

The impact of joint line restoration on functional results after hinged knee prosthesis

Serdar Yilmaz, Deniz Cankaya, Alper Deveci, Ahmet Firat¹, Bulent Ozkurt, Murat Bozkurt¹

ABSTRACT

Background: Hinged knee prosthesis is an effective treatment method as a salvage procedure in marked ligamentous insufficiency and severe bone defects. Joint line determination and restoration are difficult due to large bone defects and distorted anatomy. We evaluated the impact of joint line alteration on the outcome in rotating hinge knee arthroplasty (RHKA).

Materials and Methods: 35 patients who had rotating hinged knee prosthesis applied between 2008 and 2013 were evaluated in this retrospective study. The patients were studied radiologically and clinically. Five patients were lost to followup and two patients died, leaving a total of 28 (7 male, 21 female) patients for final evaluation. The average age of the patients was 66.19 ± 8.35 years (range 52–83 years). The patients were evaluated clinically with Knee Society knee and functional score and patellar score. The joint line positions were evaluated radiographically with femoral epicondylar ratio method. The outcomes were also evaluated according to age, body weight and gender. Student's *t*-test, independent *t*-test, and the Wilcoxon signed rank test were used in the statistical analysis.

Results: The mean Knee Society knee and functional score significantly improved from preoperative 19.52 ± 11.77 and 12.5 ± 15.66 respectively to 72.46 ± 14.01 and 70.36 ± 9.22 respectively postoperatively ($P < 0.001$). The mean range of motion of the knee improved from $55.95^\circ \pm 25.08^\circ$ preoperatively to $92.14^\circ \pm 13.47^\circ$ postoperatively ($P < 0.001$). Joint line position was restored in 20 patients (71.4%). Joint line alteration did not affect Knee Society Scores (KSSs) in contrast to patellar scores. Additionally, KSS was better in the patients with body mass index ≤ 30 at followup ($P = 0.022$ and $P = 0.045$).

Conclusion: RHKA is an effective salvage procedure for serious instability and large bone defects. Restoration of the joint line improves the patellar score although it had no effect on the clinical outcome.

Key words: Arthroplasty, epicondyle, joint line, knee

MeSH terms: Knee replacement, total, osteoarthritis, knee, knee prosthesis

INTRODUCTION

Total knee arthroplasty (TKA) is an effective treatment method in patients complaining of pain due to degenerative knee arthritis.¹ Correct knee alignment and ligamentous balance are essential for better results after TKA.² In cases where soft tissue balance cannot be maintained such as those with severe deformities in primary arthroplasty or revision cases with serious bone defects

or marked ligamentous insufficiency, conventional knee prosthesis will fail in a short period of time.³ A constrained type knee prosthesis may be used as a salvage procedure in these situations.^{4,5}

Changes in the knee joint line have adverse effects on knee arthroplasty.⁶⁻⁹ However, the determination of the correct joint line in revision knee arthroplasty is difficult because of large bone defects.¹⁰ The elevation of the joint line is associated with inferior clinical results and may lead to patellar impingement, decreased range of motion (ROM), mid-flexion instability, quadriceps weakness and increased patellofemoral contact forces with the resulting in anterior

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knee pain, increased component wear and extensor mechanism failure.⁶⁻⁹ Better functional scores have been reported with knee arthroplasty within <5 mm or 8 mm of joint line elevation.^{7,8,11}

Hinged knee prosthesis was developed to overcome uncorrectable ligamentous imbalance, large bone defects, severe deformities, and revision surgery where soft tissue balance cannot be maintained because of bone defects or ligamentous insufficiency.^{4,5,12} The joint line determination and restoration are difficult in hinged knee prosthesis because of large bone defects. This may be a factor contributing to the low functional scores in hinged knee prosthesis. Although joint line alteration has been related to anterior knee pain, to the best of our knowledge, there has been no study of the impact of joint line alteration on the functional scores after hinged knee arthroplasty. In this study, the clinical and radiographic results and the impact of joint line restoration on functional outcome and anterior knee pain were evaluated after surgery with rotating hinge knee arthroplasty (RHKA).

