Severe Genu Recurvatum Deformity Treated with Primary Rotating Hinge Replacement: A report of 2 cases

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Introduction: *Osteoarthritis in severe genu recurvatum associated with quadriceps weakness is one of the most challenging problems in total knee arthroplasty. The recurrent recurvatum deformity after knee replacement can be prevented by using rotating hinge knee prosthesis (RHK). However, the implant survivorship and performance of knee function after surgery are not well documented.*

Materials and Methods: *We reported the early clinical and radiographic outcomes of end-stage severe genu recurvatum arthritis associated with quadriceps weakness treated with RHK in 2 patients. The initial hyperextension deformity were 35 and 42 degrees measured from sagittal weight bearing radiograph. The follow-up time was 18 months.*

Results: *Quadriceps muscle strength at the last follow up were 36% and 126% above the preoperative baseline. Modified Time Up and Go test was improved from 31.06 to 18.26 seconds at 18 months follow-up in one patient. Both patients showed significant improvement in WOMAC knee score and Knee Society Score at the last follow-up. There were neither radiographic signs of implant loosening nor recurrent deformity in both patients.*

Conclusion: *The quadriceps muscle strength can be improved even in preexisting neuromuscular disorder. Primary RHK can be used as salvage procedure for severe genu recurvatum arthritis with quadriceps weakness from neuromuscular disorder.*

Key words: *Total knee replacement, motor weakness, Genu recurvatum, Quadriceps recovery, Rotating hinge prosthesis, result*

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Introduction

Degenerative osteoarthritis with genu recurvatum deformity is a challenging problem for reconstruction with total knee replacement (TKR). The most common surgical problem is the recurrent recurvatum deformity[1,2]. Previous literatures have been show that patients with post-operative recurvatum deformity following TKR have significantly poorer functional result[3,4]. Normally, osteoarthritis with mild degree of genu recurvatum deformity can be managed with conventional implant by using a surgical technique described by Petterson and Insall[2]. It has been recognized that the rate of recurrent genu recurvatum after TKR was 3.7% in patients without neuromuscular disorder[5]. However, the incidence of recurrence genu recurvatum following conventional or constrained condylar knee implant (CCK) TKR, could be high as 50% in quadriceps-weakness patients[6,7]. Moreover, the patient with recurrent recurvatum deformity usually reported dissatisfaction and disability. To prevent this problem, rotating hinge knee prosthesis (RHK) is one of the promising implant designs. The extension stopper design in RHK prosthesis prevents post-operative recurrence of the deformity and eliminates unbalance flexion-extension gap. However, controversy exists over the use of RHK prosthesis in primary surgery with regard to implant survival and complexity of future revision. However, the new RHK design shows good to excellent mid-term results as reported by Petrou et al[8] and Barrack[9]. The new RHK is designed to reduce force transmitted to the fixation interface, so it improves the implant survival. As the longer implant survival has been proved, RHK should be the more suitable implant to prevent recurrent genu recurvatum after TKR especially in severe recurvatum associated with neuromuscular disorder patients.

To our knowledge, only few literatures have reported the use of primary RHK in genu-recurvatum deformity associated with quadriceps-weakness patients[6,10]. Most studies only focused on survival of the implant and the recurrent

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recurvatum deformity rate without information on the patient performance after surgery. We have herein reported the objective performance knee function in term of quadriceps strength recovery, modified time up to go test and the functional knee score in patients with quadriceps-weakness, severe genu-recurvatum deformity who are receiving primary RHK.

Materials and Methods

Between 2013 and 2015, 2 primary RHKs were performed in lower extremity weakness patients affected by end-stage genu recurvatum arthritis by an experienced adult reconstruction surgeon at our institution. The selection criteria were failed-conservative- treatment osteoarthritis patients with pain and difficult ambulation, genu recurvatum with quadriceps weakness at least grade 3 according to Medical Research Council (MRC) scale for muscle strength[11]. Decision for the use of RHK was made preoperatively according to physical examination, risk of post-operative recurrent genu recurvatum deformity (RRD), future complication and patient expectation. The visual analog pain scale (VAS), quadriceps muscle strength (QP), Modified time up and go test (TUGT), Knee Society score (KSS), and WOMAC knee score were recorded pre and post-operatively. Radiographic signs of implant loosening were collected pre-operatively and post-operatively. QP was measured by using peak-force hand held dynamometer device (Microfet2, Hoggan Health industries, USA), applied at just above the ankle in knee flexion 40-50 degrees and asked patient to extend their knee against examiner. TUGT was the time spending from sit, chair-raise and walk straight forward for 3 meters.

