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Long Term Results With the Interlocking Uncemented Long Stem in Revision Hip Arthroplasty: A Mean 15-Year Follow-Up

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ABSTRACT

Stem fixation is difficult to achieve in severe proximal bone loss in revision hip surgery. In this study, we sought to present the results of distally-locked stem with screws (HUCKESTEP HIP stem) in 21 revision hips with mean follow-up period of 15 years. The preoperative mean Japanese Orthopaedic Association hip score had improved from 54 to 75 points. Further revisions were required for 2 stems, in one because of infection and the other because of screws fracture and subsidence. With removal of the stem for any reason as an end-point, the cumulative survival at 15 years was 90.4%. While this study had small number, the use of this interlocking stem for revision hips with extensive proximal bone defects provided satisfactory 15-year clinical and radiographic results.

Stem fixation is difficult to achieve in certain cases of femoral stem revision performed secondary to osteolysis or a periprosthetic femoral bone fracture because of the presence of extensive bone defects in the proximal femur. The HUCKSTEP HIP (B. Braun-Aesculap, Tuttlingen, Germany) system is derived from the titanium alloy intramedullary nail fixation designed for the treatment of femoral comminuted fractures by Huckstep et al in 1967 [1,2] and is composed of a distally locked stem with screws at the proximal and distal ends. This system has been used in cases of stem revision performed secondary to loosening or severe osteolysis at the proximal femur and in those in which proximal fixation is not feasible due to reasons such as a periprosthetic fracture. We conducted this study to establish the mid- to long-term clinical and radiographic results of the use of this interlocking femoral stem used in revision total hip arthroplasty with proximal femoral bone defects.

Materials and Methods

This study was approved by the local institutional review boards and performed in accordance with the ethical standards of the 2000 revised version of the Declaration of Helsinki (original version 1964). All patients provided informed consent for participation in the clinical trial. Between 1993 and 2002, we performed revision total hip arthroplasty in 50 patients. Among them, we used an interlocking femoral stem in 41 hips of 40 patients who had proximal femoral bone loss (Paprosky type 2 defect or higher) and in whom it was difficult to obtain proximal fixation. Patients who were lost to follow-up or who died were excluded. This was a consecutive series of unselected patients and included all patients undergoing this surgery.

The HUCKSTEP HIP stem (Fig. 1) is a straight stem made of a titanium alloy with a circumferential porous coating on the proximal surface of the stem. The stem is available in a diameter of 12.5 mm only and in 4 different lengths: 160, 210, 260, and 320 mm. The proximal stem section has 2 holes for 4.5-mm diameter screws running from anterior to posterior. At the distal stem section, the 160-mm long stem has 3 holes, and the rest have 6 holes running from lateral to medial, for screw insertion. This distal mechanism of fixation permits an exact restoration of lower limb length and provides the initial axial and rotational stability.

All surgeries were performed by one senior surgeon. Intraoperatively, the femoral implant was removed and the canal debrided of fibrous tissue, following which reaming was performed with flexible bone reamers and by gradually increasing their thickness to 13 mm in 1 mm increments. The reaming was performed using the mini C-arm image intensifier to ensure that the anterior cortex at the femoral bow was not violated. This was followed by rasping. The prosthesis holder and targeting instrumentation were fixed to the stem and introduced into the canal without strong hammering. Trial reduction was performed after positioning of the trial components to check for leg length, anteversion, and stability in all directions. Definitive components were then implanted. The proximal and distal screws were then locked using the targeting device. Finally, an adequate amount of bone graft was used to fill the bone defects in the medullary cavity (Fig. 1). The

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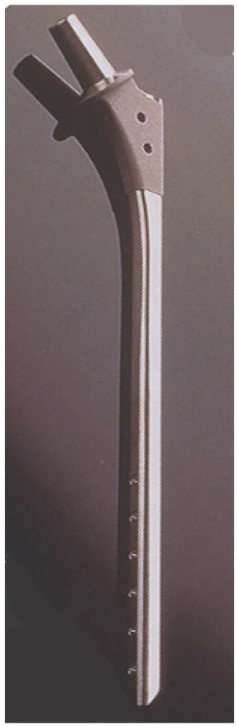

Fig. 1. Photograph of the HUCKSTEP HIP stem.

autologous bone grafts mixed with fresh-frozen allografts taken from femoral heads of other patients and apatite-wollastonite glass ceramic (AW-GC) were used in all hips to reconstruct the bone defects in the proximal femurs and medullary cavity. The fresh-frozen femoral heads were prepared by milling large particles in a bone mill and washing with AW-GC particles used as allografts. The bone grafting was performed according to the method described by Kim et al [3]. The morselized bone was packed into the bone defect as much as possible. Furthermore, the cortical autograft was held to the bone defect by steel wires, and the gap between the bone defect and cortical autograft was filled with the morselized cancellous autografts and allografts.

Postoperatively, partial weight-bearing was encouraged for 3 months and then more weight-bearing with crutch walking was recommended for the following 3 months. Full weight-bearing was permitted 6 months after surgery.

