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ORIGINAL STUDY

Mid-term results of rotating hinge knee prostheses

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Between December 2002 and December 2007, we retrospectively assessed the mid term results of the Nexgen rotating hinge prosthesis in the hands of a single surgeon in difficult primary and complex revision situations. Forty four patients (46 knees) were included in the study : they were followed for an average of 62 months. Knee Society knee score improved from a preoperative mean value of 47 to a mean value of 81 at follow-up ($p < 0.05$) whereas the mean function score improved from 17 (0-40) to 67.5 (0-90) at follow-up ($p < 001$). Mean flexion range improved from 65° to 96° at follow-up ($p < 0.05$). In conclusion, rotating hinge knees gave satisfactory results in difficult revision situations associated with major bone loss, instability or periprosthetic fracture. They also provided satisfactory results in selected cases of advanced primary osteoarthritis.

Keywords : revision knee arthroplasty ; mid term results ; survivorship ; rotating hinge knee prosthesis ; instability ; bone loss.

INTRODUCTION

Over the last two decades, primary Total Knee Arthroplasty (TKA) has proven to be very successful with survivorship rates as high as 95% at 15 years (*16*). As the numbers of primary TKA's have increased there has been a corresponding increase in revision TKA (*2,13,25*) with about 5 - 13% of primary knees requiring revision TKA within 10 to 15 years (*13*). The outcomes of revision TKA have not been very encouraging with failure rates reported between 11 to 60% (*3,6,9,17,20,22*). The poor results of revision arthroplasty have been attributed to a variety of causes such as poor or absent bone stock (*6,22,25*), compromised extensor mechanisms (*8,25*), infection (*3,6*), absence of or very poor ligamentous stability (*6,17,25*), prosthesis malalignment (*17,25*), and aseptic loosening (*9,11*).

Revision TKA especially in the presence of severe global instability, bone loss and communited distal femoral fractures often necessitates the use of more constrained designs like the hinged prosthesis. In recent years, hinged prostheses were used essentially for knee reconstructions following resection of neoplasms around the knee (*4*). Initial designs were truly fixed hinges ; they required extensive bone resection and allowed movement in only flexion or extension with no possibility of varus, valgus or axial rotation ; they also produced

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large amounts of particulate wear debris which lead to synovitis and osteolysis (*1,22,27*). In addition excessive forces were transmitted to the bone cement interfaces owing to the inability of these prostheses to accommodate gait related rotational stresses at the knee, and this also lead to early failure because of early aseptic loosening, implant breakage or both (*11,19,27*). Rand *et al* (*17*) in their series reported satisfactory results in 65-75% of knees with high rates of loosening and complications using prostheses of a constrained hinge type.

The modern day rotating knee designs have a more conforming articulation which provides for stability and rotation reducing wear and debris generation. The addition of metaphyseal sleeves, modular fluted stems with variable offsets to improve alignment allowed for a press-fit fixation. The availability of modular segments allowed for filling large bone defects often encountered in difficult revision situations. All these improvements were an effort to reduce failure rates while using hinged prostheses and improve the articulation between the mobile bearing element and the tibial component (*2*). The rotating hinge arthroplasty, apart from giving stability, allows rotation thereby reducing torsional stress on the bone-implant interface (*8*).

The purpose of our study was to evaluate the mid term results and survivorship of the Nexgen rotating hinge prosthesis in complex primary and revision situations. We used the Nexgen Rotating Hinge Prosthesis in all our patients in this study, in contrast to previous reported series which used several different types of rotating hinged prostheses.

The design of the NexGen Rotating Hinge Knee (Zimmer, Warsaw, USA) features a modular hinge mechanism that results in 95% of the load being carried by the tibial condyles, similar to the loading pattern of a primary implant design. The trochlear groove allows the patella to track deeply, similar to a primary knee design. This maximizes the patellofemoral contact area, increases the resistance to lateral subluxation, and provides a smooth transition from flexion to extension. The central location of the hinge axis keeps the femoral condyles in a consistent position in the sagittal plane. This allows for more normal patellar tracking since the patella does not shift posteriorly during flexion. Designs that have the center of rotation located posteriorly can cause "booking" of the joint, which may result in stress on the cement interfaces or accelerated polyethylene bearing wear in the hinge.

