

# Total hip arthroplasty in steroid-induced osteonecrosis: early functional and radiological outcomes

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**Background:** The proportion of total hip arthroplasties (THAs) associated with corticosteroid use is uncertain, and the mechanisms of corticosteroid-induced osteonecrosis remain unknown. We sought to evaluate the clinical and radiographic outcomes, complications and satisfaction with THA among patients with corticosteroid-induced osteonecrosis.

**Methods:** We retrospectively assessed functional outcome at a minimum 1-year follow-up using the Western Ontario and MacMaster Universities Arthritis Index (WOMAC); Oxford Hip Score; Short Form (SF)-12; University of California, Los Angeles (UCLA) Activity; and patient satisfaction scores.

**Results:** We included 31 patients (35 hips). The average follow-up was 20 (range 12–55) months, and the average age at surgery was 47 (range 19–78) years. At follow-up, patients showed significant improvement in all 4 components of the WOMAC (means: function 84, stiffness 75, pain 86, global 84), Oxford-12 (mean 83) and SF-12 (means: mental 40 and physical 48) scores. However, there was no significant improvement in the UCLA Activity scores. Mean patient satisfaction scores were good for pain relief (86), function (80), recreation (77.5) and overall results of surgery (86). Radiographic review at follow-up showed that all components were well fixed with no evidence of loosening. The complication rate was high (17%), with 6 complications in 5 patients (6 of 35 hips). Four patients (4 of 35 hips; 11%) required reoperations.

**Conclusion:** Total hip arthroplasty in patients with corticosteroid-induced osteonecrosis of the femoral head is successful in reducing pain and improving function; however, the rate of complications and reoperation is high.

**Contexte :** On ignore quelle est exactement la proportion d'arthroplasties totales de la hanche (ATH) associées à la corticothérapie et quels mécanismes sous-tendent l'ostéonécrose induite par les corticostéroïdes. Nous avons voulu évaluer les résultats cliniques et radiographiques et les complications de l'ATH, de même que la satisfaction des patients à son endroit chez les patients atteints d'ostéonécrose induite par les corticostéroïdes.

**Méthodes :** Nous avons analysé rétrospectivement les résultats fonctionnels après au moins 1 an lors d'un suivi effectué au moyen de l'indice WOMAC (*Western Ontario and MacMaster Universities Arthritis Index*), du score d'évaluation Oxford à 12 questions, du questionnaire SF-12 (*Short Form-12*), du questionnaire d'activité de l'Université de la Californie à Los Angeles (UCLA) et d'un questionnaire sur la satisfaction des patients.

**Résultats :** Nous avons inclus 31 patients (35 hanches). Leur suivi moyen a duré 20 (de 12 à 55) mois et l'âge moyen au moment de la chirurgie était de 47 (de 19 à 78) ans. Au moment du suivi, les patients ont fait état d'une amélioration significative des 4 dimensions de l'indice WOMAC (moyennes : fonctionnement 84, raideur 75, douleur 86, globale 84) ainsi que des indices Oxford-12 (moyenne 83) et SF-12 (moyennes : fonctionnement mental 40 et fonctionnement physique 48). On n'a toutefois observé aucune amélioration significative des scores d'activité de l'UCLA. Les indices moyens de satisfaction des patients étaient qualifiés de bons en ce qui a trait au soulagement de la douleur (86), au fonctionnement (80), aux loisirs (77,5) et aux résultats globaux de la chirurgie (86). L'examen radiologique au moment du suivi a montré que tous les éléments étaient bien cimentés, sans signe de déhiscence. Le taux de complication a été élevé (17 %), soit 6 complications chez 5 patients (6 hanches sur 35). Quatre patients (4 hanches sur 35; 11 %) ont eu besoin d'une réintervention.

**Conclusion :** L'arthroplastie totale de la hanche chez des patients atteints d'ostéonécrose de la tête fémorale induite par les corticostéroïdes réussit à soulager la douleur et à améliorer le fonctionnement, mais le taux de complications et de réinterventions est élevé.