All knees were operated using medial parapartellar approach after tourniquet was fitted at 350 mmHg. Bone work was done using measure resection technique. We used a technique described by Petterson and Insall[2] which was decreasing amount of distal femoral cut and decreasing femoral anterior-posterior size to balance extension and flexion gap as much as possible. The proximal tibia was prepared by using intra-medullary guide. Proximal tibial was cut perpendicularly to the tibial axis in coronal plane. In sagittal plane, there was no tibial slope as recommended for Nex Gen RHK design. The patella was resurfaced. Peri-articular cocktails (0.5% bupivacaine 20 ml, ketorolac 30 mg, cefuroxime 750 mg, tranexamic acid 250mg) was injected before implanting the prosthesis. All patients were operated by using Nex Gen RHK (Zimmer®, Warsaw, Ind, USA) prosthesis. PMMA bone cement (Palacos®, Heraeus, Wehrheim, Germany) was used at the back-side of femoral and tibial components, but not for the stems. All patients were operated under regional anesthesia. Suction drain was applied and 500 mg of Tranexamic acid was injected intra-articularly through the drain. Suction drain was clamped for 2 hours and removed within 48 hours after surgery. We encouraged patients to start full weight bearing ambulation with walker at second post-operative day. Discontinuation of walker and switch to single cane was encouraged by 6 weeks. All patients were followed up regularly until 12 month, with radiographic assessment at 6 months and then yearly. The radiographic signs of implant migration and loosening were recorded.

Patients and results

Case 1

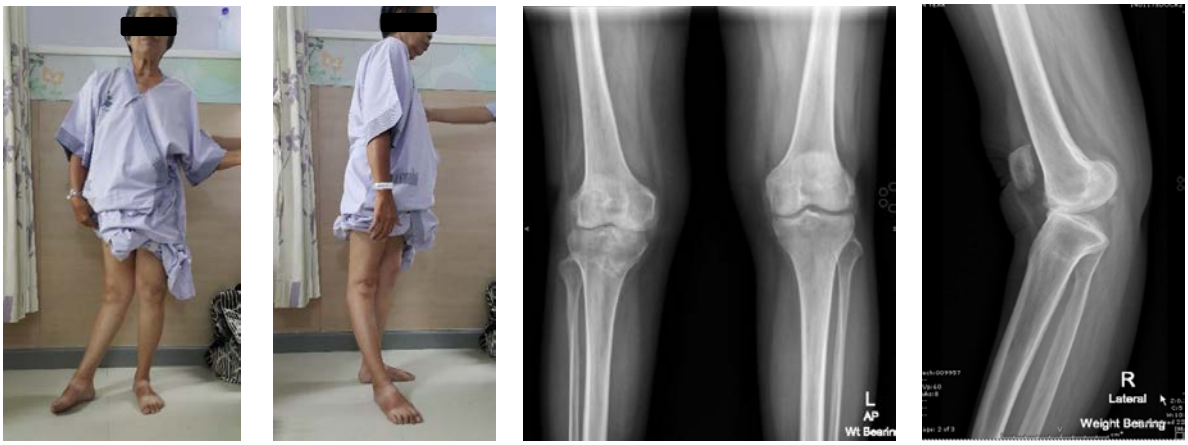
A seventy-five-year-old woman came in to the clinic with disabling pain and walking difficulty. Twenty-years ago, she was diagnosed with a brain tumor and underwent craniotomy with tumor removal. After brain surgery, she experienced right lower limp weakness and her right knee was gradually deformed (figure1). The physical examination showed grade 3 muscle strength at right hip and knee both flexion and extension, according to MRC scale. Right ankle dorsiflexion and plantar flexion strength were grade 0. Range of motion at right knee was, measured by goniometer, 140 degrees flexion and 42 degrees hyperextension. She was scheduled for total knee replacement with RHK prosthesis. Pre-operative and post-operative data were shown in table 1. Pre-operative clinical and radiographic evaluations were shown in figure1. Concerning post-operative period, we encourage patient to perform self-quadriceps exercise as much as possible. We allow patient to ambulate full weight bearing without brace from the second post-operative day. The gait assistance device was discard as soon as possible.

