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Hip Resurfacing Arthroplasty in Treatment of Avascular Necrosis of the Femoral Head

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Background: Hip resurfacing is a conservative type of total hip arthroplasty but its use is controversial, especially in patients with osteonecrosis. The aim of this study was analysis of the clinical and radiographic outcomes of hip resurfacing in patients with osteonecrosis.

Material/Methods: Between 2007 and 2008, 30 hip resurfacing arthroplasties were performed due to osteoarthritis secondary to avascular necrosis of femoral head staged as Ficat III and IV.
Patients were qualified to resurfacing arthroplasty when the extent of avascular necrosis using Kerboul's method was <200° and the angle between avascular necrosis and head-neck junction was >20°. All patients were evaluated clinically and radiologically before and 60 months after the operation.

Results: The mean Harris Hip Score (HHS) score increased from 47.8 to 94.25 ($p<0.05$). Physical activity level (University of California, Los Angeles activity score – UCLA activity score) improved from 3.7 to 7.55 ($p<0.05$). No implant migration was observed.

Conclusions: Management of osteonecrosis of the hip with resurfacing arthroplasty seems to be effective in strictly-selected patients.

MeSH Keywords: Arthroplasty, Replacement, Hip • Femur Head Necrosis • Osteoarthritis, HipBackground

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Background

Osteonecrosis of the femoral head is caused by impaired vascular supply. Avascular necrosis is a progressive condition leading to complete destruction of the hip joint. Usually young, active people between 20 and 50 years of age are affected by the disease and their occupational and physical activity is substantially limited [1–3].

Surgical treatment of the advanced stage (Ficat III° and IV°) of this entity is a challenging issue. Total hip replacement (THR) is the criterion standard in the management of end-stage avascular necrosis of the femoral head [4]. Because of relatively young age and high activity of the patients, the results of THR in this group of patients are not encouraging. Especially, the use of cemented hip endoprostheses results in high rate of revision surgeries [5,6]. Introduction of uncemented total hip arthroplasty significantly improved clinical results [7,8]. Kim et al. did not observe any aseptic loosening incident after almost 10 years of follow-up in 118 total hip replacements [9].

Despite good results of uncemented total hip replacement, the lifespan of patients with osteonecrosis of the femoral head exceeds the longevity of the implant and further revision surgeries are usually required. Thus, conditions leading to increased osteolysis around the implants (e.g., stress-shielding and wear of polyethylene) may substantially deteriorate the situation during revision surgery [10,11]. Also, the higher dislocation rate among patients undergoing hip replacement with use of standard 28-mm heads has been unsatisfactory [12,13].

New technologies like total hip resurfacing are a new approach to surgical management of end-stage avascular necrosis of the femoral head.

This study aims to present clinical and radiological outcomes of metal-on-metal hip resurfacing in a series of strictly selected patients with osteonecrosis of the femoral head.

Material and Methods

Between 2007 and 2008, Birmingham hip resurfacing (Smith&Nephew) for treatment of avascular necrosis of the femoral head was performed in 30 male patients at our unit.

Inclusion criteria were: presence of avascular necrosis in Ficat III or IV stage, disease in operated hip only, age under 60 years, and BMI under 35. Exclusion criteria were: age over 60 years, BMI over 35, bilateral avascular necrosis, other pathologic changes in the contralateral hip, and presence of considerable dysfunction in the musculoskeletal system or any general disabling disease.

Table 1. Ethiology of avascular necrosis.

	(n=30)	
Injury	23.3%	(n=7)
Alcohol	20.0%	(n=6)
Steroids	10.0%	(n=3)
Idiopatic	46.7%	(n=14)

The mean age and BMI of the patients were 42.7 years (range 28–59) and 27.6 (range 21–33.9), respectively (Table 1). The mean duration of symptoms was 3.8 years (range 1–10). The patients were qualified to hip resurfacing when the following criteria were met: presence of avascular necrosis in Ficat III and IV stage, extent of necrotic area measured by Kerboul's method <200°, and angle between the necrotic fragment and head-neck junction >20° (Figure 1A, 1B).

