Exeter small femoral stem for patients with small femurs

Kwok-hing Chiu,1 Kin-wing Cheung,1 Kwong-yin Chung,1 Wan-yiu Shen2
1 Department of Orthopaedics and Traumatology, Prince of Wales Hospital, The Chinese University of Hong Kong, Hong Kong
2 Department of Orthopaedics and Traumatology, Queen Elizabeth Hospital, Hong Kong

ABSTRACT

Purpose. To report the long-term results of total hip arthroplasty (THA) using small size Exeter femoral stems.

Methods. Eight men and 34 women aged 60 to 83 (mean, 70) years underwent 45 THAs using the Exeter small stem with offsets of 30 mm (n=3), 33 mm (n=15), and 35.5 mm (n=27). The Harris hip score was assessed pre- and post-operatively. Stem alignment and axial subsidence of the stem were measured. Radiolucent lines around the femur were recorded at 14 Gruen zones. Completeness and thickness of the cement mantle and cement fractures were also noted. Ectopic ossification, if present, was graded. Stem loosening was based on the Olsson definitions.

Results. The mean follow-up was 9 (range, 5–12) years. The mean Harris hip score improved from 37 (range, 13–61) to 80 (range, 47–96) [p<0.001]. At the latest follow-up, the score was excellent (90–100) in 8 (18%) of the hips, good (80–89) in 21 (47%), fair (70–79) in 9 (20%), and poor (<70) in 7 (16%). All hips had a complete cement mantle of ≥2 mm. All stems were inserted without intramedullary reaming. 11 (24%) of the hips developed stem subsidence of <2 mm; all stabilised within 2 years. None of these patients had pain or other radiological signs of loosening. Six stems showed radiolucent lines of <1 mm in the upper zones, which were not progressive. No cement fracture or subsidence was noted. Using revision for any cause as an endpoint, the overall survival rate of Exeter small femoral stem was 100% at 10 years and 89% at 12 years.

Conclusion. The results of Exeter small stems for patients with small femurs are good.

Key words: arthroplasty, replacement, hip; femur

INTRODUCTION

The double-tapering and absence of collar are the design features of the Exeter femoral stem. Owing to its polished surface, this design enables the stem to subside within the cement mantle. Minor distal stem movements within the cement mantle transmit
the load into the cement and hence into the bone. This protects the bone-cement interface.\textsuperscript{1} The matt-surfaced Exeter stem used from 1976 to 1985 achieves inferior results.\textsuperscript{1–3} The long term results of the polished stem have been encouraging.\textsuperscript{1,6–11}

The standard femoral stem size with offsets of 37.5 mm and 44 mm might not be suitable for patients with small femurs. In a study using the Exeter standard stem (offset 37.5 mm) for patients with small femurs (mean height of 160 cm and weight of 58 kg) followed up for a mean of 13 years,\textsuperscript{8} the stem revision rate secondary to aseptic loosening was 22\% when over-sized implants were used, whereas none of those with appropriate-sized stems failed. We report the long-term results of total hip arthroplasty (THA) using small size Exeter femoral stems.

MATERIALS AND METHODS

From July 1998 to December 2005, 55 Chinese patients underwent 59 primary THAs through the posterior approach using the cemented Exeter small femoral stem (Stryker, Warsaw [IN], USA). Of these, 2 patients (2 hips) were lost to follow-up, and 11 patients (12 hips) died of unrelated causes at age 75 to 92 (mean, 80) years. Their latest mean Harris hip score was 76 (range, 55–90). The remaining 45 hips in 8 men and 34 women aged 60 to 83 (mean, 70) years used stems with offsets of 30 mm (n=3), 33 mm (n=15), or 35.5 mm (n=27) [Fig. 1]. The mean body weight and height of these patients were 56 (range, 33–78) kg and 151 (range, 137–164) cm, respectively. Their diagnoses included dysplasia (44\%), avascular necrosis (29\%), osteoarthritis (18\%), and fractures (9\%). According to the Charnley functional classification, 14 (31\%) hips were class A (unilateral disease), 21 (47\%) hips were class B (bilateral disease), and 10 (22\%) hips were class C (multiple joint involvement, systemic disease).