There was no hyperextension deformity on the physical examination at 18 month follow-up. Regard the post-operative radiograph, there was slightly non-progressive knee hyperextension on the radiograph taken at first operative day and the 18 months follow-up. Our patient reported significant improvement of pain on weight bearing since the second week and no pain during weight bearing until the last follow up. This directly correlated with a gradual improvement in WOMAC and KSS scores during the follow-up period. As knee stability increased, this patient reported improvement in chair-raise, stair-climbing and walking ability. This result was seen in 41% faster TUGT at 18 month compared with the pre-operative level. Considering the QP, muscle strength recovered to baseline by 3 months and increased by 36% from baseline at 18 months. There were no radiographic and clinical signs of implant loosening at 1 year (figure2).

Case 2

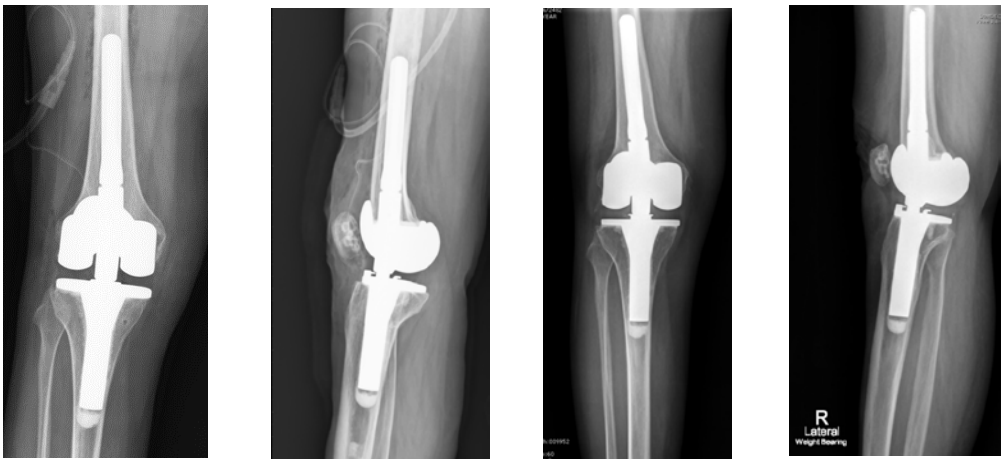
A seventy-seven-year-old man had suffered from poliomyelitis since he was 3 years old. He complained of pain and genu recurvatum deformity on his left lower extremity. Physical examination shows hip muscle strength grade 5, knee extension grade 3 muscular weakness according to MRC scale. Ankle dorsiflexion and plantar flexion were grade 0. The preoperative knee range of motion was 150 degrees flexion and 35 degrees hyperextension without extension lag. Initial radiograph showed arthritic changes with severe hyperextension (figure3). The pre-operative and post-operative data has been summarized in table1. He was scheduled for total knee replacement using RHK prosthesis according to the previously described criteria.

There was no genu recurvatum deformity on the physical examination at the last follow-up. Pain was significantly reduced. There was only mild pain during a long distance walk. WOMAC and KSS scores were improved. Quadriceps muscle strength was 126% improved from baseline. The postoperative radiograph was taken at 18 months (figure 4). There was a non-progressive sclerotic line around the tip of femoral stem without signs of implant migration. Neither radiolucency line between bone-cement nor cement-prosthesis interface were observed.



A B C D

Fig. 1 Pre-operative clinical and radiographic evaluation. Picture on left (A, B) show genu valgus and recurvatum deformity. Plain radiograph on the right (C, D) show arthritis change with 42 degrees recurvatum deformity.