Etiology of avascular necrosis of the femoral head is presented in Table 1.

All patients were assessed clinically before and 60 months after the operation.

Surgical technique

All operations were performed with the patient in the lateral position and through a lateral approach (Hardinge approach) and all patients received antibiotic prophylaxis at the time of induction of anesthesia as well as 2 postoperative doses of antibiotics. Enoxaparin was used as prophylaxis for thromboembolic disease.

Clinical analysis

Pain, function, deformity, and range of motion were evaluated with the use of the Harris hip score [14].

Level of physical activity was assessed with UCLA activity score prior to surgery and at each postoperative visit up to 3 years after surgery [15].

Radiographic analysis

The femoral head necrosis was calculated by adding the area of necrosis in the anteroposterior and frog-lateral radiographs as in Kerboul's method [16]. The angle between the necrotic fragment and head-neck junction was also evaluated in anteroposterior preoperative x-rays (Figure 1C). Migration of prosthesis components was assessed in immediate anteroposterior postoperative radiographs and 5 years after the operation. The abduction angle was measured on the acetabular side. On

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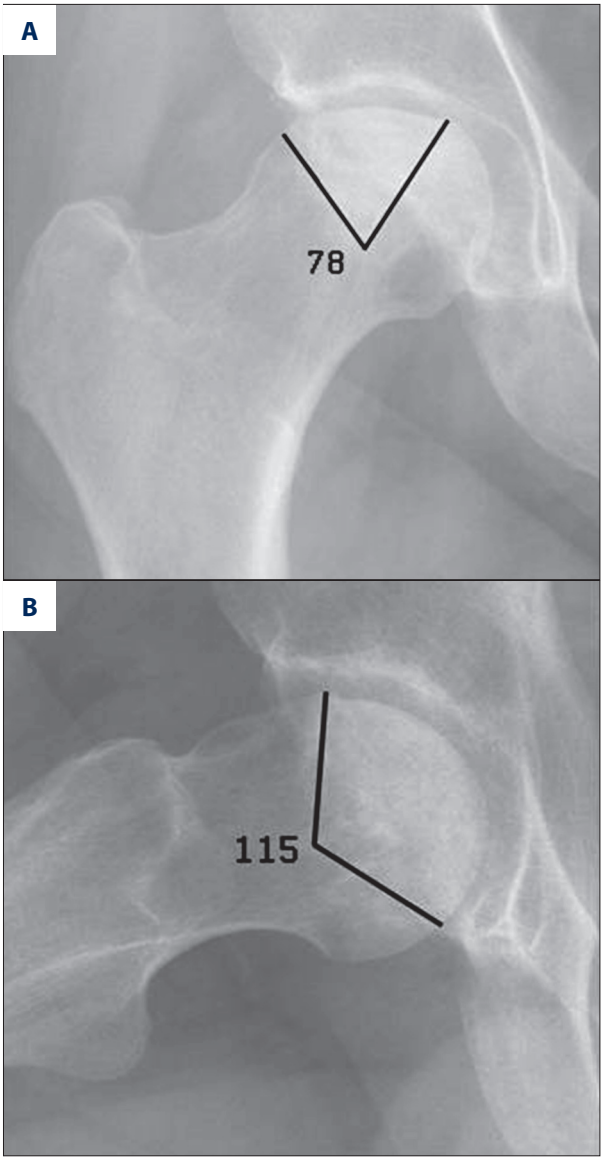

Figure 1. (**A**) Kerboul's angle, A-P view, (**B**) Kerboul's angle, axial view, (**C**) Angle between necrotic fragment and head-neck junction.

the femoral side, varus-valgus shift was determined by measurement of stem-shaft angle. Additionally, detection of axial collapse of femoral component was assessed with the use of the component-lateral cortex ratio (the ratio of the prosthesis length to the length of prosthesis and the bone segment extending to the lateral femoral cortex, (Figure 2A, 2B).

