

Long-term Results of Hybrid Total Knee Arthroplasty: Minimum 10-years Follow-up

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Purpose: To evaluate the survival rate and long term clinical outcomes of hybrid total knee arthroplasty (TKA).

Materials and Methods: We retrospectively analyzed 113 hybrid TKAs (NexGen) in 86 patients that were followed for more than 10 years. Kaplan-Meier survival curves were generated using revision as an end point. Knee Society Score (KSS) and range of motion were evaluated for clinical assessment and plane radiographs were used to evaluate implant problems.

Results: At 11.2 years (range, 10 to 12.2 years) of follow-up on average, 7 knees required revision. The reason for revision was aseptic loosening in 4 knees (1 in femoral and tibial component and 3 in tibial component only) and infection in 3 knees. The survival rate was 93.8% at 12 years for all knees, and 96.5% when septic loosening was excluded. The KSS improved from 29.3 to 91.5 in the Cruciate-Retaining type (CR) and from 21.5 to 90.3 in the posterior stabilizing type (PS) at latest follow-up. The average range of motion was improved from 120.6° to 133.8° in the CR type and 119.5° to 135.5° in the PS type.

Conclusions: Hybrid TKA provides good survival rates and clinical results comparable to cemented TKA.

Key words: Total knee arthroplasty, Hybrid, Long term follow-up, Survival rate.

Introduction

Total knee arthroplasty (TKA) has evolved significantly since the 1960s and TKAs using a variety of prosthesis designs have been documented in many studies¹⁻³. Although TKA has contributed to improvement of patient's quality of life, it has been associated with some complications including osteolysis, component loosening, and polyethylene wear. To prevent these

postoperative complications, various fixation techniques have been employed^{4,5}. Currently, hybrid fixation has become the most preferred alternative to cementless fixation that has been receiving conflicting reviews. Survivorship of hybrid TKA is high according to many short-term follow-up studies⁶⁻⁸, but it has not been fully investigated in long-term studies^{9,10}. The purpose of our study was to evaluate the survivorship and clinical and radiographic results of hybrid TKA during ≥10 years of follow-up.

Materials and Methods

1. Materials

Of the 168 TKAs performed by the same surgeon at our institution between April 1997 and May 1999, 139 (82.8%) were hybrid TKAs. Of these, 113 TKAs (86 patients) with a minimum follow-up of 10 years were included in this study. Hybrid TKA was indicated when neither the interfacial gap between the bone and a trial prosthesis after bone resection nor movement of the trial prosthesis during joint motion was observed with the naked eye. The mean follow-up period was 11 years and 2 months (range, 10 years to 12 years and 2 months). There were 5 males and 81

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females with a mean age of 62.9 years (range, 48 to 77 years) (Table 1).

2. Preoperative Diagnosis

The preoperative diagnosis was degenerative arthritis in 106 knees (93.8%), osteonecrosis in 4 knees (3.5%), rheumatoid arthritis in one knee (0.9%), and post-traumatic arthritis in 2 knees (1.8%).

3. Implant

The same hybrid prosthesis (NexGen, Warsaw, IN, USA)

Table 1. Demographic Data

	CR type	PS type	Loosened patients
Number of knees	74	33	6
Mean age	63 (± 7.6)	66 (± 7.5)	56.4 (± 8.8)
Gender (male/female)	8/66	6/27	1/5
Diagnosis			
Osteoarthritis	68	32	6
Rheumatoid arthritis	0	1	0
Osteonecrosis	4	0	0
Traumatic arthritis	2	0	0

CR: cruciate retaining, PS: posterior substituting.

with a cemented tibial component and a cementless femoral component was used in all knees. The patient's age, preoperative deformity and contracture, and intraoperative evaluation of the posterior cruciate ligament (PCL) were taken into consideration for determining either a cruciate-retaining (CR) or a posterior stabilizing (PS) design. The CR design was used in knees with $\geq 10^\circ$ of varus deformity or $\geq 15^\circ$ of flexion contracture before surgery. The PS design was used when lift off was observed after bone resection for the use of CR design. The CR prosthesis was used in 52 patients (70 knees) and the PS prosthesis in 34 patients (43 knees) (Fig. 1).

