A concise minimum eight year follow-up of proximally porous-coated tapered titanium femoral stem in primary total hip arthroplasty

Benjamin Beecher · Philip Glassner · Henrik Malchau · Young-Min Kwon

Received: 10 January 2012 / Accepted: 9 February 2012 / Published online: 14 March 2012
© Springer-Verlag 2012

Abstract

Purpose Our goal was to assess clinical and radiographic outcomes using a second-generation circumferentially proximally porous-coated titanium alloy stem at a minimum of eight years of follow-up.

Methods Ninety-one hips (80 patients) with Fibre Metal Taper (FMT, Zimmer Inc, Warsaw, IN, USA) femoral stems implanted between May 1998 and April 2002 were followed prospectively and re-evaluated at a minimum of eight years postoperatively. The median patient age was 56 (range 34–78) years, with 40 women and 40 men. Radiographic data and clinical follow-up using Harris Hip Score (HHS) and EuroQol (EQ)-5D outcome measures were evaluated.

Results Mean follow-up was 9.61 (range 8–12.3) years. At the time of the most recent follow-up, the mean HHS was 85.8 (range 46–100) points, mean EQ-5D Weighted Health State Index was 0.76 (range 0.05–1.00), and mean EQ-5D Visual Analogue Score was 80 (range 24–100). All stems were biologically stable, with all hips having osseous ingrowth. One stem was revised due to early periprosthetic fracture with stem subsidence. No hip had diaphyseal osteolysis.

Conclusions To our knowledge, the data presented here represent the longest clinical follow-up of this second-generation cementless, proximally porous-coated femoral stem. The stems were found to perform well clinically and radiographically beyond the first five years previously

reported in the literature. Patients had high levels of satisfaction and function, and osseous fixation occurred reliably without evidence of distal osteolysis.

Introduction

The Versys Fibre Metal Taper stem (FMT, Zimmer Inc, Warsaw, IN, USA) was introduced in 1998 for use without cement for primary and revision total hip arthroplasty (THA). This second-generation titanium alloy stem features a proximal porous-coated circumferential ingrowth surface consisting of titanium fibre metal mesh, a midstem consisting of a corundumised ongrowth surface, and a tapered, distally polished surface finish. This stem was designed to provide reliable metaphyseal ingrowth by press-fit fixation of 0.5 mm [1] and to limit distal osteolysis with its circumferential proximal porous fibre metal. The corundumised surface finish of the midstem was designed to promote secure bone implant interface [2]. In addition, the trapezoidal cross-section was designed to improve proximal fill and rotational stability. The purpose of our study was to assess clinical and radiographic outcomes of this second-generation femoral stem at a minimum follow-up of eight years and a mean follow-up of 9.61 years.

Materials and methods

Following the institutional review board approval, between May 1998 and April 2002, 91 total hip replacements (THR) (80 patients) with implantation of a second-generation tapered titanium femoral stem, the FMT, were followed prospectively and re-evaluated at a minimum of eight years postoperatively with complete radiographic and clinical

B. Beecher (✉) · H. Malchau · Y.-M. Kwon
Department of Orthopaedic Surgery, Massachusetts General
Hospital, Harvard Medical School,
Boston, MA, USA
e-mail: brbeecheer@partners.org

P. Glassner
Hunterdon Orthopedic Institute, Orthopedics,
Flemington, NJ, USA

follow-up. Patients' respective diagnoses are listed in Table 1. Patient age ranged from 34 to 78 (median 56) years. Preoperative quality assessment of hip function was categorised by the Charnley functional classification system (Table 2.)

Fifty percent of patients were men. Five surgeons participated in the series. Fifty-three hips were implanted through a posterior approach and 38 through a lateral modified Hardinge approach. The FMT stem is proximally coated with a titanium fibre mesh for porous ingrowth. The midportion of the stem is corundumised and sintered for bony ongrowth, whereas the distal third of the stem is polished and trapezoidal in cross-section for initial stability. Proximally, standard and large metaphyseal bodies are available, where the large metaphyseal version increases the medial curve by 4–5 mm, depending on stem size. Stem diameters increase in 1-mm increments, and two offset options are available to allow a precise implant match to the patient's femoral geometry.