Osteonecrosis of the femoral head accounts for 5%–12% of total hip arthroplasties (THAs) performed in the United States, but the proportion associated with corticosteroid use is uncertain.<sup>1</sup> The exact mechanisms of corticosteroid-induced osteonecrosis remain unknown, with the disease developing in only 8%–10% of all corticosteroid users.<sup>2</sup> Whereas some studies have reported that osteonecrosis is more likely to occur in patients receiving long courses of corticosteroids, others have suggested that the magnitude, rather than frequency, of the dose is more critical.<sup>3–5</sup>

Long-term use of corticosteroids is known to cause osteoporosis and to have a direct inhibitory effect on osteoblastic bone-forming activity as well as an effect on bone remodelling. Other issues unique to some patients on long-term corticosteroid therapy (e.g., renal transplant patients) are the prevalence of postsurgical infections and wound-healing problems.<sup>6</sup> Some authors have suggested that these patients may be at greater risk for insertional periprosthetic fracture at the time of THA and/or failure of bony ingrowth of cementless femoral stems.<sup>7</sup> However, other authors have reported acceptable results and low failure rates with the use of cementless femoral stems using modern implant designs and post-transplant immunosuppression protocols, despite the previously mentioned risks.<sup>8,9</sup> Given the potential complications previously associated with THA following renal transplantation, it is possible that patients with osteonecrosis using corticosteroids for other indications may also be at risk.

The primary purpose of this study was to report the experience at a single institution of THA in patients with corticosteroid-induced osteonecrosis. We assessed the functional outcomes after THA using patient-derived and disease-specific scores. The secondary purpose of the study was to assess the radiological outcomes, short-term complications and patient satisfaction after THA.

## METHODS

We performed a retrospective review of prospectively collected data to assess the clinical and radiological results of THA performed in patients with corticosteroid-induced osteonecrosis between March 2003 and June 2007. The study was approved by our University Institutional Review Ethics Board and by our hospital ethics board.

We identified patients who underwent THA for corticosteroid-induced osteonecrosis with a minimum 1-year follow-up using our longitudinal research database. The diagnosis of corticosteroid-induced osteonecrosis was

determined based on the history of corticosteroid therapy, plain radiographs and/or on preoperative magnetic resonance imaging (MRI) reports. No intraoperative frozen sections were performed to confirm the diagnosis.

We contacted patients by mail to inform and invite them to participate in the study; a questionnaire package of the functional outcome scores was included in the packages mailed to any patient who had incomplete postoperative scores in our database. We followed up on any questionnaires not returned after 6 weeks, and failure to respond to the second mailing was followed up by a telephone interview. We collected baseline demographic characteristics of patients as well as a comprehensive list of diagnoses necessitating corticosteroid therapy.

Two of us (B.A.M. and D.S.G.) performed the operations. The approach used (i.e., posterolateral, anterolateral gluteal-sparing, straight lateral transgluteal) was based on the surgeon's preference. All of the acetabular components were cementless (Trilogy; Zimmer). The femoral components were either porous-coated cementless or cemented.

All patients received 3 doses of prophylactic antibiotics (cefazolin) after the operation. Clindamycin was used instead in patients who had reported an allergy to penicillin. Deep venous thrombosis prophylaxis consisted of low-molecular-weight heparin for 10 days after the operation. No specific prophylaxis for heterotopic ossification was used. Patients were allowed full weight bearing (using crutches) from the day of surgery; as physiotherapy progressed, they discontinued the use of walking aids as tolerated. Clinical and radiological follow-up occurred at 6 weeks, 1 year and annually thereafter.

The functional outcome scores assessed were the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), which is a disease-specific questionnaire with 4 domains (function, stiffness, pain, global);<sup>10</sup> the UCLA Activity score, which rates the patient's activity level on a scale from 1 (worst) to 10 (best);<sup>11</sup> the Short Form (SF)-12, which is a generic quality of life questionnaire and a subscale of the Short Form (SF)-36, calculated on a scale from 0 (worst) to 100 (best);<sup>12</sup> the Oxford Hip Score, which is a joint-specific questionnaire;<sup>13</sup> and the patient satisfaction score, which uses a 4-question instrument to measure satisfaction in 4 domains (pain relief, functional ability to perform home or yard work, ability to perform recreational activity, overall satisfaction with the results of surgery).<sup>14</sup> The scale for patient satisfaction ranges from 0 (very dissatisfied) to 3 points (very satisfied), and scores are multiplied by a factor of 8.33 to give a total between 0 and 100. The scores are normalized to a 0–100 scale, where 0 is the least satisfied and 100 is the most satisfied.<sup>14</sup>