4. Survivorship Analysis

The accumulative survival rate was calculated using the Kaplan-Meier method. The follow-up period was divided into one year intervals. Annual success was defined as a prosthesis in situ and failure as implant removal due to deep infection or revision. Survival rates, standard deviations and confidence intervals were calculated using SPSS ver. 15.0 (SPSS Inc., Chicago, IL, USA). Analysis of survivorship data was performed using the log-rank test.

5. Clinical Assessment

According to the American Knee Society rating system¹¹⁾, knee score and function score were assessed preoperatively and at the

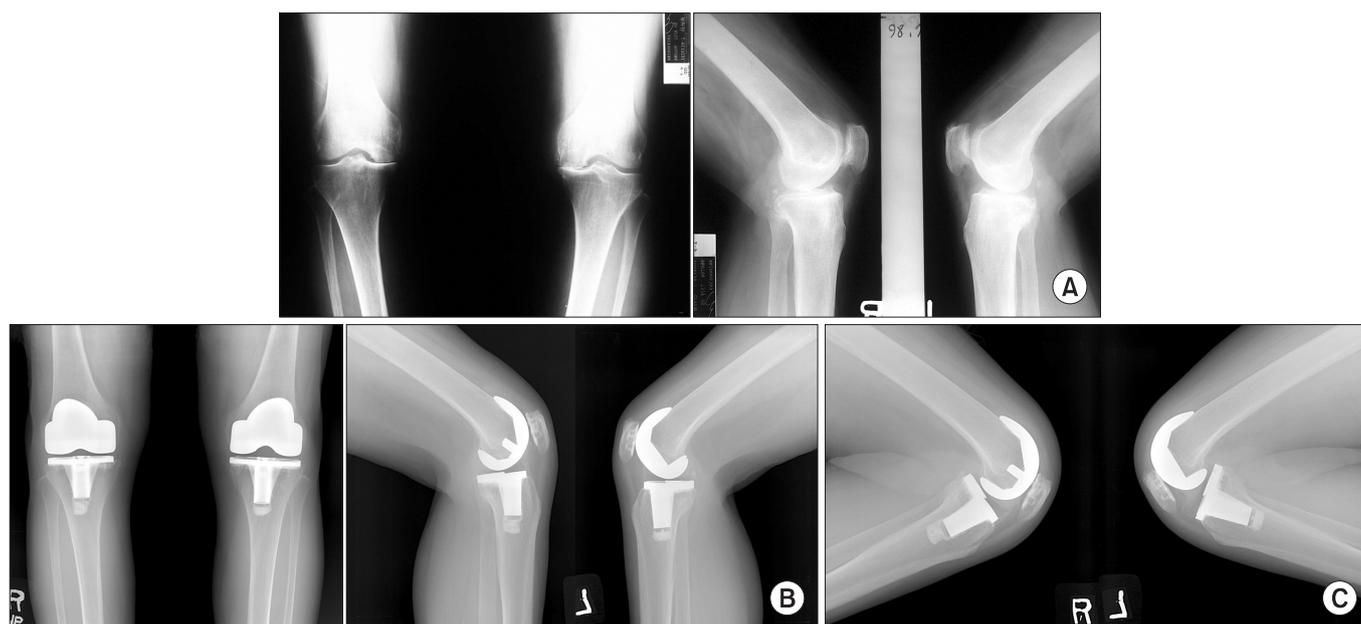


Fig. 1. A 65-year-old female who had undergone total knee arthroplasty on both knees. (A) Preoperative anteroposterior and lateral radiographs show osteoarthritic changes. (B) The cruciate retaining type implant in the right knee and posterior stabilizing type in the left knee were inserted. After 12 years, the radiographs show no loosening on both components. (C) After 12 years, the full-flexion film shows excellent flexion on both knees.

last follow-up. The 100-point knee score consisted of pain (50 points), range of motion (25 points; 1 point for 5°), mediolateral stability (15 points), and anteroposterior stability (10 points). Points were deducted for flexion contracture, extension lag, and malalignment. The 100-point function score included walking ability (50 points) and stair climbing (50 points). Points were subtracted for the use of one cane (5 points), 2 canes (10 points), and crutches or walker (20 points).

