Int J Clin Exp Med 2018;11(6):5867-5872
www.ijcem.com /ISSN:1940-5901/IJCEM0063970

Original Article

Primary total knee arthroplasty with rotating-hinge prosthesis in severely compromised knees

Yi Leng[1], Min Zeng[2], Yihe Hu[2], Jianxi Zhu[2], Weiping Su[2], Jie Xie[2]

[1]Department of Rehabilitation, Xiangya Hospital, Central South University, No. 87 Xiangya Road, Changsha 410008, Hunan, China; [2]Department of Orthopedics, Xiangya Hospital, Central South University, No. 87 Xiangya Road, Changsha 410008, Hunan, China

Received December 7, 2016; Accepted February 6, 2018; Epub June 15, 2018; Published June 30, 2018

Abstract: Aim: To evaluate the efficacy of primay total knee arthroplasty (TKA) with a rotating-hinge device in severely compromised knees. Methods: 28 patients who underwent primary TKA with rotating-hinge prosthesis at our institution from 2006 to 2012 were retrospectively reviewed. Indications for the use of a rotating-hinge prosthesis were extreme ligament imbalance or severe bone loss. Clinical evaluations were performed prior to surgery and at the final follow up which included visual analog scale (VAS), Hospital for Special Surgery (HSS) Knee Scores, range of motion (ROM) measurements, assessment of postoperative complications and radiographic data. Data were analyzed with Student's t test with significance at $p < 0.05$. Results: Mean follow-up period was 6.5 years (range 4-10 years). Mean VAS score decreased from 8.1 (range 6-10) preoperatively to 1.2 (range 0-3) at final follow-up (P=0.01). Mean HSS score improved from 38.5 (range 25-62) preoperatively to 86.3 (range 72-95) at final follow-up (P=0.02). Average ROM was 64° (range 20-90°) before surgery and 98° (range 90-110°) at final follow-up (P=0.04). There was no malalignment at the final follow-up. No signs of prosthesis subsidence or loosening were observed. Conclusion: Primary TKA using a rotating-hinge prosthesis is effective at improving the pain and function of severely compromised knees.

Keywords: Knee, arthroplasty, rotating-hinge, surgical protocol

Background

Total knee arthroplasty (TKA) in unstable knees is a challenge for the reconstructive surgeon. The use of condylar TKA designs is restricted because of serious bony and ligamentous defects [1, 2]. Constrained prostheses are often needed to restore lower limb alignment and ensure initial stability [3, 4]. Hinged implants provide inherent rigidity, with femoral and tibial components mechanically linked by an axle. Fixed hinged designs result in increased torsional stresses, lead to a high risk of implant loosening and poor outcomes [1, 5]. Rotating-hinged devices with an improved design have been introduced to provide good initial stability while avoiding torsional stresses along the prosthesis/cement/bone interface [3, 4]. A flexing and rotating (Endo-Modell, Waldemar Link, Hamburg, Germany) rotating-hinge knee prosthesis was developed and aimed to avoid torsional stresses and reduce patellofemoral tension [6-8]. Most studies associated with the use of this device are focused on revision surgery [5, 9, 10]. Debate continues as to the use of this prosthesis for primary TKA, particularly with respect to operative indications, surgical techniques and long term efficacy [1, 3, 11, 12]. A clear operative protocol for rotating-hinge implants in this setting is still lacking.

We performed a retrospective study to evaluate the outcomes of primary TKA with a rotating-hinge device in severely compromised knees. Factors of particular interest included operative indications, surgical techniques and operative efficacy.

