Mid-term outcomes using rotating-hinge prosthesis for primary and revision total knee arthroplasty

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ABSTRACT

Objective: To analyze the clinical and radiological mid-term outcomes of 34 rotating-hinge total knee arthroplasties. **Materials and Methods:** We studied 34 hinge knee prostheses. The arthroplasty indication was in the setting of primary surgery for 10 patients (29.5%) and in the setting of revision for 24 patients (70.5%). The overall average age was 78.5 years (range, 54-85 years). **Results:** The average follow-up was 6.5 months (range, 2-12). The achieved range of motion (ROM) was 110º of flexion (range, 70º-130º) and 5º of extension (range, 0º-20º). The average Knee Society Score (KSS) improved from 38 in the preoperative period to 82 in the postoperative period. Radiolucent lines (>2 mm) around the femoral or tibial components or around the stems were observed in 8 patients (23%). Five out of 34 patients (14.7%) developed complications. Three patients (8.9%) developed a deep infection. Two patients (5.9%) developed patellofemoral complications. Prosthesis survivorship without revision was 94% at 6.5 years. And, considering aseptic loosening as a revision cause, prosthesis survivorship was 100%. **Conclusion:** Modern rotating-hinge knee prostheses provide good outcomes in terms of function and pain relief. They also provide a low rate of aseptic loosening at mid-term follow-up. However, deep infection and septic loosening are common.

Key words: Rotating-hinge knee; revision knee arthroplasty; primary knee arthroplasty.
Level of Evidence: IV

Resultados a mediano plazo de la prótesis abisagrada rotatoria en el reemplazo total de rodilla primario y de revisión

RESUMEN

Objetivo: Comunicar los resultados clínicos y radiológicos a mediano plazo de 34 artroplastias totales de rodilla abisagradas rotatorias. **Materiales y Métodos:** Se evaluó a un grupo de 34 prótesis abisagradas de rodilla. Se indicó una bisagra a 10 pacientes (29,5%) sometidos a una cirugía primaria y a 24 (70,5%), a una cirugía de revisión. La edad promedio de la serie era de 78.5 años (rango 54-85). **Resultados:** El seguimiento promedio fue de 6.5 años (rango 2-12). El rango de movilidad conseguido fue 110º de flexión (rango 70-130º) y 5º de extensión (rango 0-20º). El puntaje promedio en el KSS mejoró de 38 antes de la cirugía a 82 en el posoperatorio. En la evaluación radiológica, se detectaron líneas radiolúcidas >2 mm alrededor del componente femoral o tibial, o alrededor de los vástagos, en 8 casos (23%). Cinco de 34 pacientes (14,7%) sufrieron complicaciones. En tres casos (8,9%), se trató de una infección profunda. Dos pacientes (5,9%) tuvieron complicaciones rotulofemorales. La supervivencia de la prótesis libre de revisión a los 6.5 años fue del 94%. Si consideramos el aflojamiento aséptico como causa de revisión, la supervivencia fue del 100%. **Conclusión:** Las prótesis abisagradas rotatorias de rodilla modernas logran buenos resultados funcionales y de alivio del dolor. También se asocian a bajas tasas de aflojamiento aséptico a mediano plazo. Sin embargo, las complicaciones sépticas son frecuentes.

Palabras clave: Bisagra rotatoria de rodilla; artroplastia de revisión; artroplastia primaria.
Nivel de Evidencia: IV

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INTRODUCTION

One of the main goals of any knee arthroplasty (primary or revision) is to achieve a stable knee that would allow for a functional and durable knee joint. Total joint replacement requires the presence of competent collateral ligaments. However, for primary arthroplasties involving severe misalignment or revision arthroplasties involving severe bone defects and/or severe ligamentous instability, it is usually necessary to use constrained implants such as hinge prostheses. The first hinge knee prostheses that were designed in the 1970s and the 1980s were associated with high rates of aseptic loosening.[1,2] However, the improvements in their design have reduced the initially reported failure rates.[3-11] Current rotating-hinge prostheses provide great intrinsic stability allowing at the same time for rotational movements that mimic the physiological biomechanics of the knee joint, thus diminishing the forces transmitted to the bone-cement interface.[6-11]

Our objective is to report the clinical and radiological mid-term outcomes of 34 rotating-hinge total knee arthroplasties.

