



Cementless Total Hip Arthroplasty Using the COREN Hip System: A Minimum Five-Year Follow-up Study

Hee Joong Kim, MD, Jeong Joon Yoo, MD, Wonyeong Seo, MD, Min Nyeon Kim, RN, Taehoon Kang, MD
Department of Orthopaedic Surgery, Seoul National University Hospital, Seoul, Korea

Purpose: This study presents the clinical and radiological outcomes of cementless total hip arthroplasty using the COREN hip system after a minimum duration of follow-up of 5 years.

Materials and Methods: We evaluated the results of a consecutive series of the first 200 primary total hip arthroplasties that had been performed in our hospital in 169 patients between February 2007 and April 2011. Six patients (6 hips) had died within 5 years, and 12 patients (13 hips) had been lost to follow-up, leaving a total of 151 patients (181 hips) available for the study. All patients were evaluated clinically and radiologically with special attention to thigh pain, implant fixation, radiolucent line and osteolysis around implants.

Results: The mean Harris hip score improved from 59.4 preoperatively to 97.2 postoperatively. No patient complained of thigh pain. All implants demonstrated radiographic evidence of stable fixation by bone ingrowth without any change in position. No implant was loose radiographically or was revised. Eleven hips (7.7%) had a radiolucent line around the femoral stem. Focal osteolytic area was detected in 3 cases (2.1%). An osteolytic lesion was stabilized in 1 case and further observation was needed in 2 cases in which the lesions were detected several years after surgery. Stress shielding was observed in 80.3% of cases (first degree, 35.9%; second degree, 44.4%); there were no cases of third or fourth degree stress shielding. One case was complicated by bacterial infection and repeated dislocation.

Conclusion: Mid-term results of total hip arthroplasty using the COREN hip system are very encouraging clinically and radiologically.

Key Words: Hip, Cementless total hip arthroplasty, COREN hip system

Submitted: April 17, 2018 1st revision: June 19, 2018
2nd revision: June 19, 2018 Final acceptance: June 19, 2018
Address reprint request to
Hee Joong Kim, MD
(<https://orcid.org/0000-0002-3994-5672>)
Department of Orthopaedic Surgery, Seoul National University
Hospital, 101 Daehak-ro, Jongno-gu, Seoul 03080, Korea
TEL: +82-2-2072-2970 FAX: +82-2-764-2718
E-mail: oskim@snu.ac.kr

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Total hip arthroplasty, which began to become popular at around 1960, can dramatically improve the quality of human life and is regarded as one of the best surgeries developed in the last 100 years¹.

Initially, the bone cement fixation method developed by Sir John Charnley was mainly used^{2,3}. However, as the bone cement was mistakenly believed to play an important role in the pathogenesis of aseptic loosening⁴, cementless implants with biological fixation started to be developed in the early 1980s and are widely used up to date⁵.

In Korea, the first total hip arthroplasty was performed by Ahn et al.⁶ in the late 1960s. In 1988, Kim et al.⁷ started to use a porocoated femoral stem of his own design and reported satisfactory results with this stem. The efforts to develop and manufacture artificial hip joints in Korea began in the 1990s and a few developments were trialed clinically but were unsuccessful. The COREN hip system (Corentec, Seoul, Korea), which was developed in the early 2000s and commercialized in 2006, is recognized as the first successful artificial hip joint system developed in Korea.

The COREN system has been used at our institution since February 2007. We evaluated the clinical and radiological outcomes of total hip arthroplasty using this system after a follow-up of at least 5 years.

MATERIALS AND METHODS

This study was approved by the institutional review board of our hospital (H-1607-049-774). The first 200 primary total hip arthroplasties performed in 169 patients using the COREN hip system between February 2007 and April 2011 were included. Six patients (6 hips) died within 5 years, and 12 patients (13 hips) were lost to follow-up. The remaining 151 patients (181 hips) were evaluated with a minimum follow-up of 5 years (average, 87 months; range, 60 to 118 months).

