Cone femoral prosthesis for osteoarthritis of the hip with femoral dysplasia

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ABSTRACT

Purpose. To assess the clinical and radiological outcomes of total hip replacement (THR) using the cone femoral prosthesis.

Methods. Four men and 15 women (26 hips) aged 19 to 78 (mean, 45) years underwent THR for osteoarthritis of the hip with femoral dysplasia using the cone femoral prosthesis. Only 17 patients (24 hips) were available for review. Pain and functional limitation were assessed using the Oxford hip score. Stable fixation by bone ingrowth was defined as no subsidence or radiolucent lines around the prosthesis.

Results. The mean follow-up duration was 50 (range, 25–92) months. The mean Oxford hip score improved from 44 (range, 32–54) preoperatively to 17 (range, 12–28) at the latest follow-up. Prosthesis survival was 100%. All prostheses showed stable integration with bony ingrowth and no measurable subsidence. 15 hips had excessive anteversion of 25º to 90º. No patient had venous thromboembolism, deep prosthetic infections or dislocations.

Conclusion. The cone prosthesis is less complex and expensive than the modular prosthesis. The early functional and radiological outcomes were excellent, with marked improvement in pain and function. This constitutes effective treatment for osteoarthritis of the hip with femoral dysplasia.

Key words: arthroplasty, replacement, hip; hip dislocation, congenital; hip prosthesis; osteoarthritis

INTRODUCTION

Total hip replacement (THR) improves quality of life (in terms of pain and mobility) in patients with osteoarthritis. Patients with femoral dysplasia pose difficulties with respect to THR, because they are usually younger and the femoral morphology varies greatly. Dysplastic femora are more anteverted (10º–
14º) than femora in healthy age- and sex-matched subjects. The anteversion is secondary to torsion between the femoral isthmus and lesser trochanter. The cross-section of the medullary cavity remains anteverted even after osteotomy of the femoral neck, forcing conventional prosthetic stems into excessive anteversion. The medullary canal is also narrow and straight. Placement of a conventional prosthesis with its proximal flare may lead to inadvertent fracture of the proximal femur. The narrow canal allows only a thin mantle of cement for femoral stems and may lead to early failure.

The cone prosthesis is a modification of the Wagner revision stem designed to overcome the limitations of conventional prostheses in femoral dysplasia. It is a non-cemented femoral component with a conical shape and cone progression angle of 5º. The lack of a proximal flare enables placement within the narrow medullary cavity. A circular cross-sectional area enables intra-operative correction of excessive version in the femur. When the prosthesis is fully seated, 8 longitudinal ribs spaced along the circumference of the stem provide high-pressure contact areas with the cortical bone, thus achieving optimal rotational stability for primary fixation. Fixation of the stem is diaphyseal in nature and the prosthesis is made of tissue-compatible titanium-aluminium-niobium alloy with a grit-blasted surface that promotes osseointegration. The use of the cone prosthesis is reported to produce good results.

Figure 1 Intra-operative measurement of version. After femoral neck osteotomy, the leg is placed in a vertical position (A) over the operating table. A perpendicular line to that of the leg (B) is drawn and the neck anteversion (C) is assessed. The femoral neck is 50º anteverted in this patient.

MATERIALS AND METHODS

Between September 1998 and September 2004, 4 men and 15 women (26 hips) aged 19 to 78 (mean, 45) years underwent THR for osteoarthritis of the hip with femoral dysplasia using the cone femoral prosthesis. Two men and 5 women underwent staged bilateral THR. Two patients were lost to follow-up; the remaining 17 patients (24 hips) were reviewed.

Of the 17 patients, 12 had congenital hip dislocation, one had post-traumatic osteonecrosis of the femur with an abnormal femoral morphology, 4 had dysplasia each associated with another pathology, namely: juvenile chronic arthritis, craniocleidal dysplasia, achondroplasia, or a generalised connective tissue disease causing global ligamentous laxity. These conditions were not specifically associated with femoral dysplasia, but the morphology of their femora was characteristic of dysplasia and unsuitable for conventional prostheses. The 12 patients with congenital hip dislocation had undergone previous surgeries, including open reduction (5 hips), closed reduction (1 hip), femoral osteotomy (3 hips), and pelvic osteotomy (5 hips).

In 5 hips the trochanter was osteotomised to facilitate exposure and advance the trochanter; the remaining 19 hips were approached laterally. The femoral neck was osteotomised to expose the acetabulum. Version was assessed intra-operatively. With the leg vertical over the side of the operating table, the angle between the midpoint of the neck cut and a perpendicular line to the leg axis was measured using a goniometer (Fig. 1). The acetabulum was prepared and the appropriate acetabular component and liner was implanted anatomically. The femur wasreamed using conical T-handled reamers. The implant size was based on the size of the final hand reamer used. The cone prosthesis was then impacted into the femur with appropriate adjustment for version.

After implantation of the acetabular components, 10 acetabula received morsellised bone grafting to the superior defect. Four hips had structural autografting to the acetabulum. All hips were placed in the native acetabulum. One hip underwent femoral shortening to enable location of the prosthetic hip. One hip had a posterior acetabular wall fracture and underwent internal fixation with two 6.5-mm cannulated screws.

All acetabular components were non-cemented and included 17 Allofit cups (Centerpulse Orthopedics, Winterthur, Switzerland), 3 Fitek cups (Centerpulse Orthopedics, Winterthur, Switzerland), 2 Trilogy cups (Zimmer, Warsaw [IN], USA), and 2
Mallory cups (Biomet, Warsaw [IN], USA). 22 stems were implanted with a 28-mm head and 2 with a 22-mm head. All heads were made of cobalt chromium and mated to either a polyethylene (19 hips) or metasul acetabular liner (5 hips). The size of the femoral component used ranged from 13 to 21 mm (Table 1).

