP stem. Other groups postulated that the learning curve for using this short stem prosthesis was completed after 20 procedures regardless of the experience, and that the clinical outcome was not affected by the learning curve [21, 22].

In summary, the anatomical design of the CFP stem seems to promote a reasonable physiological load distribution to the proximal femur and permits the implantation even under unusual anatomical conditions (Fig. 5). Preservation of the femoral neck should enable the surgeon to maintain most of the circumflex artery branches, and thus, to support the osseous integration of the stem. Further advantage arises from the fact that revision of the stem is technically easy, since it can be easily extracted, and a second neck resection can be performed. Overall, the mid-term durability of the CFP stem is excellent and as good as any cemented stem. The anatomical shape and the use of titanium alloy reduce the stiffness of the stem, which appears to lead to less thigh pain and stress shielding.

Fig. 5 Implantation of the CFP (collum femoris preserving) prosthesis in a 58-year-old male patient with femoral neck fracture 36 years after traumatic thigh amputation



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