The study group included 93 men and 58 women. The mean age at the index operation was 47 years (range, 19-69 years). The primary diagnoses included osteonecrosis of the femoral head (108 cases), degenerative arthritis secondary to acetabular dysplasia (28 cases), sequelae of hip joint infection (10 cases), Legg-Perthes disease (9 cases), rheumatoid arthritis (6 cases), nonunion of a femoral neck fracture (4 cases), ankylosing spondylitis (2 cases) and degenerative arthritis due to other causes (14 cases). The senior author (HJK) performed all of the procedures. Total hip arthroplasty was performed in the lateral decubitus position through a posterolateral approach in 176 cases and a transtrochanteric approach in 5 cases. In all cases, an alumina-alumina bearing system (BioloX Forte; CeramTec, Plochingen, Germany) was used. A 28-mm diameter head was used in 131 cases and a 32-mm diameter head in 55 cases.

Postoperatively, toe-touch non-weight-bearing crutch walking was recommended for the first 6 weeks followed by tolerable weight bearing to full weight bearing at 10 weeks. Patients were invited for follow-up evaluation at 6 weeks, 3 months, 9 months and then annually after the

surgery.

Clinical outcomes were assessed with the use of the Harris hip score and a questionnaire that included items on thigh pain and noise; the questions were asked directly at the follow-up visit (142 cases) or by means of a telephone interview (39 cases).

Radiological evaluation was possible only in 142 cases for which follow-up radiographs for ≥ 5 years were available. The last radiographic evaluation was performed at a mean of 86 months (range, 60 to 118 months) after the surgery. Serial radiographs were examined with respect to component stability⁸, radiolucent lines, osteolysis, evidence of stress shielding⁸, migration of the components, and loosening. Zones described by Gruen et al.⁹ and DeLee and Charnley¹⁰ were used to assess the location and extent of radiolucent lines and osteolysis. Osteolysis was defined as a periprosthetic cystic or scalloped lesion with a diameter exceeding 2 mm that had not been present on the immediate postoperative radiographs^{11,12}. When heterotopic ossification was observed, it was graded by the criteria of Brooker et al¹³.

Other complications such as dislocation, infection, deep vein thrombosis, and ceramic fracture were also examined.

RESULTS

The mean Harris hip score improved considerably from 59.4 (range, 30 to -69) preoperatively to 97.2 (range, 84 to 100) at the last follow-up. Noise in the hip-joint area, which was occasional and transient, was reported in 7 cases (3.9%), including squeaking noise in 3 cases (1.7%) out of them¹⁴. No patient complained of thigh pain.

According to the criteria for implant fixation described by Engh et al.⁸, all acetabular cups and femoral stems were stably fixed with bony ingrowth. No changes in implant position such as stem subsidence were detected on follow-up radiographs. There was no evidence of implant loosening and no cases of implant revision up to the last follow-up.

Eleven hips (7.7%) had a radiolucent line around the femoral stem. It was located in Gruen zone 7 in 10 cases and in zones 1 and 7 in one case (Fig. 1). Generally, the lines appeared 3 to 9 months after surgery and then remained unchanged with a gradual sclerotic change of the outer margin. No radiolucent lines were detected around the metal shells.

Focal osteolytic area was detected in 3 cases. In one case, it was detected in Gruen zone 1 at postoperative year 1 and remained until 7 years after the operation with no increase in size (Fig. 1). In the other 2 cases, osteolysis was detected

in zones 1 and 7 at postoperative years 5 (Fig. 2) and 9 (Fig. 3), respectively. These two lesions needed further follow-up to evaluate temporal changes.

Stress shielding was observed in 80.3% of cases. It was

first degree of Engh et al.⁸⁾ in 51 hips (35.9%) and second degree in 63 hips (44.4%); there were no cases of third or fourth degree stress shielding.

Heterotopic ossification was identified in 25 cases (17.6%).

