Cementless acetabular revision arthroplasty

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Objective: To evaluate the effects of clinical factors on outcome after acetabular revision with a cementless beaded cup.

Design: Retrospective case series.

Setting: Tertiary care referral centre.

Patients: Forty-one patients who underwent acetabular revision with a cementless cup were followed up for a mean of 3.4 years.

Interventions: Acetabular revision with a beaded cementless cup in all patients. A morcellized allograft was used in 10 patients.

Outcome measures: A modified Harris hip score (range of motion measurement omitted), the SF-36 health survey, and the Western Ontario McMaster (WOMAC) osteoarthritis index. Multivariate analysis was used to evaluate the effects of age, gender, morcellized allografting, time to revision from the previous operation, acetabular screw fixation and concurrent femoral revision on outcome.

Results: Gender accounted for a significant portion of the variation seen in the SF-36 physical component scores ($r = 0.36$, $p = 0.02$), with women tending to have worse results. Increasing age was associated with lower WOMAC index function scores ($r = 0.36$, $p = 0.03$), whereas concurrent femoral revision tended to have a positive effect on WOMAC index function ($r = 0.39$, $p = 0.01$). None of the potential clinical predictors had any significant effect on the SF-36 mental component scores, or WOMAC index pain and stiffness scores.

Conclusions: In cementless acetabular revision arthroplasty, physical function, as measured by generic and limb-specific scales, may be affected by gender, age and the presence of a concurrent femoral revision. Time to revision from the previous operation, morcellized allografting and screw fixation of the acetabulum did not affect outcomes. This information may provide some prognostic value for patients' expectations.

Objectif : Évaluer les effets des facteurs cliniques sur le résultat après une révision acétabulaire avec cupule emboutie sans ciment.

Conception : Étude de cas rétrospective.

Contexte : Centre d'aiguillage de soins tertiaires.

Patients : Quarante et un patient qui ont subi une révision acétabulaire avec cupule sans ciment ont été suivis en moyenne pendant 3,4 ans.

Interventions : Révision acétabulaire avec cupule emboutie sans ciment chez tous les patients. On a utilisé une allogreffe morcelée chez 10 patients.

Mesures de résultats : Score modifié de Harris pour la hanche (mesure de l'amplitude du mouvement omise), questionnaire sur la santé SF-36, et indice Western Ontario McMaster (WOMAC) sur l'arthrose. On a utilisé une analyse à variables multiples pour évaluer les effets, sur le résultat, de l'âge, du sexe, de l'allogreffe morcelée, de la période écoulée entre la révision et l'intervention précédente, de la fixation par vis acétabulaires et de la révision simultanée du fémur.

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RÉSULTATS : Le sexe est à l'origine d'une partie importante de la variation constatée dans les résultats du volet sur les éléments physiques du questionnaire SF-36 (r = 0,36, p = 0,02), et les résultats ont tendance à être plus mauvais chez les femmes. On a établi un lien entre le vieillissement et des résultats fonctionnels plus faibles selon l'indice WOMAC (r = 0,36, p = 0,03), tandis que les révisions fémorales simultanées ont eu tendance à avoir un effet positif sur l'indice WOMAC (r = 0,39, p = 0,01). Aucun des prédicteurs cliniques possibles n'a eu d'effet significatif sur les résultats du volet sur les éléments mentaux du questionnaire SF-36, ou sur les résultats relatifs à la douleur et à la raideur selon l'indice WOMAC.

CONCLUSIONS : Dans une arthroplastie de révision acétabulaire sans ciment, le sexe, l'âge et une révision fémorale simultanée peuvent avoir une incidence sur la fonction physique mesurée au moyen d'échelles génériques et spécifiques à chaque membre. Le temps écoulé entre l'intervention antérieure et la révision, l'allogreffe morcelée et la fixation par vis de l'acétabulum n'ont pas eu d'effet sur les résultats. Ces renseignements peuvent avoir une certaine valeur prédictive en ce qui concerne les attentes des patients.

