Original article

Total hip replacement in young non-ambulatory cerebral palsy patients

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ABSTRACT

Introduction: The everyday life of a non-ambulatory adolescent or young adult with cerebral palsy can be severely impaired by a painful or stiff hip. The usual surgical solutions such as proximal femoral resection (PFR) are not entirely satisfactory for pain relief, and are mutilating.
Hypothesis: A retrospective study assessed the impact of total hip replacement (THR) on such impairment, on the hypothesis that it is more effective than PFR in relieving pain, without aggravating disability.
Patients and methods: The surgical technique consisted in implanting a dual-mobility prosthesis with uncemented acetabular component and cemented femur, after upper femoral shaft shortening and short hip-spica cast immobilization. Forty THRs were performed in 33 patients, including 31 with multiple disability. Follow-up assessment focused on change in functional status, pain, and range of motion.
Results: Mean follow-up was 5 years. Pain was more or less entirely resolved. Improvement in range of motion was less striking, and there was no significant change in functional status. There were 2 general, 2 septic and 10 mechanical complications, 6 of which required surgical revision.
Discussion: In non-ambulatory cerebral palsy, THR provided much better alleviation of pain than found with PFR treatment. It should be reserved for patients able to withstand fairly long surgery and with femur size compatible with implantation of a femoral component, however small.
Level of evidence: IV, retrospective study.

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1. Introduction

For parents and care-givers, it is important for an adolescent or young adult with cerebral palsy (CP), and who often has multiple disabilities, to be able to be seated comfortably. This requires a well-balanced spine and fairly flexible and pain-free hip joints [1]. The more or less asymmetric retractions of spasticity often induce out-of-round hip position during growth. Non-operative treatment during childhood does not always succeed in maintaining good hip positioning and, even when it does, osteoarthritis frequently develops in young adult patients and quickly becomes disabling [2,3]. Surgical solutions such as proximal femoral resection (PFR) fail to improve pain and functional status consistently [4]. Total hip replacement (THR) has rarely been used in paralyzed hips, and even more rarely in young adult non-ambulatory CP patients, for fear of early or late complications given the neurologic problems and general fragility of these patients [5,6]. The present retrospective study sought to describe results of THR at sufficient follow-up in young adult non-ambulatory CP patients, mostly with multiple disability, on the hypothesis that THR is more effective than (PFR) in terms of pain relief, without aggravating disability.

2. Patients and methods

2.1. Patients

The medical files of all non-ambulatory CP patients operated on by the senior authors for THR between January 2001 and January 2014 were analyzed retrospectively.
During the study period, 40 THRs were implanted in 33 patients: 17 male, 16 female; mean age at surgery, 19 years 2 months (range, 13 years 6 months to 31 years 8 months).
Thirty-one of the patients had concomitant non-motor problems: mental deficiency, epilepsy or sensory impairment. Their general health status allowed a long and potentially hemorrhagic procedure. Weight, however, was low, with a mean body-mass index of 17 at surgery [5,7].
The right hip was involved in 22 cases and the left in 18; in the 7 bilateral cases, the mean interval between surgeries was 14 months (range, 1 month to 3 years 7 months).
Twenty-one of the 40 hips had history of surgery: 9 soft-tissue release procedures (adductor tenotomy), 9 femoral and pelvic osteotomies, 1 PFR, and 2 osteoma resections.

Paralytic scoliosis was frequently associated, requiring fusion up to the pelvis in 23 cases. In 16 of these cases, THR was performed after vertebral fusion, at a mean 42 months (range, 12–60 months), and in 7 vice versa at a mean 28 months (12–60 months).

Initial assessment and follow-up data were retrieved from medical files and collected by questionnaires sent to families and their community physicians.

Functional status was assessed in terms of walking capacity on the 5-level Gross Motor Function Classification System (GMFCS) [8] and of possible verticalization and self-help in transfer. All patients were GMFCS 5, 21 were able to help with transfer, and 10 were verticalized and 10 still had a possibility of verticalization.

All patients were operated on for pain confirmed by the family or care staff, in many cases assessed on the San Salvador child pain scale (Douleur Enfant San Salvador: DESS) adapted for multiple disability [9]. Pain was continuous in 16 cases, in seated position in 20, during transfer in 28 and during mobilization (e.g., for nursing care) in 26.

In 1 case pain in the seated position was located not in the hips, which were ankylosed in extension, but in the lumbar spine.

Range-of-motion study focused on flexion with an 80° threshold, determining comfortable sitting: 19 patients showed <80° flexion. Frontal and transverse motion and restriction could not be reliably quantified.

