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Original Article

Comparison of Cemented and Bone Ingrowth Fixation Methods in Hip Resurfacing for Osteonecrosis

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A R T I C L E I N F O

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A B S T R A C T

Background: The optimal surgical treatment for osteonecrosis of the femoral head has yet to be elucidated. To evaluate the role of femoral fixation techniques in hip resurfacing, we present a comparison of the results for 2 consecutive groups: group 1 (75 hips) received hybrid hip resurfacing implants with a cemented femoral component; group 2 (103 hips) received uncemented femoral components. Both groups received uncemented acetabular components.

Methods: We retrospectively analyzed our clinical database to compare failures, reoperations, complications, clinical results, metal ion test results, and X-ray measurements. Using consecutive groups caused time interval bias, so we required all group 2 patients to be at least 2 years out from surgery; we compared results from 2 years and final follow-up.

Results: Patient groups matched similarly in age, body mass index, and percent female. Despite similar demographics, the uncemented, group 2 cases showed a lower raw failure rate (0% vs 16%; $P < .0001$), a lower 2-year failure rate (0% vs 7%; $P = .04$), and a superior 8-year implant survivorship (100% vs 91%; log-rank $P = .0028$; Wilcoxon $P = .0026$). In cases that did not fail, patient clinical ($P = .05$), activity ($P = .02$), and pain scores ($P = .03$), as well as acetabular component position ($P < .0001$), all improved in group 2, suggesting advancements in surgical management. There were no cases of adverse wear-related failure in either group.

Conclusion: This study demonstrates a superior outcome for cases of osteonecrosis with uncemented hip resurfacings compared to cases employing hybrid devices.

Following success in elderly, inactive patients in the 1950s, Sir John Charnley's stemmed total hip arthroplasty (THA) design received acclaim and wide consideration as the paradigm of hip replacement prostheses; yet, he cautioned against use of THA in younger, active patients [1]. As Charnley predicted, standard stemmed THA exhibits inferior durability in these patients [2]. Hip resurfacing arthroplasty (HRA) offers an alternative to THA in young patients, providing a more functional [3], bone-preserving method. HRA offers numerous theoretical advantages, including minimal bone resection [4], greater stability [5,6], less thigh pain [7,8], avoidance of stress shielding [9,10], ease of revision [11], resumption of high range-of-motion activities [12,13], and more nearly-normal gait [14-16]. During its nascent stages, HRA provided discouraging results [17], and as a result, many surgeons abandoned the concept entirely. During unsuccessful, early HRA procedures, the poor performance of polytetrafluoroethylene and metal-on-polyethylene bearings revealed the need for a reliable bearing material if a successful HRA procedure was to be realized [18,19]. In 1991, McMinn played an instrumental role in reviving HRA with a new cobalt-chromium (Co-Cr) metal-on-metal (MOM) implant system [20].

Despite excellent results for hybrid Co-Cr resurfacing implants using femoral cement in young men with osteoarthritis (OA) [21], outcomes for patients with osteonecrosis (ON) proved less favorable [22,23]. Our previous study revealed that the most common failure mode in patients with ON was femoral cement loosening [24]. Subsequently, our study on HRA patients of all diagnoses found that loosening occurred in 3% of cemented femoral components by 10 years postoperatively [5]. To address femoral cement fixation as a potential weak link in the MOM hip-resurfacing construct, we collaborated with Biomet to develop the

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Table 1
Demographic Information.

Variable	Group 1	Group 2	*P* Value
Number of cases	75	103	—
Date range	January 2001-August 2013		—
Demographics			
Age	46 ± 12	45 ± 10	.588
Body mass index	27 ± 4	28 ± 5	.141
Female cases (# hips, %)	19/75 (25)	19/103 (18)	.267
Harris hip score (preoperative)	49 ± 12	53 ± 14	.042*
Diagnosis			
AVN (I)	0/75 (0%)	1/103 (1%)	.390
AVN (II)	2/75 (3%)	6/103 (6%)	.317
AVN (III)	32/75 (43%)	35/103 (34%)	.238
AVN (IV)	30/75 (40%)	61/103 (59%)	.011*
Unrecorded Ficat grade	11/75 (15%)	0/103 (0%)	<.0001*

Asterisk (*) represents a statistical difference.
Avascular necrosis (AVN) grades are shown.

uncemented Biomet ReCap™ system, which includes the first uncemented, fully porous-coated femoral component for MOM HRA. Its intended design pairs it together with the uncemented Magnum™ acetabular component. We first employed this porous ingrowth device in March 2007 and have continued to use it exclusively in all total resurfacing patients since 2008 [4].