As the number of total hip arthroplasties performed continues to rise owing to the increasing age and longevity of the population, the failure of the procedure will become a growing problem.[1] Aseptic loosening of the acetabular component is present in approximately 10% of patients at 10 to 15 years after the original procedure.[2–5] These patients require revision of the acetabular component, which may be complicated by osteolysis[6] occurring over time. Patients are often asymptomatic for many years as osteolysis progresses.[7] By the time they become symptomatic (pain or limp), loosening may have resulted in medial migration of the cup and continuous erosion of the acetabulum so that the medial wall of the acetabulum is often noted to be deficient in bone stock at the time of revision.[8] This makes fixation of the new acetabular component difficult. Moreover, revision arthroplasty has a higher incidence of complications than the initial procedure, including infection, deep venous thrombosis, dislocation and nerve damage.[9] In addition to bone loss, which may be severe,[7] several other factors may affect the outcome of revision acetabular arthroplasty. These include the use of a roof reinforcement ring, [10–12] age,[5,13] gender[13] and time from the previous operation to revision.[7] Another possible factor influencing outcome may be the length of follow-up. The early results from revision surgery have generally been encouraging, but osteolysis secondary to wear debris affects later outcomes.[14]

The purpose of this investigation was to evaluate the role of potential predictors of function after acetabular revision arthroplasty with a noncemented prosthesis. Both disease- or limb-specific and general functional measures of health were used as determinants of outcome. These have been used previously in the evaluation of primary hip arthroplasty and were applied to revision hip arthroplasty in this study. Investigators have used radiographic analysis and the Harris hip score to show that the use of a cementless acetabular component for revision arthroplasty produces satisfactory radiographic and clinical results.[9,14]

PATIENTS AND METHODS

Consecutive patients (from 1987 to 1996) who had undergone acetabular revision after total hip arthroplasty at the authors' institution were contacted retrospectively. The characteristics of the patient population studied are summarized in Table I. Sixty-one hips were eligible for the study and for 41 of them the patients agreed to participate. Patients were excluded from the study for the following reasons: infected hip arthroplasty; reconstruction after Girdlestone arthroplasty; revision of a bipolar arthroplasty to a total hip arthroplasty; and hip reconstruction for neoplastic disease of bone. For 20 patients who did not agree to participate or could not be reached, demographic information was available. The proportion of women in this group (55%) was similar to that of the study group. No differences were seen between the 2 groups in terms of age, duration of symptoms, reason for revision, proportion of noninflammatory arthritis, time to revision from the previous operation, estimated blood loss from revision surgery , operative time, use of screws for acetabular fixation, allograft use and proportion of femoral revisions performed.

All except 1 of the revisions were performed by the senior author (J.P.W.) who used a posterior approach to the hip. Before revision surgery, the possibility of infection was investigated by measuring the erythrocyte sedimentation rate and aspirating the hip if clinically indicated. Intraoperatively, material was obtained for culture in all patients, and the culture results were negative. If infection was found preoperatively, a new acetabular component was not implanted, and the patient was therefore not included in the study. The femoral component was revised simultaneously if it was found to be loose at the time of operation (9 hips). In patients who did not undergo femoral revision, intraoperative notes indicated that the femoral components were well fixed. A cementless Madreporic acetabular component

(with cancellous allograft supplementation in 10 patients) was implanted. The decision to use morcellized cancellous allograft was based on the intraoperative findings of a cavitary medial wall defect. In all 10 of these patients, the cavitary defect was less than 30% of the diameter of the acetabulum. Screw fixation was performed at the surgeon's discretion, depending on the stability and coverage of the acetabular component. Antibiotics were administered for prophylaxis preoperatively and for 48 hours postoperatively. Enoxaparin was given twice daily by subcutaneous injection for 5 days (30 mg per dose) for thromboprophylaxis. As well, a 5-day course of indomethacin (25 mg 3 times daily) was prescribed. Patients were allowed partial weight bearing on the affected extremity for 6 weeks and then progressed to full weight bearing over the next 6 weeks.