6. Radiographic Assessment

Standing anteroposterior (AP) view, 30° flexion lateral view, and axial view of both patellae were obtained preoperatively, 2 weeks postoperatively, one year postoperatively, and at final follow-up. According to the American Knee Society roentgenographic evaluation and scoring system¹²⁾, the obtuse angle (α) between the axis of the femur and tibial component on the anteroposterior radiograph and the acute angle (γ) between the 2 reference points on a lateral radiograph were measured. The appearance of radiolucent lines was examined. Measurements were performed by one orthopedic surgeon and one orthopedic resident; the mean values of the measurements of the 2 observers were recorded for analysis. The interclass correlation coefficients between the 2 observers were ≥ 0.91 for all data which indicated sufficiently high interobserver reliability, considering that a value between 0.81 and 1.00 is considered satisfactory¹³⁾.

7. Statistical Analysis

SPSS (SPSS Inc.) was the computer program used for statistical analysis. Paired t-tests were performed to determine statistical significance in the differences between the CR group and PS group. A p-value < 0.05 was considered statistically significant. Survival rate was calculated by the Kaplan-Meier method. Survival rate was analyzed using the log-rank test.

Results

1. Clinical Results

The mean knee score was improved from 29.3 (range, 0 to 60) preoperatively to 91.5 (range, 60 to 100) postoperatively,

in the CR group ($p < 0.001$), and from 21.5 (range, 0 to 30) preoperatively to 90.3 (range, 77 to 100) postoperatively, in the PS group ($p < 0.001$). The mean function score was improved from 48.7 (range, 5 to 70) preoperatively to 76.1 (range, 35 to 100) postoperatively, in the CR group ($p < 0.001$), and from 40.2 (range, 5 to 50) preoperatively to 66.2 (range, 40 to 100) postoperatively, in the PS group ($p = 0.002$) (Table 2). No statistically significant differences were found between the 2 groups in the knee score or the function score ($p = 0.953$). On the range of motion (ROM) assessment, the mean flexion contracture was improved from 5.7° (range, 0° to 15°) preoperatively to 0° postoperatively in the CR group ($p < 0.001$), and from 11.5° (range, 0° to 20°) preoperatively to 0.3° (range, 0° to 2°) postoperatively, in the PS group ($p < 0.001$). The mean maximum flexion increased from 126.3° (range, 55° to 150°) preoperatively to 133.8° (range, 145° to 150°) postoperatively in the CR group ($p < 0.001$) and from 131.0° (range, 125° to 150°) preoperatively to 135.8° (range, 125° to 150°) postoperatively in the PS group ($p = 0.008$). The mean ROM increased from 120.6° (range, 15° to 150°) preoperatively to 133.8° (range, 135° to 150°) postoperatively, in the CR group ($p < 0.001$), and from 119.5° (range, 100° to 150°) preoperatively to 135.5° (range, 130° to 150°) postoperatively in the PS group ($p < 0.001$). No statistically significant difference was noted between the 2 groups in the ROM assessment ($p = 0.633$).

2. Radiographic Assessment

Component loosening occurred in 7 knees: septic loosening in 3 knees and aseptic loosening in 4 knees. In the latter 4 knees, tibial component loosening only was seen in 3 knees (Fig. 2); femoral and tibial component loosening occurred in one knee. One to 2 mm radiolucent lines appeared around the femoral component in 2 knees (5.7%) and around the tibial component in 25 knees (23.8%) in the CR group, but no progression was noted during the follow-up (Table 3).

3. Survival Rate Analysis

The survival rate at 12 years after surgery was 93.8% for all knees and 96.5% when deep infection was excluded. No statistically significant difference between the groups was found

Table 2. Knee Society Score and Knee Function Score

Type	Knee society score		p-value	Knee function score		p-value
	Pre-OP	Post-OP 10 yr		Pre-OP	Post-OP 10 yr	
CR type	29.3 (± 11.5)	91.5 (± 7.7)	$< 0.001^a$	48.7 (± 13.9)	76.1 (± 24.4)	$< 0.001^a$
PS type	21.5 (± 8.1)	90.3 (± 8.0)	$< 0.001^a$	40.2 (± 11.8)	66.2 (± 16.3)	0.002 ^{a)}

Pre-OP: preoperative, Post-OP: postoperative, CR: cruciate retaining, PS: posterior substituting.