Postoperatively, partial weight-bearing exercises were prescribed for 6 weeks and progressed to full weight bearing based on individual assessment. Patients were evaluated clinically and radiographically before and after surgery (at 6 weeks, 3, 6, and 12 months), and annually thereafter. Pain and functional limitation during the preceding 4 weeks were assessed using the Oxford hip score, which was derived from a 12-part questionnaire; each question had 5 possible graded responses. A higher score indicated increased pain and disability; overall scores ranged from 12 to 60.

Vertical migration of the component was measured visually on plain anteroposterior radiographs of the hip. Reference was made by drawing a horizontal line at the level of the tip of the lesser trochanter. Another horizontal line was made at the level of the shoulder of the prosthesis and the distance between the 2 lines measured. The integration of the femoral component within the medullary cavity was assessed radiographically. Stable fixation by bone ingrowth was defined as no subsidence or radiolucent lines around the prosthesis.

**RESULTS**

The mean follow-up duration was 50 (range, 25–92) months. The early functional and radiological outcomes were excellent. There were marked improvements in pain and function as shown by the Oxford hip scores, which were comparable to those achieved with conventional prostheses for primary osteoarthritis. Prosthesis survival was 100%, with no impending failures on radiographic and clinical evaluation. All prostheses showed stable integration by bony ingrowth (Fig. 2), with no measurable subsidence.

The mean preoperative and latest Oxford hip scores were 44 (range, 32–54) and 17 (range, 12–28), respectively. Scores for all 12 items of the questionnaire decreased by a mean of 2. The mean score for pain was 5 (severe in 13 patients and moderate in 4) preoperatively and improved to 2 (range, 1–3) at the latest follow-up. No patients complained of thigh pain, conceivably attributed to the rotationally stable design of the cone stem.

15 hips had excessive anteversion of 25° to 90°.
Table 2
The 15 hips with anteversion

<table>
<thead>
<tr>
<th>Hip No.</th>
<th>Anteversion</th>
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<tbody>
<tr>
<td>1, 2</td>
<td>60°, 70°</td>
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<tr>
<td>3</td>
<td>45°</td>
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<tr>
<td>4, 5</td>
<td>50°, 50°</td>
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<td>6</td>
<td>45°</td>
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<tr>
<td>7</td>
<td>45°</td>
</tr>
<tr>
<td>8, 9</td>
<td>45°, 45°</td>
</tr>
<tr>
<td>10</td>
<td>30°</td>
</tr>
<tr>
<td>11, 12</td>
<td>25°, 25°</td>
</tr>
<tr>
<td>13, 14</td>
<td>30°, 30°</td>
</tr>
<tr>
<td>15</td>
<td>90°</td>
</tr>
</tbody>
</table>

There were 4 complications. One patient developed a neuropraxia of the common peroneal component of the sciatic nerve resulting in foot drop, which later resolved. Another developed a superficial wound infection, which resolved with washout and drainage. One patient developed a transient psychosis in the immediate postoperative period. One patient sustained a delayed femoral periprosthetic fracture (Vancouver type 3) through a screw hole and underwent internal fixation using a plate, screws, and a bone graft. The corresponding cone prosthesis remained solidly fixed. No patient endured venous thromboembolism, deep prosthetic infection or dislocation.

DISCUSSION

In the 70s, reconstruction for late-presenting congenital hip dislocation was not indicated. Conventional femoral prostheses have provided poor and unpredictable results. With the advent of femoral components specifically designed to accommodate the dysplastic femur, results have been more encouraging. The success of the operation lies in correct preoperative planning, which ensures that the morphology of the selected femur guarantees contact between the bone cortex and the middle third of the prosthetic stem. Operative techniques and specific indications for different types of hip dysplasia have been reported.

Our study compares favourably with other studies using conventional femoral stems with similar follow-up duration. The cone prosthesis is a non-modular structure and therefore less expensive. It obviates the complexities and potential costs incurred with highly modular femoral components, such as the S-ROM.

Despite wide variation in the femoral version, the cone prosthesis can be inserted in the desired position without compromising the proximal bone. It is rotationally stable once seated. The fluted stem has a similar design to the cone prosthesis, and is the most rotationally stable non-cemented stem (comparable to cemented implants).

Primary stability of the prosthesis is a prerequisite for secondary stability by bony ingrowth. This enables adaptation of the implant bed with regard to load transfer at the bone implant interface.

A 95% 10-year prosthetic survival can be predicted at the 2-year follow-up so long as there are no radiolucent lines ≥2 mm around the prosthesis and it has not migrated ≥2 mm distally. The prosthetic survival of our patients was comparable to those studies; to date no patient showed evidence of loosening/radiolucent lines or measurable subsidence. However, our patients were younger and likely to have higher levels of activity than those with primary osteoarthritis of the hip. Conceivably, higher levels of activity could reduce survival of their prosthesis. In addition, there is about a 5-mm margin of error in the evaluation of subsidence, and we could not confidently conclude that there was no subsidence of ≥2 mm. In a study investigating the micro-migration of the cone prosthesis in 14 hips using radiostereometric analysis, the mean subsidence at 5 years was 0.27 mm, which indicates that the cone prosthesis is vertically stable.

REFERENCES