Radiography found femoral head dislocation in 18 cases, subluxation in 15, and good positioning in 6, but with severe deformity or inclusion by osteoma. In 1 case, the femoral head had been resected.

Statistical analysis used pairwise comparison of pre- and post-operative variables on McNemar’s test for paired data (a non-parametric test for qualitative data), confirmed by multiple correspondence analysis.

The significance threshold was set at 0.05.

2.2. Surgical technique

The surgical approach was lateral, with trochanteric osteotomy and neck section, sometimes with immediate shortening of the femoral shaft to facilitate acetabular exposure.

The acetabular component was positioned within the native acetabulum. In 15 cases, a bone block taken from the femoral head was added and fixed by K-wire. After nativeacetabulum reaming, the acetabular component was impacted, taking account of frontal and sagittal spine orientation.

Upper femoral shaft shortening removed a mean 3.5 cm (range, 1–6 cm), conserving the whole metaphysis to receive the proximal part of the implant.

Osteotomy fixation used the extremity of the implant; persistent mobility, however, required fitting a 4-hole plate with unicortical screws in 5 cases.

Femoral antetorsion within the osteotomy was adjusted on introducing the femoral component, with the implant head well positioned inside the acetabulum so that the patella pointed upward. This often involved reducing initially excessive antetorsion.

Small-diameter femurs were reamed, completing metaphyseal preparation.

A small “dysplastic” or “made-to-measure” implant was used, and cemented in all but 3 cases. Trochanteric synthesis was prepared before fixing the femoral component with 2 metal or single-filament sutures and freshening of the lateral side of the shaft to receive the trochanteric medallion.

The definitive femoral stem was then introduced in the acetabulum, with a trial head to determine neck length. The definitive 26-mm steel head was introduced, outside the surgical field, in the mobile acetabular insert. The assembly was then impacted into the Morse cone of the femoral component, and then gently reduced within the acetabulum (Fig. 1).

The greater trochanter was reinserted in a rig prepared ahead of femoral fixation. A deep Redon aspiration drain was fitted before closure. Possible indications for adductor tenotomy were checked, and were systematically absent after femoral shortening.

A hip spica cast was used in 23 hips for the first 2 weeks. Gentle mobilization under traction was then initiated, and seated posture was resumed once hip flexion reached 80°.

Mean operative time, including cast fitting, was 200 min (range, 110–300 min).

Blood was collected for only 13 patients; mean blood-loss was 463 ml (range, 45–1520 ml), requiring transfusion of 1–4 units of autologous blood in 18 (out of 33) patients.

3. Results

3.1. Functional assessment

Three of the 33 died, at 38, 65 and 102 months postoperatively. Mean follow-up was 63.2 months (range, 9–147 months) (Fig. 2). Results are shown in Table 1.

<table>
<thead>
<tr>
<th>Function (33 patients)</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMFCS V</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Assisted sitting</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td>Independent sitting</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Verticalization possible</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pain (40 hips)</th>
<th>Before</th>
<th>After</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent pain</td>
<td>16</td>
<td>0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Pain sitting</td>
<td>20</td>
<td>1</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Pain on transfer</td>
<td>28</td>
<td>0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Pain on perineal care</td>
<td>26</td>
<td>2</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

| Motion (40 hips) | Flexion >80 | 19 | 34 | <0.05 |

Fig. 1. Dual-mobility implant parts: femoral stem, 26-mm head impacted in polyethylene insert.
Fig. 2. Painful unilateral paralytic dislocation in a non-ambulatory patient, and outcome at 12 years’ follow-up.

Function was not significantly improved by THR.

Pain, on the other hand, was greatly improved, as was range of flexion.

All 29 families who responded to the subjective questionnaire reported alleviation of pain. Four reported no improvement in sitting comfort and 10 that perineal care was not made easier.

3.2. Complications

3.2.1. General complications

One patient, with bilateral THR at a 1-month interval, suffered respiratory distress due to aspiration following the second procedure, requiring intensive care complicated by respiratory infection implicating multidrug-resistant Pseudomonas. The patient died 9 years later from secondary amyloidosis (Fig. 3a and b).

One patient developed mesenteric artery syndrome, resolved non-operatively.

3.2.2. Septic complications

One case of early deep infection was treated by lavage and antibiotic therapy, with good progression but complicated by acetabular loosening.

One case of late deep infection was discovered during revision for femoral loosening.

3.2.3. Mechanical complications

Six mechanical complications required revision surgery:

• 1 femoral loosening, revealing sepsis;
• 2 cases of delayed femoral osteotomy consolidation, managed by decortication, graft and internal fixation;
• 1 case of greater trochanter detachment;
• 1 osteoma, hindering motion, managed by resection;
• and 1 case of disassembly between the prosthetic femoral head and the Morse cone (Fig. 4).