Statistical methods

Statistical analysis was performed using Statistica 7.1 PL. The Shapiro-Wilks test was used to evaluate whether individual datasets were consistent with a normal distribution: groups were then compared using an unpaired t-test or Mann-Whitney U test, as appropriate. Paired data were assessed using the paired t-test or Wilcoxon's matched-pairs signed ranks test. A p-value <0.05 was considered to be statistically significant.

Results

The mean preoperative Harris hip score of 47.8 (range 6.9–80.9) improved significantly (p value <0.001), to 94.25 (range 87.8–100) at the latest follow-up. Physical activity level (UCLA activity score) improved from 3.7 (range 2–7) to 7.55 (range 4–10) ($p<0.05$) (Table 2).

The mean Kerboul's angle and the angle between the necrotic fragment and head-neck junction in the study group were 161.4° (range 90–200) and 26.4 (range 20–38), respectively.

There was no significant change (p=0.1) in acetabular inclination from the baseline, where the mean acetabular abduction angle was 51.1 (range 33–64) to the latest follow-up, where it was 52.6 (range 33–65). The mean postoperative stem-shaft angle (139.9; range 126–159) and component-lateral cortex ratio (0.6; range 0.3–0.7) remained unchanged at 140.2 (range 126–158, p=0.64) and 0.6 (range 0.3–0.7, p=0.91), respectively (Table 3).

Discussion

Surgical treatment of femoral head avascular necrosis remains a challenge for orthopedic surgeons. Because of young age and relatively high activity of these patients, and the fact that they will probably require revision surgery in the future,

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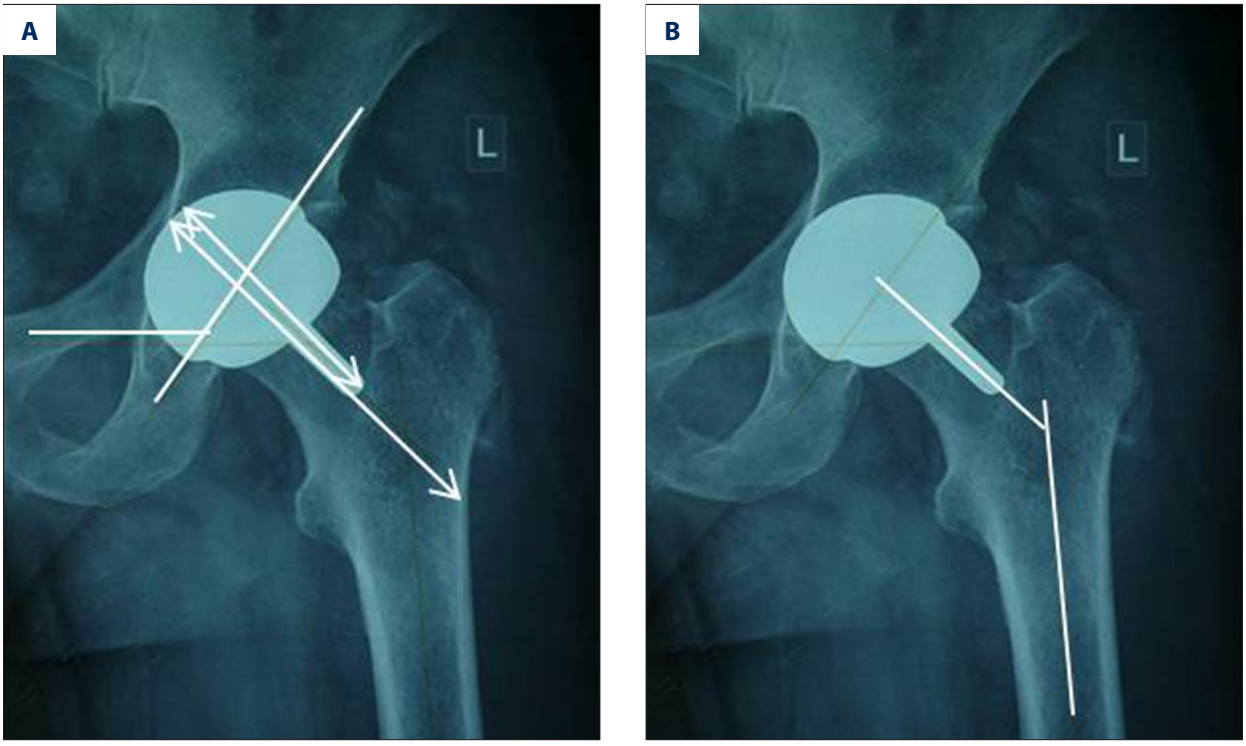

