

## Original Article

## Reverse hybrid total hip arthroplasty in select patients

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## A B S T R A C T

**Keywords:**  
 cemented cup  
 cementless stem  
 total hip arthroplasty  
 reverse hybrid

**Purpose:** To report the result of cemented cups and cementless stems (reverse hybrid) in 17 total hip arthroplasties (THAs).

**Methods:** From January 2003 to January 2008, 17 hips (17 patients) received reverse hybrid THAs and were included in this study. The mean patient age was 70 years (range, 52–81 years). The reasons for a reverse hybrid THA were an acetabulum too small to accommodate a metal shell, a severely osteoporotic acetabulum with thin subchondral bone, in which press-fit and screw fixation of the metal shell was deemed unstable, irradiation arthritis, and sequelae of sepsis, while the proximal femoral canal is normally shaped for a press-fit stem. Demographic data, surgical techniques, reasons for surgery, Harris hip score, and complications were reported.

**Results:** The average Harris hip score was 84.4 (range, 48–100) points at an average follow-up of 40.1 months (range, 24–73 months). One patient had a Vancouver type 2B fracture and received reoperation with open reduction. The patient had a 3-cm subsidence of the stem and thigh pain at follow-up. Another patient had an asymptomatic 1.5-cm subsidence of the stem. No loosening, migration, or progressive radiolucent lines around the cup were noted in any patient.

**Conclusion:** Reverse hybrid THA was associated with good clinical and radiographic results of the cemented cups in patients with the four selection criteria. It is noteworthy that one periprosthetic femoral fracture and one asymptomatic stem subsidence occurred. The lower average hip score with reverse hybrid THA than with ordinary THA is attributable to major comorbidities in the patients.

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## 1. Introduction

Charnley's total hip arthroplasty (THA) utilized acrylic bone cement for fixation of both the acetabular cup and the stem and began a new era of joint surgery.<sup>1</sup> Microstructure coatings for bone ongrowth were introduced later for cementless fixation of the components in an attempt to prevent complications associated with acrylic cement.<sup>2</sup> The

contemporary cementing technique of using plug, cement gun, and pressurization has improved the results of cemented stems.<sup>3,4</sup> Hence, the so-called hybrid THA, cementless fixation of the cup, and cement fixation of the stem using the contemporary technique were popularized.<sup>5</sup> However, in certain circumstances, for example when a cementless cup cannot be well fixed with the press-fit technique or screws, a cemented acetabular component may be a better choice than the cementless one. The combination of a cemented cup and a cementless stem (reverse hybrid) in select clinical situations is rarely used in THA, and to our knowledge has been scarcely reported. The purpose of this study is to report the use of reverse hybrid hip arthroplasty in 17 patients.

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## 2. Patients and methods

### 2.1. Selection criteria

During the period from January 2003 to January 2008, 686 primary THAs were performed by the corresponding author. Among the 686 hips, 17 hips (17 patients) that were managed with a cemented cup combined with a cementless stem (reverse hybrid) were included in this study. The reasons for performing a reverse hybrid THA were as follows: A) the acetabulum was too small to accommodate a metal shell or a metal shell for a 28-mm head and the patient carried a high risk of dislocation (three hips); B) the acetabulum was severely osteoporotic with thin subchondral bone in which press-fit and screw fixation of the metal shell was deemed unstable (eight hips); C) irradiation-related arthropathy in which bone ongrowth to the metal shell may be retarded (one hip); and D) a mixed condition resulting from the sequelae of a septic hip and any of the above (three hips). In addition, two patients with a combination of A and B were managed with reverse hybrid THA. In patients with sequelae of a septic hip, antibiotic-impregnated cement based on sensitivity tests was used. In these patients, an average of 2-g vancomycin in one pack of polymethylmethacrylate cement was used. In the other 14 patients, cefuroxime, 0.5 g was used as prophylaxis.

The 17 patients included 4 males and 13 females with an average age of 70 years (range, 52–81 years) (Table 1). Preoperative diagnoses were osteonecrosis of the femoral head (six cases) neglected femoral neck fracture (three cases), sequelae of septic arthritis (three cases), irradiation arthropathy (three cases), femoral neck fracture with secondary osteonecrosis of the femoral head (one case), and osteoarthritis secondary to dysplasia (one case). The major comorbidities of the patients are summarized in Table 2.

### 2.2. Surgical technique

Surgery was performed largely based on what Ranawat and others<sup>6</sup> described. It is summarized as below. Under

**Table 2**

Patients' comorbidities.