MATERIALS AND METHODS

We retrospectively studied 36 knee hinge prostheses in 35 patients with no oncologic disease that were implanted by two surgical teams at different centers between December 2003 and January 2014. Two patients were lost to follow-up and thus excluded from the study, resulting in a series of 34 prostheses in 33 patients. The arthroplasty indication was in the setting of primary surgery for 10 patients (29.5%) and in the setting of revision for 24 patients (70.5%). The indications for surgery in the primary surgery group were: severe genu valgum associated with medial collateral ligament insufficiency (6 cases); severe genu varum associated with medial collateral ligament insufficiency (2 cases); genu recurvatum after poliomyelitis (1 case); and chronic medial collateral ligament disruption without misalignment in a 78-year-old patient (1 case). The indication for surgery in the revision surgery group was severe ligament insufficiency, associated or not with bone loss. Fourteen (58%) revision surgeries were indicated in the second revision stage for septic loosening, and the remaining 10 cases were due to instability. The average age was 78.5 years (range, 54-85 years). Nineteen patients (56%) were women and 15 men (44%). The prostheses were implanted in 19 right knees and 15 left knees (Table).

The prostheses were: in 27 cases, the Endo-Model® (LINK®, Hamburg, Germany) rotating-hinge prosthesis; in 7 cases, the B-ROTAX® (Aston Medical®, France) rotating-hinge prosthesis.

Pre- and postoperative assessment included evaluation of all knees with the KSS[12] and the ROM evaluation was performed using a goniometer with the patient in dorsal recumbent position. Postoperative X-rays were examined in search of loosening signs. Antimicrobial prophylaxis was administered with 2g cefazolin. The patients received a dose of 15 mg/kg tranexamic acid before the surgery and a second dose at the time of closure.[13] None of the procedures included the use of a blood pressure cuff. Skin incisions were made along the median line; in the revision cases, the previous incision was used and, in cases with more than one, the outer incision was used. The 6 patients presenting a severe valgus misalignment were operated on through a lateral parapatellar approach.[14] In the rest of the patients that underwent primary surgery and in all who underwent revision surgery, a medial parapatellar approach was used. A rectus snip was performed in 18 cases (53%) to provide wider exposure. An anterior tibial tubercle osteotomy was performed in a revision (case 15) to facilitate removal of the tibial stem (Figure 1). Cemented stems and antibiotic impregnated cement were used in all cases. The patellar component was only implanted in selected cases, according to the degenerative involvement in primary surgeries and to the remaining bone in revision surgeries. Antithrombotic prophylaxis consisted of subcutaneous low-molecular-weight heparin (40mg/day) for 30 days as from 12 hours after surgery. The rehabilitation protocol consisted of knee mobility exercises and weight-bearing walking using a walker, according to tolerance, as from 48 hours after surgery.

Table. Demographics, indications and outcomes

Case	Age	Side	Sex	Condition	Brand	Preoperative KSS	Postoperative KSS	Complications
1	54	L	M	Prosthetic instability	Link®	35	90	
2	74	R	F	2nd stage infection	Link®	40	85	
3	68	R	M	2nd stage infection	Link®	45	85	
4	77	R	F	2nd stage infection	Link®	37	93	
5	72	L	F	2nd stage infection	Link®	30	75	
6	82	L	M	Prosthetic instability	Link®	45	90	
7	79	R	F	Prosthetic instability	Link®	30	81	
8	67	R	M	Severe genu valgum	Link®	41	57	
9	79	L	M	Severe genu valrum	Link®	34	85	
10	72	R	F	Severe genu valrum	Rotax®	42	91	
11	72	R	M	2nd stage infection	Rotax®	47	83	
12	77	L	F	Severe genu valgum	Rotax®	35	76	
13	79	R	F	Severe genu valgum	Rotax®	30	82	Infection
14	69	L	M	2nd stage infection	Link®	43	81	
15	76	R	F	2nd stage infection	Link®	36	92	Infection
16	80	L	F	Prosthetic instability	Link®	39	90	
17	85	R	M	Severe genu valgum	Rotax®	43	75	Patellar luxation
18	68	L	F	2nd stage infection	Rotax®	40	91	
19	62	R	M	Recurvatum	Link®	30	82	
20	78	L	F	2nd stage infection	Link®	30	85	
21	71	R	F	2nd stage infection	Link®	5	50	Infection
22	65	L	M	Prosthetic instability	Link®	40	85	
23	67	R	F	Prosthetic instability	Link®	20	92	
24	75	R	F	Prosthetic instability	Link®	35	87	
25	73	L	M	Prosthetic instability	Link®	30	69	Patellar luxation
26	85	R	F	Severe genu valgum	Link®	41	87	
27	53	L	F	Prosthetic instability	Link®	37	87	
28	65	R	M	Prosthetic instability	Link®	45	93	
29	70	R	M	2nd stage infection	Rotax®	45	69	
30	70	L	F	2nd stage infection	Link®	30	91	
31	72	L	F	Severe genu valgum	Link®	15	82	
32	68	R	M	2nd stage infection	Link®	45	93	
33	78	R	M	Chronic MCL disruption	Link®	40	70	
34	83	L	F	2nd stage infection	Link®	34	85	

F: female; M: male; R: right; L: left; KSS: Knee Society Score; MCL: medial collateral ligament.