Table I

Patient Demographic Data for 41 Hips

Demographic	No. of hips
Patient gender	
Male	20
Female	21
Patient age, yr*	62.0 (13.2)
Diagnosis	
Osteoarthritis	21
Nonosteoarthritis	20
Reason for revision	
Dislocation	11
Aseptic loosening	30
Infection	0
Acetabular fracture	0
Time to revision, yr*	7.4 (4.2)
Follow-up, yr*	3.4 (1.9)
Duration of symptoms, mo*	14.1 (15.2)
Operative time, min*	88.4 (35.6)
Estimated blood loss, mL*	509.5 (223.4)
Screws used	
No	24
Yes	17
Allograft used	
No	31
Yes	10
Work status	
Working	11
Working part time due to hip	1
Not working due to hip	8
Not working for other reasons	9
Retired	11
General satisfaction	
Extremely satisfied	9
Very satisfied	14
Moderately satisfied	9
Mildly satisfied	4
Not at all	5

*Values are means (and standard deviations).

To evaluate functional outcome, the following questionnaires were given to patients: the Harris hip score,[15,16] the Western Ontario McMaster (WOMAC) osteoarthritis index[17] and the SF-36 health survey.[18] The Harris hip rating system evaluates pain, function, activities, deformity and range of motion, with a maximum of 100 points.[15,16] The deformity and range of motion sections contribute only a maximum of 10 points to the overall Harris hip score. Since we did not examine the patients and this study evaluated the patients' perception of functional status, the Harris hip score was modified by excluding the deformity and range-of-motion portions. A previous study has shown that the range-of-motion portion of the Harris hip score correlates significantly with the WOMAC physical function score.[17] The maximum score achievable on this modified Harris hip score was 90 points, indicating the most positive functional status. The SF-36 health survey is a generic index of health, containing 36 items.[18] Eight dimensions were evaluated: physical function, role physical, bodily pain, general health, vitality, role emotional, social function and mental health. Scores were determined according to the SF-36 scoring manual and transformed so that the most positive state of health was represented by 100 points.[18] Two summary measures were calculated to serve as outcome measures of general health: PCS (physical component score) and MCS (mental component score).[18] The WOMAC osteoarthritis index contains 5 items in the pain category, 2 items in the stiffness category and 17 items in the function category.[17] Scores were calculated for each of the 3 categories and transformed so that the most positive state of health was represented by 100 points and the most negative state of health by zero points.[19]

To evaluate the effect of certain clinical predictors of outcome, multivariate analysis was used. Potential predictors of outcome were age, gender, time to revision from previous hip operation, use of a morcellized allograft, use of screws for additional acetabular fixation, and femoral revision.

Radiographs were examined preoperatively and postoperatively. Radiolucencies around the acetabular component were classified according to the system of Charnley and DeLee.[20] Bone defects were also classified, according to the American Academy of Orthopaedic Surgeons Committee on the Hip.[21]

STATISTICAL ANALYSIS

The (modified) Harris hip scores were computed. The results of the SF-36 survey were compared to those of the normal American population using Student's *t*-test. Bivariate and multivariate analyses were performed between 5 of the outcome measures (SF-36 PCS measure, SF-36 MCS measure, WOMAC pain score, WOMAC stiffness score and WOMAC function score) and the potential predictors of functional outcome.[22,23]

All calculations were performed using SAS (Statistical Analysis System, Version 5, Cary, NC) on a MAG 1450 personal computer (Magnum, Markham, Ont.).

RESULTS

Clinical characteristics of the patient group

Table I shows that approximately one-half of the patients were female. Noninflammatory arthritis was present in 37 of the 41 hips. The initial diagnosis was primary osteoarthritis in approximately one-half of the hips. Developmental hip dysplasia and subsequent degenerative osteoarthritis occurred in 10 hips. Post-traumatic osteoarthritis and avascular necrosis leading to degenerative hip joint changes accounted for 3 hips each. Inflammatory arthritis occurred in only 4 hips (3 of these were in men). The most common reason for revision was aseptic loosening (73%). Screws were used to enhance acetabular fixation in 17 hips (42%), and morcellized femoral head allografting was used in 10 hips (24%). In 4 hips, the acetabular component had already been revised.

