



Mid- to long-term results of resurfacing hip arthroplasty in Japanese patients: a comparison of osteoarthritic vs non-osteoarthritic patients

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Abstract

Past reports showed good mid-term results of RHA for Japanese patients. However, few reports have compared the mid- to long-term results for RHA in Japanese patients with and without osteoarthritis. Therefore, this study investigated the mid- to long-term results of RHA in Japanese patients with osteoarthritis compared to those without. We conducted a retrospective review of a consecutive series of 92 hips in 80 patients (59 men and 21 women). The minimum follow-up period was 5 years. The JOA hip scoring system was used to clinically evaluate hip function. In the radiological assessment, stem–shaft angle, inclination of the acetabular component, postoperative complications, and adverse reactions around RHA were evaluated. The 10-year survival rate using the Kaplan–Meier method was investigated to compare patients with and without osteoarthritis. A significant difference was observed between the preoperative and postoperative JOA hip scores of either group. Also, the radiological assessment revealed no significant changes in either group. All three revision THAs were performed on patients in the only non-osteoarthritis group. In the osteoarthritis group, the 10-year survival rate was 94% (95% CI 81.8–100) in males and 100% (95% CI 100) for females; in the non-osteoarthritis group, the rate was 80% (95% CI 55.1–100) in males and 66.7% (95% CI 13.3–100) for females. In conclusion, this study showed good mid- to long-term clinical results for young Japanese osteoarthritis patients, with less satisfactory mid- to long-term results in patients without osteoarthritis.

Keywords Resurfacing hip arthroplasty · Osteoarthritis · Osteonecrosis · Japanese · Implant survivorship

Introduction

Total hip arthroplasty (THA) is an extremely successful orthopedic procedure for reducing pain and restoring mobility [1]. The recent development of highly cross-linked polyethylene or ceramic-on-ceramic bearings, which minimize wear problems, has resulted in expanding the indications for THA to younger patients [2, 3]. However, when young, highly active patients with hip joint disorders undergo THA; implant loosening or osteolysis around the acetabulum or femur may require revision hip arthroplasty in the future. Excessive bone loss may also occur. In such cases, total hip

resurfacing (RHA) presents several advantages over THA, including preservation of the metaphyseal femoral bone, reduced risk of postoperative dislocation due to the large femoral head, low friction rate of the bearing surface, good postoperative ADL or hip function, and easy revision if needed [4]. Past reports have shown that good indications for RHA are young, male, with osteoarthritis of the hip joint; RHA performed for these patients has a low revision rate [5]. On the other hand, complications such as femoral neck fracture, the elevation of metal ion concentrations, and adverse reactions to metal debris (ARMD) are known to contribute to postoperative complications [3, 4]. Therefore, both good and poor results have been reported for RHA, and opinion on its utility is divided [6, 7]. Nishii et al. have reported good mid-term results of RHA for Japanese patients; however, few reports have compared the mid- to long-term results for RHA in Japanese patients with and without osteoarthritis [8].

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The purpose of this study is to investigate the mid- to long-term results of RHA in Japanese patients with osteoarthritis compared to those without.

Materials and methods

This investigational protocol was conducted with the approval of the Kanazawa University Graduate School of Medicine Ethics Committee. In accordance with the requirements of this review, all patients were provided informed consent.

We conducted a retrospective review of a consecutive series of 92 hips in 80 patients (59 men and 21 women) who had undergone RHA between January 2003 and July 2012. The cases in this study included a minimum follow-up period of 5 years. The mean age of the patients was 44.5 ± 8.1 years (30–60 years). Patients were followed up for a mean of 7.9 years (range 5–14 years). Short femoral neck due to DDH or Perthes diseases and more than two-third collapse of the femoral head due to osteonecrosis were excluded. The preoperative diagnosis was secondary osteoarthritis due to DDH (Crowe type I) or trauma in 40 hips, osteoarthritis of the hip due to other diseases (neurological disorder and pigmented villonodular synovitis) in 2 hips, osteonecrosis of the femoral head (ONFH) in 45 hips, rheumatoid arthritis in 1 hip, and ankylosing spondylitis in 4 hips. The patients of ONFH were classified according to Japanese Investigation Committee (JIC) criteria [9]. There were 22 patients in stage 3A, 12 patients in stage 3B, and 11 patients in stage 4. We defined the patients with hip osteoarthritis due to DDH or trauma as the osteoarthritis group, and all other patients as the non-osteoarthritis group. There were 17 females and 23 males in the osteoarthritis group, and 4 females and 48 males in the non-osteoarthritis group. A posterolateral approach was used in 70 hips, the Dall approach in 2 hips, and the Hardinge approach in 20 hips. Hardinge and Dorr approaches are included together