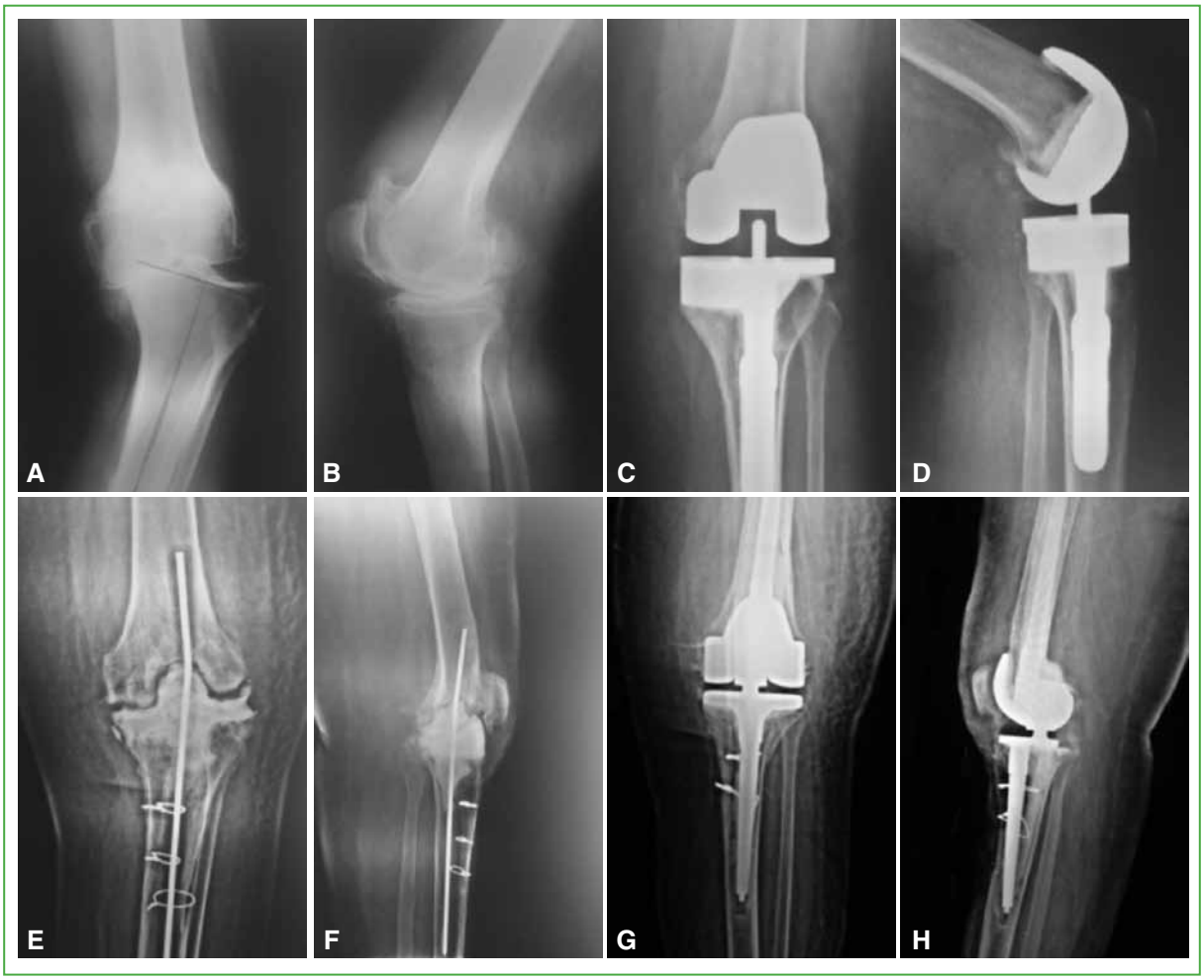

Figure 1. Case 15. **A and B**. Severe genu valrum. **C and D**. Total knee arthroplasty with medial tibial augmentation and uncemented stem. **E and F**. First revision stage due to septic loosening. Anterior tibial tubercle osteotomy and placement of a non-articulating spacer. **G and H**. Second revision stage with a total knee hinge prosthesis.