MATERIALS AND METHODS

35 patients who had rotating hinged knee prosthesis applied between 2008 and 2013. Five patients were lost to followup and two patients died, leaving a total of 28 (7 male, 21 female) patients for final evaluation. The average age of the patients was 66.19 ± 8.35 years (range 52–83 years). The study was approved by the Institutional Review Board. Informed consent was obtained from all the study participants. Preoperative and postoperative radiographs, demographic information and the operation data were obtained from patient files. Paraplegic or bedridden patients, patients with mental retardation or dementia for whom evaluation of the functional state would be meaningless and those with active prosthetic infections were excluded from the study. The patients were called for a final followup examination. RHKA primary surgery was applied to 4 patients and revision surgery to 24 patients. The primary arthroplasties were performed because of severe varus deformity (28–22° varus deformities) in 3 patients and knee dislocation associated with degenerative arthritis in one patient. The revision surgeries were performed for septic loosening in 8 patients as a second stage procedure, aseptic loosening in 10 patients, knee dislocation after total knee prosthesis in 3 patients, ligamentous instability in 2 patients (medial collateral ligament over anterior cruciate ligament and posterior cruciate ligament insufficiency) and periprosthetic femoral fracture in one patient [Table 1].

Operative procedure

All patients were operated with cemented Endo-Model rotating hinged knee prosthesis (Waldemar Link GMBH

and Co., Hamburg, Germany) and surgery was performed through a medial parapatellar arthrotomy and under tourniquet control. In cases of septic loosening, two staged exchange arthroplasty was applied with hand made spacer made up of antibiotic loaded cement. The time interval between the spacer application and the final prosthesis with RHKA was 5.2 months (range 3–9 month). Structural bone allografts were not used to fill the defects. Metal augments and cement were used to fill the defects instead of structural bone grafts. The joint line determination was made intraoperatively according to the tibial tubercle, epicondyles and the fibular head position, such as at a point 1.5 cm to 2 cm proximal to the fibular head, 2.2 cm proximal to the tibial tuberosity, 2 cm to 2.5 cm distal to the lateral femoral epicondyle or 2.5 cm to 3 cm distal to the medial femoral epicondyle. It was attempted to restore the joint line via block augments. The patella was replaced in 5 patients. Prophylactic first generation cephalosporin was used preoperatively and for 48 h after the surgery. A suction drain was retained until the second postoperative day.

Postoperative management

The postoperative management was similar for all patients and isometric quadriceps exercises were started on the day of surgery. Passive and active knee flexion exercises were started with the aid of a physiotherapist on the postoperative day one. Continuous passive motion application was started on the postoperative 2nd day to facilitate ROM exercises. Postoperatively, the patients were encouraged to walk with the aid of a walker with weight-bearing as tolerated.

Outcome assessments

The patients were evaluated clinically and radiographically. Knee Society knee score and Knee Society function score¹³ were measured and compared preoperatively taken from the patient files and at the final followup. The patellar score was also measured at the final followup.¹⁴ Age of the patients and body mass index (BMI) were recorded from the patient files. We grouped the patients into ≤ 65 years and over 65 years and BMI of ≤ 30 and over 30 and investigated the influence of the age and BMI on the outcomes. ROM of the patient's knee was measured manually with a goniometer and compared preoperatively and postoperatively. The radiographs included an antero posterior and true lateral view and the measurements were taken by one of the authors on scaled digital radiographs.

The joint line positions were evaluated with the femoral epicondylar ratio method.^{15,16} In this method, the medial and the lateral epicondyles were identified and the transepicondylar distance (TeD) was measured from the antero posterior radiograph. The joint line was defined

Table 1: Clinical details of patients

Patient	Age (years)	Gender	BMI	Underlying pathologies	Followup (months)	OR time (min)	Complications	Outcome score				
								KSS knee		KSS function		Patellar score
								Preoperative	Followup	Preoperative	Followup	
1	68	Female	33.2	Aseptic loosening (posteromedial femoral condyle and tibial defect)	27	110	Superficial infection (no pathogen)	30	59	25	65	12
2	74	Female	21.6	Knee dislocation	34	90	-	0	57	0	65	12
3	72	Male	25.6	Instability	16	140	-	27	82	5	75	12
4	56	Female	31.3	Severe varus deformity	19	130	-	38	85	35	85	15
5	58	Female	35.6	Septic loosening (medial femoral condyle large defect)	21	180	Limited knee ROM, arthroscopic release applied	8	56	0	65	20
6	80	Male	34.2	Aseptic loosening (distal irregular defect on both femoral condyle)	31	110	-	22	69	0	75	23
7	59	Female	34.7	Instability	39	150	-	22	78	25	85	15
8	70	Female	36.5	Aseptic loosening (lateral femoral condyle and anterior part of large tibial defect)	32	130	Superficial infection (staph epidermis)	21	76	5	65	12
9	52	Female	35.4	Septic loosening (both femoral condyle large defect)	16	160	-	17	66	15	65	11
10	56	Male	26.4	Aseptic loosening (lateral femoral condyle defect)	29	80	-	17	82	0	75	15
11	68	Female	32.6	Knee dislocation after TKR (both femoral condyle defect)	29	130	-	0	49	0	55	14
12	71	Female	31.1	Periprosthetic fracture	34	100	Superficial infection (no pathogen)	0	57	0	65	20
13	59	Male	24.8	Aseptic loosening (medial femoral condyle defect)	37	120	-	43	90	55	85	23
14	71	Female	28.7	Septic loosening (both femoral condyle large defect)	30	120	-	16	75	15	75	26
15	60	Female	32.6	Aseptic loosening (tibial defect)	41	130	-	24	83	5	65	11
16	72	Female	34.5	Septic loosening (medial femoral condyle and medial tibia defect)	36	150	-	16	76	0	75	23
17	76	Male	28.7	Severe varus deformity	41	100	Limited knee ROM, arthroscopic release applied	22	75	15	65	17
18	74	Female	30.6	Knee dislocation after TKR (both femoral condyle and tibial defect)	30	120	-	0	47	0	65	9
19	76	Female	30.1	Aseptic loosening (lateral femoral condyle large defect)	27	180	Superficial infection (<i>Acinetobacter</i>)	22	84	0	75	16
20	83	Male	26.6	Aseptic loosening (both femoral condyle defect)	34	120	Superficial infection (<i>Acinetobacter</i>)	41	85	35	75	15