Figure 2. (**A**) Hip resurfacing; inclination angle, component-lateral cortex ratio, (**B**) Hip resurfacing; stem shaft angle.

Table 2. Clinical results.

	Before the operation	5 years after the operation	p value
Harris hip score	47.8 (6.9–80.9)	94.25 (87.8–100)	p<0.001
UCLA activity score	3.7 (2–7)	7.55 (4–10)	p<0.05

Table 3. Radiographic results, component alignment.

	Immidietly after the operation	5 years after the operation	p value
Acetabular inclination angle	51.1 (33–64)	52.6 (33–65)	p=0.1
Stem-shaft angle	139.9 (126–159)	140.2 (126–158)	p=0.64
Component-lateral cortex ratio	0.6 (0.3–0.7)	0.6 (0.3–0.7)	p=0.91

the selection of arthroplasty type is a concern. The overall 5-year outcomes of hip resurfacing arthroplasty in our study are promising. Clinical state of patients improved and the mean Harris hip score and UCLA activity score increased substantially postoperatively and remained excellent 5 years after the procedure. The radiographic analysis showed no component migration or collapse. A strict application of indications is necessary, which is supported by the results of Chun et al. [17]. They performed hip resurfacing arthroplasty in 139 patients with osteonecrosis of the femoral head when the size of the lesion was less than 50% of the entire head and the head-neck junction was intact at least to a 5 mm above the head-neck junction. The extent of necrosis was evaluated with the use of magnetic resonance imaging. After the average follow-up period of 88 months, there were no complications requiring additional surgical treatment and the clinical state of patients was excellent.

Yoo et al. [18] also presented excellent results of metal-on-metal resurfacing arthroplasty in 185 hips with osteonecrosis of the femoral head after a mean of 88 months follow-up. HHS and UCLA activity score improved significantly and in radiological analysis no component migration or loosening was observed. There were no revision surgeries in their series. Preoperative

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necrotic area extent was measured with using MRI scans and averaged 42.7% (range 11–60). In our study, necrosis was determined by x-ray, which is less precise but more available. Moreover, according to the study of Steinberg et al. [19] comparing different modes of determining osteonecrotic lesion in femoral head, the necrotic extent assessed in Kerboul's method as 200° corresponded to no more than 30% determined by MRI.

Mont et al. [20] compared clinical results of hip resurfacing arthroplasty in femoral head avascular necrosis and osteoarthritis. Each group consisted of 42 hips and the patients did not differ in terms of age or BMI. In both groups, mean Harris hip score was 91 after a mean follow-up period of 41 months. Two years after the operation, the mean Harris hip score was 96.65.

In both groups the results were good; however, in both groups 2 patients required revision surgeries. In the avascular necrosis group, neck fracture and aseptic loosening were the reasons. In the osteoarthritis group, 2 revisions were done because of neck fractures.

Revell et al. [21] performed 73 hip resurfacing replacements in patients with femoral head necrosis; 52 (71.2%) were done in men and 21 (28.8%) in women, mean age 43 years. The extent of necrosis was determined only in anteroposterior radiographs with the method similar to Kerboul's and the mean value was 111° (range 18–180°). The final qualification to hip resurfacing was done during the procedure when less than 35% of the femoral head was necrotic and the head-neck junction was preserved. The results were very good, after a mean follow-up of 6.1 years (range 2–12). There were 5 revisions (6.8%), and aseptic loosening was the reason in 2 cases. Septic loosening, subtrochanteric fracture, and acetabular fracture at time of primary surgery that did not heal were the reasons for the 3 remaining revisions.