Cephazolin was used as the prophylactic antibiotic. Patients with a previous history of thromboembolism received prophylactic subcutaneous low-molecular-weight heparin. The cementing techniques included pulsatile lavage, intramedullary cement restrictor, vacuum cement mixing, use of a cement gun and pressurisation. To ensure the cement being introduced in a retrograde manner, a small humeral nozzle was used when the medullary cavity was too narrow for the standard hip nozzle. Stems were inserted after appropriate broaching without reaming. All stems were modular and had a polished-surface. 26 mm metal heads were used in the first 14 hips, whereas 28 mm metal heads were used in the later 31 hips. Cemented all-polyethylene Exeter cups were used in 38 hips, and cementless Trident cups (Stryker, Warsaw [IN], USA) were used in 7 hips. All the operations were performed by the first 2 authors or under their supervision. Postoperatively, full weight bearing was allowed with walking aids for 6 weeks.

The Harris hip score was assessed pre- and post-operatively. Anteroposterior and lateral radiographs were taken. Stem alignment and axial subsidence of the stem were measured. Radiolucent lines around the femur were recorded at 14 Gruen zones.\textsuperscript{12} Completeness and thickness of the cement mantle and cement fractures were also noted. Ectopic ossification, if present, was graded according to the Brooker classification.\textsuperscript{13} All radiographic measurements were corrected for magnification, using the diameter of the prosthetic femoral head as a reference.

According to the Olsson definitions of stem loosening,\textsuperscript{14} any change of stem position combined with radiolucency at the cement-bone interface was defined as definite stem loosening. Pure stem axial subsidence in the cement mantle without radiolucency, metal-cement radiolucency of ≤1 mm confined to upper lateral third of the stem, and cement-bone radiolucency of ≤2 mm confined to the proximal third of the stem were considered as suspected stem loosening. Any non-progressive incomplete radiolucency of <1 mm in the cement-bone interface was not considered as loosening.

Results were compared using paired Student’s \( t \) test and Pearson Chi squared test, as appropriate. Survival rates of the femoral stem were calculated, using revision surgery for any cause or aseptic loosening as the end-point.

Figure 1 Small Exeter stems with 30 mm, 33 mm and 35.5 mm offset compared to the standard 37.5 mm offset stem.
RESULTS

The mean follow-up was 9 (range, 5–12) years. The mean Harris hip score improved from 37 (range, 13–61) to 80 (range, 47–96) [p<0.001]. At the latest follow-up, the score was excellent (90–100) in 8 (18%) of the hips, good (80–89) in 21 (47%), fair (70–79) in 9 (20%), and poor (<70) in 7 (16%). For the 7 hips with poor score, 6 belonged to functional class C and in one the Exeter acetabular cup was subsequently revised because of aseptic loosening. Clinical results were not significantly different between patients with and without avascular necrosis (p=0.928, Student’s t test).

Of these 45 hips, one Exeter cup was revised after 11 years because of aseptic loosening. One hip was revised with excisional arthroplasty after 11.5 years in a woman who had undergone the primary THA at the age of 72 years. At age 78 years, she had a squamous cell carcinoma of the vagina and was treated with tumour excision and radiotherapy. At age 83 years, she had osteolysis of the right acetabulum with pelvic discontinuity that was not evident one year earlier. She had no pain over her right hip and had a Harris hip score of 82. She was diagnosed as having osteoradionecrosis. Initially, the patient refused operation as she was asymptomatic. Subsequently, the acetabular cup became dislodged, although the femoral stem was well-fixed (Fig. 2). Excisional arthroplasty was performed in view of difficulty in revision, the patient’s age, and general condition. She had little pain and could walk with a frame after surgery.