Multivariate analysis of clinical predictors of outcome (Table II)

Stepwise linear regression analysis showed that the hips of women had worse outcomes on the PCS measure ($r^2 = 0.36$, $p = 0.02$). Also, WOMAC function scores were negatively affected by age ($r^2 = 0.36$, $p = 0.03$). Performing a concurrent femoral revision influenced WOMAC function scores positively ($r^2 = 0.39$, $p = 0.01$). The use of screws and allografts, and the time to revision from the previous operation did not affect any of the outcome variables. None of the potential clinical predictors of outcome had any significant effect on the MCS and WOMAC pain and stiffness scores.

Clinical outcomes

The hip-specific and general measures of health revealed that patients generally had not achieved normal function at the time of follow-up. The mean (and standard deviation) Harris hip score (66.2 [19.5]) was about 73% of the maximum value attainable at the time of follow-up. Similarly, the WOMAC scores were below the maximum values of 100 (Fig. 1). The SF-36 scores for the revision arthroplasty group were generally lower than the values for the normal population (Fig. 2) in the areas of physical function ($p = 0.00005$), role physical ($p = 0.00005$), vitality ($p = 0.00005$), and mental health ($p = 0.04$). The lack of normal physical function was corroborated by the PCS summary measure being significantly less than that of the normal population ($p = 0.00005$). The MCS was actually higher than normative values ($p = 0.009$) (Fig. 3).

Complications

Postoperative dislocation occurred in 5 hips and was managed by closed reduction in all cases. Two patients experienced wound hematomas, which were managed conservatively. A sciatic nerve palsy developed in 1 patient and did not resolve. No patients in this investigation suffered thromboembolic disease or significant heterotopic ossification. Overall, the complication rate was 20%. No other significant complications, including systemic ones, were noted.

Radiographic outcome

Preoperative radiographs indicated dislocation in 7 hips. Twelve hips had radiolucencies in DeLee and Charnley zones I, II and III.[20] Five hips had radiolucent lines in zone II alone. Isolated radiolucent lines in zone I and zone 3 were seen in 1 hip each. Radiolucent lines in zones I and II combined and zones II and III combined were seen in 1 hip each. No pelvic discontinuities or segmental wall defects were seen in these hips. Radiographs of the hip were available for review in 34 of 41 cases postoperatively. Postoperative radiographs showed that all 10 bone grafts had incorporated. In 10 hips, persistent radiolucency (2 to 3 mm thick) occurred. In 9 of these hips, the radiolucencies were in zones II and

Table II

Multivariate Analysis of Clinical Predictors on Outcome of Cementless Acetabular Revision

Analysis measures	SF-36 PCS	WOMAC function
Significant factors*	Female gender	Age
r^2	0.36	0.36
p value	0.02	0.03
Intercept	51.9	105.4
95% CI for parameter estimate	–15.7 to –1.3	–1.06 to –0.06

*There were no significant factors for the SF-36 mental component score and WOMAC (Western Ontario MacMaster University) pain and stiffness scores. CI = confidence interval, PCS = physical component score.

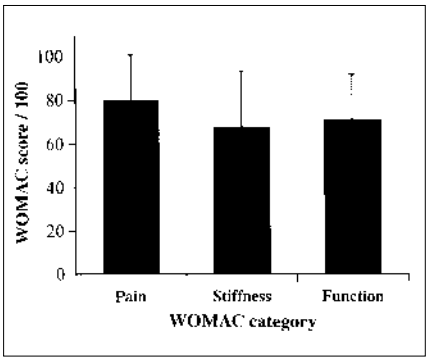

FIG. 1. Hip scores in each of the 3 categories of pain, stiffness and function of the Western Ontario McMaster (WOMAC) osteoarthritis index.

III, as defined by DeLee and Charnley.[20] In 1 hip there was an isolated zone I radiolucency. No hips had complete radiolucencies surrounding the acetabular component. None of the hips demonstrated migration of the socket in follow-up radiographs.