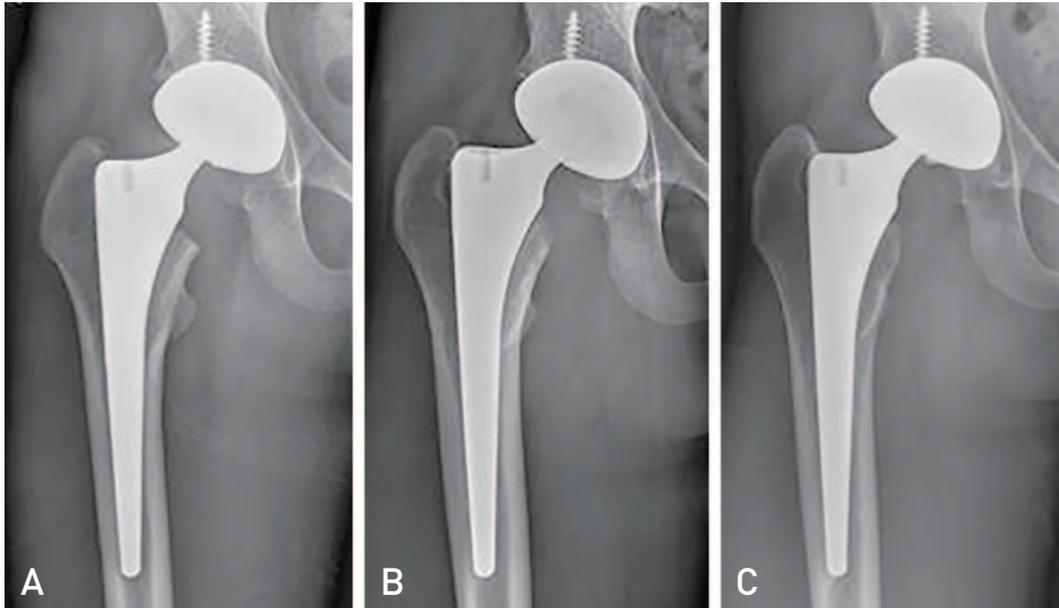


Fig. 1. A 21-year-old male patient underwent total hip arthroplasty for osteonecrosis of the femoral head. **(A)** Early postoperative radiograph shows well-implanted joint components. **(B)** Anteroposterior radiograph taken 1 year after index arthroplasty revealed an osteolytic lesion in zone 1, a radiolucent line in zone 7 and rounding of the most proximal medial edge of the cut femoral neck. **(C)** Anteroposterior radiograph taken 7.5 years after arthroplasty demonstrates no remarkable changes in the osteolytic lesion or radiolucent line, and the loss of the medial cortical density of the proximal femur.