as lateral approach. Birmingham hip resurfacing prostheses (Midland, Medical Technologies Ltd, Birmingham, UK) were used in 33 hips (14 hips in the osteoarthritis group and 19 in the non-osteoarthritis group); ADEPT (Finsbury Orthopaedics, Surrey, UK) was used in 59 hips (26 in the osteoarthritis group and 33 in the non-osteoarthritis group). In all cases, the authors performed CT-based three-dimensional templating using Hip-OP software (Istituti Ortopedici Rizzoli, Bologna, Italy) or the Stryker CT-based navigation system (Stryker Inc., Mahwah, NJ) to create a precise preoperative plan. A CT-based navigation system was used in the last 60 hips (27 hips in the osteoarthritis group and 33 in the non-osteoarthritis group) to achieve precise alignment of the acetabular component. The average outer diameters of the acetabular component in the osteoarthritis and non-osteoarthritis groups were 55.2 ± 3.8 mm (range 48–62 mm) and 55.3 ± 2.9 mm (range 48–60 mm) respectively, and the average diameters of the femoral component in the two groups were 48.8 ± 3.8 mm (range 42–56 mm) and 49.3 ± 2.9 mm (range 42–54 mm) (Table 1).

Operative procedure

All operations were performed by the senior surgeon (TK), and were performed in a lateral decubitus position. The operation was begun on the femoral side to provide a wider operative space for the acetabulum. A guidewire was inserted into the femoral head center so as to achieve a slightly valgus alignment against the anatomical proximal axis of the femoral neck. The femur was cylindrically reamed up to one size over the size of the planned femoral component according to the preoperative three-dimensional templating. Next, we reamed the acetabulum to the lateral wall of the teardrop and reamed up to 1 mm under the size of the planned acetabular component. The planned acetabular component was press-fit to the acetabulum, after which we took an intraoperative anteroposterior radiograph of the hip to check the appropriate inclination or anteversion of the

Table 1 Patient demographic data

Parameters	Osteoarthritis group ($n = 40$)	Non-osteoarthritis group ($n = 52$)	p
Male/female	23/17	48/4	0.001 ^b
Mean age	46.4 ± 7.4	43.1 ± 8.2	0.15 ^a
Implant ADEPT/BHR	26/14	33/19	0.52 ^b
Surgical approach posterior/lateral	31/9	39/13	0.48 ^b
Navigation/non-navigation	27/13	33/19	0.42 ^b
Average diameter of the acetabular component	55.2 ± 3.8	55.3 ± 2.9	0.60 ^a
Average diameter of the femoral component	48.8 ± 3.8	49.3 ± 2.9	0.89 ^a

Mean and standard deviation

^aUnpaired T test

^bFisher's exact probability test

component. Finally, additional cylindrical reaming of the femur was performed if necessary, and the femoral component was fixed with bone cement. When performing RHA for osteonecrosis patients, we removed the unstable necrotic bone and used bone cement to fill the cavity. The joint capsule was repaired to its original site after final implantation. The postoperative rehabilitation schedule was free weight-bearing after the operation.

Assessment

The Japanese Orthopaedic Association (JOA) hip scoring system was used to clinically evaluate hip function. The JOA hip score includes scores of pain (40 points), ROM (20 points), walking (20 points), and activities of daily living (20 points), with a maximum score of 100 points [10]. The preoperative and final follow-up JOA hip scores were compared.

Anteroposterior hip X-rays were taken postoperatively and again about 2 weeks, 3 months, and 1 year after the operation. Thereafter, X-rays were taken at 1-year intervals. For the radiological evaluation, stem–shaft angle and inclination of the acetabular component were evaluated. Stem–shaft angle was defined as the angle between the stem of femoral component and the proximal perpendicular femoral axis. The inclination angle of the acetabular component was defined as the angle between the interteardrop reference line and the line connecting the lateral and medial edges of the acetabular component.