One of us (W.A.R.) performed the radiological evaluation and did not participate in any of the surgeries. The radiographic follow-up examinations were performed using serial anteroposterior projection of the pelvis and cross-table lateral hip view of the replaced hips. Femoral component migration, calcar resorption or rounding was determined from the serial radiographs. Radiodensities, lucencies, femoral sclerosis and resorption were studied using the zones described by Gruen and colleagues.<sup>15</sup> Radiographic analysis of cemented femoral component fixation was performed using the criteria of Harris and colleagues.<sup>16</sup> Radiographic analysis of cementless femoral component fixation was performed as described by Engh and colleagues,<sup>17</sup> categorizing the fixation as bone ingrown, stable fibrous ingrown or unstable fibrous fixation. Acetabular migration was also assessed. In addition, the bone-metal interface was divided into the zones described by DeLee and Charnley<sup>18</sup> and analyzed for lucency and sclerosis. Heterotopic ossification, if present, was graded according to the classification of Brooker and colleagues.<sup>19</sup>

### Statistical analysis

Statistical analyses were performed using SAS software version 9.1 (SAS Institute). We compared the preoperative and final clinical scores with at least 1 year follow-up using paired *t* tests. Differences in proportions were assessed using the  $\chi^2$  test or the Fisher exact test as appropriate. We considered results to be significant at  $p < 0.05$ .

**Table 1. Patient demographic characteristics at baseline**

| Characteristic   | No.*            |
|--|-----------------|
| Hip joints   | 35              |
| Sex  |                 |
| Male   | 15              |
| Female   | 16              |
| Age, mean (SD) [range] yr                                | 47 (14) [19–78] |
| SD = standard deviation.<br>*Unless otherwise indicated. |                 |

**Table 2. Diagnosis necessitating corticosteroid therapy**

| Diagnosis                            | No. patients |
|--------------------------------------|--------------|
| Leukemia with bone marrow transplant | 6            |
| Systemic lupus erythematosus         | 6            |
| Non-Hodgkins lymphoma                | 4            |
| Renal transplant                     | 3            |
| Rheumatoid arthritis                 | 3            |
| Inflammatory bowel disease           | 2            |
| Bronchial asthma                     | 2            |
| Psoriatic arthritis                  | 2            |
| Juvenile rheumatoid arthritis        | 2            |
| Orbital myositis                     | 1            |
| Total                                | 31           |

## RESULTS

Our initial cohort consisted of 35 patients who underwent 39 THAs. Of these, 3 patients (3 hips) were not followed up at our institution, and 1 patient (1 hip) died in the early postoperative period. The final cohort consisted of 31 patients (15 men and 16 women; 35 hips). The average follow-up was 20 (range 12–55) months, and the average age at surgery was 47 (range 19–78) years (Table 1). A comprehensive list of diseases necessitating corticosteroid treatment is provided in Table 2.

The surgeons used a posterolateral approach for 21 hips, an anterolateral gluteal-sparing approach for 7 and a straight lateral transgluteal approach for 7. The femoral components were porous-coated cementless in 28 cases and cemented in 7.

No patients were lost to follow-up. At final follow-up, patients showed significant improvement in all 4 components of the WOMAC index, the Oxford Hip Score and the SF-12 (mental and physical) scores. However, there was no significant improvement in the UCLA Activity score (Table 3).

On the final follow-up radiographs, all of the acetabular components appeared to be well fixed, with no evidence of progressive radiolucencies or component migration. All but 1 of the cementless femoral components were categorized as stable bone ingrown. One femoral stem was categorized as stable fibrous ingrown. All of the cemented femoral stems were considered to be stable. Heterotopic ossification was noted in 9 (25.7%) hips: grade I in 7 hips, grade II in 1 and grade III in 1.

