Functional Recovery following Ceramic-on-Ceramic Total Hip Arthroplasty in Patients Younger than Fifty-Five Years of Age

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Introduction

Total hip arthroplasty (THA) is widely regarded as one of the most successful surgeries in orthopaedics.[1] In young patients (variably defined, here we will use the cutoff of younger than 55 years of age), there is concern that patients' expected lifetime will exceed the expected lifetime of their implants. Additionally, because of their younger age, they are presumed to be more active and therefore will subject their implants to more cycles per unit time, as well as higher stresses and wear rates.[2]

Hard-on-hard bearing materials have demonstrated decreased wear rates and increased survival compared to traditional bearings.[3,4] Second generation ceramic-on-ceramic bearings, for example, have been reported in Level 1 studies to survive at 100% at 51 months and 96% at 8 years.[3,4] For these reasons, alternative bearing surfaces are promoted for young patients with the assumption that they will be more active, subjecting their joints to high loads and cycles. The magnitude of increase in activity following ceramic-on-ceramic THA in young patients has not been quantified.

We asked: 1) what magnitude does activity level increase in young patients following ceramic-on-ceramic THA, 2) what are their midterm (minimum 2-year) clinical outcomes, and 3) what is their complication profile?

Methods

We reviewed 100 consecutive uncemented ceramic-on-ceramic THAs in 79 patients younger than 55 years of age at the time of surgery (Table 1). Procedures occurred between February 1999 and April 2006, and all were performed by two high volume hip arthroplasty surgeons (JPG and CLN). In all patients, the choice of the ceramic-on-ceramic was based on age and reported activity levels. Fourteen patients were not included in the final analysis: three patients died due to causes unrelated to their arthroplasty (two from gun-shot wounds and one from an unknown cause), four patients refused consent to participate in the study, and seven patients were lost to follow

Table 1. Patient characteristics

	Original cohort	Included in final analysis
Number of Hips	100	80
Male	37	30
Female	42	35
Average Age (years)	38 (18-55)	39 (18-55)
BMI (kg/m^2)	30.1 (18.8-60.2)	29.4 (18.8-60.2)
Follow-up (months)		54 (24-110)
Diagnosis		
AVN	36	31
Osteoarthritis	34	29
Dysplasia	4	2
Rheumatoid arthritis	2	2
Post traumatic	3	1
Implant		
Reflection cup:Synergy stem	58	49
Reflection cup:Spectron stem	12	7
Reflection cup:Anthology stem	7	5
Trident Cup:Secur-Fit stem	22	19
Lineage cup:Profemur stem	1	0

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up at the time of study. The remaining 65 patients comprised 30 men and 35 women with a mean age of 39 at the time of surgery. Preoperative diagnoses included avascular necrosis (31), osteoarthritis (29), dysplasia (2), rheumatoid arthritis (2), and posttraumatic arthritis (1). Six prostheses failed and were excluded from the activity level analysis. The minimum follow-up period was two years with a mean of 54 months (range 24 – 110 months). The study was approved by our institutional review board and was carried out according to its guidelines.

All patients underwent THA through a standard posterior approach with implantation of modern ceramic-on-ceramic THA designs. Fifty-eight were Reflection cups coupled with Synergy stems, 12 were Reflection cups with Spectron stems, seven were Reflection cups with Anthology stems (all Smith & Nephew, Memphis, TN), 22 were Trident cups with Secur-Fit stems (Stryker, Kalamazoo, MI), and one was a Lineage cup with Profemur stem (Wright Medical, Arlington, TN). Postoperatively, patients were allowed full weight-bearing and underwent uniform post-operative care, which followed a standard protocol of physical therapy beginning on the first post-operative day.

All patients were followed routinely after surgery; this included, at a minimum, visits at two weeks, six weeks, three months, one year, and two years postoperatively. Primary outcome measures included preoperative and two years post-operative UCLA Activity Scores and Harris Hip Scores (HHS) recorded by the attending surgeons (JPG and CLN).[5,6] Secondary outcome measures included radiographic evaluation by two investigators (RC and GCL) for signs of radiolucency around the implants, malposition, and subsidence. Their independent assessments had a correlation of 1.0. All patients were contacted by telephone at the time of study (between two and nine years post-operatively) to confirm implant survival and current UCLA score. Any discrepancy was investigated with an additional clinic visit and radiographic examination (two patients). Patients were asked whether they were satisfied with their current activity level, and this was recorded as a binary answer. Patients were asked to identify their activity limiting factors; answers were categorized as: 1) no limitations, 2) other (non-operative hip) musculoskeletal limitation, 3) psychological impediments and lack of motivation, and 4) pain or disability of the operative hip. Finally, patients were asked whether they experienced a change in occupation activity level following THA; answers were categorized as: 1) same or similar occupation activity level, 2) more active occupation, 3) less active occupation or disability.