Bose et al. [22] clinically and radiologically evaluated 96 patients who were operated on because of hip avascular necrosis. The mean age was 39 (range 18–69) and the mean BMI was 25.5 (range 17.1–42.9). There were 60 (84.5%) men and 11 (15.5%) women. The patients were assessed clinically with use of the UCLA physical activity score, the mean preoperative score was 3.2, and after a mean follow-up period of 5.4 years (range 4–8.1) it increased to 6.86 ($p<0.01$). Component migration was assessed by measuring inclination angle, femoral-stem angle, and component-lateral cortex ratio. Immediate postoperative and follow-up measurements remained unchanged. Three (3.12%) hips required revision, 1 because of acetabular loosening and the remaining 2 because of neck fracture.

A relatively high failure rate after hip resurfacing in patients with osteonecrosis of the femoral head was presented by Daniel et al. [23], who performed 66 procedures in 59 patients (mean age 43.9 years (range 19–67.7). After a mean follow-up of 7.1 years, there were 5 complications, giving a failure rate of 7.6%. The authors concluded that avascular necrosis of the femoral head should be a relative contraindication to hip resurfacing.

In our group, we did not observe complications requiring revision surgery. In the studies presented above [20–23] the frequency of revision operations because of aseptic loosening, neck fracture, and femoral head collapse ranged from 0% to 6.7%. Although resurfacing arthroplasty in the above studies was performed in Ficat III° and IV° avascular necrosis of the femoral head, none of them described the precise extent of necrosis. Additionally, women accounted for 6.3–31% of the operated patients, which is known to be related to more frequent complications in hip resurfacing [24,25]. We believe that restrictive qualification criteria for hip resurfacing and the use of an anterolateral approach might be useful prognostic factors in our group. Blood supply to the femoral head is much better preserved during an anterolateral approach [26,27].

There was no dislocation of the prosthesis in our group. Large heads allow for greater range of motion, cause fewer dislocations, and improve hip kinematics [28,29].

Because of recent reports of increased ion levels, pseudotumor formation after metal-on-metal hip arthroplasty, further follow-up of this group is necessary [30–32].

As a result of metal wear and extensive necrosis of the femoral head, short-stemmed solutions for patients with osteonecrosis of the femoral head may be considered. The Birmingham Mid-Head Resection prosthesis has a femoral neck-preserving feature and is available in a ceramic-on-metal configuration. Itayem et al. [33] performed radiostereometric analysis of BMHR stem in 13 hips and showed no significant migration 2 years after the operation. The short-stem Totak hip arthroplasty seems to be another sound alternative for active patients, and aims to preserve proximal bone stock for future revisions, to improve biomechanical reconstruction, and also gives the opportunity to use ceramic bearings. Kim et al. [34] reviewed 500 patients (630 hips) with mean age of 52.7 years who underwent short-stem arthroplasty. Apart from good clinical and functional results, they reported no cases of aseptic loosening. The mean follow-up was 15.8 years (range 11–18 years).

Limitations

The limitations of our study are that it was a retrospective analysis performed over a short period of observation, and had a small cohort. The small number of patients is related to the strict inclusion criteria.

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Conclusions

Based on the results, we can state that hip resurfacing leads to significant reduction in pain and improves daily functioning of patients. In addition, the qualification criteria used in our study seem to be appropriate, but the limitations mentioned above are drawbacks of this work.

Statement

Dr Pyda has received royalties from Smith&Nephew and took part in an observational study on another hip implant. Dr Koczy serves as a paid consultant to Smith&Nephew, has received royalties from Smith&Nephew, and took part in an observational study on another hip implant. Dr Mielnik serves as a paid consultant to Smith&Nephew, has received royalties from Smith&Nephew, and took part in an observational study on another hip implant. Dr Hermanson serves as a paid consultant to Smith&Nephew, has received royalties from Smith&Nephew, and took part in an observational study on another hip implant.

None of these authors have any financial arrangement with a company whose product figures prominently in the manuscript.

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