The relative merits of these and other implants employing porous ingrowth fixation vs those fixed with polymethylmethacrylate cement continue to be debated by surgeons and scientists worldwide. Porous fixation was first introduced in the 1970s, and now, approximately 60% to 90% of the 300,000 THAs performed per year in the United States involve these uncemented components [25]. As THAs move toward eliminating cement entirely, many HRA systems still continue to use femoral cement [24,26]. Although the results of cemented HRA implants are satisfactory for cases of OA [16,27], femoral failure in HRA remains a problem in high-risk, ON patients. The exothermic reaction generated from cement curing may lead to damage of the femoral head [28] and could influence these failure modes. A benchtop study [29] determined that increased temperature develops in cystic defects filled with cement, confirming the suspected hypothesis that cement results in thermal damage of the femoral head. In another study, the same author reported a higher incidence of femoral failures when cysts are present [28]. In our own study of femoral complications with head cysts, we found no difference in failure rate when cysts were present or not, but our technique involved filling cysts with acetabular bone graft before cementing [30]. This discrepancy between publications also supports the hypothesis that thermal injury from cement may be a causative factor in femoral failures after resurfacing. Hybrid fixation for MOM hip resurfacing is the current standard, but they exhibit a higher failure rate when implanted into patients with ON. Critics of uncemented femoral resurfacings contend that osteonecrotic femoral heads lack adequate blood supply to allow bone ingrowth and stable fixation into a porous coating. In our experience, however, we encounter live, bleeding bone at the base of the femoral head in all resurfacing cases for ON. If the femoral head were truly dead, we suggest that all implants would migrate radiographically and be symptomatic by 2-year follow-up.

The primary goal of this study is to examine 3 hypotheses on the reduction of femoral failure in resurfacing of the necrotic hip: First, uncemented fixation with a fully porous-coated implant will eliminate cement-related failures caused by thermal bone necrosis, cement toxicity to bone, or cement fatigue failure. Next, porous femoral implants will achieve stable implant fixation as evidenced by lack of migration or stem radiolucency at 2 years postoperation. Lastly, using a completely uncemented resurfacing system will eliminate both early and late femoral failure modes.

Materials and Methods

Patients and Methods

From January 2001 to August 2013, a single surgeon performed 3262 HRA procedures. Of these, we identified 178 cases (5.5%) in 150 patients with a primary diagnosis of ON as our study group from the prospective database. Choosing August 2013 as a cutoff allowed at least 2 years of follow-up for each patient. We offered

Table 2
Metal Ion Results and Associated Reference Values.

Variables	Group 1 (Hybrid)		Group 2 (Uncemented)		*P* Values Between Groups 1 and 2	
	Unilateral (N = 18)	Bilateral (N = 17)	Unilateral (N = 37)	Bilateral (N = 24)	Unilateral	Bilateral
Co (μg/L)*	1.2 ± 0.62	4.6 ± 10.6	3.1 ± 12.9	1.4 ± 0.69	.5369	.1463
Cr (μg/L)*	0.9 ± 0.60	3.5 ± 3.33	1.3 ± 3.50	1.5 ± 0.91	.6337	**.0077***
Test date (y postoperative)*	7.9 ± 2.07	8.6 ± 1.36	3.0 ± 1.47	2.7 ± 0.91	**<.0001***	**<.0001***
#, % Patients tested	35 (47%)		61 (59%)		.0969	
#, % Levels converted	4 (22%)	3 (17%)	6 (16%)	5 (21%)	.5892	.8026
Total normal (#, %)	15 (43%)		39 (64%)		**.0455***	
Normal (#, %)	12 (67%)	3 (17%)	31 (84%)	8 (33%)	.1499	.2627
Optimal (#, %)	18 (100%)	16 (89%)	35 (95%)	24 (100%)	.3173	.2301
Acceptable (#, %)	0 (0%)	1 (5.5%)	1 (2.7%)	0 (0%)	.4839	.2301
Problematic (#, %)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1.000	1.000
Potentially toxic (#, %)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1.000	1.000

	Normal[a]	Optimal[b]	Acceptable[c]	Problematic[c]	Potentially Toxic[b]
Unilateral					
Co (μg/L)	<1.5	<4.0	4-10	10-20	>20
Cr (μg/L)	<1.5	<4.6	4.6-10	10-20	>20
Bilateral					
Co (μg/L)	<1.5	<5.0	5-10	10-20	>20
Cr (μg/L)	<1.5	<7.4	7.4-10	10-20	>20

Statistically significant *P* values are bolded and denoted by an asterisk (*).
[a] Laboratory normal for patients without metal bearings.
[b] According to DeSmet/van der Straeten.
[c] According to our previous analysis.