Materials and method

Patient characteristics

From 2006 to 2012, 28 primary TKAs with rotating hinge prostheses were performed at our institution on 28 patients with severely deformed knees. Indications for the use of a rotating-hinge prosthesis were extreme ligamentous

Table 1. General information and clinic feature of included patients

		n=28
Sex	Female	11 (39.3%)
	Male	17 (60.7%)
Age	72.5 years	Range: 60-81 years
Aetiology	Osteoarthritis	7 (25.0%)
	Rheumatoid arthritis	8 (28.6%)
	Posttraumatic arthritis	9 (32.1%)
	Charcot arthropathy	4 (14.3%)
Deformity	Flexion deformity	14 (50.0%)
	Valgus deformity	8 (28.6%)
	Varus deformity	17 (60.7%)

Table 2. Comparison of HSS score, VAS score, and ROM of knee between pre- and post-operation. (n=28, x ± s)

Time	VAS score	HSS score	ROM (°)
Preoperative	8.1±1.3	38.5±9.6	64±15
Last follow-up	1.2±0.8	86.3±8.9	98±11
Statistic	t=2.77, P=0.01	t=2.45, P=0.02	t=2.10, P=0.04

imbalance and/or severe bone loss. Primary diseases included osteoarthritis in seven knees, rheumatoid arthritis in eight, posttraumatic arthritis in nine, and Charcot arthropathy in four. Patients included 11 women and 17 men, with median age 72.5 years (range 60-81) at the time of surgery. Mean follow-up was 6.5 years (range 4-10 years). All patients were hospitalized because of knee pain and instability. Physical examination revealed severe knee instability, ligamentous laxity and deformity. Radiographic examination revealed massive bone destruction, large periarticular osteophytes and malalignment. Preoperative full-leg radiographs and three-dimensional CT reconstructions were obtained to measure limb alignment and identify bone defects. Flexion deformity was noted in 14 knees, valgus deformity in eight and varus deformity in 17 (**Table 1**). The research protocol was reviewed and approved by our institutional IRB.

Surgical procedure

Under general anesthesia and with a tourniquet, a senior surgeon performed all TKAs through a medial parapatellar approach. Osteophyte removal and soft tissue releases were performed for joint exposure. A V-Y quadricepsplasty was performed if improved extensor mechanism exposure was required. Bone resection was guided by extra-medullary tibial and intra-medullary femoral alignment. Flexion and extension gap balance were obtained with measured bone resection and soft tissue releases. Bone defects were filled with cement or metal augments at depths of less than 5 mm or more than 5 mm, respectively. A cemented long-stemmed prosthesis (Waldemar Link, Hamburg, Germany) with patellar flange, anti-luxation and rotational features was implanted after trialing. The lateral retinaculum was adequately relaxed for possible patellar subluxation, and no patellas were resurfaced. A thorough pulsatile lavage was performed, and suction drains were placed before closure.

Following surgery, antibiotic prophylaxis with cefazolin was given for 48 h and rivaroxaban was administered for 2 weeks for deep vein thrombosis prophylaxis. The suction drain was removed approximately 24-48 hours postoperatively, depending on drainage volume. Flexion-extension motion was permitted on the second post-operative day with the help of a continuous passive motion device. Patients were permitted to walk with crutches 1 week after surgery, and advanced to full weight bearing 3 months post-arthroplasty. For patients with patella fractures, an adjustable long-leg brace was recommended to limit knee ROM for at least 3 months. A manual adjusting device was used to gradually increase flexion-extension range of motion over that period.

Data collection

Clinical and radiographic data were prospectively gathered pre-operatively, post-operatively and during follow-up (3, 6 and 12 months post-operatively, and every year thereafter). Clinical evaluation consisted of visual analog scale (VAS) score, Hospital for Special Surgery (HSS) Knee Scores, ROM and postoperative complication assessment. Radiographic review included an assessment for prosthesis loosening, and measurements of mechanical axis, femorotibial angle, tibial varus/valgus alignment, and knee procurvatum/recurvatum. The criteria for postoperative malalignment included a

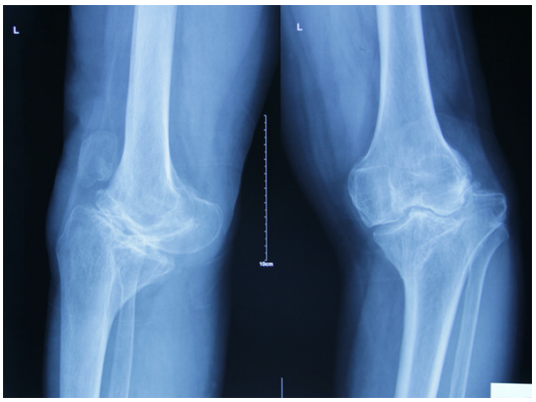

Figure 1. Pre-operative anteroposterior and lateral radiographs of a 64-year-old women revealing severe bone defects, knee instability, and deformity.