Postoperative complications such as femoral neck fracture, implant loosening, postoperative dislocation, and postoperative surgical site infection were also assessed.

To detect adverse reactions to RHA, informed consent was obtained and an MRI was taken 3 years after the operation. Abnormal lesions around the hip joint were divided into cystic lesions, liquid effusions, and no particular. The cystic lesions were classified according to the system of Hauptfleisch et al. and divided into lesions on the anterior, posterior, and lateral sides of the great trochanter [11].

Survival analysis was analyzed by the Kaplan–Meier method to estimate the cumulative probabilities of failure, comparing patients with and without osteoarthritis. Also, we investigated the survival rate, comparing males and females in each group. Furthermore, we performed Kaplan–Meier method to estimate the cumulative probabilities of failure in ONFH patients, comparing stage 3A and stage 3B or 4 patients. The end point was defined as any revision or loosening of the implant.

Statistical analysis

Statistical analysis was performed using SPSS software (PASW Statistics Base version 19; SPSS, Chicago, Illinois).

The value of the JOA score, stem–shaft angle, and inclination of the acetabular component was expressed as mean \pm standard deviation. Parameters including mean age, average diameter of the acetabular and femoral component, the JOA hip score and radiological evaluation were compared between two groups by an unpaired *T* test. Parameters including sex, implant, surgical approach, navigation use, and MRI evaluation were compared between two groups by Fisher's exact probability test. A *p* value < 0.05 was considered statistically significant.

Results

Clinical evaluation

The JOA hip score in the osteoarthritis group increased from a mean preoperative score of 52.0 ± 14.0 to a mean postoperative score of 96.1 ± 5.7 points at the last follow-up.

The JOA hip score in the non-osteoarthritis group at the last follow-up increased from a mean preoperative score of 54.6 ± 13.3 to a mean postoperative score of 94.8 ± 8.4 points. Significant difference was observed in either groups ($p = 0.01$).

Radiological evaluation

The mean stem–shaft angle in the osteoarthritis group was 141.9 ± 6.0 degrees in the postoperative state and $141.4 \pm 6.1^\circ$ at the final follow-up. The mean stem–shaft angle in the non-osteoarthritis group was $139.8 \pm 5.7^\circ$ in the postoperative state and $138.8 \pm 6.6^\circ$ at the final follow-up. The mean inclination of the acetabular component in the osteoarthritis group was 38.8 ± 5.1 postoperatively and $38.7 \pm 5.0^\circ$ at the final follow-up, while the mean inclination in the non-osteoarthritis group was $38.8 \pm 4.9^\circ$ postoperatively and $38.9 \pm 4.8^\circ$ at the final follow-up. No cases had an acetabular inclination angle of 50° or more. There were no significant differences in the stem–shaft angle or inclination of the acetabular component between the postoperative state and final follow-up in either group.

Postoperative complications

The results of our investigation of postoperative complications are summarized in Table 2. We found femoral neck fractures in three cases (ONFH due to steroid in two cases and ankylosing spondylitis in one case), postoperative dislocation in one case, delayed postoperative wound healing in one case, and aseptic loosening of the femoral stem or acetabular component in three cases (ONFH due to steroid in one case, neurological disorder in one case, and osteoarthritis due to DDH in one case). In osteoarthritis group,

Table 2 Incidence of postoperative complications

Complications	Osteoarthritis group (<i>n</i> = 40)	Non-osteoarthritis group (<i>n</i> = 52)
Femoral neck fracture	0	3
Postoperative dislocation	1	0
Postoperative delayed wound healing	0	1
Aseptic loosening of femoral or acetabular implant	1	2
Converted to THA	0	3

postoperative dislocation was caused in one case because the patient fell down accidentally. Also, one patient had slight radiolucent line around acetabular component, but acetabular abduction angle did not change in a follow-up period. In non-osteoarthritis group, we performed osteosynthesis for two of the femoral neck fracture cases; subsequent revision THA was not necessary because we were able to detect the slight varus malalignment in the radiography. However, revision THA was performed in one case because this case had a displaced femoral neck fracture. The two cases of aseptic femoral head loosening and cup loosening also were converted to total hip arthroplasty. All three revision THAs were performed on patients in the non-osteoarthritis group.