There were 6 complications in 5 patients for an overall

**Table 3. Quality of life outcome scores**

| Instrument   | Score, mean (SD) [range] |                         | <i>p</i> value |
|--|--------------------------|-------------------------|----------------|
|  | Baseline                 | Follow-up               |                |
| WOMAC  |                          |                         |                |
| Function   | 37.6 (21.2) [0.0–75.0]   | 84.0 (18.8) [29.4–100]  | < 0.001        |
| Stiffness  | 35.1 (22.1) [0.0–75.0]   | 75.0 (24.3) [12.5–100]  | < 0.001        |
| Pain   | 36.1 (21.4) [0.0–75.0]   | 86.3 (18.4) [35.0–100]  | < 0.001        |
| Global   | 42.2 (22.1) [0.0–78.1]   | 84.1 (18.4) [31.3–100]  | < 0.001        |
| Oxford Hip Score <sup>13</sup>   | 30.9 (18.3) [4.2–62.5]   | 83.0 (18.0) [33.3–100]  | < 0.001        |
| SF-12  |                          |                         |                |
| Physical   | 25.2 (5.6) [13.8–34.9]   | 40.2 (13.6) [12.2–61.5] | < 0.001        |
| Mental   | 39.7 (11.3) [22.5–56.7]  | 48.6 (11.1) [28.4–66.6] | 0.039          |
| UCLA Activity score  | 3.2 (1.6) [2.0–6.0]      | 5.2 (2.0) [2.0–8.0]     | 0.33           |
| Patient satisfaction score   |                          |                         |                |
| Pain   | NA                       | 88.2 (21.5) [33.3–100]  |                |
| Function   | NA                       | 80.4 (28.6) [0.0–100]   |                |
| Recreation   | NA                       | 77.5 (31.5) [0.0–100]   |                |
| Overall  | NA                       | 86.3 (26.1) [0.0–100]   |                |
| Mean   | NA                       | 83.1 (25.3) [16.7–100]  |                |
| NA = not applicable; SD = standard deviation; SF-12 = Short Form 12; <sup>12</sup> UCLA = University of California, Los Angeles; <sup>11</sup> WOMAC = The Western Ontario and McMaster Universities Osteoarthritis Index. <sup>10</sup> |                          |                         |                |

rate of 17%. Of these complications, 2 did not require reoperation; these were intraoperative calcar fracture not affecting the stability of the femoral stem and a superficial infection that was successfully treated with intravenous antibiotics. Reoperation was required for 4 complications (risk of reoperation 11%). Two patients underwent reoperation for a periprosthetic fracture around a cementless proximal coated femoral component. The first patient was a 49-year-old man taking corticosteroids to manage acute myeloid leukemia. The corticosteroid therapy was discontinued at the time of the index THA. The patient fell 2 months after the THA and sustained a Vancouver type B1 fracture, which was managed by open reduction and internal fixation of the fracture with retention of the femoral stem. At final follow-up 2 years after the initial THA, the patient had a satisfactory outcome from the operation (WOMAC global score of 80 points). The second patient was a 68-year-old woman taking corticosteroids to manage rheumatoid arthritis. The patient fell 2 months after her THA and sustained a Vancouver type AL fracture and subsequent subsidence of the stem. This was managed by open reduction and internal fixation of the fracture and revision of the femoral stem to a fully porous-coated implant. At her 1-year follow-up, the patient was doing well and had a satisfactory outcome (WOMAC global score of 85 points). The third patient was a 34-year-old man taking corticosteroids after renal transplant; the patient underwent reoperation (linear exchange and large femoral head 32 mm) 2 years after the index THA for recurrent hip dislocation. At final follow-up 3 years after the revision procedure, the patient had a satisfactory outcome (WOMAC global score of 96 points) and experienced no further dislocation. The fourth patient underwent reoperation for deep infection following the index THA; the patient was a 55-year-old woman taking corticosteroids to manage systemic lupus erythematosus. She had a persistent deep infection that was managed by a 2-stage exchange 3 months after the index procedure. She was taking corticosteroids at the time of the operation. Necrotizing fasciitis developed as a complication of the recurrent infection, which was successfully controlled following surgical debridement and multiple 2-stage revisions. The patient had sciatic nerve palsy due to necrotizing fasciitis, and that was managed by reconstructive surgery (sciatic nerve grafting and tendon transfer); the patient had a poor functional outcome (WOMAC global score of 56 points) at her 4-year follow-up.

At final follow-up, the mean patient satisfaction score was 83.1 (range 16.7–100) points. The mean satisfaction score was 88.2 points for pain relief, 80.4 for function, 77.5 for recreation and 86.3 for overall results of the surgery (Table 3).