RESULTS

The average follow-up was 6.5 months (range, 2-12). The achieved ROM was 110º of flexion (range, 70º-130º) and 5º of extension (range, 0º-20º). The femorotibial axis was restored in all the patients. The average KSS improved from 38 in the preoperative to 82 in the postoperative. The outcome was considered satisfactory (KSS>80) in 26 cases (76.5%), regular in 6 cases (17.6%), and poor in 2 cases (5.9%). Radiolucent lines (>2 mm) around the femoral or tibial components or around the stems were observed in 8 patients (23%). The radiolucent lines were progressive only in one case, which patient had a septic loosening and required a revision.

Five out of 34 patients (14.7%) developed complications. Three patients (8.9%) developed a deep infection; all of them were cases of reinfection. Two of them underwent surgical cleaning and suppressive antibiotic therapy (cases 13 and 15). The remaining patient required prosthesis removal and a new spacer implantation; however, the patient refused to undergo a new surgery (case 21). Two patients (5.9%) developed patellofemoral complications. One of them sustained repeated patellar dislocation episodes and required a revision, which included patellar component implantation and lateral retinaculum release (case 17) (Figure 2). The other patient sustained patellar subluxation episodes and, as the patient refused to undergo a new surgery, underwent conservative treatment with a muscle strengthening program.