No.	Comorbidity
1	Thalassemia, coronary artery disease, sequel of poliomyelitis
2	Congestive heart failure, cervical cancer
3	Spondylosis
4	Asthma, compression fractures of spine, osteoporosis, spondylosis
5	Parkinsonism, stroke, knee flexion contracture, osteoporosis
6	Cervical cancer, vulvular cancer, lymph edema, bronchiectasis, spondylosis
7	Chronic obstructive pulmonary disease, compression fracture of the spine, spondylosis
8	Nil
9	DM triopathy
10	Traumatic brain injury, Alzheimer's disease, compression fracture
11	Nil
12	DM, hypertension
13	Alzheimer disease, chronic renal disease
14	Cervical cancer, DM, hypertension, end-stage renal disease, hyperparathyroidism
15	DM
16	Cervical cancer, bone metastasis
17	Gastric cancer, DM, aspiration pneumonitis

DM = diabetes mellitus.

anesthesia, the patient was placed in the lateral recumbent position. A 5–7-cm skin incision was made for the Harding approach to the hip. The only exception was Case 1 in whom a transtrochanteric approach was adopted because of severe dysplasia and deformity of the left proximal femur and acetabulum. A structured bone graft was also fixed to the acetabulum in this case only because of the shallowness and small diameter of the acetabulum.

After capsulectomy, the hip was dislocated anteriorly for preparation of the acetabulum with chisels and reamers. At the dome, ischium, and pubis, 7–11 holes for cement anchorage were created using a 3.5-mm drill bit. The cement in doughy consistency was introduced and pressed into the cancellous bed after meticulous hemostasis. A flanged polyethylene cup (Trident; Stryker Orthopaedics, Mahwah, NJ, USA) of adequate size with an inner diameter

**Table 1**

Patient characteristics.

No.	Sex	Age (y)	Side	Diagnosis	Inclusion criteria	Follow-up (mo)	Harris hip score	Complication
1	Woman	52	Left	Sequel of infection	A, B, D	73	95	Nil
2	Woman	74	Left	Neglected FNF	A	60	77	Nil
3	Woman	71	Left	ONFH	B	48	87	Nil
4	Woman	79	Left	ONFH	B	47	80	Nil
5	Woman	76	Right	Neglected FNF	B	47	69	Stem sinking 1.5 cm
6	Woman	68	Right	Irradiation arthropathy	B, C	45	48	Periprosthetic fracture, stem sinking 3 cm
7	Man	74	Left	ONFH	B	43	89	Nil
8	Man	70	Right	ONFH	B	41	97	Nil
9	Woman	74	Right	Neglected FNF	B	40	73	Nil
10	Woman	73	Right	OA, dysplasia	A	40	94	Nil
11	Woman	76	Left	ONFH	B	36	88	Nil
12	Man	81	Left	Sequel of infection	B, D	34	97	Nil
13	Woman	69	Right	Sequel of infection	A, B, D	32	85	Nil
14	Woman	61	Left	Irradiation arthropathy	B, C	31	87	Nil
15	Woman	73	Right	ONFH	A	25	85	Nil
16	Woman	54	Left	Irradiation arthropathy	C	24	100	Nil
17	Man	68	Left	FNF, ONFH	B	24	85	Nil

ONFH = osteonecrosis of the femoral head; OA = osteoarthritis; FNF = femoral neck fracture; A = small acetabulum; B = osteoporosis; C = irradiation-related arthropathy; D = sequel of sepsis.

of 28 mm (except Case 1 who received a polyethylene cup with a 22-mm inner diameter due to the extremely small acetabulum; Fig. 1) was inserted and held with pressure at the appropriate orientation in all cases until the cement was set. The excess cement was then removed (Fig. 2).

The proximal femur was exposed by external rotation and adduction of the hip and prepared with broaches. A stem of proper size was inserted with the press-fit technique. Secur-Fit Max (Stryker Orthopaedics, Mahwah, NJ, USA) stems were used in all cases except for Case 2 (Fiber Metal Taper; VerSys System; Zimmer, Inc, Warsaw, IN, USA) and Case 5 (Excia System; Aesculap, B. Braun, Germany). A 28-mm head (except in case number 1) with appropriate neck length was assembled. The hip was reduced, and the stability was checked again. A 1/8-inch suction drain was placed, and the wound was closed in layers.