DISCUSSION

This study attempted to evaluate the effects of certain clinical factors on patient-related outcomes. From a prognostic point of view and for patient information, it is useful to conduct regression analysis of factors that could potentially affect outcome in addition to performing descriptive outcome studies. The variables used (gender, age, time to revision from previous operation, femoral revisions, screw fixation of the acetabular cup, and morcellized allografting) were theorized to be likely predictors of functional outcome. However, none of these factors affected the MCS of the SF-36 or WOMAC pain and stiffness scores. Obviously, other factors must play a role in determining these scores. Although these results are negative, at least we could conclude that in this group of patients some factors that would be expected to affect outcome, especially age and gender, do not significantly affect mental health, pain and stiffness scores. This may provide surgeons and patients with some useful prognostic information.

Multivariate analysis found that gender accounted for a portion of the variation in the PCS. Previous studies have demonstrated that men tend to have increased rates of revision after primary hip arthroplasty.[12] Our study showed that women have worse outcomes after revision surgery. Perhaps this is because of the increased incidence of osteoporosis experienced by women with increasing age. This would lead to greater deficiencies in acetabular bone stock over time, thus making the revision hip surgery a more difficult operation. Reconstitution or support of the bone stock generally leads to more successful outcomes.[9,13,24,25]

WOMAC function scores were affected by patient age and concurrent femoral revision. The average age of the patients was 62.0 years, similar to the findings of other studies.[10,26–28] Increased age was associated with worse WOMAC function. This may be owing to the presence of comorbidities, although the general health of patients in this group was similar to that of the normal population, according to the SF-36. Increased age may also be associated with osteoporosis, which may render revision more difficult. Moreover, the worse function seen in older patients may also be related to declining function with age. The presence of a femoral revision at the time of acetabular revision accounted for some of the variation seen in WOMAC function scores and positively affected them. Whereas additional femoral revision would lead to increased operative time and possibly greater blood loss, patients had better WOMAC function scores than those whose femoral components were not revised. Unfortunately, preoperative function was not known in the study patients. It is possible that those who underwent femoral revision had worse preoperative function than those whose femoral components were well fixed. Therefore, postoperative function may

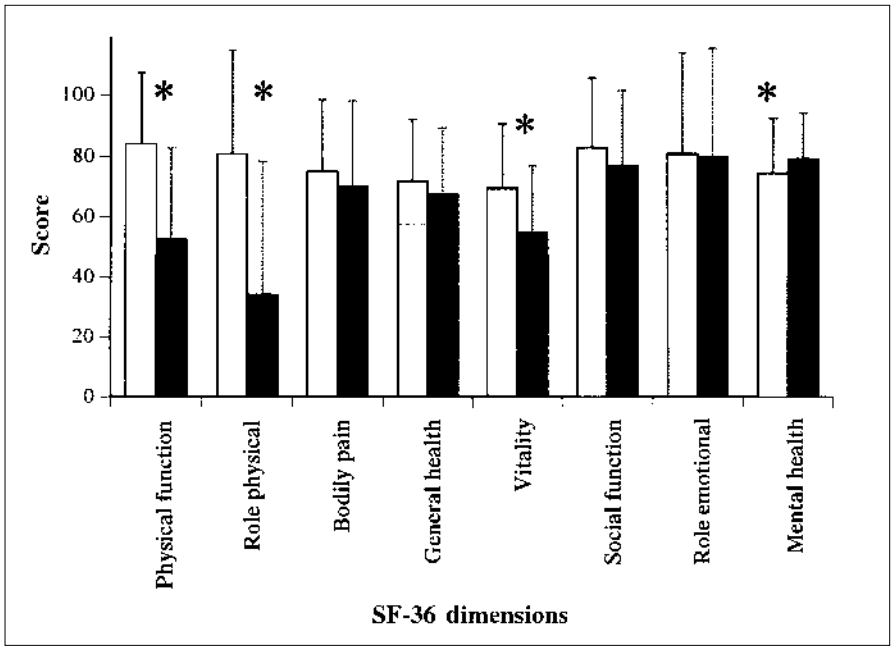

FIG. 2. Comparison of SF-36 health survey scores in the study hips (black bars) with those of the normal population (white bars). *Significant at $p = 0.05$.