Since the NexGen Rotating Hinge Knee takes advantage of modular design by using augments, the basic bone cuts are the same as those made for NexGen primary system components. This helps to minimize bone loss and allows use of instrumentation commonly used in primary implant procedures. To resist subluxation, the NexGen Rotating Hinge Knee locking mechanism design offers a minimum "jump height" of 40 mm.

The ratio of conformity between the femoral condyles and the highly dished tibial articular surface is virtually 1-to-1. By maximizing contact area, the stresses in the polyethylene are distributed across a larger surface area. The rotation of the NexGen Rotating Hinge Knee platform is designed to displace torsional loads from the cement interfaces to the soft tissues, since it allows up to 25° of movement in internal and external rotation. The modularity of the hinge post extension pin allows the implantation to proceed without requiring the knee to be excessively distracted while the components are assembled. The NexGen Rotating Hinge Knee femoral and tibial components are cemented into position, and with minimal distraction, the tibial articular surface can be inserted. The hinge post extension is inserted into the tibial baseplate and tightened.

The present study is a retrospective analysis of our clinical and radiological outcome with this rotating hinge prosthesis.

PATIENTS AND METHODS

A retrospective study was performed on a cohort of 47 patients who underwent NexGen rotating hinge knee replacement between December 2002 to December 2007, with a mean follow-up of 62 months (range : 36 to 96 months). One patient died and two were lost to follow-up, leaving 44 patients (46 knees) for the study. There were 30 females and 14 males with a mean age of 69 years (range : 57 to 81). All the surgeries were performed by the senior author (AR). The indication for surgery was revision in 39 knees and complex primary in 7 knees (Table I) (Fig. 1-6).

Table I. — Indications for the procedure in our series

Surgery	Indications
Primary Revision	3 Non union of medial femoral condyle with osteoarthritis and medial ligamentous deficiency 4 Infected non union of supracondylar fracture with osteoarthritis 13 Aseptic loosening and severe bone loss 10 Infection 7 Medial collateral instability 3 Dislocations with both medial and lateral ligamentous deficiency 6 Periprosthetic fractures

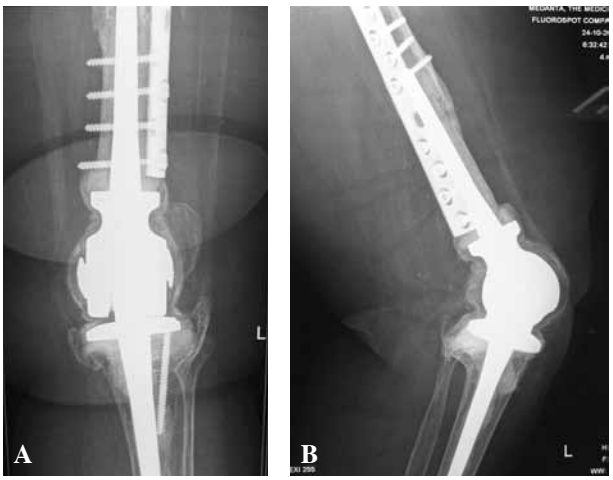

Fig. 1. — Aseptic loosening following revision surgery : preoperative radiographs. A : AP view ; B : Lateral view.

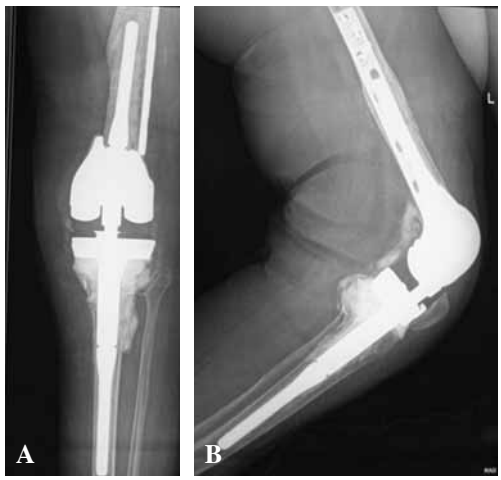

Fig. 2. — Aseptic loosening after RHK prosthesis : Post operative radiographs .A : AP view ; B : Lateral view.