MRI evaluation

Informed consent was obtained and MRIs were performed for 74 hips due to the detection of adverse reactions around the total hip resurfacing. All patients did not have a symptom. The results of the MRI evaluations are shown in Table 3. Abnormal lesions around the total hip resurfacing were detected in 32 hips. Fluid collection appeared in 24 hips, in the lateral greater trochanter in 22 hips, and posterior in 2 hips. In the non-osteoarthritis group, it was the tendency to occur fluid correction. Cystic lesions occurred in 8 hips. According to the Hauptfleisch MRI classification system, Type I lesions (thin-walled cystic mass, cystic wall < 3 mm) were in 7 hips, 1 hip had Type II (cyst wall > 3 mm, but less

Table 3 Results of MRI evaluations

Adverse reaction around RHA	Osteoarthritis group (<i>n</i> = 35)	Non-osteoarthritis group (<i>n</i> = 39)	<i>p</i>
No particular	23	19	0.10 ^a
Fluid correction	7	17	0.04 ^a
Cystic lesion			
Type I	5	2	0.24 ^a
Type II	0	1	0.99 ^a
Type III	0	0	1 ^a

^aFisher's exact probability test

than the diameter of the cystic components) (Fig. 1), and none had Type III. The Type I cases occurred in the lateral greater trochanter in 2 hips, anterior in 2 hips, and posterior in 3 hips. The Type II case was in the anterior. There is no significant difference in cystic lesion occurrence between the two groups. We performed no revision THAs due to abnormal lesions around implants.

Survival analysis

The 10-year survival rate using the Kaplan–Meier method was 95% for the osteoarthritis group (95% CI 85.4–100) and 79% (95% CI 55.1–100) for the non-osteoarthritis group, using any revision or loosening of the implant as the end point, although there was no significant difference between the osteoarthritis and the non-osteoarthritis groups (Fig. 2a). In the osteoarthritis group, the 10-year survival rate was 94% (95% CI 81.8–100) in males and 100% (95% CI 100) for females (Fig. 2b); in the non-osteoarthritis group, the rate was 80% (95% CI 55.1–100) in males and 66.7% (95% CI 13.3–100) for females. There was no significant difference between males and females (Fig. 2c).

The 10-year survival rate using the Kaplan–Meier method was 100% (95% CI 100) for stage 3A patients and 79% (95% CI 49.5–100) for stage 3B or 4 patients. There may be a tendency toward lower survivorship for stage 3B or 4 patients although there was no significant difference between two groups (Fig. 2d).

Discussion

Several reports have assessed the mid- to long-term clinical results of metal-on-metal hip resurfacing arthroplasty, comparing osteonecrosis with other diseases. Amstutz et al. showed that the survival rate of metal-on-metal hip resurfacing using the Conserve plus system was almost

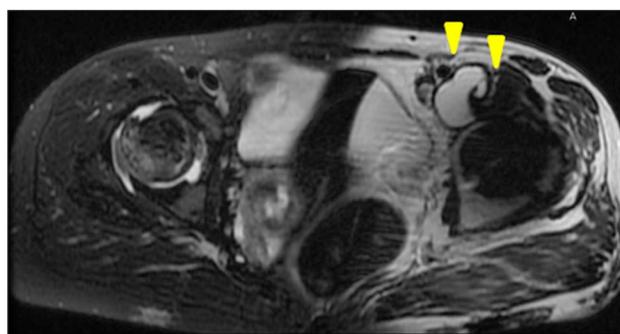


Fig. 1 A 33-year-old woman with osteonecrosis of the left femoral head due to steroids. MRI revealed a thick-walled cystic mass in the anterior portion of the RHA