Patients were prospectively enrolled and underwent THR in conjunction with either a cementless titanium fibre mesh cementless acetabular component (Trilogy Cup, Zimmer Inc; $n=45$) or a roughened cancellised titanium backside surface cementless acetabular component (Sulzer cup, Sulzer Orthopedics, Austin, TX, USA; $n=46$) and highly cross-linked polyethylene. The femoral heads were all cobalt chrome, and were either 28 mm, 32 mm, or 36 mm. All patients were followed up at a minimum of eight (range 8–12.3; mean 9.61) years and were assessed both clinically and radiographically. Clinical outcome measures included the Harris Hip Score (HHS), the EuroQol (EQ)-5D Weighted Health State Index, and the EQ-5D Visual Analogue Score. All patients at most recent follow-up received standard anteroposterior (AP) radiographs of the pelvis, AP of the hip, frog lateral view of the hip, and cross-table shoot through laterals of the hip. An independent orthopaedic surgeon assessed all films to determine bony ingrowth into the prosthesis, any undetected fracture, and/or component subsidence.

Results

Ninety-one hips (80 patients) were followed up prospectively and were re-evaluated at a minimum of eight years

Table 1 Patients' diagnosis for primary THR

Diagnosis	Number of hips
Osteoarthritis	70
Avascular necrosis	8
Developmental dysplasia of the hip	7
Post-traumatic osteoarthritis	1
Inflammatory	3
Acromegaly	2

Table 2 Preoperative quality assessment

Charnley class	Percent
A	21
B	19
C	60

postoperatively with radiographs, HHS, and EQ-5D scores. The clinical outcome scores are shown in Table 3.

Radiographic follow-up showed 99% FMT stem survival at a minimum follow-up of eight years. Only one stem was revised due to a periprosthetic fracture in the subacute postoperative period. The stem subsided and was revised to a fully porous-coated device (Fig. 1). All other stems showed evidence of osseous ingrowth on final radiographs and no evidence of distal osteolysis (Fig. 2). There were no instances of fibrous ingrowth or thigh pain.

Eleven patients had a further procedure performed, which consisted of one patient who had a head/liner exchange for instability; five closed reductions of hip dislocations (two in patients with a diagnosis of lupus and global laxity, one of which was the above patient); one irrigation and debridement of a superficial wound infection; three bursectomies with removal of painful trochanteric wires; and one revision of a loose acetabular component at which time the FMT stem was inspected and found to be stable (Fig. 3).

Discussion

The debate over the best method for optimal femoral stem fixation in THA has been ongoing for more than 30 years, since the first-generation of noncemented stems was clinically evaluated [3–5]. There were early concerns over relatively high failure rates of some of the first-generation stems, with some studies reporting 25% failure at ten years [6]. Many of these early failures were related to the lack of circumferential coating of the stems, which created channels for particulate debris. However, a 2006 study by Martinez de Aragon et. al. evaluating the follow-up of a first-

Table 3 Outcome Measures

Outcome measure	Mean score	Range
HHS: operative side	85.8	46–100
HHS: nonoperative side	85.1	39–100
EuroQol (EQ)-5D: Visual Analogue Score	80.4	24–100
EuroQol (EQ)-5D: Weighted Health State Index	0.76	0.05–1.00
Years follow-up	9.61	8.0–12.3
Age at surgery (years)	56.4	34.1–78.1

Fig. 1 AP radiographs: **A** postop FMT, **B** stem subsided, **C** revision to cemented implant

generation cementless femoral component showed 83% survival at 21 years [7]. Concerns of stem failure led to many surgeons favouring the “hybrid” THA, with a cemented femoral component and press-fit acetabular component. Although a meta-analysis by Morshed et. al. in 2007 comparing cemented with uncemented fixation found no significant advantage of one fixation method over another, the authors

reported superior results with cemented fixation in studies that did not restrict analysis to patients under 55 years of age [8]. The development of the next generation of noncemented femoral stems has shown much promise, with a recent Finnish registry study showing better long-term results in patients over 65 years using noncemented versus cemented femoral stems [9]. These second-generation stems include fully coated and tapered stems with varied proximal coatings, such as fibre metal titanium mesh and hydroxyapatite [10–12]. There have been numerous mid- and long-term studies published that demonstrate excellent outcomes of a variety of second-generation, noncemented stems, with high rates of bony ingrowth, low rates of revision, and satisfied patients [13–26].