The procedure was performed using previous skin incisions in revision cases and anterior midline incision in primary cases. Bone cuts were made using intramedullary cutting jigs. A two-stage procedure was used in revision of infected TKA. Six patients with stiff knees needed a rectus snip to facilitate good exposure, which did not alter our postoperative protocol. Pulsatile lavage was used in all cases. Gentamicin impregnated bone cement (DePuy CMW, Johnson and Johnson) was used in all patients. Cement was applied to the surface of the tibia after making small drill holes on the tibial surface and using pulsatile lavage to remove any blood clots. Cement was also applied to the stem-implant junction in all cases before the tibial implant was cemented in place. For the femur the cement was applied to the femoral implant and the stem-implant junction before the implant was cemented onto the distal femur. Augments were used as mentioned in Table II.

We assessed the clinical outcome using the Knee Society Score (KSS), Range of motion (ROM) and serial radiology. We obtained KSS (knee and functional score) and ROM before surgery and at latest follow-up. We assessed the radiological outcome to seek signs of loosening and bone loss before revision and at the latest follow-up. The femur and tibia were divided into standard zones (*5*).

RESULTS

The mean Knee Society knee score improved from a preoperative value of 47 (range : 11-72) to 81 at follow-up (range : 40-99) ($p < 0.05$). The mean Knee Society function score improved from 17 (0-40) to 67.5 (0-90) at follow-up ($p < 001$).

Mean Range of Motion improved from 65° preoperatively to 96° at follow-up ($p < 0.05$).

At follow-up, 16 patients were walking without support, 25 patients with one stick and 4 patients with two elbow crutches. One patient was bedridden.

Fig. 3. — Knee dislocation following primary total knee replacement. Pre operative radiograph (Lateral view).

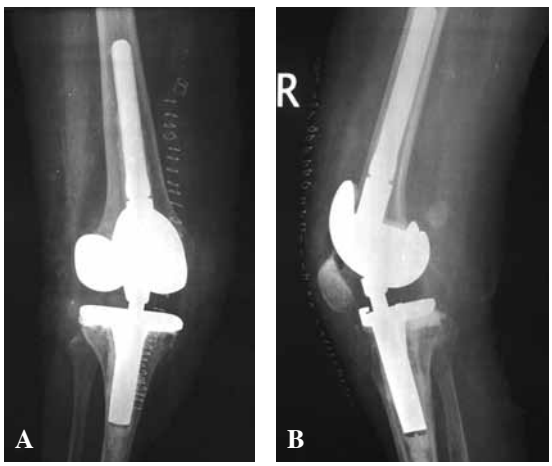

Fig. 4. — Knee dislocation following primary total knee replacement after RHK™ prosthesis. Post operative AP radiograph. A : AP view ; B : Lateral view.

Fig. 5. — Stage 1 procedure following infected primary total knee replacement : radiographs. A : AP view ; B : Lateral view.

Fig. 6. — Stage 2 procedure following infected primary total knee replacement after RHK prosthesis radiograph. A : AP view ; B : Lateral view.

The average stay in hospital was 9 days (range : 8 days to 11 days).

The radiographic analysis showed non progressive radiolucent lines in 7 knees. Along the femoral stem they were seen in zone 4 in three knees and zone 5 in two knees. Along the tibial stem they were seen in zone 2 in two knees. These were less than 2mm and no loosening or subsidence was observed during the period of study. No evidence of radiolucency was seen along the tibial plateau. The mean post operative alignment was in 5.5° valgus (range : 4° -7°).

Complications included 2 patients with an intraoperative fracture of the medial tibial condyle due to osteopenia ; both were treated with cancellous screw fixation. The fractures healed subsequently. One patient fell in her bathroom and subsequently developed a periprosthetic fracture and foot drop. She denied any further surgery and was bedridden at the last follow-up. Two patients had patellar subluxation at 90° flexion but this did not interfere with their activities of daily living, and they were therefore not surgically treated. One patient had superficial infection which was treated with oral antibiotics.