Five other mechanical complications required no revision surgery:

• acetabular loosening complicating sepsis, with recurrence of osteoma, causing painless stiffness in flexion;
• in the same patient, osteoma on the contralateral THR;

Fig. 4. Disassembly between head and Morse cone, requiring surgical reduction.

• 2 proximal metaphyseal fractures, managed by traction (Fig. 5);
• and 1 case of lateral cortex resorption in a non-cemented implant (Fig. 6).

4. Discussion

The everyday life of a non-ambulatory adolescent or young adult with cerebral palsy can be severely impaired by a painful or stiff hip [1]. The present retrospective study assessed the impact of THR on such impairment. To our knowledge, this is the largest published series. Surgical technique was consistent, and performed by a single team. All patients were followed up, at a mean 5 years. Pre- and post-operative functional status was assessed by the therapists in the centers managing the patients.

The results for these 33 patients were very satisfactory in terms of pain and range of flexion, enabling comfortable sitting. There was no change in the “non-ambulatory” functional status, but self-help in transfer was at least maintained.

There is no well-established consensus as to the role of surgery in painful hip in adolescents and young adults with multiple disability. Isolated soft-tissue procedures such as adductor tenotomy and, possibly, obturator neurotomy, may facilitate perineal care but do not reposition the hip and have no impact at all on pain [10]. Conservative bone surgery can only be effective in hips with minimal bone and cartilage deformity of the femoral head, which is rarely the case in dislocated or subluxated hips [11]. PFR, even when extended to associate muscle plasty, often shows difficult postoperative course, with prolonged pain and risk of peri-articular ossification and of upward migration of the femoral shaft; at best, it leaves a slack limb, with non-physiological seated posture due to the absence of support from the upper third of the femur, and no possibility of verticalization or help in transfer. On the other hand, it is a rapid procedure, with little blood loss, and can even be performed bilaterally in a single step in very fragile patients with very small femurs [11–14]. Hip fusion, even in unilateral cases, is hardly indicated in patients who have or are likely to have spinal fusion including the pelvis. Prolonged cast immobilization is another disadvantage of PFR in non-ambulatory patients [15]. We have no experience of femoral shaft interposition implants as used in humeral prostheses, or of resurfacing associated to femoral shortening [16,17].

Finally, THR series in CP mainly included ambulatory patients; results for pain were good, but with complications such as recurrent dislocation, acetabular loosening or intra pelvic acetabular migration [2,4–6,18–20].

The following important technical points should be noted.

The approach with trochanteric osteotomy optimizes gluteal muscle positioning after the femoral procedure [4,20]. Femoral shortening facilitates reduction without having to free retracted musculotendinous structures [20], and allows easy adjustment of femoral antetorsion to harmonize implant stability and adequate positioning of the knee. In the longer term, the muscle relaxation provided by shortening can reduce the risk of intra pelvic implant migration. In cases of subluxation or good positioning of the hip, femoral shortening is to be weighed against simple soft tissue (adductor and psoas) release. Dual-mobility acetabular components prevent dislocation in patients strongly exposed to this risk [21]. Dual-mobility allows a certain “imperfection” in acetabular orientation, in favor of good coverage of the recipient native acetabulum [4,12,15,19,22]. The femoral stem should preferably be cemented; the greater volume of uncemented stems can cause intraoperative femoral fracture and lateral bone resorption.
Two weeks’ immobilization in traction or a spica cast is advisable before resuming seated posture, to limit the risk of dislocation and displacement of the greater trochanter [20,23]. In case of bilateral THR, the two procedures should not be too close in time in this fragile population [22]. If oblique pelvis of spinal origin is associated with dislocated or subluxated hip, unless hip pain is the prime symptom or flexion is severely restricted it seems logical first to correct the frontal or sagittal pelvic tilt induced by the scoliosis [3,12,17,20].

5. Conclusion

The present results reinforce the choice of a technique that is more complex but much more satisfactory than PFR. It is a sure and effective treatment for painful hip in non-ambulatory adolescent and young adult CP patients, even when they have multiple disability [5,7,12,19,20]. Alleviation of pain, the principal presenting symptom, was systematic. Functional status was in no cases aggravated, and self-help in transfer was notably conserved. Despite a non-negligible rate of complications, by end of follow-up (with no loss to follow-up) there were no cases of failure requiring THR ablation to achieve efficacy equal to that of PFR.

Disclosure of interest

The authors declare that they have no competing interest.

References