Clinical assessment was performed by two of the authors who were not the operating surgeon and who had over 20 years of experience. Additionally, they were blinded to the radiographic result at the time of the evaluation. Clinical assessment of hip joint function was performed preoperatively and at the most recent follow-up using the Japanese Orthopaedic Association (JOA) hip score [4]. The JOA Hip Score is a 100-point scale that comprises the subcategories of pain (0–40 points), range of motion (ROM; 0–20 points), ability to walk (gait; 0–20 points), and activities of daily living (ADL; 0–20 points). The maximum total score for a normal hip is 100 points, and high scores indicate better function. Patients with a good result achieved a score of $\geq$70 points. The final follow-up and preoperative scores were compared. Patients were carefully monitored for development of complications including dislocation, infection, fracture, sciatic nerve palsy, and deep venous thrombosis.

The most recent radiographs were reviewed and compared with the initial postoperative radiographs. Two experienced examiners who were not the operating surgeon and who were blinded to the patient characteristics reviewed all radiographs and made all radiographic observations. Standardized images of the hip with the femur in the anteroposterior and lateral planes were obtained with a standard tube to cassette distance of 115 cm. The degree of preoperative bone loss was recorded as described by Paprosky et al [5]. Radiographs were assessed for loosening, stable fixation, or bone ingrowth around the prosthesis based on criteria described by Engh et al [6]. Radiolucencies along the metal-bone interface were documented based on a modification of the method described by Gruen et al [7]. Stress shielding was assessed on the basis of bone density according to the criteria described by Moreland and Moreno [8]. Briefly, minimal stress shielding was indicated by little or no change in cortical density. Moderate stress shielding was indicated by significant and obvious loss of cortical density and thickness, whereas severe stress shielding was indicated by major, striking, and an impressive degree of bone loss. Cortical hypertrophy and osteolytic changes in cancellous bone density were recorded. Subsidence was measured using the Callaghan et al technique [9]. A movement of 3 mm or more was evaluated as subsidence, or alternatively, subsidence was regarded as definitely having occurred if the interlocking screws had broken. The osteotomy site in patients who had a bone fracture before surgery was considered as having healed radiologically if callus was seen bridging the site in the anteroposterior and lateral planes according to Chen et al [10]. The degree of stem filling was determined by the method developed by Mertl et al [11]. Stem filling was described as the ratio of stem diameter to femoral canal diameter 2 cm below the lesser trochanter, and referred to as the metaphyseal filling index (MFI). The presence or absence of screw fracture was determined. Failures were defined as stem removal, stem revision, stem migration over 5 mm, or extended osteolysis.

The data were stored until review by an independent blinded observer. Statistical analyses were conducted using the JMP 11 (SAS Institute Inc., Cary, NC, USA). The data were analyzed using the Wilcoxon rank sum test. The level of significance was set at $P < 0.05$. Survivorship was calculated using the Kaplan–Meier analysis, with removal of the component for any reason as the criterion for failure. Survivorship data and 95% confidence intervals (CI) are presented with $P < 0.05$ considered as being significant.

Results

Of the 40 consecutive patients (41 hips) enrolled, 2 were lost to follow-up, and 18 died of causes unrelated to the surgery. The remaining 20 patients (21 hips) were included in the study. A telephone interview with a standardized questionnaire, including the JOA score items, was conducted for 2 patients as they did not have a yearly follow-up visit and were not willing to come to the institution personally. Radiographic analysis could not be performed in these patients.

The study participants included 6 men and 14 men (mean age at surgery, 62 years [range, 26–74]) with a mean follow-up duration of 15 years (range, 12–20). The diagnosis at the time of the primary hip replacement in these patients was developmental dysplasia of the hip in 14 patients (15 hips), fracture in 4 patients (4 hips), and femoral head necrosis in 2 patients (2 hips). Nineteen patients (20 hips) had undergone only 1 hip arthroplasty in the same hip before the revision and 1 patient (1 hip) had undergone 2 previous arthroplasties. The indication for the index revision was aseptic loosening of the cemented total hip arthroplasty in 11 hips (both components in 10 hips and only femoral component in 1 hip), failed hemi-replacement arthroplasty in 7 hips (aseptic loosening of the stem with migration), infected cemented bipolar prosthesis in 1 hip, and peri-prosthetic and prosthetic fracture in 2 hips. The length of the HUCKSTEP HIP stems used in the present study was 160 mm in 3 hips, 210 mm in 3 hips, and 260 mm in 15 hips. Both the femoral and the acetabular components were revised in 20 hips, and only the femoral component was revised in 1 hip. Exposure was achieved using a transfemoral osteotomy in 3 hips and a posterolateral approach in the remaining 18 hips. A transverse osteotomy for the correction of angular deformity in the diaphysis was performed in 4 hips. The bone defects in the medullary cavity were grafted with autologous bone chips and artificial bone granules in 11 hips, with allograft and artificial bone granules in 8 hips, and with only artificial bone in 2 hips (Fig. 2).