On anteroposterior radiographs, 43 (96%) femoral stems were within 2º of neutral alignment, one stem was in 3º varus, and one in 5º varus. All hips had a complete cement mantle of ≥2 mm. All stems were inserted without intramedullary reaming. 11 (24%) hips developed stem subsidence of <2 mm; all stabilised within 2 years. These were considered as suspected loosening according to the Olsson classification. None of these patients had pain or other radiological signs of loosening. Six stems showed radiolucent lines of <1 mm in the upper zones but they were not progressive. No cement fracture or subsidence was noted.

There was no infection in these 45 hips. Deep vein thrombosis occurred in 4 patients. One hip dislocated anteriorly on day 6 and was treated with closed reduction and bracing. Ectopic ossification was detected in 6 hips; all were grade one according to the Brooker classification.

Using revision for any cause as an endpoint, the overall survival rate of Exeter small femoral stem was 100% at 10 years and 89% at 12 years (Fig. 3).
Using revision surgery for aseptic loosening as an endpoint, the survival rate was 100% at a maximum of 12 years.

DISCUSSION

The minimal cement mantle thickness should be 2 mm. For the 73 Exeter femoral stems with 37.5-mm offset used from 1986 to 1992, 36% of the stems were oversized with cement mantle thickness <2 mm. In some cases, intramedullary reaming was necessary to fit the smallest standard size implant. Some studies have reported good long-term results using both broaching and reaming in medullary canal preparation. Nonetheless, good long-term results have also been reported using broaching only to preserve the bone stock in the medullary canal and improve the cement interdigitation. In studies using cadaveric femurs, reaming decreases the bone-cement interface fixation strength. Broaching should only be used in medullary canal preparation for a cemented femoral prosthesis. Reaming together with an incomplete cement mantle gave a failure rate of 100% within 9 years. The use of an oversized femoral stem led to inadequate cement mantle thickness (<2 mm) and resulted in a stem failure rate of 9% at a mean follow-up of 13 years. The overall stem revision rate due to aseptic loosening was 22% at 13 years with the oversized implants. This was definitely higher than 1.6% stem revision rate due to aseptic loosening at a mean follow-up of 13 years. The use of small femoral stems avoids intramedullary reaming and provides room for a cement mantle.

In a series of Exeter small femoral stems with a mean follow-up of 9 years, the overall survival rate at 10 years was 96% and was 100% for aseptic loosening. There was no implant breakage.

According to the Harris classification, definite loosening of a cemented stem is defined as migration, or change in the position, of the stem or cement. Stem subsidence within the cement mantle as one criterion of loosening may not apply to the cemented femoral stems that are collarless, double-tapered, and have a polished surface. The ‘Exeter concept’ indicates that the distal movement of the femoral stem within the cement mantle is necessary in order to achieve optimum transmission of load into the cement and bone. Minor stem subsidence within the cement mantle produces a relative increase in compression and a reduction of shear at the stem-cement interface, within the cement, and at the cement-bone interface, and thus protects the cement-bone interface. Although the ‘Exeter concept’ remains controversial, clinical and radiographic results indicate that stem subsidence within the cement mantle alone is not a sign of loosening but protects the cement-bone interface. The superior results of a polish-surfaced stem over a matt-surfaced stem has also been reported. In a study comparing the subsidence of the Exeter polish-surfaced stem with the Charnley Elite stem (which has a small collar and matt surface), subsidence occurred only at the cement-implant interface in the Exeter polished stem, whereas it occurred at both the cement-implant and cement-bone interfaces for the Charnley Elite stem, although the extent of subsidence was smaller. If the subsidence occurred at the cement-bone interface, the cement-bone fixation might be interrupted and lead to failure. Moreover, for stems with a rough surface, subsidence at the cement-implant interface might generate small wear particles leading to osteolysis.

REFERENCES


