Uncemented primary press-fit total hip arthroplasty: a 3 to 6 years of experience

S Vidyadhara, SK Rao
Trauma and Joint Replacement Services, Department of Orthopaedics, Kasturba Medical College, Manipal, 576 104, Karnataka, India

ABSTRACT

**Purpose.** To analyse the 3 to 6 years’ clinicoradiological outcome of 45 uncemented total hip arthroplasties performed in 37 patients using cementless Spotorno stem and St Nabor cup.

**Methods.** The main indications for surgery were avascular necrosis of the femoral head and rheumatoid arthritis. Younger patients with good bone quality and a trumpet-shaped femur were eligible. A single surgeon performed all the operations using a posterolateral approach. Patients were reviewed at 6 weeks, 3 months, 6 months, and yearly thereafter. The clinical status was recorded using the Harris Hip Score. All radiographs were analysed by 2 independent blinded observers on 2 separate occasions.

**Results.** The mean follow-up period was 49 months and the mean Harris Hip Score at the latest follow-up was 94. Osseointegration in the form of trabeculae running from the endosteum to the prosthesis surface along with tropism of the calcar was evident in 73% of the hips. None of the remaining hips showed any continuous radio-opaque lines suggestive of a lack of bone ongrowth. Patients with endosteal condensation had better Harris Hip Scores. Intra-operative stability of the implants could fairly predict outcome.

**Conclusion.** Initial clinicoradiological results of uncemented total hip arthroplasty are promising in younger patients with good bone quality and a trumpet-shaped femur.

**Key words:** arthroplasty, replacement, hip

INTRODUCTION

Uncemented total hip arthroplasty (THA) has gained popularity particularly among younger patients, because of the simplicity of surgery, preservation of bone stock, and longevity of the implants. The first generation of uncemented femoral components had a high incidence of osteolysis, thigh pain, aseptic loosening, and need for revision. The newer generation has a tapered design that achieves primary press-
fit fixation in the proximal femoral diaphysis with load transmission comparable to that of the normal femur.\textsuperscript{2–6} The rationale for tapered stems is based on a self-locking principle, low modulus of elasticity, and fixation in the proximal femoral diaphysis.

The cementless Spotorno (CLS) stem is straight with a continuous medial arch and an undersized tip to prevent distal cortical fitting (Fig. 1a). This prevents the stress riser effect at the tip. Primary stability is accomplished by supporting the proximal stem in a retained bed of both cortical and trabecular bone. St Nabor cup is a pure titanium shell with a polyethylene liner. It has a flattened hemispherical shape with sharp edged barbed overlaps and polar circular cutting ring segments (Fig. 1b). Both components have rough blasting of small corundum particles on their surfaces. The press-fit fixation provides primary mechanical stability till secondary biological osseointegration (bone ongrowth) occurs.

We report our experience and clinicoradiological results of 45 uncemented THAs performed in younger patients with good bone quality and a trumpet-shaped femur.

### MATERIALS AND METHODS

Between January 1999 and July 2002 inclusive, 45 uncemented hip arthroplasties were performed on 37 patients using a CLS stem and St Nabor cup at the Kasturba Medical College, India. The mean age of the 31 male and 6 female patients was 45 (standard deviation [SD], 6; range, 28–59) years. Eight patients underwent bilateral surgery while operations on 22 of the remaining 29 hips were on the right side. The mean preoperative Harris Hip Score (HHS) was 43 (SD, 10; range, 31–100). One patient with a preinjury HHS of 100 had sustained a posterior fracture dislocation of the hip (Pipkin type 2). Avascular necrosis of the femoral head was the commonest indication for surgery (Table).

The Spotorno score was calculated by adding points given for factors such as the patient’s age and sex, osteoporosis (Singh’s index), and the anatomy of the femur (morphocortical index).\textsuperscript{2} One point was added for patients on steroid therapy prior to surgery. Patients with a score of <5 were eligible for uncemented THA. The mean Spotorno score of our patients was 3.5 (SD, 0.7; range, 2–5).