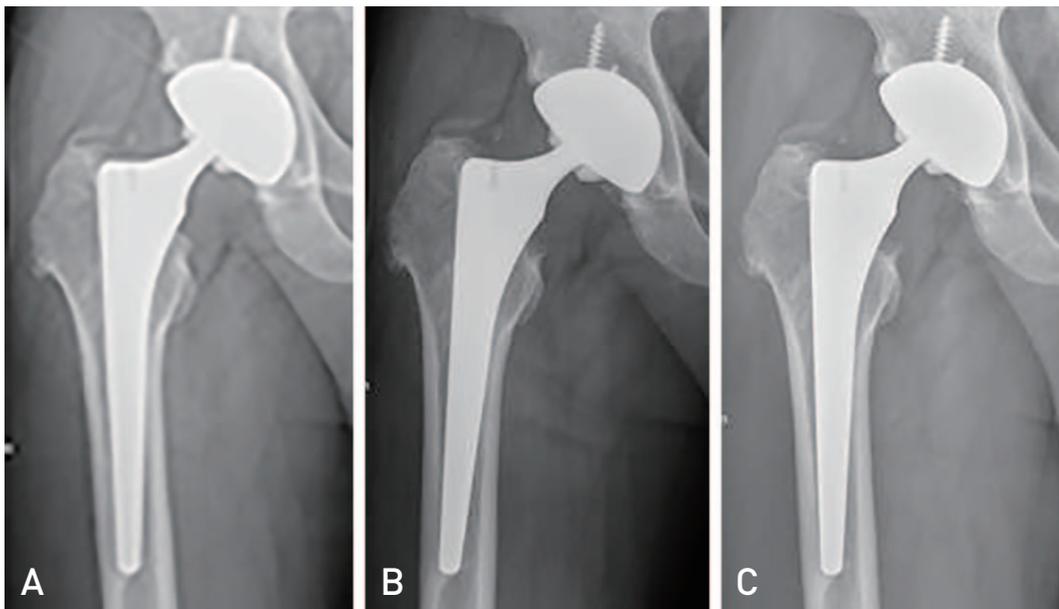


Fig. 2. A 49-year-old male patient suffered from osteonecrosis of the femoral head. **(A)** Anteroposterior radiograph taken 4 years after surgery shows stably fixed implants. **(B)** Anteroposterior radiograph taken at 5 years after surgery demonstrates osteolytic lesions in zones 1 and 7. **(C)** Anteroposterior radiograph taken 7 years after surgery shows no marked change in the size of the osteolytic lesions, but their margins became sclerotic.

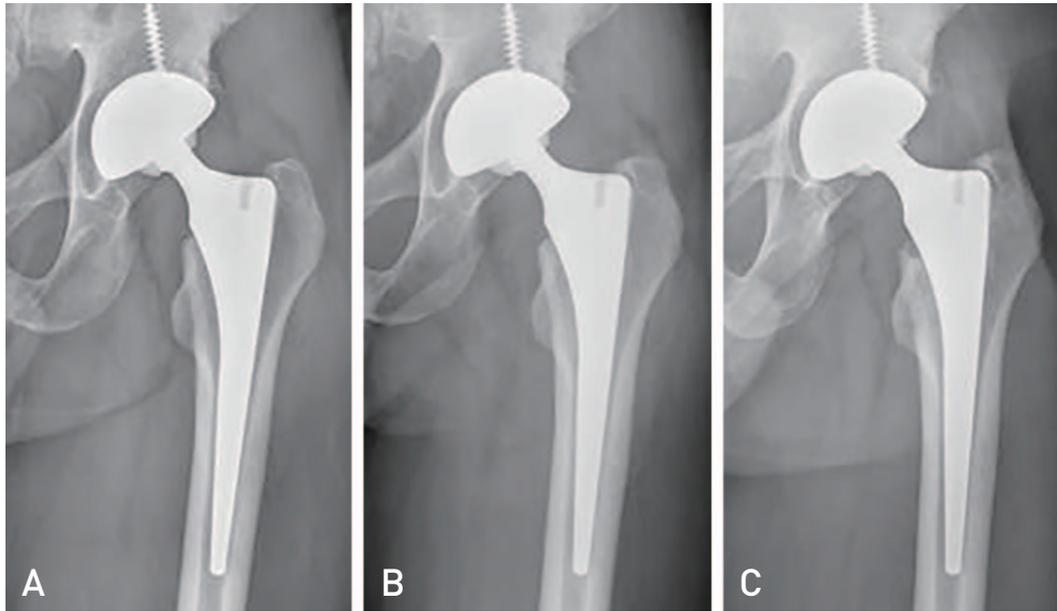


Fig. 3. A 46-year-old male patient had total hip arthroplasty because of degenerative arthritis secondary to acetabular dysplasia. **(A)** Anteroposterior radiograph taken at 1 year after arthroplasty shows stably fixed implants and mild rounding of the medial edge of the cut femoral neck. **(B)** Anteroposterior radiograph taken 6 years after arthroplasty demonstrates no marked changes. **(C)** Anteroposterior radiograph taken 9 years after arthroplasty shows osteolytic lesions in zones 1 and 7.

Thirteen cases were grade I and 12 cases were grade II.

Femoral fractures occurred in 5 cases (2.7%) during stem implantation. Four were localized to the proximal femoral end and one was extended distally below the middle of the stem. All were treated with circumferential wiring and healed without any problem.

Femoral nerve palsy occurred in one case as a surgical complication. It gradually partially recovered during the follow-up period. However, residual palsy did not markedly disturb daily activity.