Table II. — Use of Augments

Trabecular metal cones	4 (1 Tibial and 3 Femoral) in infected TKA and aseptic loosening
Posterior Femoral Augments	4 in aseptic loosening
Tibial Full Augments	2 in medial collateral deficiency
Tibial Full Wedge	1 in Infected TKA

DISCUSSION

As the number and complexity of revision arthroplasties continue to rise with higher numbers of primary TKAs being performed every year, the challenges of complex failures, severe bone loss and global instability are likely to present more and more often during revision operations. Modern modular rotating hinged TKA's seem to offer a solution to address such issues.

Walker *et al* (*27*) reported good short-term results in terms of pain relief and ROM with early generation rotating hinge knee implants ; however the average follow-up was only 12 months. Though they had initial success in terms of functional improvement they encountered complications such as tibial tubercle avulsion, cortical bone perforation, patellar subluxation and progressive radiolucency. Rand *et al* (*19*) in their review of the first 50 cases performed in their institution found numerous complications including patellar instability (22%), sepsis (16%) and implant breakage (6%). They also observed lucent lines more than one millimetre in width along 25 per cent of femoral and 50 per cent of tibial components. Thirteen knees showed progressive lucent lines and 5 knees showed probable radiological loosening. Shaw *et al* (*24*) reviewed the outcome of 38 knees which received Kinematic rotating hinge prostheses (20 primary and 18 revisions). The major complication in their series was patellar instability (21% primary and 36% of revision knees). Seven per cent of primary knees and twenty percent of revision knees showed evidence of aseptic lucency progression in one or more zones. They did not have any radiographic evidence of aseptic loosening in their review. They suggested that the Kinematic rotating hinge prosthesis could be used in patients where there was functional absence of collateral ligament stability.

Barrack (*2*) studied 23 knees in 22 patients implanted with modern second-generation rotating hinge prostheses, evaluated over a period of 2 to 9 years. He reported satisfactory clinical results and range of motion in comparison to standard condylar revision knee arthroplasty.

Joshi and Navarro-Quilis (*12*) emphasised the critical importance of appropriate joint line position and flexion-extension gap balance in a properly implanted rotating hinge. They observed that imbalance of the flexion extension gaps could lead to instability through the arc of motion with a stable knee in extension and at 90° flexion. In their review of 78 revision TKAs for aseptic loosening, 57 patients had excellent results. They had 3 cases of knee dislocation and 4 of instability. They attributed this to mechanical failure as described by Wang and Wang (*28*) whereby excessive flexion gap contributes to instability in flexion and posterior dislocating forces on the prosthesis may cause mechanical failure. Gustke (*7*) suggested that the rotating hinge can jump the post and dislocate if the flexion extension spaces are not balanced. We did not face any such instances in our series. In our series there was no incidence of dislocation and we attribute it to the design feature of the hinge extension post. It works as an anterior restraint to distraction like a lock down screw.

Pradhan *et al* (*15*) in their retrospective study of 51 rotating hinge prostheses implanted for revision situations like infection and aseptic loosening, found a notable improvement in pain, stability, ROM and mobility of the patient. In their follow-up of maximum 6 years they had excellent to good results in 33 patients especially those implanted for aseptic loosening.

Pour *et al* (*14*) in their cohort of 44 knee arthroplasties implanted with modern generation Kinematic rotating hinge prostheses with a mean follow-up of 4.2 years had substantial improvement in function and reduction in pain but had a large number of complications such as periprosthetic infection in three knees, aseptic loosening in four and periprosthetic fracture in one patient, leading to

failure. Their 5-year survivorship was 68.2% with need for re surgery or revision as the end point.

Springer *et al* (*25*) reported early results of distal femoral replacement for non neoplastic limb salvage in their series of 26 knees and highlighted major associated complications. In their report periprosthetic infection was the main cause of failure (5 knees). They concluded that the use of constrained prostheses should be reserved for the elderly and sedentary patients.