### 2.3. Postoperative care

The patient was allowed to sit and walk with a walker 8 hours after surgery and partial weight bearing was allowed as tolerated. The suction drain was removed 24–48 hours after surgery. Patients were discharged 3–10 days (average 6.7 days) after surgery when they could ambulate with a walker without significant pain. Full weight bearing of the affected limb was encouraged 6 weeks after surgery.

### 2.4. Follow-up and clinical evaluation

The patients were followed regularly at the outpatient clinic. Harris hip scores and radiographs were recorded postoperatively at 3 months, 6 months, 1 year, and then yearly thereafter. In the cases who did not return for regular follow-up, hip scores were evaluated by telephone contact.

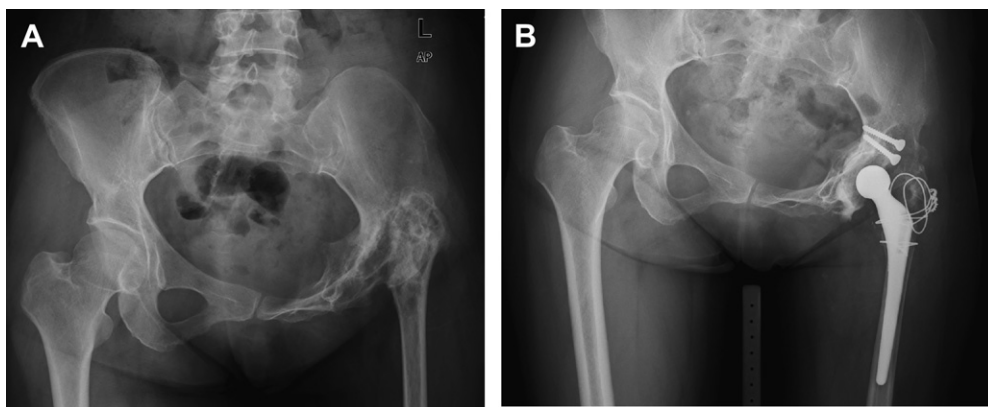
## 3. Results

The 17 patients were followed for an average of 40 months (range, 24–73 months). The average postoperative Harris hip score was 84 points (range, 48–100 points) (Table 1) compared to the average preoperative Harris hip score of 41 points. No infection or dislocation occurred

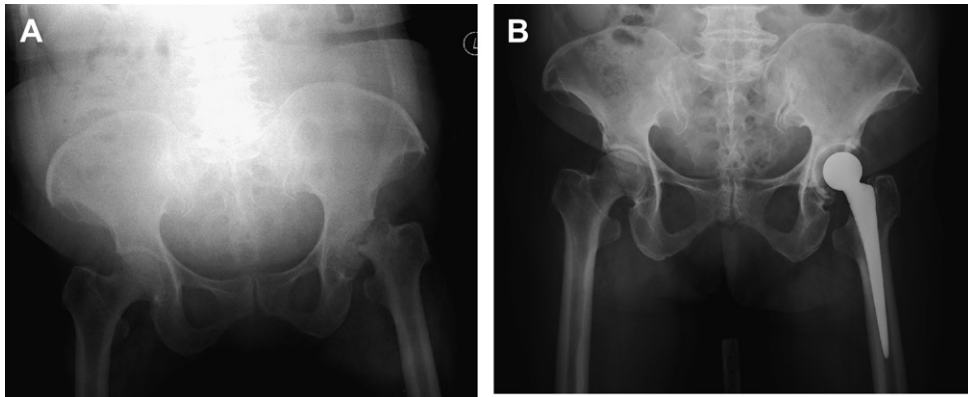
during the follow-up period. Fourteen of the patients were able to walk without an aid and three patients needed a cane or crutches due to the comorbidities of parkinsonism, knee contracture, and spine disorders (Table 2). No loosening, migration, or progressive radiolucent lines were found in the cup components in the follow-up radiographs; however, subsidence of the femoral stem was found in two cases. One patient had an asymptomatic 1.5-cm subsidence of the stem (Case 5, Fig. 3) and the other sustained a Vancouver type B2 fracture of the femur (Case 6) that was managed with open reduction. However, the stem had a 3-cm subsidence that was associated with thigh pain at 45 months after surgery (Fig. 4). No revisions for the cups or the femoral stems in the 17 patients were necessary.