To our knowledge, this study reports the longest follow-up of the FMT stem. Three prior publications evaluated midterm results of proximally coated, collarless, titanium fibre metal stems. Two evaluated the FMT at a minimum five year follow-up, and one evaluated the Anatomic Hip (Zimmer Anatomic Hip; Zimmer) at mean 11-year follow-up [16, 24, 25]. The study by Akhavan and Goldberg retrospectively reviewed 100 consecutive hips in 97 patients who had a THA with an FMT stem, with a minimum five year (mean 6.2 year) follow-up. They used HHS and radiographs to evaluate outcomes. Mean HHS was 98 (range 86–100), and all patients available for radiographic follow-up had stable, bony ingrown stems [24]. Klein and colleagues reported similar results in their study of 129 hips implanted with an FMT at a minimum five year follow-up, with a mean HHS of 92% and 100% survival of the FMT component [16]. Butler et al. reviewed the results of 91 patients at a minimum ten year follow-up who had a THA with a similar component, the Anatomic Hip, which is also a collarless, titanium stem with a proximal, circumferential coating of fibre metal mesh. They also had excellent results, with a mean HHS of 95 and only two stems that were considered loose, one of which

Fig. 2 **A** AP, **B** frog-lateral, and **C** shoot thru lateral radiographs at 10.3 years s/p left THA with FMT

Fig. 3 AP radiographs: **A** postop, **B** loose acetabular cup, **C** revised acetabular cup

required revision for subsidence and the other having stable fibrous ingrowth [25].

Our study findings are consistent with previously published reports with follow-up up to five years, with all stems obtaining stable osseous ingrowth at a mean of 9.61 years postoperatively (excluding the one stem that was revised for early periprosthetic fracture). In comparing our data to Klein et al., our study has a longer follow-up, well beyond the first five years, with minimum of eight years and mean of 9.61 years. Our mean HHS was 85.8, which was slightly lower than reported by Klein et al., whose study participants had Charnley function classes of 54% A, 18% B, and 28% C. This differs from our cohort of 21% A, 19% B, and 60% C. These differences in patients' overall health state contributed to our HHS scores being lower (85.8 vs. 92.0). In our study, 12 complications occurred in 11 patients. All except one complication were not related to the stem itself. One head/liner exchange for instability, five closed reductions of hip dislocations, one irrigation and debridement of a superficial wound infection, three bursectomies with removal of painful trochanteric wires and one revision of a loose acetabular component did not appear to be due to the FMT stem. There was one case of early periprosthetic fracture with subsidence that required revision. This 1% fracture rate is less than Akhavan and Goldberg's reported rate of 6%, and Klein et al. described two intraoperative fractures during seating of the FMT stem out of 129 implanted stems [16, 24].

In conclusion, this second-generation cementless, proximally porous-coated femoral stem performed well clinically and radiographically at an average of 9.61 years of follow-up. Patients had high levels of satisfaction and function. To our knowledge, this is the longest follow-up of the FMT stem, with our data displaying continued ingrowth of the prosthesis with satisfactory clinical outcomes beyond the first year. We will continue to follow up this cohort of patients both clinically and radiographically to document the long-term outcome of this stem.

Acknowledgments Harry Rubash, Dennis Burke, Andrew Freiberg

Conflict of interests The authors declare that they have no conflict of interest.