A single surgeon performed all the operations using the posterolateral approach. Femoral neck osteotomy was performed according to the preoperative templating. The acetabulum was reamed to a size 1 mm less than that of the St Nabor metal shell or till the subchondral bone was seen. The acetabular shell was then impacted into position over the bone grafts collected from the reamed material. The stability of acetabular cup seating was assessed intraoperatively before the handle was removed. All the acetabular cups were fixed with 2 or 3 screws over the washers for additional stability. The polyethylene insert was then threaded into the shell. The femoral canal preparation began by removing the remaining bone from the lateral neck at the base of the greater trochanter. A thin tapered reamer was passed down the canal. Wedge-shaped broaches with slightly prominent regions in the areas of the flutes were impacted into the canal using a mallet. When the first broach was seated partway, the anteversion of the broach was measured with respect to the tibial shaft. Broach size was increased to the anticipated size from preoperative templating or until solid seating was perceived. If the broach position was as expected from the preoperative templates, the broach handle was removed and a trial reduction of the hip was carried out. The implant corresponding to the final broach size was selected and manually inserted into the femoral canal. The sound during stem impaction changed as the implant seated onto cortical bone. The

<table>
<thead>
<tr>
<th>Diagnoses</th>
<th>No. of hips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avascular necrosis of femoral head</td>
<td>13</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>9</td>
</tr>
<tr>
<td>Ankylosing spondylitis</td>
<td>6</td>
</tr>
<tr>
<td>Femoral neck fracture with complications</td>
<td>6</td>
</tr>
<tr>
<td>Primary osteoarthritis of hips</td>
<td>4</td>
</tr>
<tr>
<td>Fracture dislocation of hip with secondary degenerative arthritis</td>
<td>2</td>
</tr>
<tr>
<td>Developmental dysplasia of hip with arthritis</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
</tr>
</tbody>
</table>

Table

Preoperative indications for surgery
impaction of CLS stem was found to achieve a stable interference fit in the proximal femur.

The patient who had a posterior fracture dislocation of the hip (Pipkin type 2), impression fracture of the acetabulum, and sciatic nerve palsy underwent primary excision arthroplasty followed by an uncemented THA 3 weeks later. Three weeks of upper tibial pin traction after excision arthroplasty resulted in a 10° flexion deformity of the knee which was corrected with stretching exercises. For patients with dysplastic hips, the teardrop was used as an intra-operative landmark for positioning of the cup. Another patient who had an un-united trochanteric fracture for 2 years and a failed dynamic hip screw in situ underwent implant removal and uncemented THA.

Patients were allowed toe touch weight bearing for 6 weeks and then progressive weight bearing as tolerated. Most patients used crutches for 6 weeks and then advanced to a walking stick. Full weight bearing was allowed after 3 months. Patients were reviewed at 6 weeks, 3 months, 6 months, and yearly thereafter. Clinical status was recorded using the HHS. Limp was described as mild when detected only by a trained observer, moderate if apparent to an untrained observer, and severe. Standard anteroposterior and lateral radiographs were taken at each follow-up by a single radiographer; the X-ray tube was placed 90 cm away from the patient and centred over the pubic symphysis with both patellae facing the ceiling. Cross table translateral projections were used for the lateral radiographs.

The acetabular cup was analysed on the immediate postoperative radiographs with respect to containment (partial/complete), orientation (neutral/horizontal/vertical), version (anteversion/retroversion), and distance of the teardrop from its medial edge. The CLS stem was studied with respect to its position (varus/valgus/vertical), version (anteversion/retroversion), canal fill ratio, and level of the lesser trochanter compared to the ischial tuberosity. At intervals of 1 cm, the canal fill ratio was measured as the mean ratio of stem diameter to the canal diameter at the corticocancellous junction in the metaphysis and diaphysis. The follow-up radiographs were evaluated for radiolucent lines in the Gruen zones for the stem and in the DeLee and Charnley zones for the cup. Any bone ongrowth and stress shielding was recorded. Endosteal reaction was carefully assessed with a specific note on condensation or atrophy. Vertical subsidence of the stem was measured directly from serial anteroposterior radiographs by measuring the distance between the trochanter tip and the stem shoulder.