^{a)}Statistical significance ($p < 0.05$).



Fig. 2. A 57-year-old female has been performed cruciate retaining -type total knee arthroplasty on the left knee. (A) Six years after the operation, the radiograph shows loosening of the tibial component. (B) Revision arthroplasty was performed. (C) Five years after the revision arthroplasty, the radiograph shows no loosening of the prosthesis.

Table 3. Radiological Evaluation of Femoral Component

Type	α angle		p-value	γ angle		p-value
	Imm. post-OP	Post-OP 10 yr		Imm. post-OP	Post-OP 10 yr	
CR	97.5 (± 1.4)	96.6 (± 2.5)	0.662	3.7 (± 2.4)	2.4 (± 1.4)	0.128
PS	98.0 (± 2.1)	97.0 (± 2.3)	0.027	4.0 (± 2.3)	2.9 (± 2.0)	0.149

Imm. post-OP: immediate postoperative, CR: cruciate retaining, PS: posterior substituting, post-OP: postoperative.

^aStatistical significance ($p < 0.05$).

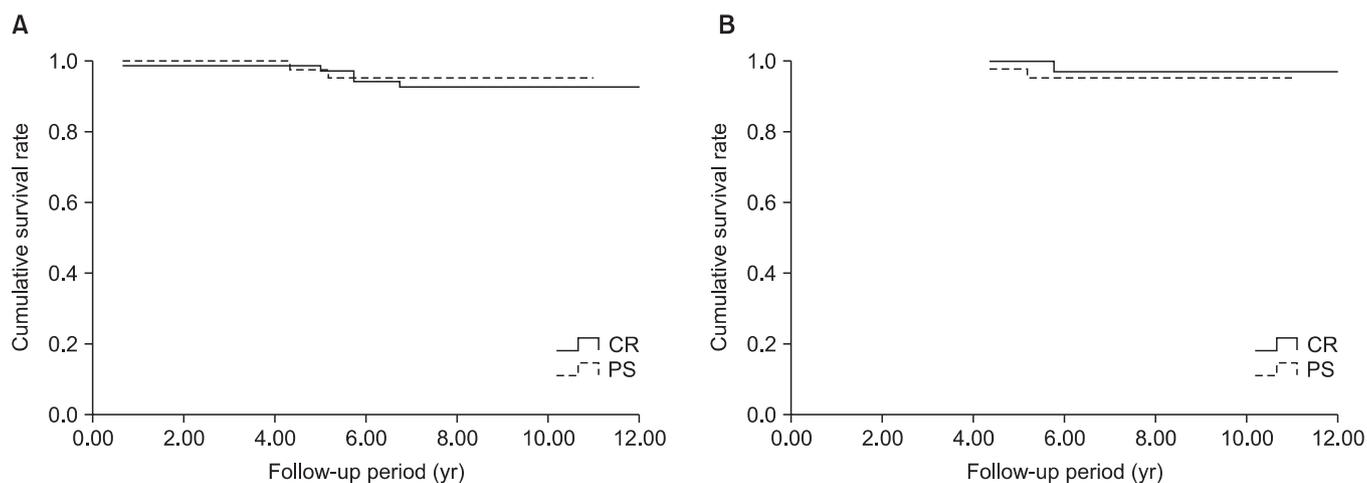


Fig. 3. Kaplan-Meier survival curves were generated: (A) Including Infection. (B) Excluding Infection. CR: cruciate retaining, PS: posterior stabilizing.

on 12-year survival rate ($p=0.632$) (Fig. 3).

4. Complications

Revision, defined as failure, was required in 7 knees. Infection was the cause of revision in 3 knees in the CR group and aseptic loosening in the remaining 4 knees, 2 in the PS group and the other 2 in the PS group. There were no periprosthetic fractures or patella dislocations. These complications occurred at a mean of 81 months after surgery and did not recur after revision.