In one case, bacterial infection developed immediately postoperatively. It was controlled by surgical drainage with debridement, which was performed three times, and there was no recurrence until postoperative year 9. In the same case, posterior dislocation occurred 3 months postoperatively (1 month after the last surgical drainage) and was treated conservatively.

DISCUSSION

In the COREN hip system, the femoral stem and acetabular cup are made of titanium alloy (Ti6Al4V). The femoral stem is straight, double wedged, and tapered with a rectangular cross-section (Fig. 4). There are anterior, posterior and lateral vertical ribs on its proximal end. Its surface is grit blasted and then further treated by micro-arc oxidation after¹⁵⁻¹⁸.



Fig. 4. Photograph of the alumina-on-alumina COREN hip system (Corentec, Seoul, Korea).

In this study, all femoral stems were fixed stably with bony ingrowth without position change or subsidence, and the fixation was well maintained up to the latest follow-up. Other studies have reported similar results^{15,17-19}. In contrast, early postoperative subsidence of the stem has been reported in many studies of the cementless Spotorno stem (CLS stem;

Zimmer, Warsaw, IN, USA), whose design is similar to that of the COREN prosthesis²⁰⁻²². The better early fixation might be the result of three proximal vertical pins for rotational stability and micro-arc oxidation treatment to maximize the contact surface with bone¹⁶.

Unlike in other reports^{15,17-19}, 11 cases (7.7%) showed a radiolucent line in Gruen zone 1 or 7. The thickness of these lines did not exceed 2 mm. They did not expand or affect the stability of the stem (Fig. 1).

We found rounding of the most proximal medial edge of the cut femoral neck (first degree) in most cases and some reduction in the proximal medial cortical density (second degree of stress shielding by Engh et al.⁸) in more than half of the cases (Fig. 1). We found no cases of severe reduction in the proximal medial cortical density or extensive resorption. These results are quite different from those of Kim et al.¹⁷, who observed stress shielding only in 19.7% of cases. There is also big difference between results of Schramm et al.²¹ (37%) and of Yamasaki et al.²³ (1.5%), who used the CLS stems. These discrepancies might be due to the differences in subjective interpretation of the change in cortical density.

No patient complained of thigh pain in the present study. Most studies¹⁷⁻¹⁹ that used the COREN stems reported a very low incidence of thigh pain, similar to studies that used the CLS stems, which have similar design and surface treatment^{20,21}.

The surface of the COREN acetabular cup is coated with porous titanium by a plasma-spray method. In all cases, the acetabular cup was fixed stably by bone ingrowth no change in position and no radiolucent line detected in any case. Very similar results were observed in another study that used an acetabular cup made of the same material using the same surface treatment²⁴.

It was a retrospective study and radiological evaluation was not possible in all cases. However, it was a series of consecutive cases, and we believe that the number of cases and the follow-up rate were good enough for objective data analysis.

CONCLUSION

The clinical and radiological results of total hip arthroplasty using the COREN hip system were very satisfactory after a follow-up of at least 5 years. All implants were stably fixed with bone ingrowth and no aseptic loosening occurred during the follow-up period. No patients needed revision surgery for any reason.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

