



# Analysis of the complications of the collum femoris preserving (CFP) prostheses

Mingqing LI, Yihe HU, Jie XIE

Department of Orthopedics, Xiangya Hospital, Central South University, Changsha, China

**Objective:** The aim of this study was to evaluate the clinical and radiological outcomes and complications of total hip arthroplasty (THA) using the collum femoris preserving (CFP) prosthesis.

**Methods:** The study included the 142 hips of 125 patients (mean age: 50 years; range: 38 to 60 years) who underwent THA with CFP prosthesis between January 2004 and December 2011. There were 70 males (82 hips) and 55 females (60 hips). Patients were assessed using the Harris hip score (HHS) and visual analog scale (VAS). Radiographs were evaluated according to the Gruen zones and DeLee and Charnley zones to assess the prosthesis position, loosening and ectopic ossification.

**Results:** Follow-up was obtained over  $4.72 \pm 2.16$  (range: 1 to 8.4) years and no patients were lost to follow-up. Mean HHS improved from  $51.43 \pm 4.14$  points preoperatively to  $90.27 \pm 6.60$  points postoperatively, while VAS scores decreased from  $8.3 \pm 3.12$  to  $2.1 \pm 1.54$  by the final review. The HHS revealed excellent and good results in 87.4% of patients. Mild ectopic ossification occurred in 4 cases (2.8%), which were all Grade 1 according to the Brooker classification and without clinical symptoms. In 5 cases (3.5%), bone loss was found in the proximal femur. Radiolucent lines surrounding the stem were not observed in any case. There was no prosthesis loosening or femoral prosthesis subsidence. The survival rate was 100% for the femoral and acetabular components. Ten fractures (7%) of the lateral femoral diaphysis at the tip of the stem occurred during surgery and none of these required additional treatment. No infection, dislocation or deep vein thrombosis was observed.

**Conclusion:** Total hip arthroplasty with CFP prosthesis appears to be a good option for young patients for a variety of etiologies but close attention should be paid to the prevention of complications.

**Key words:** Arthroplasty; collum femoris preserving prosthesis; follow-up; hip joint.

Total hip arthroplasty (THA) is an effective and thorough method for the reconstruction of the hip joint. The femoral neck is the most solid structure of the proximal femur and the center of stress distribution for the hip joint. The retention of the femoral neck preserves the trabecular systems of the metaphyseal cancellous bone, which allows for more even distribution of physiological load along the diaphysis. The protection of the blood

supply of the femoral neck permits increased bone in-growth. However, the femoral neck must be resected with a normal femoral prosthesis during THA. The excision of the femoral neck results in the reduction of bone mass and an imbalance of the stress distribution. Higher rates of intraoperative complications with standard-length stems have been observed compared with shorter stems.<sup>[1]</sup> As a result, it has become increasingly

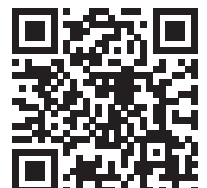
**Correspondence:** Yihe Hu, MD. Central South University Xiangya Hospital, Department of Orthopedics 87 Xiangya Road, Changsha, Hunan, P.R. China.

Tel: (+86-158) 0262 9709 e-mail: yihehu@126.com

**Submitted:** August 24, 2013 **Accepted:** June 18, 2014

©2014 Turkish Association of Orthopaedics and Traumatology

Available online at  
www.aott.org.tr  
doi: 10.3944/AOTT.2014.13.0060  
QR (Quick Response) Code



important to develop prostheses and operative techniques that preserve as much healthy bone as possible, so that only pathological tissue is removed.<sup>[2-5]</sup>

Consequently, short stem prostheses that preserve the femoral neck have become increasingly popular. The follow-up of various types of short stem prosthesis have shown very good mid-term clinical results.<sup>[6-7]</sup> The concept of femoral neck preserving hip replacement, such as the collum femoris preserving (CFP) implant, was introduced during the mid-1990s.<sup>[8]</sup> The CFP short stem prosthesis was introduced especially for younger patients as a cementless implant providing the possibility of less invasive implantation. However, few reports have been published regarding the complications of such prostheses. The aim of this study therefore was to evaluate the clinical results and complications of the CFP prosthesis.

## Patients and methods

A total of 142 total hip arthroplasties with the CFP prosthesis were conducted in 125 patients (mean age: 50 years; range: 38 to 60 years) at our institution between January 2004 and December 2011. Outcomes were investigated retrospectively. There were 70 men (82 hips) and 55 women (60 hips). Patients aged under 65 years who underwent primary THA for non-infected hip disease and an intact femoral neck were included (Table 1). The exclusion criteria were osteoporosis, severe hip dysplasia and malignant disease.