References

1. Mallory TH, Head WC (1988) A total hip replacement system: clinical experience and recommendations. *Contemp Orthop* 17 (4):21–28
2. Feighan JE, Goldberg VM, Davy D et al (1995) The influence of surface-blasting on the incorporation of titanium-alloy implants in a rabbit intramedullary model. *J Bone Joint Surg Am* 77-A (9):1380–1395
3. Harris WH (1992) The first 32 years of total hip arthroplasty. One surgeon's perspective. *Clin Orthop Relat Res* 274:6–11
4. Rothman RH, Cohn JC (1990) Cemented versus cementless total hip arthroplasty. A critical review. *Clin Orthop Relat Res* 254:153–169
5. Ring PA (1978) Five to fourteen year interim results of uncemented total hip arthroplasty. *Clin Orthop Relat Res* 137:87–95
6. Clohisy JC, Harris WH (1999) The Harris-Galante uncemented femoral component in primary total hip replacement at 10 years. *J Arthroplast* 14(8):915–917
7. Martinez de Aragon JS, Keisu KS (2007) 21-year results of the uncemented fully textured lord hip prosthesis. *Clin Orthop Relat Res* 454:133–138
8. Morshed S, Bozic KJ, Ries MD, Malchau H et al (2007) Comparison of cemented and uncemented fixation in total hip replacement: a meta-analysis. *Acta Orthop* 78(3):315–326
9. Makela KT, Eskelinen A, Pulkkinen P et al (2008) Total hip arthroplasty for primary osteoarthritis in patients fifty-five years of age or older. An analysis of the finnish arthroplasty registry. *J Bone Joint Surg Am* 90(10):2160–2170
10. Chambers B, St Clair SF, Froimson MI (2007) Hydroxyapatite-coated tapered cementless femoral components in total hip arthroplasty. *J Arthroplast* 22(4 Suppl 1):71–74
11. Surdam JW, Archibeck MJ, Schultz SC Jr et al (2007) A second-generation cementless total hip arthroplasty mean 9-year results. *J Arthroplast* 22(2):204–209
12. Geesink RG, de Groot K, Klein CP (1987) Chemical implant fixation using hydroxyl-apatite coatings. The development of a human total hip prosthesis for chemical fixation to bone using hydroxyl-apatite coatings on titanium substrates. *Clin Orthop Relat Res* 225:147–170

13. Mulliken BD, Bourne RB, Rorabeck CH et al (1996) A tapered titanium femoral stem inserted without cement in a total hip arthroplasty. *J Bone Joint Surg* 78-A(8):1214–1225
14. Moyer JA, Metz CM, Callaghan JJ et al (2010) Durability of second-generation extensively porous-coated stems in patients age 50 and younger. *Clin Orthop Relat Res* 468(2):448–453
15. Bhalodiya HP, Singh SP (2009) Results with the cementless Spotorno stem in total hip arthroplasty. *J Arthroplast* 24(8):1188–1192
16. Klein GR, Levine HB, Nafash SC et al (2009) Total hip arthroplasty with a collarless, tapered, fiber metal proximally coated femoral stem: minimum 5-year follow-up. *J Arthroplast* 24(4):579–585
17. Nishino T, Mishima H, Miyakawa S et al (2008) Midterm results of the Synergy cementless tapered stem: stress shielding and bone quality. *J Orthop Sci* 13(6):498–503
18. Baltopoulos P, Tsintzos C, Papadakou E et al (2008) Hydroxyapatite-coated total hip arthroplasty: the impact on thigh pain and arthroplasty survival. *Acta Orthop Belg* 74(3):323–331
19. McLaughlin JR, Lee KR (2008) Total hip arthroplasty with an uncemented tapered femoral component. *J Bone Joint Surg Am* 90(6):1290–1296
20. Yoon TR, Rowe SM, Kim MS et al (2008) Fifteen- to 20-year results of uncemented tapered fully porous-coated cobalt-chrome stems. *Int Orthop* 32(3):317–323
21. Gabbar OA, Rajan RA, Londhe S et al (2008) Ten- to twelve-year follow-up of the furlong hydroxyapatite-coated femoral stem and threaded acetabular cup in patients younger than 65 years. *J Arthroplast* 23(3):413–417
22. Kim YH (2008) The results of a proximally-coated cementless femoral component in total hip replacement: a five- to 12-year follow-up. *J Bone Joint Surg Br* 90(3):299–305
23. Hankins M, Shepperd JA (2008) Long-term results of a hydroxyapatite-coated femoral component in total hip replacement: a 15- to 21-year follow-up study. *J Bone Joint Surg Br* 90(1):27–30
24. Akhavan S, Goldberg VM (2007) Clinical outcome of a fibermetal taper stem: minimum 5-year follow-up. *Clin Orthop Relat Res* 465:106–111
25. Butler JB, Lansky D, Duwelius PJ (2005) Prospective evaluation of total hip arthroplasty with a cementless, anatomically designed, porous-coated femoral implant: mean 11-year follow-up. *J Arthroplast* 20(6):709–716
26. Vidalain JP (2011) Twenty-year results of the cementless Corail stem. *Int Orthop* 35(2):189–194