Discussion

Efforts have been made continuously to elucidate factors that may be associated with the survivorship of TKA. Rand and Ilstrup¹⁴⁾ analyzed the success rates of TKA in 9,200 knees: the rates of implant survival were 99% at 2 years postoperatively, 98% at 5 years postoperatively, and 91% at 10 years postoperatively in knees with a CR TKA and the rates were similar in knees with a PS TKA. They suggested that primary arthroplasty, rheumatoid arthritis,

≥60 years of age, and use of a metal backed tibial component could be variables for prolonged survival of TKA. In the current study, the survivor rate was 93.8% at 12 years postoperatively, similar to that in the abovementioned study and there were no remarkable differences between the CR group and the PS group.

Fixation method may be associated with the survivorship of TKA. Hybrid fixation method was first introduced in the late 1980s with a goal of overcoming the most common cause of failure in cementless TKA, tibial component loosening, by promoting bone ingrowth into uncemented components. The technique has been considered advantageous in reducing polyethylene wear that can occur due to third body wear from bone cement debris, decreasing operative time, and allowing for ease of revision⁶. In a study by Campbell et al.¹⁵, hybrid TKA resulted in significantly low survival rate compared to cemented TKA during a 5-year follow-up period. However, there have been many studies reporting good short-term follow-up results^{6,7}, and the technique produced no significantly different results compared to cemented TKA in a 12.8-year long-term follow-up study¹⁶. The survival rate was 95% after hybrid TKA in some studies involving a 15-year follow-up period¹⁷⁻²⁰. Such high long-term survivorship of hybrid TKA has been attributed to improvement in implant design and surgical technique⁹, the use of porous-coated femoral component and non-porous-coated tibial component²¹, and proper fitting between the implant and the femur²¹. We believe these factors contributed to the excellent long-term survival rate in our study. The femoral component was porous-coated in all knees. Uncemented fixation was performed only when bone-implant interfacial gap was not observed in the naked eye after femoral bone resection. Cemented fixation was used when incongruity between the cut surface and the implant was noted or stable fixation appeared unachievable during trial insertion and ≥1 mm interfacial gap was observed. Uncemented fixation can result in osteolysis due to polyethylene wear particle interposition between the implant and the bone. However, the incidence of osteolysis around the femoral component is significantly low⁹ and uncemented fixation yields fewer radiolucent lines than cemented fixation in zone 4 where ingress of debris particles between the component and the femur occurs²². Osteolysis is more frequently observed around the tibial component. In this study, femoral component loosening occurred only in one knee of the four knees with component loosening and radiolucent lines in zone 4 were observed in one case. Therefore, we thought the incidence of osteolysis around the femoral component could be reduced by choosing proper implants and fixation methods. In addition, considering that

femoral component loosening and tibial component loosening both occurred in this one case, we could not rule the possibility of spontaneous resolution of infection in the past.

There has been debate whether the PCL should be retained or removed during TKA and retention, resection, and conditional retention of the PCL have been suggested as possible options^{23,24}. PCL retention allows for efficient walking, increased ROM, higher resistance to posterior shear force for stability, and preservation of the joint surface height and sensory function²⁵⁻²⁷. On the other hand, PCL resurfacing facilitates deformity correction, small tibial bone resection, and joint conformity for polyethylene wear reduction²⁴. In this study, no statistically significant differences were noted between the CR group and PS group in terms of the postoperative knee score, function score, and survival rate.

This study is limited in that only one system was used in all the TKAs and the results were reviewed, retrospectively. However, the significance of this study is that it shows that the long-term survival rate of hybrid TKA using the NexGen implant was comparable to cemented TKA (98.3% in the ≥5-year follow-up study by Bin et al.²⁸ and 87.6% in the 10-year follow-up study by Duffy et al.²⁹). In addition, hybrid TKA resulted in excellent postoperative ROM.

Conclusions

Hybrid TKA using the NexGen implant yielded results comparable to cemented TKA in terms of clinical results, including ROM and function, and radiographic results in a minimum 10-year follow-up.

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