A posterolateral approach was used in all patients. All procedures were performed by an experienced orthopedic surgeon with the patients in the lateral position under general anesthesia. A drainage tube was placed through the incision and removed 24 to 48 hours after surgery. Osteotomy was performed 1.5 cm above the intertrochanteric fossa in order to preserve the femoral neck and proximal cancellous bone. The CFP stem and the trabeculae-oriented pattern (TOP) acetabular cups (Waldemar Link GmbH, Hamburg, Germany) were used as cementless components for the THA. Stems used in this study consisted of titanium and calcium phosphate coating. Either slightly (A) or strongly (B) curved stems with a CCD angle of 126° were implanted. The length of the stems varied according to their widths (five sizes ranging from extra-small to extra-large). Patients were allowed to apply partial load-bearing of 30 kg 3 days after surgery followed by a gradual increase to full weight-bearing within 1 month. Patients were regularly seen in our outpatient institution at the 3rd, 6th and 12th postoperative months and then once a year thereafter for clinical and radiological assessment.

Functional outcome was assessed using the Harris

**Table 1.** Preoperative diagnoses in the individuals in this cohort.

Preoperative diagnosis	Number of occurrences	
	n	%
Osteoarthritis	52	41.6
Avascular necrosis	45	36.0
Rheumatoid arthritis	16	12.8
Ankylosing spondylitis	5	4.0
Posttraumatic osteoarthritis	4	3.2
Perthes' Disease	2	1.6
Developmental dysplasia of the hip	1	0.8

hip score (HHS) and visual analog scale (VAS) on admission and at follow-up. Results were grouped as excellent ( $\geq 90$  points), good (89 to 80 points), fair (79 to 70 points) and poor ( $< 70$  points). The attitude of patients was assessed with the use of four subjective categories (very satisfied, satisfied, unsatisfied and very unsatisfied). Radiographs were evaluated using the Gruen<sup>[9]</sup> and DeLee and Charnley zones.<sup>[10]</sup> Stem orientation was determined by the position of the stem relative to the contact of the tip to the medial or lateral cortex and was defined as neutral, valgus (contact between the tip and the medial cortex) or varus (contact between the tip and the lateral cortex). Stem size was determined by the medullary filling in the distal third of the stem and was defined as correct (gap between the stem and cortical bone 1 to 2 mm), oversized (hard contact between stem and cortical bone) or undersized (gap  $> 2$  mm). Furthermore, the satisfaction of the patient was assessed.

Study data are presented as the mean value  $\pm$  standard deviation and range. Differences between the pre- and postoperative data were evaluated by paired *t*-tests. If the sample data were not normally distributed, the Wilcoxon signed rank test and the Mann-Whitney rank sum test were used. 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 using SPSS software v.19.0 (SPSS Inc., Chicago, IL, USA).

## Results

During the study period no patients died or were lost to follow-up. Postoperative follow-up data were obtained over  $4.72 \pm 2.16$  (range: 1 to 8.4) years. Preoperative HHS was  $51.43 \pm 4.14$  (range: 45 to 60) points and increased to  $90.27 \pm 6.60$  (range: 74 to 98) points at the final follow-up evaluation, which was statistically significant ( $p < 0.05$ ). Excellent or good HHS results were recorded in 87.4% of the patients (Table 2).

The VAS reduced from  $8.3 \pm 3.12$  points preopera-

**Table 2.** Distribution of the Harris hip scores (HHS): excellent ( $\geq 90$  points), good (89 to 80), fair (79 to 70), and poor ( $< 70$ ).

Rating	HHS preoperative			HHS postoperative		
	n	%	Mean $\pm$ SD	n	%	Mean $\pm$ SD
Excellent	0/142	0		85/142	59.9	
Good	10/142	7.0		39/142	27.5	
Fair	25/142	17.6		18/142	12.7	
Poor	107/142	75.4		0/142	0	
Overall			51.43 $\pm$ 4.14			90.27 $\pm$ 6.60*

\* $p < 0.001$  vs. preoperative score.

tively to  $2.1 \pm 1.54$  points at the final review. After THA, all patients felt either very satisfied or satisfied with their outcomes. No patient complained about thigh pain during the follow-up period.