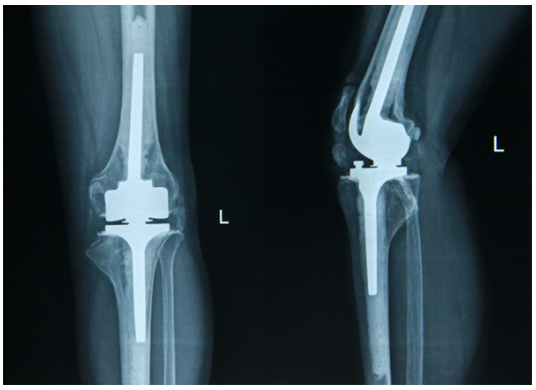

Figure 3. Post-operative anteroposterior and lateral radiographs after implantation of a rotating prosthesis revealing favorable composition.

Figure 2. Pre-operative full-leg radiographs of this patients revealing limb malalignment.

Figure 4. Post-operative full-leg radiographs revealing favorable limb alignment.

femorotibial angle greater than 10° of valgus, any degree of varus and femoral flexion or extension [13]. Prosthesis loosening was diagnosed with a complete radiolucent line of 2 mm or more, a cement fracture around the implants or a change in component position [14].

Statistical analysis

All statistical analyses were performed using SPSS 19.0 (IBM Corp., Armonk, NY, USA). Pre- and post-operative VAS scores, ROM measurements and HHS scores were analyzed with stu-

dent's t-test. *P* values < 0.05 were considered statistically significant.

Results

For one patient with 0 to 30° knee ROM, an intraoperative patella avulsion fracture was encountered during knee exposure and subsequently treated with an absorbable thread tension band. The fracture united within 3 months, and this patient retained an extension deficit of 10° at final follow-up. Extension deficits were also present in three other knees, and ranged from 5 to 10°. All were likely because of the intraoperative V-Y quadricepsplasty or quadriceps release. No neurovascular injuries or dislocations were detected intraoperatively or postoperatively. Two deep infections were diagnosed postoperatively, and those patients required a two-stage revision. All patients were followed for 4-10 years. Mean VAS score decreased from 8.1 (range 6-10) preoperatively to 1.2 (range 0-3) at final follow-up (P=0.01). Mean HSS score improved from 38.5 (range 25-62) preoperatively to 86.3 (range 72-95) at final follow-up (P=0.02). The average knee ROM was 64° (range 20-90°) before surgery and 98° (range 90-110°) at final follow-up (P=0.04) (**Table 2**). There were no malalignments at the final follow-up. No signs of prosthesis subsidence or loosening were observed at final follow-up (**Figures 1-4**).

Discussion

Utilizing clinical exam findings and radiographic evaluations, we found acceptable mid-term benefits of TKA with rotating-hinge implants on grossly unstable knees with serious bony and ligamentous defects. The efficacy of rotating-hinge primary TKA has been evaluated in several studies, with results varying from poor to acceptable [3, 5, 15, 16]. Guenoun et al [16] had an unacceptably high complication rate of 30.8% after 52 rotating-hinge primary TKAs with a mean follow-up of 3 years. Pour et al [5] believed that knee salvage reconstruction with rotating-hinge devices was satisfactory in 44 knees after a mean follow-up of 4.2 years, despite a relatively high rate complication and failure rate (18.2%). Petrou et al [3] in a series of 100 knees with 7-15-year follow-up found rotating-hinge devices to be ideally suited for arthroplasty of deformed knees, with good or excellent results in 91% of cases. Barrack [15] reported satisfactory results in a series of 23 knees after 2-9 year follow-up. The inconsistent findings of these papers suggest that TKAs using rotating-hinge devices have divergent results in different patient populations with diverse surgical protocols. Controversies persist concerning the indication, operative technique and efficacy of these devices.

