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The Wagner Cone Stem for the Management of the Challenging Femur in Primary Hip Arthroplasty

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ABSTRACT

Background: Splined conical stems offer design features that facilitate their use in the misshapen, dysplastic proximal femur.
Methods: This study assessed the survivorship of a conical prosthesis when applied to secondary coxarthrosis because of a range of pathologies. Fifty-one prostheses were implanted in 50 patients with a mean age of 50 (range, 15-80) and a median follow-up of 34 months (range, 24-73 months). Indications for the stem included developmental (36), neuromuscular (7), post-traumatic or surgical (7), and inflammatory conditions (1). Survivorship, functional outcome (WOMAC [Western Ontaria and McMaster University Osteoarthrits Index], Oxford Hip Score, and UCLA [University of California Los Angeles]), health status (short form-12 [SF-12]), satisfaction, and osseointegration were determined.
Results: Survivorship for aseptic loosening was 100% at 2 years and 98.04% for septic revision. Eight patients required reoperation, 4 for instability, and 1 each for infection, impingement, adverse reaction to metal debris, and pelvic insufficiency fracture. The mean WOMAC score was 85 (standard deviation [SD], 18), the mean Oxford Hip Score 84 (SD, 18), the mean physical SF-12 score was 48.3 (SD, 8.6), and the mean mental SF-12 was 53.7 (SD, 9.2), the mean satisfaction score was 91.5 (SD, 3.9), and the mean UCLA was 6 (SD, 1.6). All femoral components demonstrated osseointegration.
Conclusion: The cone femoral prosthesis demonstrates excellent early survival and osseointegration when applied to the challenging femur. Because of these encouraging results, we recommend this prosthesis be considered for the small, abnormal femur in primary hip arthroplasty.

A number of congenital, developmental, or acquired abnormalities of hip development can lead to distorted anatomy of the proximal femur after skeletal maturity. These include developmental dysplasia, neuromuscular disorders, as well as infection, injury, or surgical intervention in early childhood, to mention just a few. The following anatomic variations may follow, alone or in combination, in these settings: undersized femoral neck or canal, excessive varus or valgus angulation, abnormal version, and limited horizontal offset [1,2]. If hip joint arthroplasty is later required, these deformities may prove to be challenging to manage because standard stems cannot be easily accommodated by the undersized, deformed femur. Instead the surgeon needs to consider specialized designs, modularity, or customized manufacture [3-5].

The Cone prosthesis (Zimmer-Biomet, Warsaw, IN), developed by Wagner H and Wagner M [6], was designed to address many of these issues. Meant for cementless fixation, it is a Protasul-64 titanium alloy stem with a corundum-blasted surface with a mean surface asperity height of 5 μm, a 5° taper, and 8 longitudinal flutes distributed around the circumference and length of the stem. The presence of the flutes results in high contact pressures between the stem and endosteal bone, which confers rotational stability [7-9]. The relatively high conical taper leads to taper-lock axial or vertical stability. The cylindrical design allows for “dial-in” selection of anteversion, permitting correction of torsional abnormalities affecting the proximal femur. In addition, it has a reduced

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horizontal offset to accommodate the limited offset encountered in so many of the congenital and acquired deformities encountered in this group of patients.

Implantation is relatively straightforward. The medullary canal is prepared with a series of conical reamers of increasing size instead of the angular-shaped rasps and broaches used for more conventional femoral stems. These features of the implantation system and final stem have expanded the indications for the cone prosthesis to include the undersized, cylindrical femur seen in congenital dislocation and dysplastic coxarthrosis, congenital coxa vara, deformation and intramedullary bony scarring of the proximal femur resulting from previous osteotomies, fractures or growth disturbances, and congenital deformities [10-12]. It is easily adapted to deformities relating to neuromuscular disorders as well, such as cerebral palsy, poliomyelitis, and spina bifida. Many of these entities also have a reduced horizontal offset—another attractive feature of the stem design.

Initial reports have demonstrated excellent results in both the short and medium term with the Cone prosthesis [6,13,14]. Longer term survivorship of 91.5% at a mean of 11.5 years [12] has been reported. This represents an improvement on previous studies in this difficult cohort of patients [15-17]. To date, most published outcome studies have either been from the designer center or include cases treated by one of the designer surgeons [6,9,12]. Reports of its use and outcomes in the North American centers have not been well documented.

The aims of this study were to report the radiological, clinical, and patient-reported outcomes of the Wagner cone femoral prosthesis when applied to the challenging femur resulting from a breadth of underlying conditions in the largest series from a North American institution.