REFERENCES

1. Learmonth ID, Young C, Rorabeck C. *The operation of the century: total hip replacement. Lancet.* 2007;370:1508-19.
2. Charnley J. *Anchorage of the femoral head prosthesis to the shaft of the femur. J Bone Joint Surg Br.* 1960;42-B:28-30.
3. Charnley J. *Arthroplasty of the hip. A new operation. Lancet.* 1961;1:1129-32.
4. Jones LC, Hungerford DS. *Cement disease. Clin Orthop Relat Res.* 1987;(225):192-206.
5. Sanfilippo JA, Austin MS. *Implants for total hip arthroplasty. Expert Rev Med Devices.* 2006;3:769-76.
6. Ahn HY, Kim KH, Shim SH. *A case of McKee-Farrar prosthetic replacement of the hip. J Korean Orthop Assoc.* 1970;5:29-34.
7. Kim YM, Kim HJ, Jin JS, Moon YW. *Clinical study of Kim's femoral stem. J Korean Orthop Assoc.* 1991;26:1365-70.
8. Engh CA, Bobyn JD, Glassman AH. *Porous-coated hip replacement. The factors governing bone ingrowth, stress shielding, and clinical results. J Bone Joint Surg Br.* 1987; 69:45-55.
9. Gruen TA, McNeice GM, Amstutz HC. *"Modes of failure" of cemented stem-type femoral components: a radiographic analysis of loosening. Clin Orthop Relat Res.* 1979;(141): 17-27.
10. DeLee JG, Charnley J. *Radiological demarcation of cemented sockets in total hip replacement. Clin Orthop Relat Res.* 1976;(121):20-32.
11. Joshi RP, Eftekhari NS, McMahon DJ, Nercessian OA. *Osteolysis after Charnley primary low-friction arthroplasty. A comparison of two matched paired groups. J Bone Joint Surg Br.* 1998;80:585-90.
12. Maloney WJ, Jasty M, Harris WH, Galante JO, Callaghan JJ. *Endosteal erosion in association with stable uncemented femoral components. J Bone Joint Surg Am.* 1990;72:1025-34.
13. Brooker AF, Bowerman JW, Robinson RA, Riley LH Jr. *Ectopic ossification following total hip replacement. Incidence and a method of classification. J Bone Joint Surg Am.* 1973; 55:1629-32.
14. Capello WN, D'Antonio JA, Feinberg JR, Manley MT, Naughton M. *Ceramic-on-ceramic total hip arthroplasty: update. J Arthroplasty.* 2008;23(7 Suppl):39-43.
15. Park YS, Kim YS, Lee JM, Sun DH, Moon YW, Lim SJ. *Cementless total hip arthroplasty with use of the COREN hip system. J Korean Hip Soc.* 2007;19:457-62.
16. Lim YW, Kwon SY, Sun DH, Kim HE, Kim YS. *Enhanced cell integration to titanium alloy by surface treatment with microarc oxidation: a pilot study. Clin Orthop Relat Res.* 2009;467:2251-8.
17. Kim SM, Moon YW, Lim SJ, et al. *Minimum seven-year follow-up of cementless total hip arthroplasty with the COREN hip system. Hip Pelvis.* 2013;25:173-81.
18. Lee JM, Jeon JB. *Result of a minimum five-year follow-up of hip arthroplasty using the Bencox[®] hip stem. J Korean*

- Orthop Assoc.* 2014;49:126-32.
19. Lim YW, Lee KH, Bae SH, Kwon SY. *Comparative analysis of two cementless stems in total hip arthroplasties in patients with osteonecrosis of femoral head - Summit[®] stem and Bencox[®] stem.* *J Korean Hip Soc.* 2012;24:25-31.
 20. Robinson RP, Deysine GR, Green TM. *Uncemented total hip arthroplasty using the CLS stem: a titanium alloy implant with a corundum blast finish. Results at a mean 6 years in a prospective study.* *J Arthroplasty.* 1996;11:286-92.
 21. Schramm M, Keck F, Hohmann D, Pitto RP. *Total hip arthroplasty using an uncemented femoral component with taper design: outcome at 10-year follow-up.* *Arch Orthop Trauma Surg.* 2000;120:407-12.
 22. Smeekes C, de Witte PB, Ongkiehong BF, van der Wal BCH, Barnaart AFW. *Long-term results of total hip arthroplasty with the CementLess Spotorno (CLS) system.* *Hip Int.* 2017;27:465-71.
 23. Yamasaki T, Yasunaga Y, Mori R, Hamanishi M, Shoji T, Ochi M. *The Cementless Spotorno stem in THA: 10 year results.* *Hip Int.* 2014;24:98-102.
 24. Yoo JJ, Kim YM, Yoon KS, Koo KH, Song WS, Kim HJ. *Alumina-on-alumina total hip arthroplasty. A five-year minimum follow-up study.* *J Bone Joint Surg Am.* 2005;87:530-5.