## 4. Discussion

THA has been performed for more than 60 years and is a well-established surgery. Components can be cemented or cementless depending on the patient's condition and the surgeon's preference. Cemented THA has been shown to yield excellent outcomes by Charnley and other surgeons.<sup>1,7</sup> The Swedish registry of THAs has also shown that cemented THA provides excellent outcomes, and that the outcomes are better than cementless THA.<sup>8</sup> In the Swedish registry, aseptic loosening was the major reason for revision of cementless THAs. Improvements in the cementing technique have been shown to decrease the 10-year revision rate by half in Swedish registry as well.<sup>8</sup> Fully cemented THA had a lower rate of revision compared to cementless THA when considering all causes of failure in a 7-year analysis of 42,665 primary cases of THA from the New Zealand Joint Registry.<sup>9</sup> Della Valle and associates<sup>10</sup> also reported a relatively low rate of revision (5%) and loosening (10%) after follow-up of more than 20 years, though with a higher but still relatively low rate of radiographic loosening. However, other reports observed a higher rate of aseptic loosening and revision associated with cemented acetabular components, especially in young active patients.<sup>11–13</sup> Improved cementing techniques have decreased the rate of loosening of the stem but not of the cup.<sup>14</sup>



**Fig. 1.** (A) A 52-year-old woman (Case 1) with severe deformity of the left hip due to sequelae of septic arthritis during early childhood. (B) Six years after reverse hybrid total hip arthroplasty with a 22-mm inner diameter polyethylene cup, strut autogenous bone graft, press-fit stem, and osteoplasty of the proximal femur, the result was excellent.



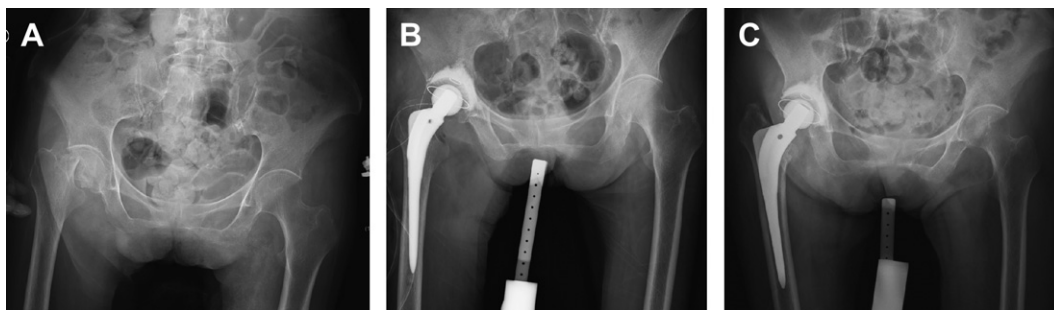
**Fig. 2.** (A) A 74-year-old woman (Case 2) sustained a displaced femoral neck fracture of the left hip that was neglected. Note the acetabulum is small and osteoporotic, but the femoral canal is narrow and normal shaped. (B) The reverse hybrid total hip arthroplasty has been well fixed for 5 years.

Cementless fixation was developed to enhance the durability of components based on its biologic bond with the host bone, though cementless fixation did not solve the problem of osteolysis, which is seen in cemented total hips. Cementless THA also has a higher wear rate<sup>15–17</sup> leading to early exchange of the liner,<sup>12</sup> higher dislocation rate due to malposition,<sup>9</sup> and cup-liner problems.<sup>8</sup> Chawda et al<sup>18</sup> have demonstrated a lower rate of reproducibility of positioning of acetabular component in cementless sockets than in cemented sockets using an imageless navigation system, which may explain the higher rate of revision for dislocation with a cementless acetabular component. Cementless acetabular components have been shown to be associated with a lower rate of acetabular revision for aseptic loosening<sup>9</sup> in long-term follow-up, but patients may still need revisions for other causes. Subgroup analysis in a review article revealed superior survival with cementless fixation in studies including patients 55 years of age or younger as compared to those that studied patients of all ages.<sup>19</sup>

Initial stability plays a key role in bone ongrowth to a cementless cup.<sup>20</sup> In elderly patients with severe osteoporosis, it is very difficult to achieve initial stability of a metal cup without cement. In patients with an acetabulum smaller than 44 mm, only a 22-mm head can be used, which carries a higher risk of dislocation and wearing.<sup>21,22</sup>