A B C D

Fig.2 A, B show the immediate post-operative film and C, D were the x-ray at 1 year follow-up. There were neither implant migration nor abnormal radiolucency line between bone-cement and cement-prosthesis interface.

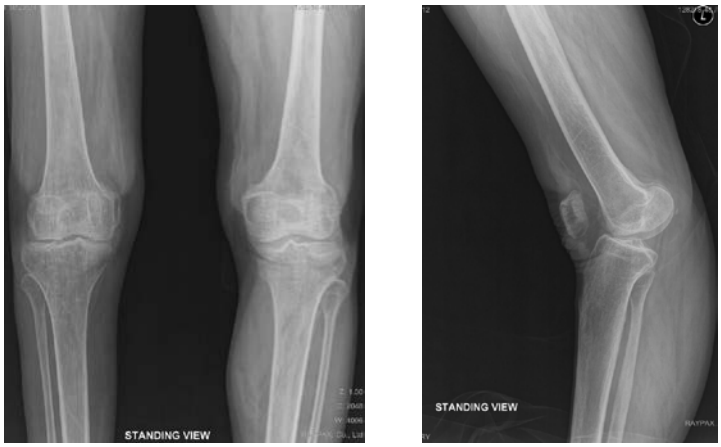
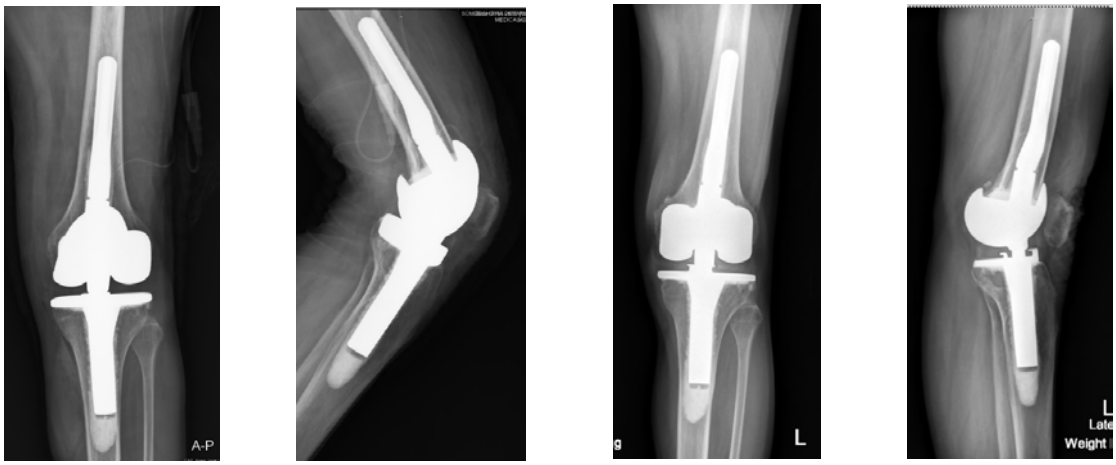


Fig.3 Preoperative radiographic evaluation. There was an arthritis change in both views with 35 degrees hyperextension deformity.



A B C D

Fig. 4 A, B show the immediate post-operative x-ray and C, D were the 18-month radiographic evaluation. There was a non-progressive sclerotic line at tip of femoral stem. Neither implant malposition nor abnormal radiolucency line between cement-prosthesis interface were observed.

Table1 Summary of the preoperative and postoperative data of 2 patients. : NA, not available

	Case 1	**Case 2**
Flexion arch (degrees)		
- Pre-operative	140	150
- 3 months	120	NA
- 6 months	116	NA
- 18 months	123	124
Hyperextension (Degrees)		
- Pre-operative	42	35
- 3 months	0	NA
- 6 months	0	NA
- 18 months	0	0
VAS during walking		
- Pre-operative	7	5
- 3 months	0	NA
- 6 months	0	NA
- 18 months	0	0

	Case 1	Case 2
QP (Newton)		
- Pre-operative	74	30
- 3 months	80	NA
- 6 months	68	NA
- 18 months	101	68
TUGT (sec)		
- Pre-operative	31.06	NA
- 18 months	18.26	NA
WOMAC		
- Pre-operative	92	49
- 3 months	57	NA
- 6 months	56	NA
- 18 months	54	31
KSS		
- Pre-operative	75	85
- 3 months	144	NA
- 6 months	149	NA
- 18 months	164	170