Rotating-hinge devices conform favorable initial stability through a link between the tibial and femoral components. Rotation of the tibial bearing around a yoke on the tibial platform reduces torsional stress at the prosthesis/cement/bone interface, leads to a lower risk of loosening and favorable outcomes [6-8]. Rotating-hinge devices are applied not only to revision knee surgery and oncologic reconstructions, but to primary TKA in specific situations. However, the indications for rotating-hinge primary TKA have remained controversial. Increased constraint produces torsional stress at the prosthesis/cement/bone interface, and therefore leads to a high risk of failure. The use of constrained prostheses was not advocated in cases where a condylar prosthesis could be implanted [1, 12, 17]. Grossly unstable knees with serious bony and ligamentous defects require the use of a rotating-hinge prosthesis to ensure intrinsic implant stability [1]. Our study suggested that, for primary non-tumorous TKA, rotating-hinge devices could be implanted in cases of lateral ligament compromise, and massive distal femur or proximal tibia bone loss. This finding is in agreement with several previous studies [2, 12, 15, 16].

A good surgical technique is one of the key elements that define the efficacy of rotating-hinge devices. Detailed preoperative planning, including the evaluation of soft tissue balance and bone deficiency simplifies the surgical approach [18]. V-Y quadricepsplasty was not performed in our early study, and one knee with 0 to 30 ROM intra-operatively was found to have a patella avulsion fracture. Since then, a V-Y quadricepsplasty was proposed for knees with difficult exposures, especially stiff knees with serious osteoporosis. Quadriceps release was proposed for tight extensor mechanisms. Although V-Y quadricepsplasty and quadriceps release might lead to an extension deficit, our results suggest that a deficit of 5 to 10° is acceptable. Rotating-hinge devices still could transmit high

forces to the prosthesis/cement/bone surface, especially in cases of limb malalignment. Using extra-medullary tibial and intra-medullary femoral alignment, and by filling bony defects with cement or metal augments, none of our cases had malalignment at final follow-up.

The most frequent complication of a rotating hinge prosthesis is periprosthetic infection, with rates higher than both primary and revision surgeries. Springer et al [19] reported an infection rate of 19% in a series of 26 knees over an average follow-up of 58.5 months. Yang et al [2] reported a 14% deep infection rate in 50 knees after a mean follow-up of 15 years. The relatively high infection rate of previously papers might be attributed to older patient age, serious joint disease on presentation and extensive operative exposure [2, 5, 19]. Only two cases (7.1%) of deep infections were reported in our study at final follow-up, probably because of our strict perioperative management. Anterior knee pain is usually reported after rotating-hinge TKA, with rates between 5 and 22% [3, 20, 21]. The incidence of anterior knee pain in our study was 10.7%. We propose that one of the main causes for this complication was that the patellas were not resurfaced. The lack of roll-back in the femoral and tibial components of rotating-hinge devices and the increased tension on the patellofemoral joint also accounted for increased pain complaints [21]. Several studies previously reported that patella misalignment and non-resurfacing are associated with anterior knee pain [22].

In conclusion, our study showed primary TKA using a rotating hinge prosthesis can effectively relieve the pain and improve the function of severely compromised knees. There are several limitations in our study. It is retrospective and non-controlled. The length of follow-up may have been too short (range 4-10 years), although an average duration of 6.5 years is acceptable for studying the medium-term effects of rotating-hinge TKA for severely compromised knees. Our study is underpowered, so outcome differences on the basis of the underlying diagnosis was not possible. Our findings should be further validated with a well-powered prospective study.

Disclosure of conflict of interest

None.

Abbreviations

TKA, total knee arthroplasty; VAS, visual analog scale; HSS Knee Scores, Hospital for Special Surgery Knee Scores; ROM, range of motion.

Address correspondence to: Dr. Jie Xie, Department of Orthopedics, Xiangya Hospital, Central South University. No. 87 Xiangya Road, Changsha 410008, Hunan, China. Tel: +86 073989753006; Fax: 0731-89753006; E-mail: xszm268@163.com

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