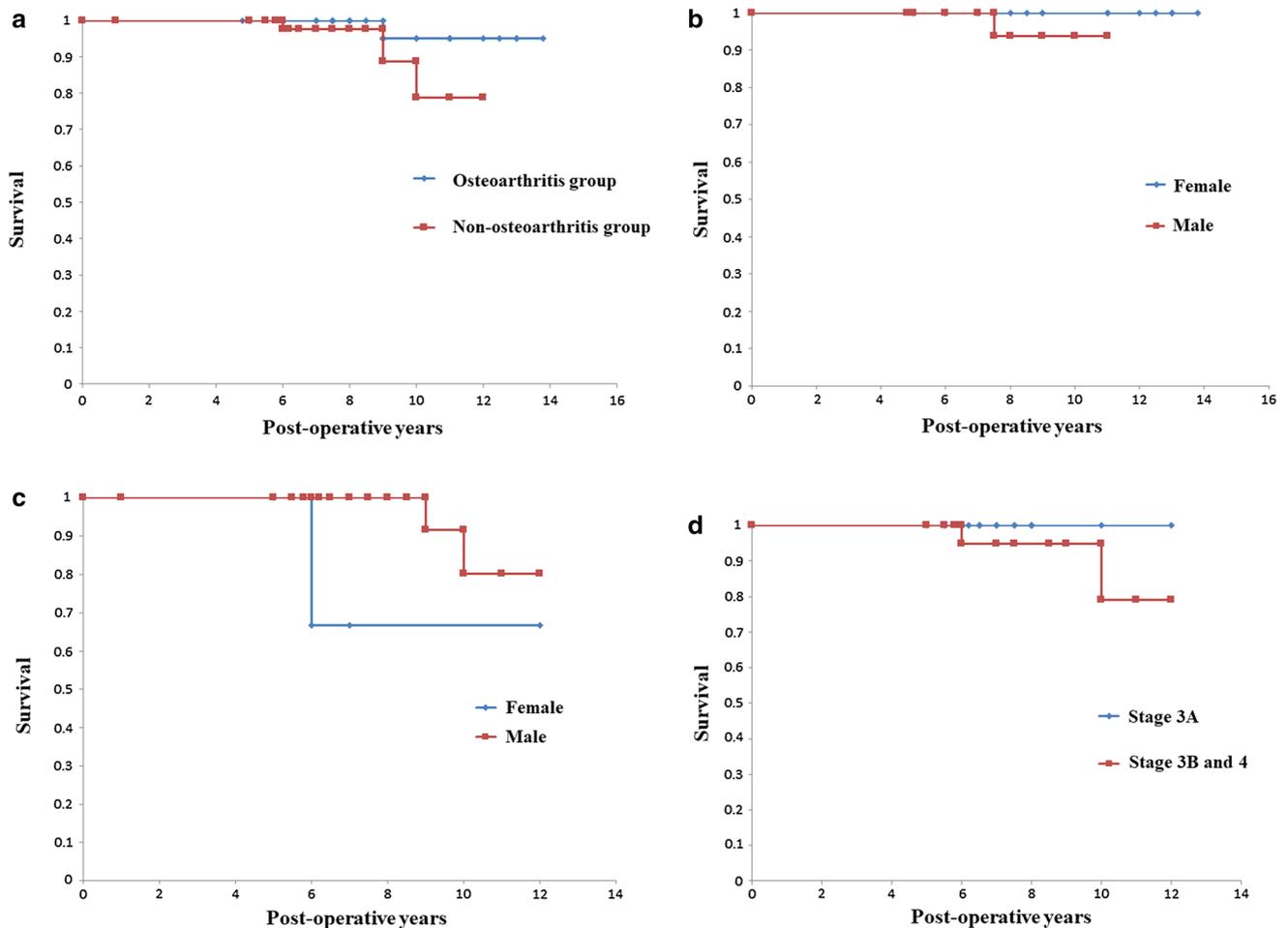


Fig. 2 Survival rates following RHA. Kaplan–Meier method was used to estimate the cumulative probabilities of failure. The end point was defined as any revision or loosening of the implant. **a** Survival rate of osteoarthritis and non-osteoarthritis groups. **b** Survival rate of

males and females in the osteoarthritis group. **c** Survival rate of males and females in the non-osteoarthritis group. **d** Survival rate of ONFH patients

93% for a mean follow-up of 8 years, with no difference in survivorship between the osteonecrosis patients and others [12]. On the other hand, McMinn et al. reported that the survival rate of the metal-on-metal hip resurfacing using Birmingham hip resurfacing system was 96% for a mean follow-up of 10 years, and found a survival rate of 93% for patients with osteonecrosis and 97% for those with other diseases [13]. They also mentioned that the osteonecrosis patients were at increased risk of postoperative femoral head collapse [13]. Our results showed that the 10-year survival rate of the osteoarthritis group was 95% and the survival rate of the non-osteoarthritis group, which included many osteonecrosis patients, was 79% using any revision or loosening of the implant as an end point. Our results for patients with osteoarthritis were in agreement with previous reports. Therefore, the mid- to long-term results of resurfacing hip arthroplasty may also be good for Japanese patients with osteoarthritis, but there may be a

tendency toward lower survivorship for non-osteoarthritis patients.