Discussion

Total knee replacement (TKR) in genu recurvatum patients is usually problematic among arthroplasty surgeons, especially in patients who have muscular weakness. Arthrodesis is not the recommended procedure in this situation since this procedure restricts knee motion and causes difficultly in climbing up and down stairs[12]. To achieve the goal of treatment of end stage osteoarthritis which are pain relief and restored knee function, TKR is the more appropriate option than arthrodesis.

Recurrent recurvatum deformity (RRD) following TKR is the most controversial topic as this deformity diminishes knee sagittal stability, causes unwelcome pain and decreases patient sastisfaction. Koo et al[3], reported significantly poorer functional knee score in patients with mean recurvatum of -3.94 degrees compared with mean flexion contracture 5.78 degrees at 2 years following TKR. Patients with recurvatum at 6 months after TKR, had 6.5 times higher risk of deformity progression compared with those without recurvatum at 6 months[4]. Meticulous balance of the flexion-extension gap is crucial. It is necessary to make the extension gap a bit smaller than the flexion gap to prevent recurrent deformity when conventional implant is used. However, in severe recurvatum associated with lower extremity weakness, those problems could not be addressed with the conventional implant. The incidence of RRD has been proposed by Meding et al[5]. They reported 2 out of 53 patient had RRD and did not require revision surgery. However in the study group of Meding, no patients had muscular weakness. Theoretically, in quadriceps weakness patients, the incidence of RRD could be much higher than the patient with genu-recurvatum with only ligament laxity and greater chance of deformity progression. Costanzo and Pancino[13] described that patients with quadriceps weakness lose their ability to lock the knee during the load bearing phase of the step. They compensate this phenomenon by passively moving gravity line in front of the articular axis of the knee during stance phase which results in genu recurvatum deformity. This theory was supported by up to 50% RRD rate in neuromuscular disorder patients with osteoarthritis treated with conventional TKA implant as reported by Tigani et al[6], and Giori and Lewallen[7]. For those reasons, rotating hinge knee (RHK) prosthesis is a more appropriate implant to prevent RRD in these patients. Extension stopper and hinge connect between femoral-tibial components eliminate the risk of post-operative hyperextension deformity and it is easier to balance extension-flexion gap. However, concern has been expressed over the use of constrained implant in primary TKR due to increase in load transfer to the fixation interface and consequently loosen the implant. Considering that, the modern rotating hinge design allows better distribution of shearing force and reduces amount of force interaction at hinge mechanism by transferring 95% of compression force through the articular contact between femoral condyle and tibia articular surface rather to the hinge mechanism alone[14,9]. We believed the survival rate of new RHK design could be longer than expected and could be used in quadriceps weakness patients.

Our study demonstrated an improvement in pain, functional score, and TUGT in both patients. There was no radiographic sign of implant loosening at 18 month follow up. Survival of RHK has been reported in several studies. Barrack[9] reported non implant loosening in modern RHK

during 2-9 years follow-up. On the contrary, Martin et al[15] who have demonstrated decrease in survival free rate of all-cause reoperation at 10 years with hazard ratio of 2.07 for RHK compared with unconstrained implant. The implant overall revision-free survival rates for RHK were 74.6% at 10 years. However, the most common cause of re-operation were wound complication, infection and stiffness, not implant loosening.

In the majority of patients following TKR, quadriceps strength will recover on average to preoperative baseline within 6 months[16]. This also included the patients with neuromuscular disorder as our data showed that quadriceps strength returned to baseline at 3 months after surgery. Surprisingly, both patients showed 36% and 126% quadriceps strength improvement at the last follow-up. Therefore, even a patient with preexisting neuromuscular disorder still has a chance to improve muscle strength postoperatively. Encouraging postoperative muscle strengthening exercise is imperative as higher quadriceps muscle strength leads to better knee function[17].