The UCLA and HHS results were analyzed for statistical significance using a two-tailed, paired student t-test using Excel (Microsoft, Redmond, WA).

Results

Patients under the age of 55 years demonstrated an increase in activity level following ceramic-on-ceramic THA (Table 2). The mean UCLA activity score increased from 4.0 to 7.7. Only 9 patients (13.9%) reported that their activity was limited by symptoms from their operative hip (residual pain in eight patients and embarrassment of squeaking in one patient, Table 3). Twenty-eight patients (43.1%) felt unlimited in their activity level, while 15 patients (23.1%) were limited by other musculoskeletal complaints and 13 patients (20.0%) were limited by psychological constraints (disinterest in greater activity or fear of accelerating bearing wear). The majority of patients (52,80%) were satisfied with their overall activity level. Fifty-seven patients (87.7%) reported keeping the same or similar occupation, while two patients (3.1%) reported having a more active occupation following surgery: one transitioned from disability to waitressing and the other became a bus driver following a more sedentary position (Table 4). Six patients (9.2%) reported having an occupation preoperatively but were collecting disability benefits by the time of survey. Interestingly, five of these patients demonstrated an increase in activity levels, from a mean of 3.9 (range 3-6) to a mean of 6.4 (range 5-7), while one patient demonstrated an unchanged UCLA score of 3.

Midterm clinical outcomes following ceramic-on-ceramic THA in patients under 55 years old showed an improvement in HHS and reassuring radiographic measures. The mean HHS increased from 52.8 (range 30-65) to 91.0 (range 38-100). Radiographic evaluation of all hips included serial AP pelvis, AP hip, and frog-lateral hip radiographs. The radiographs were evaluated for radiolucent lines, osteolytic lesions, and component failure (e.g., fractures). At a mean radiographic follow up of 49 months (24-98 months), no hips had evidence of subsidence, loosening, or osteolysis. The seven patients lost to follow-up at two years demonstrated satisfactory radiographic evaluation and HHS greater than 90 at the one year follow-up visit.

At this midterm follow-up period, ceramic-on-ceramic THA in young patients demonstrated a failure rate of 7.5% and a subjective squeaking complaint of 21.6%. Of the 80 hips included in this study, 74 (92.5%) survived at time of study and 6 required revision by two years following index surgery. Two patients underwent revision for ceramic liner fracture (2.5%), and one patient (1.3%) each for acetabular component loosening, intolerable squeak, periprosthetic fracture, and instability. The two ceramic fractures occurred early in the life of the implant (average 12 months). One fractured upon the patient falling forcefully from standing onto a stone surface; the other was due to a fall from a horse onto the patient's operative side. Of the surviving hips, 16 patients (21.6%) complained of subjective squeaking; however, only five patients (6.8%) demonstrated objective squeaking on clinical examination. Including the hip that was revised for squeaking, this yields a demonstrable squeaking rate of 8.1%.

Discussion

When discussing the use of ceramic-on-ceramic and other alternative bearings in young patients, authors distinguish the young based on longer life expectancy and presumed increased activity level, leading to increased demand.[4,7] One prior report suggested that patients under 75 years were

Table 2. Activity score results

	Preoperative	At time of follow-up	P value
UCLA Activity Score	4.0 (1-10)	7.7 (2-10)	<0.001
Harris Hip Score	52.8 (25-69)	91.0 (38-100)	<0.001

Table 3. Self-reported reasons for activity limitations

	No. (%)
Symptoms from the operative hip (pain, squeaking)	9 (13.9%)
Symptoms from other musculoskeletal area(s)	15 (23.1%)
Psychological/motivational causes	13 (20.0%)
No reported limitation	28 (43.1%)

Table 4. Occupational changes

	No. (%)
Maintaining the same or similar occupation	57 (87.7%)
Now in a greater physically demanding occupation	2 (3.1%)
Now collecting disability	6 (9.2%)

physically more active than those older than 75 years at one year following conventional THA;[8] however, the magnitude of activity increase following ceramic-on-ceramic THA in young patients has not been reported. We asked: 1) what magnitude does activity level increase in young patients following ceramic-on-ceramic THA, 2) what are their midterm (minimum 2 year) clinical outcomes, and 3) what is their complication profile?