Hernandez-Vaquero and Sandoval-Garcia (*8*) retrospectively reviewed 26 patients following rotating hinge arthroplasty to examine if acceptable results were obtainable using a single arthroplasty device with a mean follow-up of 46 months. They assessed the patients clinically (Knee Society score) and radiographically for component positioning, bone loss or any signs of loosening. They concluded that reconstruction with a rotating hinge total knee prosthesis can provide substantial improvement in function and a reduction of pain in the knees in extreme circumstances such as severe ligamentous deficiency. They suggested that this prosthesis be used as a salvage procedure reserved for the elderly and sedentary patients with severe ligamentous deficiencies and where other revision surgeries fail.

We have presented our series of 44 patients (46 knees) with a mean follow-up of 62 months (range : 36 to 96). The main feature in our series was the use of a single rotating hinge implant (Nexgen) and surgery performed by one surgeon. In our series the mean Knee Score improved from 47 (11-72) preoperatively to 81 (40-99) at follow-up and the mean functional score improved from 17 (0-40) to 67.5 (0-90) at follow-up ($p < 001$). The Mean Range of Motion improved from 65° preoperatively to 96° flexion at follow-up. There were no flexion contractures in our series.

Complications included 2 patients with an intraoperative fracture of the medial tibial condyle due to osteopenia ; they were treated with cancellous screw fixation and subsequently healed. One patient fell in her bathroom and incurred a periprosthetic fracture and foot drop. One patient had a patellar subluxation at 90 degree flexion. One patient had superficial infection which was treated with oral antibiotics.

We agree with other authors that, owing to its high constraint, the hinged prosthesis should be used judiciously. One should reserve hinged prostheses for use in the presence of severe global ligamentous instabilities, in the presence of severe bone loss, severe dysfunction of the extensor mechanism or communited fractures, be it a primary or a revision situation.

Our data suggest that the mid-term results with the Nexgen Rotating Hinge knee in our patients, with an average follow-up of 62 months, was better than other series where different implants were used. This may be attributed to the use of a single type of modern rotating hinged implant (Nexgen rotating hinge) by one surgeon, and better understanding and experience gained over years. The outcome reported in our series is encouraging for indications such as severe bone loss, instability, peri prosthetic fractures, tumours and extensor apparatus disruption.

We also advocate using this option in selected cases of primary neglected degenerative arthritis in patients presenting very late with the above features, in cases where less constrained options would not possibly give a well aligned and balanced knee.

REFERENCES

1. **Bargar WL, Cracchiolo A III, Amstutz HC.** Results with constrained total knee prosthesis in treating severely disabled patients and patients with failed total knee replacements. *J Bone Joint Surg* 1980 ; 62-A : 504-512.
2. **Barrack RL.** Evolution of the rotating hinge for complex total knee arthroplasty. *Clin Orthop Relat Res* 2001 ; 392 : 292-299.
3. **Cameron HU, Hunter GA.** Failure in total knee arthroplasty : mechanisms, revisions, and results. *Clin Orthop Relat Res* 1982 ; 170 : 141-146.
4. **Choong PF, Sim FH, Pritchard DJ, Rock MG, Chao EY.** Megaprostheses after resection of distal femoral tumours. A rotating hinge design in 30 patients followed for 2-7 years. *Acta Orthop Scand* 1996 ; 67 : 345-351.
5. **Ewald FC.** The Knee Society total knee arthroplasty roentgenographic evaluation and scoring system. *Clin Orthop Relat Res* 1989 ; 248 : 9-12.
6. **Goldberg VM, Figgie MP, Figgie HE 3rd, Sobel M.** The results of total knee arthroplasty. *Clin Orthop Relat Res* 1988 ; 226 : 86-92.
7. **Gustke KA.** Preoperative planning for revision total knee arthroplasty : avoiding chaos. *J Arthroplasty* 2005 ; 20 (Suppl 2) : 37-40.