All radiographs were analysed on 2 separate occasions, by 2 independent observers blinded to the study. The inter-observer agreement between the 2 observers was moderate (kappa=0.63) and the intra-observer agreement between the 2 occasions was good (kappa=0.78).

RESULTS

Clinical results

The mean follow-up period was 49 (SD, 7; range, 36–63) months. The mean HHS at one-year follow-up was 93 (SD, 4; range, 86–99), at 2-year follow-up it was 96 (SD, 3; range, 88–100), and at the latest follow-up was 94 (SD, 3; range, 88–98). Activity-related mild pain around the gluteal or groin region in 4 patients improved with muscle strengthening exercises over 6 months. One patient had persistent mild thigh pain (associated with an intra-operative non-tight-fit stem) and another had fatigue pain in the glutei on prolonged walking, even after 2 years. Most patients (90%) were walking pain-free, without any support at the 2-year follow-up; none had a poor result.

In patients with developmental dysplasia of the hip, their mean limb length discrepancy of 3.5 (SD, 1.2) cm was corrected to <6 mm after surgery. 34 patients had a limp while walking at the 3-month follow-up, but down to 16 at 6 months and only 3 at 2 years. The patients with a mild limp at the 2-year follow-up had significant abductor weakness. Muscle strengthening exercises helped 2 of them walk without a limp at the latest follow-up. One patient’s limp persisted, probably because of habitual limping. Intra-operative splintering of the greater trochanter occurred in 3 patients during broaching or stem impaction. This problem was fixed intra-operatively with either a lag screw or stainless steel wire, followed by non-weight bearing for 6 weeks. Attention should be paid to detect early cortical breaks before displacement so as to facilitate fixation. No fracture resulted in stem instability, additional operative treatment, or compromise in the final clinical result. One patient with repeated dislocations (twice in 6 months) had a reduced anteversion of both components. The CLS stem was repositioned with adequate anteversion to achieve stability. The patient had a HHS of 88 at the 4-year follow-up. Another patient with postoperative deep venous thrombosis was treated successfully with low-molecular-weight heparin. One patient operated on for ankylosing spondylitis developed heterotopic ossification and had restriction of the hip movement.
by 40% in all directions at the 6-month follow-up (Fig. 2). This did not have any impact on the patient’s functional outcome although the stiffness persisted at the 5-year follow-up. 35 patients were very satisfied with the surgery and the remaining 2 were less satisfied. One of the latter had additional surgery for repositioning of the femoral stem and the other had anterior thigh pain.

Radiological results

Analysis of the acetabular cups revealed partial containment in 16 hips and complete containment in 29. Orientation was neutral in 37 hips, vertical in 7, and horizontal in one. The mean anteversion was 14º (SD, 4º; range, 3º–22º) and the mean distance between the cup and the tear drop was 0.4 (SD, 0.2; range, 0.2–0.7) mm. The CLS stem was neutral in 32 hips, valgus in 11, and varus in 2. The mean stem anteversion was 7º (SD, 2º; range, 3º–11º). The mean level of the lesser trochanter was 5 (SD, 3.2; range, 0–12) mm below the ischial tuberosity. The canal fill ratio was 94% (SD, 3%; range, 88–99%) in the metaphysis and 78% (SD, 7%; range, 68–93%) in the diaphysis. At the latest follow-up, radiographs showed satisfactory bone ongrowth (trabeculae running from endosteum to prosthesis) in 42 acetabular cups and 39 CLS stems. Osseointegration with good tropism of the calcar and additional subtrochanteric blockage by new bone formations was evident in 33 hips. 18 patients with evidence of endosteal condensation (Fig. 3) around the stem had a better HHS, averaging 98 (SD, 1; range, 97–99). None of the remaining hips showed any continuous radio-opaque lines suggestive of lack of bone ongrowth. No prosthesis had significant subsidence (>2 mm) at the 6-month follow-up. At the latest follow-up, stress shielding was observed in 18 hips (15 grade 1, and 3 grade 2).