Past reports have shown that one of the major clinical failures in metal-on-metal hip arthroplasty is femoral neck fracture [14]. Past reviews have indicated that the frequency of femoral neck fracture occurrence was 0.4–6% [15, 16]. It was known that the risk factors for femoral neck fracture were notch formation in the superior part of the femoral neck part or a stem–shaft angle of 130 degrees or less; therefore, it was very important to prevent notch formation of the femoral neck and varus implantation of the stem [17]. Furthermore, Zustin et al. reported that femoral neck fracture had a tendency to occur postoperatively due to extensive osteonecrosis [18]. In this study, there was no clear notch formation or varus implantation of the stem. The underlying disease of femoral neck fracture was ONFH due to steroid and ankylosing spondylitis. We think that these patients were likely to cause femoral neck fracture due to osteoporosis

with using steroid. Then aseptic loosening of the femoral stem and acetabular implant which was required to convert THA each accounted for one case in our study. Campbell et al. showed that osteonecrosis is related to aseptic loosening of the implant and postoperative femoral neck fracture [19]. Chalmers et al. reported the patients of neurological disorder had many complications such as aseptic loosening or breakage of the implant [20]. Poor bone quality for fixation of the component, and the underlying diseases such as neurological disorder may lead to implant failure or femoral neck fracture, compared with patients with osteoarthritis.

The formation of pseudotumors, a periarticular reactive mass, is another important problem that can arise after RHA. Past reports have shown an incidence rate of pseudotumors around 0.1%–4% [21, 22]. The risk factors for pseudotumor occurrence are female, 40 years old or less, and using a small component [23]. Also, edge loading caused by acetabular component malalignment has been linked to the occurrence of pseudotumors [24, 25]. Although our study included many female patients, there was only one case of a thick-walled cystic mass (1.2%); no revision THAs were performed due to abnormal lesions around the RHA. We think that our low incidence rate of clear pseudotumors may be because we achieved very precise component alignment by taking intraoperative radiographs or using a CT-based navigation system. Another previous report showed that implant design is a factor in the occurrence of adverse reactions to metal debris (ARMD), and it is possible that our low incidence rate of occurring pseudotumors which was required to convert revision THAs is because we use BHR or ADEPT prostheses which tend not to produce ARMD [26]. Although we performed no revision THAs due to pseudotumors, further follow-up will be necessary in future because abnormal lesions around the total hip resurfacing were detected in 32 hips.

Our study had three limitations. First, it is a retrospective study and the number of patients was small. Second, metal ion analysis was not done in this study because routine serum metal ion measurement is not approved by the Japanese health insurance system. The increased metal ion production from RHA is a major concern, but little has been reported conclusively about the incidence of adverse reactions to metal debris [27, 28]. Third, there was no significant difference between males and females in the non-osteoarthritis group, although there is a tendency for female patients to have a lower survival rate. In our study, the number of female patients in the non-osteoarthritis group was small; if the group had included a larger number of female patients, we might have seen a significant difference between males and females. Despite these limitations, RHA showed good mid- to long-term clinical results for young Japanese osteoarthritis patients, although we did see a tendency for less satisfactory mid- to long-term results in non-osteoarthritis

patients. We need to treat the patients having pathological backgrounds such as AS, RA, and neurological disorder carefully in consideration of general status, bone stock, and bone quality.

Conclusions

In our study, metal-on-metal hip resurfacing arthroplasty showed good mid- to long-term clinical results for young Japanese osteoarthritis patients, although we did see a tendency for less satisfactory mid- to long-term results in non-osteonecrosis patients.

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Compliance with ethical standards

Conflict of interest None.

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