8. **Hernandez-Vaquero D, Sandoval-Garcia MA.** Hinged total knee arthroplasty in the presence of ligamentous deficiency. *Clin Orthop Relat Res* 2010 ; 468 : 1248-1253.
9. **Insall JN, Dethmers DA.** Revision of total knee arthroplasty. *Clin Orthop Relat Res* 1982 ; 170 : 123-130.
10. **Jacobs MA, Hungerford DS, Krackow KA, Lennox DW.** Revision total knee arthroplasty for aseptic failure. *Clin Orthop Relat Res* 1988 ; 226 : 78-85.
11. **Jones RE, Skedros JG, Chan AJ, Beauchamp DH, Harkins PC.** Total knee arthroplasty using the S-ROM mobile bearing hinge prosthesis. *J Arthroplasty* 2001 ; 16 : 279-287.
12. **Joshi N, Navarro-Quillis A.** Is there a place for rotating-hinge arthroplasty in knee revision surgery for aseptic loosening ? *J Arthroplasty* 2008 ; 23 : 1204-1211.
13. **Kurtz S, Mowat F, Ong K *et al*.** Prevalence of primary and revision total hip and knee arthroplasty in the United states from 1990 through 2002. *J Bone Joint Surg* 2005 ; 87-A : 1487-1497.
14. **Pour AE, Parvizi J, Slenker N, Purtill JJ, Sharkey PF.** Rotating hinged total knee replacement : use with caution. *J Bone Joint Surg* 2007 ; 89-A : 1735-1741.
15. **Pradhan NR, Bale L, Kay P, Porter ML.** Salvage revision total knee arthroplasty using the Endo-Model rotating hinge prosthesis. *Knee* 2004 ; 11 : 469-473.
16. **Ranawat CS, Flynn WF Jr, Deshmukh RG.** Impact of modern technique on long term results of total condylar knee arthroplasty. *Clin Orthop Relat Res* 1994 ; 309 : 131-135.
17. **Rand JA, Bryan RS.** Results of revision total knee arthroplasties using condylar prosthesis : a review of fifty cases. *J Bone and Joint Surg* 1988 ; 70-A : 738-745.
18. **Rand JA, Bryan RS.** Revision after total knee arthroplasty. *Orthop Clin North Am* 1982 ; 13 : 201-212.
19. **Rand JA, Chao EY, Stauffer RN.** Kinematic rotating hinge total knee arthroplasty. *J Bone Joint Surg* 1987 ; 69-A : 489-497.
20. **Ritter MA, Eizember LE, Fechtman RW, Keating EM, Faris PM.** Revision total knee arthroplasty : a survival analysis. *J Arthroplasty* 1991 ; 6 : 351-356.
21. **Ritter MA.** The Herbert total knee replacement. A longer than three year follow up. *Clin Orthop Relat Res* 1977 ; 129 : 232-235.
22. **Rosenberg AG, Verner JJ, Galante JO.** Clinical results of total knee revision using total condylar 111 prosthesis. *Clin Orthop Relat Res* 1991 ; 273 : 83-90.
23. **Samuelson KM.** Bone grafting and non cemented revision arthroplasty of the knee. *Clin Orthop Relat Res* 1988 ; 226 : 93-101.
24. **Shaw JA, Balcom W, Greer RB III.** Total knee arthroplasty using the kinematic rotating hinge prosthesis. *Orthopedics* 1989 ; 12 : 647-654.
25. **Springer BD, Sim FH, Hanssen AD, Lewallen DG.** The modular segmental kinematic RH for nonneoplastic limb salvage. *Clin Orthop Relat Res* 2004 ; 421 : 181-187.
26. **Thornhill TS, Dalziel RW, Sledge CB.** Alternatives to arthrodesis for failed total knee arthroplasty. *Clin Orthop Relat Res* 1982 ; 170 : 131-140.
27. **Walker PS, Emerson R, Potter T *et al*.** The kinematic rotating hinge : biomechanics and clinical application. *Orthop Clin North Am* 1982 ; 13 : 187-199.
28. **Wang CJ, Wang HE.** Early catastrophic failure of rotating hinge total knee prosthesis. Case report. *J Arthroplasty* 2000 ; 15 : 387-391.