There are some limitations in this study. First this is the retrospective case report of only 2 patients and second, the results reported in this study was only 18 months after treatment with RHK prosthesis. Therefore, our study did not reflect mid-term and long-term result of genu recurvatum knee associated with neuromuscular disorder who were treated with RHK prosthesis.

Conclusion

Severe genu recurvatum deformity associated with neuromuscular disorder can be treated by primary RHK prosthesis with favorable result in terms of pain elimination and functional improvement. There were no implant loosening at 18 month follow-up. However, patient selection is essential, and we recommend primary RHK prosthesis in patients older than 70 year-old to reduce the chance of re-operation.

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กรณีศึกษาผลการรักษาในผู้ป่วย 2 รายที่มีภาวะข้อเข่าเสื่อมชนิดแอ่นทางด้านหน้ารุนแรงจากกล้ามเนื้อต้นขาอ่อนแรงด้วยการเปลี่ยนข้อเข่าเทียมชนิด Rotating hinge

กุลพัชร จุลสำลี, พบ, นรเทพ กุลโชติ, พบ, ศิวดล วงษ์ศักดิ์, พบ, พงศธร ฉันท์พลากร, พบ, ปพน สง่าสูงส่ง, พบ, ชาญยุทธ ศุภชาติวงศ์, พบ, วิโรจน์ กวินวงศ์โกวิท, พบ

กรณีศึกษาได้แสดงถึงผลการรักษาภาวะข้อเข่าเสื่อมชนิดแอ่นทางด้านหน้าในผู้ป่วยที่มีโรคกล้ามเนื้อต้นขาอ่อนแรงด้วยการเปลี่ยนข้อเข่าเทียมชนิด Rotating hinge การรักษาด้วยการใช้ข้อเข่าเทียมชนิด Rotating hinge จะช่วยลดโอกาสการเกิดเข่าแอ่นทางด้านหน้าซ้ำภายหลังการผ่าตัด ซึ่งมักจะเกิดได้บ่อยหากใช้ข้อเข่าเทียมชนิดปกติ (conventional implant) การผิดรูปแบบแอ่นทางหน้าภายหลังการผ่าตัดเปลี่ยนข้อเข่าจะทำให้ผู้ป่วยมีอาการปวด ใช้ชีวิตประจำวันลำบาก ซึ่งบางกรณีนำไปสู่การผ่าตัดเปลี่ยนข้อเข่าเทียมครั้งที่สอง (Revision total knee replacement) อย่างไรก็ดีการใช้ข้อเข่าเทียมชนิด Rotating hinge ในทางทฤษฎีอาจทำให้เกิดภาวะข้อเข่าเทียมหลวม (loosening) ได้เร็วกว่าปกติ ปัจจุบันการรายงานผลการรักษาภาวะดังกล่าวด้วยข้อเข่าเทียมชนิด Rotating hinge น้อย เนื่องจากภาวะดังกล่าวพบได้ไม่บ่อย

การศึกษานี้ได้รายงานผลการรักษาผู้ป่วยที่มีการผิดรูปของข่อเข่าแบบแอ่นทางด้านหน้ารุนแรงร่วมกับมีโรคกล้ามเนื้อต้นขาอ่อนแรง และรับการผ่าตัดด้วยการเปลี่ยนข้อเข่าเทียมชนิด Rotating hinge จำนวน 2 ราย ที่ระยะ 18 เดือน คณะผู้ศึกษาไม่พบว่ามีการหลวมของข้อเข่าเทียมจากภาพรังสี และไม่พบการผิดรูปซ้ำในผู้ป่วยทั้ง 2 ราย นอกจากนี้พบว่าผู้ป่วยทั้งสองรายมีกำลังกล้ามเนื้อต้นขา quadriceps ที่มากขึ้นร้อยละ 36 และ 126 เมื่อเปรียบเทียบกับก่อนการผ่าตัด ซึ่งบ่งชี้ว่าการใช้ Rotating hinge รักษาผู้ป่วยภาวะดังกล่าวสามารถป้องกันการผิดรูปซ้ำ นอกจากนี้ยังสามารถช่วยฟื้นฟูสมรรถภาพของกล้ามเนื้อต้นขาภายหลังการผ่าตัดได้เป็นอย่างดี