The improvements in activity scores observed in our series are similar to those reported by Yoo *et al* using a modified UCLA score following ceramic-on-ceramic THA.[9] They reported that 59 patients (97%) were able to participate regularly in moderate activities such as housework, shopping, and light occupational work (loosely correlating to a UCLA of 6). Fifty-five (90%) patients could regularly play sports (UCLA of approximately 7-8), and 34 (56%) could participate in impact sports (UCLA of approximately 9-10). Another study of activity level after ceramic-on-polyethylene hips reported a postoperative UCLA score of 6.3.[10] Using a pedometer, the authors found that the average gait cycles per year was comparable to that of older patients reported in the literature, and concluded that young patients following THA may not be more active than older patients. Our results show that in cohort of patients under 55 years old who are selected to undergo ceramic-on-ceramic THA, both activity level and function significantly increase at a mean of 54 months. To take our findings to the next logical step of concluding that younger patients return to a higher activity level following THA than traditional patients, we can compare our UCLA score of 7.7 (average age 39, average duration 54 months) to that reported in the literature of 6.3 (average age 58.4, duration greater than six months).[11] These findings are also consistent with several series demonstrating comparable improvements HHS following ceramic-on-ceramic THA with low rates of ceramic fracture, instability, and loosening.[12,13,9]

Yoo *et al* also reported no change in occupation due to a hip joint problem following ceramic-on-ceramic THA.[9] Our study found that most young patients maintained their occupation or entered a more active occupation. However, 9.2% of our patients were previously employed but now collecting disability benefits at the time of final follow-up. It is unclear whether hip symptoms contributed to their disabilities, but notably activity level increased in all but one patient. Possibly, social and cultural factors distinguish our cohort from that of the mentioned study.

A meta-analysis of observational studies comparing bearing surfaces in patients under 55 years found the 10 year survival for ceramic-on-ceramic bearings to be 88.9% in an overall sample size of 294 patients.[7] Our 54 month survival rate of 92.5% is consistent with these results.

Rates of ceramic fracture in the literature rates are 0.02 to 0.1%.[3] Our results showed two ceramic fractures at a rate of 2.5%, which is consistent with the mentioned cohort of patients with a mean age of 30 years. Our ceramic liner fractures occurred early at 9 months and 15 months and both were due to traumatic impact. It is possible that younger patients experience a higher rate of ceramic fracture than traditional patients due to their higher exposure to traumatic events.

The incidence of squeaking in ceramic-on-ceramic THA has been variably reported between 2 and 23%.[14-17] Our results are within the lower half this reported range, and our discrepancy between subjective and objective squeaking confirms one study reporting that 10.7% of patients complained of squeaking, but only 3.1% demonstrated objective squeaking

on clinical exam.[18] The higher rate of subjective complaints of squeaking may be related in part to the awareness of this complication from popular media and legal advertisements. It has been suggested that fourth generation ceramics do not suffer from the squeaking phenomenon, but definitive studies have not yet been reported.

This study makes several important assumptions to tests the hypothesis that activity level increases dramatically in young patients receiving THA. One assumption is that the static UCLA Activity Score at time of final follow-up reflects the dynamic activity level following THA in these young patients.This can be problematic in patients with polyarthritic disease that lead to the index THA; increased activity in the early years might lead to debilitation due to aggravation of other musculoskeletal disease, leading to a lower UCLA score that evades the question of interest. Other limitations of this retrospective study include: selection bias, loss to follow-up, and measurement bias. Three patients died and four refused participation, the inclusion of whom might have skewed these results. Seven patients were lost to follow-up but their 1-year results suggest that their inclusion would not have skewed the results. Finally, the measures of HHS and UCLA Score were collected by the operative surgeons and could have been influenced by an inherent desire for successful outcomes.

Conclusion

Our cohort of patients demonstrated an increase in activity level, an improvement in clinical outcomes, and a low incidence of failures and complications. The value of this present study comes from its quantification of activity level increase and its confirmation of prior literature of favorable outcomes following ceramic-on-ceramic THA in young patients. Interesting findings include the frequency of patients collecting disability following surgery and the self-assessments of the reasons for their limitations to do more activity.

Disclosures

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