The stem size was correct in 130 cases (91.5%) and oversized in 12 (8.5%). The stem was implanted into a neutral position in 127 cases (89.4%), aligned in valgus in 7 (4.9%) and aligned in varus in 8 (5.6%). In five cases (3.5%), a slight loss of bone in the proximal femur was observed; in the lateral part of the femoral neck in Gruen Zone 1 below the rim in 3 patients, in the medial part of Gruen Zone 7 in 1 and in both zones in one. No clinical symptoms were found in these patients. Heterotopic ossification was observed in 4 of the 142 prostheses (2.8%). All of the ossifications were Grade 1 according to the classification by Brooker et al.<sup>[11]</sup> and were observed to be close to the acetabular rim.

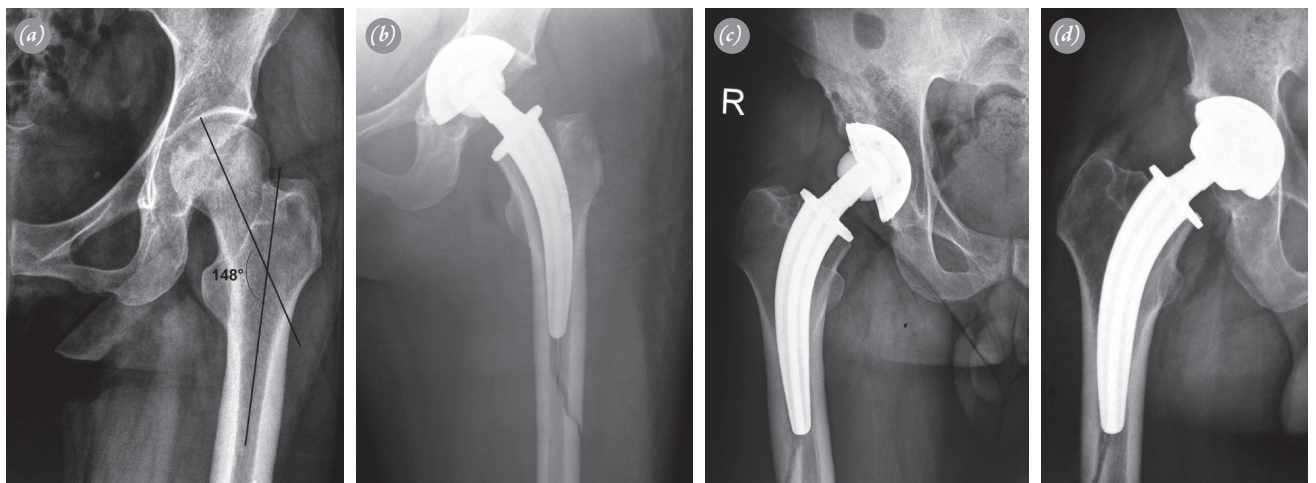
Radiolucent lines surrounding the stem were not observed in any cases. No patient required a stem revision as a result of aseptic loosening or subsidence in the follow-up study in this series. All of the cups showed signs

of stable ingrowth as defined by spot welds and the absence of migration. Radiolucent lines were not observed in any zone according to the classification of DeLee and Charnley.<sup>10</sup> None of the cups or stems required revision and, thus, the survival rate of stem and cup components were both 100%.

There were 10 intraoperative fractures (7%) of the lateral femoral diaphysis at the tip of the stem but none required additional treatment (Fig. 1). All of these patients were allowed to apply partial load-bearing of 20 kg 5 days after the operation followed by a gradual increase to full weight-bearing by 4 months postoperatively. During this time, patients were asked to walk with the aid of crutches to assist partial weight-bearing. The fractures in all of these patients healed after 8 months postoperatively. No significant differences in HHS were found between the patients with fractures and the non-fracture group ( $p > 0.05$ ).

## Discussion

The CFP stem was initially designed and introduced by



**Fig. 1.** (a) Radiograph showing an exaggerated neck-shaft angle. (b) Radiograph showing a metaphyseal fracture that did not require further treatment. (c) Radiograph showing a metaphyseal fracture as a result of oversized stems. (d) Radiograph of a metaphyseal fracture as a result of the wrong osteotomy angle.

Pipino and Calderale<sup>[12]</sup> during the late 1970s. There are multiple advantages of this prosthesis, including primary triplanar stem stability, stress loads that are distributed along the physiological lines of stress, preservation of the bone stock and blood supply and simpler revision procedures. Since its introduction, it has obtained excellent clinical results.<sup>[13]</sup>

Our data were obtained from 125 patients who were treated with the CFP prosthesis. They showed good results with respect to the implant survival rate, functional outcome and complication rate. These findings have recently been confirmed by Briem et al., who described survival rates of 100% of the cup and 99% of the stem after a medium-term follow-up.<sup>[14]</sup> 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.<sup>[15]</sup> In our study, we did not observe any radiological signs of prosthetic migration and no patient complained of thigh pain during the follow-up period.