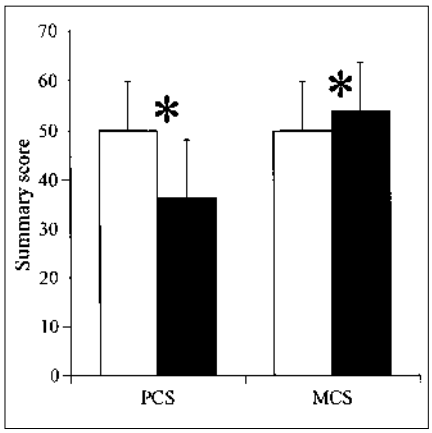

FIG. 3. The 2 summary measures, PCS (physical component score) and MCS (mental component score) of the SF-36 health survey in the study patients (black bars) are compared with data from the normal population (white bars). *Significant at $p = 0.05$.

have improved to a greater degree than in those who had acetabular revision alone. In any case, it would be useful for patients to know that should they require a femoral revision in addition to acetabular revision, their WOMAC function scores may not be negatively affected.

Patients continued to report disability on hip-specific measures at the time of follow-up. Both the Harris hip score and the WOMAC osteoarthritis index showed that hip function did not reach the maximum values attainable. The generic index of health (SF-36) revealed that patients still felt physically disabled, whereas their general and mental health remained close to normal. Although preoperative data are not available because of the retrospective nature of the study, the absolute values of the scores achieved by the patients indicate that impairment of normal or maximal function still existed more than 3 years after revision. Although the pain score component of the SF-36 did not show any significant differences from that of the normal population and patients were generally satisfied, postoperative functional disability continued. This may be the result of revision surgery further weakening muscles and soft tissues already traumatized by at least 1 previous operation. Furthermore, revision is associated with an increased rate of complications. In this study, about 20% of patients experienced some complication postoperatively, mostly in the early postoperative period. This rate is comparable to those of other series.[9,13,14,29] Patients should be warned that revision hip surgery is associated with more complications than primary surgery.

Because of the retrospective nature of this study, preoperative data are not available. Therefore, we cannot comment on whether patients actually improved after their revision procedure. However, the outcome data obtained in this study can serve as benchmarks for other studies or future investigations.[30] The outcome data can also be used to reinforce the expectations for the patient.

Radiographic analysis revealed that almost one-quarter of hips had radiolucency around the cementless acetabular component. Osteolysis induced by wear debris remains a concern in cementless acetabular arthroplasty. A longer follow-up would be useful to determine the progression of these radiolucencies over time. Silverton and colleagues[14] reported nonprogressive radiolucencies after cementless acetabular revision in 54% of their patients.

A strength of this study was that functional status was used as the primary outcome measure. Both generic and disease-specific scales were administered. Although the WOMAC osteoarthritis index has not been widely used for revision hip arthroplasty, it serves as a useful index for patients with hip problems. Another strength is that for all but 1 of these patients, 1 surgeon (J.P.W.) performed the operations, lending consistency in surgical technique. Although the follow-up was 3.4 years, this study provides useful information for patients. Whereas long-term results are important, early outcomes are of value to patients about to undergo major surgical procedures. Patients often would like to know what their status may be in the first few years after the operation and to see if there is any short-term gain. The weaknesses included the retrospective nature of the study. Therefore, comparisons with preoperative health status were not possible. We do not know whether patients' health status improved, worsened or remained unchanged after revision. Although no preoperative data were available, the absolute values of the joint-specific and generic indices of health still provide prognostic information and can serve as benchmarks for other investigations.

Conclusions

Several outcome measures (namely SF-36 MCS, and WOMAC pain and stiffness scores) after acetabular revision arthroplasty were not affected by age, gender, time to revision from previous surgery, screw fixation, allograft use and femoral revision. Female gender was associated with worse physical component score outcomes. Age and femoral revision affected WOMAC function scores. These results may serve as useful prognostic indicators for patients undergoing cementless acetabular revision arthroplasty, which is associated with a higher complication rate and generally poorer outcomes than primary surgery. A future prospective study would be useful to evaluate outcomes, using the WOMAC and SF-36 measures, after revision acetabular arthroplasty. Also, future investigations may wish to focus on other factors that may be able to account for general health and limb-specific outcomes.

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