## DISCUSSION

Total hip arthroplasty is an excellent procedure for the management of advanced osteonecrosis of the femoral head,<sup>1</sup> particularly in terms of pain relief. The results of

primary THA in patients with osteonecrosis are well documented in the literature, and the differences in the outcomes correlated with the associated risk factors of osteonecrosis show that patients with idiopathic or post-traumatic osteonecrosis of the femoral head had better results than patients with corticosteroid- or alcohol-induced osteonecrosis.<sup>20–25</sup> Similarly, the long-term results of patients taking corticosteroids after renal transplantation showed a very high complication rate of periprosthetic fractures and infection.<sup>26</sup> In a recent systematic literature review of THA for osteonecrosis of the femoral head, Johansson and colleagues<sup>27</sup> reported significantly lower revision rates in patients with idiopathic disease, systemic lupus erythematosus and heart transplants and significantly higher rates in patients with sickle cell disease, Gaucher disease, and renal failure and/or transplants. The authors concluded that osteonecrosis per se is not a predictor of poor outcome after THA.

The present study was designed to document the results of THA at our institution in patients with corticosteroid-induced osteonecrosis of the femoral head. At follow-up, there was a significant improvement in all components of the WOMAC, SF-12 and the Oxford Hip Score. Overall, the patients were satisfied with the results of their surgeries. The wide range (16.7–100 points) of mean satisfaction scores may reflect the negative impact of some patients' chronic debilitating illnesses (Table 2), which necessitated prolonged treatment with corticosteroids. Two patients (2 hips) reported a very low mean satisfaction score of 16.7 points at final follow-up; the first patient was a 63-year-old man with leukemia, and the second was a 54-year-old man with psoriatic arthritis. Both illnesses may negatively affect a patient's preoperative health status and their postoperative health outcomes.

## Limitations

Our study has a number of limitations: it is retrospective with short-term follow-up, has a small sample size, has no comparison group, and involved the use of 3 different surgical approaches and 2 different femoral stem designs. The inclusion of patients with multiple indications for corticosteroid use meant that some patients were not taking corticosteroids at the time of their surgery.

In our series, all of the patients received corticosteroid therapy at some time during the course of their disease, but only 23 of 31 (74%) patients were taking corticosteroids at the time of operation. The incidence of infection following THA ranges from 1% to 3% in the literature.<sup>28–30</sup> The infection rate for THA in corticosteroid-induced osteonecrosis ranges from 1.3% to 19% in various studies.<sup>8,26,31–33</sup> In the present study, the infection rate was 6%; this only represents 2 hips, and from our small sample size it is difficult to draw any firm conclusions about the incidence of periprosthetic infection in patients with corticosteroid-induced

osteonecrosis compared with the general THA population.

In the literature, the prevalence of postoperative periprosthetic fractures ranges from 0.1% to 2.1% depending on the series reviewed.<sup>34-40</sup> In the present study, the prevalence of periprosthetic fracture was 2 of 35 hips (5.7%), and the fractures occurred around 2 cementless femoral stems. No periprosthetic fracture occurred around the cemented femoral stems. The cemented fixation seems to have an overall lower risk of periprosthetic fracture. Our study was not designed to compare the cemented versus the cementless fixation of the femoral component, and the sample size was too small to generalize or comment on incidence of the periprosthetic fracture among cemented versus cementless fixation. Most of the patients in our study received long-term corticosteroid therapy and were at higher risk for decreased bone density. Thus, the risk of periprosthetic fracture may be greater among patients on long-term corticosteroid therapy.

Interest in the use of porous-coated cementless prostheses in osteonecrosis is owing to the relatively young age of the patients. Corticosteroids are, however, known to have a direct inhibitory effect on osteoblastic bone formation and increase bone resorption.<sup>41</sup> It is documented that chronic corticosteroid use has not been found to significantly alter bone ingrowth around cementless prostheses.<sup>8</sup> When a good initial femoral component fit was achieved, bone ingrowth reliably followed. These findings indicate that stable cementless fixation of the femoral component is possible in patients dependent on corticosteroids.<sup>42-44</sup> Our study was not designed to assess long-term fixation, therefore we cannot comment on our results in comparison with long-term results in the literature.

## CONCLUSION

Our results demonstrate that THA in patients with corticosteroid-induced osteonecrosis can be successful in reducing pain and improving function. Since the rate of complications and reoperation in our study was considerable, careful patient selection and effort to optimize fixation are warranted.

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**Competing interests:** None declared.

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