Briem et al.<sup>[14]</sup> reported a series of cases that had no intraoperative fractures. Five of these cases involved oversized stems, 2 an incorrect osteotomy angle, 2 an exaggerated neck-shaft angle and 1 correctly sized stems. However, in our study, there were 10 intraoperative fractures of the lateral femoral diaphysis at the tip of the stem. We found that when the osteotomy angle changes, this prosthetic approach to the hemi-femur lead to an abnormal stress distribution. The point of contact between the end of prosthesis and the femur where stress is most concentrated is likely to suffer an oblique fracture and fractures are also likely postoperatively if there is a large degree of femoral neck anteversion and neck-shaft angulation. The CFP prosthesis is designed in accordance with the normal anatomy of the femur with two neck-shaft angles of 126° and 117°. The compressive and tensile stresses surrounding the prosthesis will increase when the CFP prosthesis is used in patients with an oversized neck-shaft angle, which will eventually lead to a fracture. The risk factors for intraoperative periprosthetic fractures include the use of minimally invasive techniques, the use of press-fit cementless stems, female sex, metabolic bone disease, bone diseases that lead to altered morphology such as Paget's disease, and intraoperative technical errors.<sup>[16]</sup> We concluded that the principal reason for this intraoperative complication was the use of an oversized CFP prosthesis. Detailed preoperative surgical planning and appropriate measurements to determine the correct stem size can avoid this complication. Moreover, the design of the standard CFP prosthesis may not match the anatomy of Chinese people, which requires further investigation and po-

tential modifications. Jakubowitz et al. found that Mayo short-stemmed prostheses did not carry a higher fracture risk, but it is unknown whether the intrinsic properties of the CFP prosthesis increase the risk of fracture.<sup>[17]</sup>

In agreement with other studies, we found remodeling patterns with relative loss of bone in the proximal femur. Briem et al. also found relative osteopenia within the proximal femur.<sup>[14]</sup> The remodeling was largely regulated by the mechanical loading distribution pattern, which is determined by implant design and stem stiffness.<sup>[18,19]</sup> Hayashi et al. found a significant correlation between bone mineral density (BMD) and the UCLA activity rating score, while no correlation was found between BMD and BMI or between age or HHS.<sup>[20]</sup>

There were 4 (2.8%) cases of heterotopic ossification in our group. Briem et al. reported 3 (1.6%) cases of periarticular ossification, which eventually required surgical revision.<sup>[14]</sup> Heterotopic bone (HO) is a rare consequence of THA and has recently been shown to be more of a problem with resurfacing hip arthroplasty. The main mechanism of HO development has been attributed to the soft tissue dissection along with other patient-related risk factors, such as age, gender and bilaterality.<sup>[21]</sup> Resurfacing hip arthroplasty may carry an increased risk of HO in males with bilateral disease.<sup>[22]</sup> In addition, Briem et al.<sup>[14]</sup> also reported three recurrent dislocation cases due to cup malalignment, deep osteotomy and scar tissue, which were not found in our group.

There were several limitations to our study. First, only a relatively small cohort was available for analysis. Second, the duration of the follow-up combined with the small patient numbers limited our ability to generate definitive conclusions, so our conclusions must be considered as preliminary.

In conclusion, use of the CFP stem in THA had good results despite some complications. The anatomical design of the CFP prosthesis, the elimination of the distal extension of CFP stems, the short stem, the implantation of smaller components and the preservation of the femoral neck can be considered advantages of the method. Although the current follow-up duration in this series is too short to allow definitive conclusions, the CFP system provided excellent mid-term results. Continued follow-up is required to determine whether the use of CFP prostheses result in less osteolysis, stem loosening and other advantages.

