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Midterm Results of a Femoral Stem With a Modular Neck Design: Clinical Outcomes and Metal Ion Analysis

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ABSTRACT

Modular neck femoral stems have a higher-than-anticipated rate of failure in registry results, but large single-center cohort studies are lacking. This is a retrospective cohort of 152 hips implanted with a single titanium stem with a modular titanium neck, presenting clinical, radiographic, and metal ion results at a mean 4.5-year follow-up. Five hips were revised during the study period, for an overall Kaplan–Meier survival of 0.894 at 8 years. There was one modular neck fracture (0.66%), but others demonstrated corrosion or adverse tissue reaction. Serum metal levels demonstrated wide variability. Despite good clinical results in the majority of patients, we confirmed an increased rate of femoral revision at mid-term follow-up, and therefore urge caution in the use of this particular stem design.

Femoral stems that feature a modular neck allow for increased options for adjustments in offset, length, and version, which can be made independent of femoral fixation. Although several studies have reported excellent short-term clinical results with the use of these stems [1–4], the additional modular junction creates a number of new concerns, including the potential for fracture [5–12] and dissociation [13,14] of the modular neck. There is also a risk of corrosion at the neck–body junction, [15–19] which has the potential to cause significant adverse local tissue reactions (ALTR) secondary to the generation and release of metal ions and debris from this junction [16,20,21]. The Australian Orthopaedic Association's National Joint Replacement Registry (AOANJRR) documented a 7.4% revision rate at 5 years across these stem designs, increasing to 10.6% by 10 years, which is approximately two-fold higher than the failure rate of similar monolithic femoral stems [22]. This discrepancy may be related to some of these failure modes discussed.

The Profemur Z stem (Wright Medical Technology (WMT); Arlington, TN) was among the first modular neck stem designs introduced in the United States. There have been a number of case reports of modular neck fracture in this design [5–8,10,12] but to date there has been no large cohort study that has investigated outcomes of this stem. The purpose of the current study was to evaluate mid-term results of this stem design in a large cohort of patients, and report clinical and radiographic results, metal ion analysis, and survivorship.

Materials and Methods

Between May 2003 and March 2010, 195 total hip arthroplasties (THA) were performed in 176 patients by the lead author (*author initials blinded*) using the Profemur Z uncemented stem. This stem was used in all 193 primary THA procedures and two revision THA procedures performed by the senior author over this time period.

The Profemur Z stem is a dual-tapered titanium alloy stem (Ti-6Al-4 V) with a rectangular cross-section that is implanted via a broach-only technique (Fig. 1), and comes in 9 sizes ranging from 126 mm to 166 mm in length. The surface is corundum blasted to a roughness of approximately Ra 8 μ. It offers a modular neck–body junction, with 12 different neck options; ten of these modular necks can be inserted in one of two different orientations, giving a total of 22 unique neck options (Table 1). Straight necks create a 135° neck–shaft angle, while varus/valgus neck options can alter this by 8° in either direction (to 127° or 143°, respectively). Anteverted/retroverted neck options can alter version by 8° or 15° in either direction. Finally, there are options that combine anteversion/retroversion with a varus/valgus shift. The neck has a 12/14 SLT taper that allows attachment of the modular head. Over the study period, only titanium alloy necks were used, although cobalt chromium alloy necks later became available from the manufacturer.

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Of the 176 patients implanted with this stem, 12 died from factors unrelated to their hip surgery, but all hips were functioning well at the time of their death. Additionally, 13 were lost to follow-up and unable to enroll in the study. Of the 151 patients who were successfully contacted, 13 declined to participate for various reasons (poor health, relocation, no access to transportation, or no perceived problems with their hip); all reported that their hip was still functioning well. One patient who had a revision THA performed following girdlestone resection arthroplasty for chronic infection was excluded from analysis. Thus, a total of 137 patients (152 hips) were enrolled in the study and completed were able to complete a full clinical assessment (Fig. 2). Institutional Review Board (IRB) approval was obtained prior to initiation of this study, and written consent for participation was documented for every patient.