Materials and Methods

To assess the use of the implant in the context of "the challenging femur," inclusion to the study was restricted on the basis of preoperative diagnosis. As previously described, this included coxarthrosis secondary to dislocation and dysplasia, coxa vara, Legg-Calve-Perthes disease, skeletal dysplasia (multiple or spondyloepiphyseal types), previous hip fusion (Fig. 1), juvenile rheumatoid arthritis, and previous trauma requiring proximal femoral instrumentation.

The study population comprised 51 prostheses implanted in 50 patients between July 2007 and April 2012. Thirty were females, and the median age was 50 years (range, 15-80 years). The indications for hip arthroplasty are listed in Table 1. Previous surgery had been performed in 15 hips and comprised pelvic osteotomy in 4, femoral osteotomy in 7 (Fig. 2), hip arthrodesis or attempted arthrodesis in 3, instrumentation of the proximal femur after trauma in 1, and trochanteric advancement and limb lengthening in 1.

Of the 50 patients included in the study, 49 were alive at final follow-up, 1 patient having died of an unrelated condition but after completion of radiographic and patient-reported outcome. The median duration of follow-up was 34 months (range, 24-73 months). The decision to use the prosthesis was surgeon dependent but was based on preoperative templating where the proximal femoral morphology was felt to preclude a conventional, proximally flared, metaphyseal loading uncemented implant, and when the narrow diameter of the femoral medullary canal would not allow insertion of a cemented component with a satisfactory cement mantle. The implant was also chosen when correction of femoral torsion was required to accurately restore proximal femoral anatomy and hip joint mechanics and in cases where a preexisting reduced horizontal offset required a similar offset in the stem design (Fig. 3).

A posterolateral approach was used in 48 hips, whereas in 3 cases of either arthrodesis takedown or failed arthrodesis, a trochanteric osteotomy was used. After dislocation of the femoral head, the femoral neck was osteotomized at a distance from the lesser trochanter determined during preoperative templating. Implantation of the acetabular component proceeded in a conventional fashion taking into consideration the altered morphology of the acetabulum and, when required, the increased risk of postoperative instability due to preoperative neuromuscular imbalance. The medullary canal was identified with a cavity probe, and the presence of obstruction identified, for example, cortical bars from previous proximal femoral instrumentation or osteotomy. A tapered conical reamer was then introduced in the long axis of the femur. Serial reaming was performed to dilate the medullary canal and was completed when significant resistance was encountered at an appropriate penetration depth as measured from the head-center mark on the reamer. Prostheses are available in a range of diameters from 13 to 24 mm with increasing horizontal offset and 2 neck-shaft angles (125° or 135°). Trial reduction was undertaken with the appropriately sized prosthesis, the surgeon

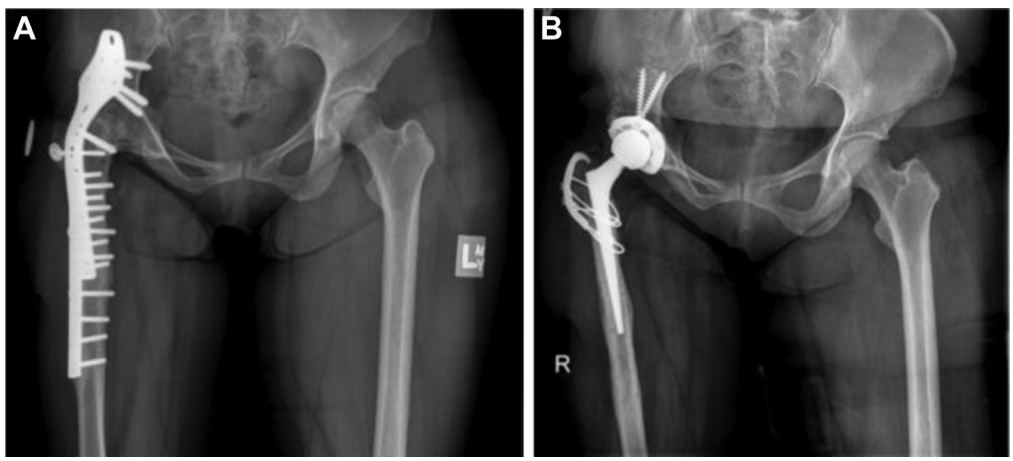

Fig. 1. The case of a patient presenting with low back pain attributed to a previous successful right hip arthrodesis for the treatment of secondary coxarthrosis because of septic arthritis in childhood. A subsequent fracture was treated with open reduction and fixation: (A) preoperative radiograph demonstrating evidence of significant deformity of the proximal femur; (B) postoperative radiograph with evidence of integration of both femoral and acetabular components and union of the trochanteric osteotomy.