**Conflicts of Interest:** No conflicts declared.

## References

1. Molli RG, Lombardi AV Jr, Berend KR, Adams JB,

- Sneller MA. A short tapered stem reduces intraoperative complications in primary total hip arthroplasty. *Clin Orthop Relat Res* 2012;470:450-61. [CrossRef](#)
2. Lingard EA, Muthumayandi K, Holland JP. Comparison of patient-reported outcomes between hip resurfacing and total hip replacement. *J Bone Joint Surg Br* 2009;91:1550-4. [CrossRef](#)
  3. Killampalli VV, Kundra RK, Chaudhry F, Chowdhry M, Fisher NE, Reading AD. Resurfacing and uncemented arthroplasty for young hip arthritis: functional outcomes at 5 years. *Hip Int* 2009;19:234-8.
  4. Goebel D, Schultz W. The Mayo cementless femoral component in active patients with osteoarthritis. *Hip Int* 2009;19:206-10.
  5. Ghera S, Pavan L. The DePuy Proxima hip: a short stem for total hip arthroplasty. Early experience and technical considerations. *Hip Int* 2009;19:215-20.
  6. Ettinger M, Ettinger P, Lerch M, Radtke K, Budde S, Ezechieli M, et al. The NANOS short stem in total hip arthroplasty: a mid term follow-up. *Hip Int* 2011;21:583-6.
  7. Zeh A, Weise A, Vasarhelyi A, Bach AG, Wohlrab D. Medium-term results of the Mayo™ short-stem hip prosthesis after avascular necrosis of the femoral head. [Article in German] *Z Orthop Unfall* 2011;149:200-5. [Abstract]
  8. Pipino F, Molfetta L. Femoral neck preservation in total hip replacement. *Ital J Orthop Traumatol* 1993;19:5-12.
  9. Gruen TA, McNeice GM, Amstutz HC. "Modes of failure" of cemented stem-type femoral components: a radiographic analysis of loosening. *Clin Orthop Relat Res* 1979;141:17-27.
  10. DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. *Clin Orthop Relat Res* 1976;121:20-32.
  11. Brooker AF, Bowerman JW, Robinson RA, Riley LH Jr. Ectopic ossification following total hip replacement. Incidence and a method of classification. *J Bone Joint Surg Am* 1973;55:1629-32.
  12. Pipino F, Calderale PM. Biodynamic total hip prosthesis. *Ital J Orthop Traumatol* 1987;13:289-97.
  13. Pipino F, Molfetta L, Grandizio M. Preservation of the femoral neck in hip arthroplasty: results of a 13 to 17 year follow-up. *J Orthop Traumatol* 2000;1:31-9. [CrossRef](#)
  14. Briem D, Schneider M, Bogner N, Botha N, Gebauer M, Gehrke T, et al. Mid-term results of 155 patients treated with a collum femoris preserving (CFP) short stem prosthesis. *Int Orthop* 2011;35:655-60. [CrossRef](#)
  15. Kinov P, Radl R, Zacherl M, Leithner A, Windhager R. Correlation between thigh pain and radiological findings with a proximally porous-coated stem. *Acta Orthop Belg* 2007;73:618-24.
  16. Davidson D, Pike J, Garbuz D, Duncan CP, Masri BA. Intraoperative periprosthetic fractures during total hip arthroplasty. Evaluation and management. *J Bone Joint Surg Am* 2008;90:2000-12. [CrossRef](#)
  17. Jakubowitz E, Seeger JB, Lee C, Heisel C, Kretzer JP, Thomsen MN. Do short-stemmed-prostheses induce periprosthetic fractures earlier than standard hip stems? A biomechanical ex-vivo study of two different stem designs. *Arch Orthop Trauma Surg* 2009;129:849-55. [CrossRef](#)
  18. Chen HH, Morrey BF, An KN, Luo ZP. Bone remodeling characteristics of a short-stemmed total hip replacement. *J Arthroplasty* 2009;24:945-50. [CrossRef](#)
  19. Gillies RM, Kohan L, Cordingley R. Periprosthetic bone remodelling of a collum femoris preserving cementless titanium femoral hip replacement. *Comput Methods Biomech Biomed Engin* 2007;10:97-102. [CrossRef](#)
  20. Hayashi S, Nishiyama T, Fujishiro T, Kanzaki N, Hashimoto S, Kurosaka M. Periprosthetic bone mineral density with a cementless triple tapered stem is dependent on daily activity. *Int Orthop* 2012;36:1137-42. [CrossRef](#)
  21. Rama KR, Vendittoli PA, Ganapathi M, Borgmann R, Roy A, Lavigne M. Heterotopic ossification after surface replacement arthroplasty and total hip arthroplasty: a randomized study. *J Arthroplasty* 2009;24:256-62. [CrossRef](#)
  22. Ritter MA, Galley M. Heterotopic bone formation following resurfacing total hip arthroplasty. *HSS J* 2011;7:41-3.