The study group consisted of 60 men and 77 women with a mean age of 59.5 years (range, 20 to 87 years) and a mean body-mass index (BMI) of 32.1 kg/m^2 (range, 16.4 to 46.7 kg/m^2). Of the 152 surgeries, twelve (7.9%) were performed for avascular necrosis, two (1.3%) were performed for rheumatoid arthritis, and one was performed for a failed primary THA (0.7%); the remaining 137 cases (90.1%) were performed for end-stage osteoarthritis.

Table 1
Modular Neck Options Used in the 152 THA Procedures.

Modular Neck Option	Number (%)
Neutral	
Short	33 (21.7%)
Long	5 (3.3%)
Varus/Valgus	
Short[a]	2 (1.3%)
Long[a]	1 (0.7%)
Ante/Retro 8°	
Short[a]	45 (29.6%)
Long[a]	17 (11.2%)
Ante/Retro 15°	
Short[a]	17 (11.2%)
Long[a]	8 (5.2%)
Ante/Retro–Varus/Valgus 1	
Short[a]	7 (4.6%)
Long[a]	7 (4.6%)
Ante/Retro–Varus/Valgus 2	
Short[a]	9 (5.9%)
Long[a]	1 (0.7%)

[a] Indicates the modular neck can be inserted in one of two orientations, which allows different ultimate stem geometries.

Operative Details

A posterior approach was used in 144 cases and a direct lateral approach was used in 7 cases. In one case, an anterior approach was attempted but was converted to a posterior approach after an iatrogenic greater trochanter fracture. The senior author performed all operations. The appropriate-sized stem was indicated by preoperative templating and determined intraoperatively by fit of the broach. The appropriate neck and head were selected based on a combination of preoperative templating and intraoperative testing of leg length, soft tissue tension, and hip stability. The neck options selected are listed in Table 1. Adapter sleeves were not used in any cases.

The acetabular components were all press-fit noncemented cups, but a variety of designs were used, including Lineage (WMT) in 34 hips (22%), Dynasty (WMT) in 98 hips (64%), Conserve (WMT) in 19 hips (13%), and Trilogy (Zimmer; Warsaw, IN) in 1 hip (1%). Both the Lineage and Dynasty shells are hemispherical titanium alloy (Ti-6Al-4 V) shells. The Conserve component is a monoblock Co-Cr-Mb alloy component with a porous coating of sintered beads. In general, usage of the Lineage shells preceded that of Dynasty shells, while the Conserve shell was used selectively at the senior author's discretion. The Trilogy cup was used in the single revision procedure at the discretion of the surgeon.

The choice of bearing surface was left to the senior author's discretion, and evolved with time. A number of different bearing surface combinations were used over the study period, including metal-on-polyethylene (MoP), metal-on-metal (MoM), ceramic-on-ceramic (CoC), and ceramic-on-polyethylene (CoP) combinations (Table 2). Two different polyethylenes were utilized over the study period. Duramer is a non-highly cross-linked ultra high molecular weight polyethylene (UHMWPE) that is gas-sterilized in ethylene

Fig. 1. The Profemur Z stem (WMT; Arlington, TN) is a dual-tapered Ti-6Al-4 V alloy stem with a corundum blasted surface and a modular neck–body junction.

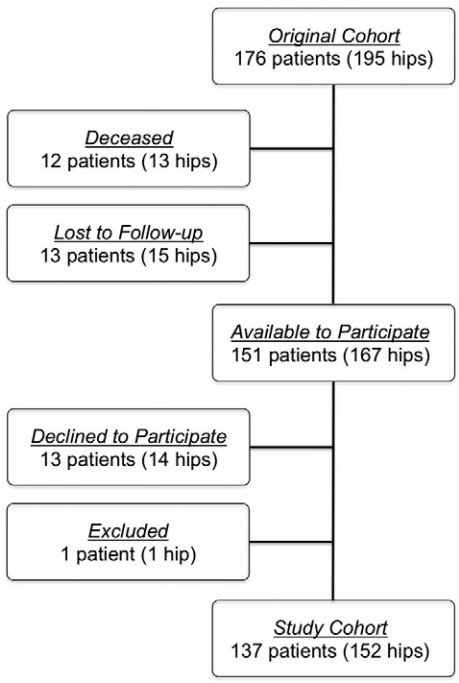

Fig. 2. Flow diagram of the patients eligible for inclusion in the study.