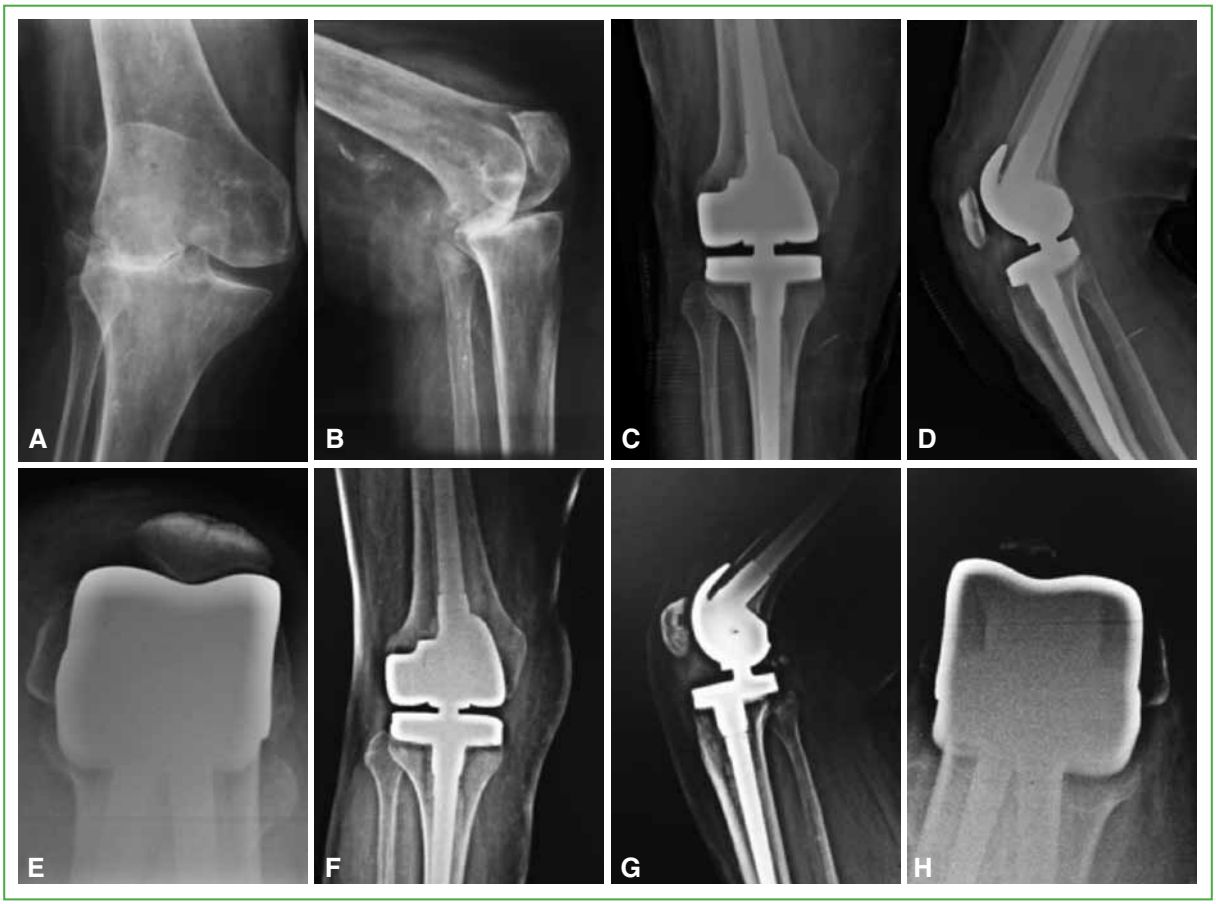

Figure 2. Case 17. **A and B**. Patient with severe genu valgum. **C-E**. Postoperative X-rays showing a mild patellar lateralization. **F-H**. Due to the presence of patellar instability symptoms, the release of the lateral retinaculum and the implantation of the patellar component were performed.

Prosthesis survivorship without revision was 94% at 6.5 years. And, considering aseptic loosening as a revision cause, prosthesis survivorship was 100%.

DISCUSSION

Knee hinge prostheses have been used to treat severe ligamentous instability in the setting of revision surgeries and even in selected cases of primary arthroplasties. The first designs date from the 1950s and were actual hinges that only allowed the motion of flexion and extension. Although the stability of these first prostheses was excellent, their inability to allow for more physiological knee movements exerted high mechanical stress on the implant, which was transmitted on to the implant/cement/bone interface leading to high rates of mechanical loosening.[1-3]

The first rotating-hinge prostheses were designed in the 1970s as an attempt to decrease the complications associated with fixed hinge devices. However, initial short and mid-term outcomes were disappointing.[1-3] Finally, since the 1990s, the third-generation model made way for more promising outcomes. In 2014, Gehrke *et al*. published their series of 238 hinges used in primary surgeries, where they reported a 0.5% rate of revision due to aseptic loosening at 13-year follow-up. However, they stressed that all of the cases considered in the series were primary replacements, which may account for the low rates.[15] In 2017, Cottino *et al*. published a series of 408 rotating-hinge prostheses with a 4.5% rate of revision due to aseptic loosening at 10-year follow-up.[16] These results outline the significant reduction of stress transmitted on to the implant/cement/bone interface by modern implants compared to the first designs.

The updates of the most modern models have also improved the patellofemoral congruence, which was not solved by the first rotating-hinge prostheses and was responsible for the patellar complications. Rand *et al*. published a series of 38 patients, with a 50-month follow-up and a 22% patellofemoral complication rate.[1] In 2001, Springer *et al*. published a series of 188 patients, with a 13% patellar complication rate.[17] In their 408-case-series, Cottino *et al*. reported a 1% patellofemoral complication rate using the modern hinges.[16] In our series, 2 patients (5.9%) presented patellar complications, and one of them underwent a revision surgery.

Infection remains one of the most common complications. The reported high rate of infections may derive from the inevitable massive exposure and soft tissue release, the long operative time, and the multiple comorbidities. In their series of knee hinge prostheses in nonneoplastic patients, Springer *et al*. reported infection in 5 (19%) of their 26 subjects.[18] In the series published by Cottino *et al*., the revision rate at 10 years rises to 22.5%, including causes related to septic failures. Nevertheless, they stated that these results are not surprising as the majority of these patients had numerous medical comorbidities and many of them had several prior operations, including many for infection.[16] Gehrke *et al*. reported a 2% infection rate in their series of 238 hinges used in primary surgeries.[15] We reported an infection rate of 8.9%, which falls within the literature reported values. This fact may be accounted for the fact that we included both primary and revision surgeries.

The functional outcomes and the improvements regarding ROM in different series are promising. Our results are consistent with several reports. In 2010, Hossain *et al*. published a comparative study of patients who had undergone a knee arthroplasty, which results are similar to ours in terms of postoperative satisfaction and ROM, regardless of the type of prosthesis (posterior stabilized, condylar constrained knee or rotating-hinge).[4]

CONCLUSIONS

Modern rotating-hinge knee prostheses provide good outcomes in terms of function and pain relief, even in the most complex settings of revision surgeries. They also provide a low rate of aseptic loosening at mid-term follow-up. However, the associated septic complications remain the main cause of failure, partly due to the patients' comorbidities and frequent previous infections.

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