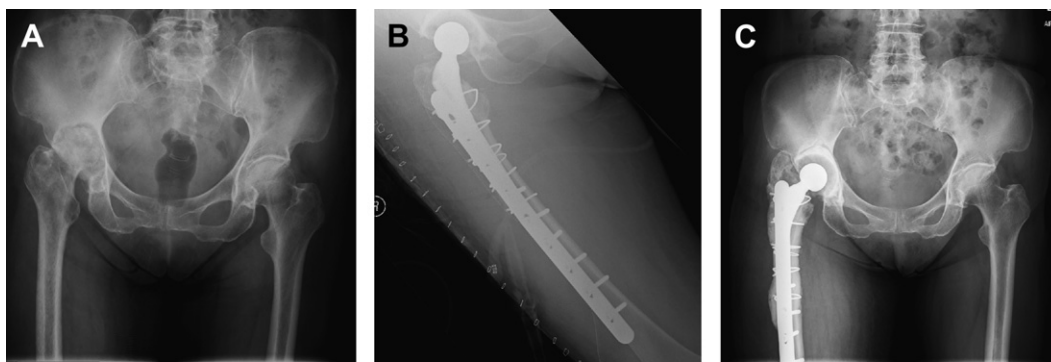
Cementing an all-polyethylene liner with a 28-mm inner diameter can help reduce this problem. Bone surfaces after radiation therapy are not an ideal surface for bone ongrowth, and a cemented cup is preferred. In cases of prior sepsis, adding antibiotics to the cement provides prolonged antibiotic elution to prevent recurrence of infection.<sup>23</sup> When the acetabular cup is cemented, an all-polyethylene cup has been shown to have better survival than a metal-backed one,<sup>24</sup> and a polyethylene cup with a flange is a better choice because the flange increases the pressure within the cement mantle on component insertion.<sup>25</sup> There were no loosening, migration, or progressive radiolucent lines around the cemented cups in our series.

A cementless stem with adequate shape to fit the proximal femoral canal can provide excellent performance, even in osteoporotic patients.<sup>26</sup> Nakamura and associates<sup>27</sup> reported no unstable stems after a minimum of 12 years of follow-up of 50 hips using anatomic medullary locking cementless stems. A minimum of 10-year follow-up in 39 hips (27 patients) with rheumatoid arthritis using cementless femoral stems with a tapered design performed by Carl and associates<sup>28</sup> showed no revisions for aseptic loosening. By avoiding cement for the femoral component, the embolic load was decreased. None of our cases (some with cardiopulmonary diseases) developed any symptoms



**Fig. 3.** (A) A 76-year-old woman (Case 5) sustained a displaced right femoral neck fracture. (B) Radiograph after reverse hybrid total hip arthroplasty. (C) The stem is noted to be subsided 1.5 cm at 47-month follow-up compared with the initial postoperative film. The patient had no complaints.





**Fig. 4.** (A) A 68-year-old woman (Case 6) developed right hip arthropathy due to irradiation for uterine cervical cancer. (B) Periprosthetic femoral fracture (Vancouver type 2B) occurred 3 weeks after reverse hybrid total hip arthroplasty, and open reduction, internal fixation with a plate and wires was performed. (C) Despite good bony union of the periprosthetic fracture, the stem subsided 3 cm. The patient complained of thigh pain and limping.

related to fat or cement embolism. Subsidence of the stem was found in two patients; one case was asymptomatic and the other case was related to a periprosthetic fracture. The average Harris hip score of the 17 patients (84 points) was lower than what is expected for an ordinary THA because of their comorbidities (41 major comorbidities in 15 patients).

There were two reports discussing reverse hybrid THA that we found. One report compared a hybrid group and a reverse hybrid group.<sup>29</sup> A paired analysis of 54 patients in each group with an average follow-up of 5.8 years showed five (9.3%) revisions in the hybrid group but only one (1.9%) stem revision for loosening in the reverse hybrid group. The five revisions in hybrid group included two for stem loosening, two for acetabular loosening, and one for stem fracture. The contemporary revision rate for cementless THA was 11.8% with 1% attributed to acetabular failure. The authors concluded that reverse hybrid THA was a successful alternative to hybrid THA. The other report, based on 26 THAs in 25 patients with more than 10 years of follow-up, showed an improvement of Harris hip score to 88 during follow-up, but definitive acetabular loosening occurred in nine (34.6%) cases.<sup>30</sup> The authors proposed that the high loosening rate may have been because a 32-mm head was used and was associated with greater volumetric wear ( $108.75 \text{ mm}^3/\text{year}$ ). The study was published in the Korean language, so the details of acetabular and cement preparation were difficult to understand. Neither of the reports illustrated clear indications for performing a reverse hybrid THA.

In conclusion, for patients with a small acetabulum, a severely osteoporotic acetabulum, irradiation-related arthropathy, and the sequelae of sepsis, a reverse hybrid THA offers a valuable option.

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