DISCUSSION

The CLS stem is straight with a continuous medial arch and an undersized tip so as to prevent distal cortical fitting.\textsuperscript{2,11,12} This reduces stress concentration at the tip of the prosthesis. The removal of the bone from the proximal femur is kept to a minimum with this implant. The tapered CLS stem produces primary press-fit fixation by viscoelastic deformation of the bone bed through the introduction of a slightly oversized implant.\textsuperscript{13} The combination of the line-to-line press fit of the stem core and interference fit of the flutes of the CLS stem gives reliable initial stability. The caput-collum-diaphysis angle of 145º is
a compromise to reduce the tilting movement of the stem. The implant is suitable for younger patients with good bone quality and a trumpet-shaped femur.

The St Nabor cup consists of a pure titanium shell and a polyethylene liner. The basic shape of the cup is a flattened hemisphere. A series of sharp edged barbed overlaps running parallel to the equator confers high mechanical stability against tilting movements and extraction forces. The polar region is provided with circular cutting ring segments for better primary stability and contact between the bone and shell.

The blasting of implant surfaces with corundum particles accelerates the transition from primary mechanical stability to biological osseointegration. Rough blasting produces irregular and sharp-edged structures, which allow better interdigitation with the bone. With the highly osteophilic nature of titanium, a long-term fixation can be achieved by bone ongrowth (osseointegration of the titanium surface with bone), in contrast to the traditional bone ingrowth. In the patient with recurrent dislocations, adequate bone ongrowth onto the titanium implant was seen as early as 6 months after implantation. The stem strongly attached to the proximal femur and was difficult to retrieve during revision surgery.

The incidence of thigh pain in uncemented THA has been 2 to 40%, due to the lack of primary stability. Sufficient initial mechanical stability at the bone-prosthesis interface is a prerequisite for extensive biological integration and long-term performance. Excessive interface micromotions can promote fibrous connective tissue formation and lead to aseptic loosening and implant failure.

Rheumatoid arthritis is commonly treated with corticosteroids and both rheumatoid arthritis and osteoporosis are more common in women than men. Therefore, in the present study the gender distribution is uneven. The mean age of our patients was 45 years (i.e. with high functional demands). The HHS was optimal at the 2-year follow-up, as the implants became more stable with the strengthened surrounding dynamic stabilisers. The lower HHS at one year was probably due to unmet expectations following arthroplasty in these relatively young patients. The restrictions imposed by THA are major determinants of clinical success. The HHS is influenced by factors that are not directly associated with the replaced hip (such as conditions of other joints and general health). In those who had one hip affected, the mean HHS was 97, whereas in bilaterally affected patients with arthritic or symptomatic opposite hips the score decreased to 85. Patients with inflammatory joint disorders (rheumatoid arthritis or ankylosing spondylitis) scored worse than the remainder; their morning stiffness of the joints persisted. The disease per se appeared to worsen the clinical outcome, although patients with ankylosing spondylitis regained a mean of 60° flexion and 60° rotation. In patients with bilaterally affected hips, the bone stock drastically improved between the 2 surgeries as per Singh’s index. This was attributed to better bone turnover after mobilisation. Patients with endosteal condensation had a better HHS. Intra-operative stability of implants could fairly predicted outcome.

There are drawbacks of this study. The measurement of version of the cup and stem on radiographs is not accurate and is subject to gross changes due to small changes in positioning. Computed tomographic scans would have provided more accurate measurements. Although the short- and intermediate-term results achieved with the CLS stem and St Nabor cup may be rated as excellent, the components’ characteristics are different from other anatomical or porous coated designs. The functional results did not decline substantially even after 3 to 6 years, which promised good overall long-term survival. Our sample of 45 THAs with 3 to 6 years of follow-up is too small and the follow-up too short to comment on the long-term survival of the prosthesis, as nowadays wear and osteolysis have become bigger concerns than fixation.

CONCLUSION

Uncemented THA is an excellent option in younger patients with good bone quality and a trumpet-shaped femur (Spotorno score of <5). In addition to attaining primary stability by press-fit fixation (tapered design of the stem and flattened hemispherically shaped cup), the osteophilic nature of the titanium facilitates the secondary osseointegration. Proximal press-fit fixation of the stem prevents distal stress shielding. Patients with endosteal condensation have better HHSs. The intra-operative stability of implants can fairly predict outcome.

REFERENCES