Contd...

Table 1: Contd...

Patient	Age (years)	Gender	BMI	Underlying pathologies	Followup (months)	OR time (min)	Complications	Outcome score				
								KSS knee		KSS function		Patellar score
								Preoperative	Followup	Preoperative	Followup	
21	58	Female	32.5	Septic loosening (tibial defect)	19	110	-	27	83	25	75	14
22	71	Female	31.1	Knee dislocation after TKR (both femoral and tibial condyle defect)	21	130	-	7	57	0	65	22
23	62	Female	23.4	Septic loosening (medial femoral condyle large defect)	33	160	-	20	84	15	65	12
24	69	Male	27.9	Severe varus deformity	17	130	-	15	91	45	85	28
25	58	Female	28.8	Septic loosening (both femoral condyle defect)	22	140	-	23	83	0	75	22
26	55	Female	30.8	Aseptic loosening (lateral femoral condyle and tibial defect)	32	130	-	32	84	25	75	23
27	64	Female	33.6	Septic loosening (both femoral condyle defect)	37	110	-	24	74	5	65	13
28	61	Female	34.5	Aseptic loosening (medial femoral condyle and tibial defect)	26	170	Deep infection (<i>Acinetobacter</i> and <i>Pseudomonas</i>) necessitating 2 stage exchange arthroplasty, wound dehiscence needed skin flap	12	42	0	45	16

BMI=Body mass index, KSS=Knee Society Score, OR=Odds ratio, ROM=Range of motion, TKR=Total knee replacement

as the most distal part of the femoral component. The epicondylar ratio was calculated as the distance between one of the epicondyles and the joint line in relation to the TeD on the AP view [Figure 1]. Thus a medial (medial epicondyle-joint line distance [MeJL]/TeD) and a lateral epicondylar (lateral epicondyle-joint line distance [LeJL]/TeD) ratio were calculated. The intended joint line was defined with MeJL/TeD assumed as 0.34 (0.28–0.42) and the LeJL/TeD as 0.28 (0.23–0.34) according to the method described by Servien *et al.*¹⁵

Implant loosening, tibiofemoral alignment and the bone loss were also evaluated on the followup radiographs.

Statistical analysis

Changes in the Knee society scores (KSSs) and ROM were evaluated via the Student's *t*-test. Independent *t*-test was used to compare outcomes according to age, BMI, and gender. The Wilcoxon signed rank test was used to analyze the influence of the joint line reconstruction on the postoperative clinical results. A value of $P \leq 0.05$ was considered as statistically significant.

RESULTS

The mean followup period was 28.95 ± 7.59 months (range 14–41 months). The mean Knee Society knee score improved significantly from 19.52 ± 11.77 (range 0–43) preoperatively to 72.46 ± 14.01 (range 47–91) postoperatively ($P < 0.001$). The mean Knee Society function score improved from 12.5 ± 15.66 (range 0–55) preoperatively to 70.36 ± 9.22 (range 55–85) ($P < 0.001$). The mean ROM of the knee was improved from $55.95 \pm 25.08^\circ$ (range 0° – 90°) preoperatively to $92.14 \pm 13.47^\circ$ (range 70° – 110°) postoperatively ($P < 0.001$). Patellar scores did not differ according to age, BMI and gender ($P > 0.05$). However, KSS was better in the patients with BMI ≤ 30 at followup ($P = 0.022$ and $P = 0.045$) [Table 2]. Additionally, Knee Society knee scores were better in the male patients at followup ($P = 0.003$).

The tibiofemoral alignment of all knees was corrected at surgery to the built-in prosthetic angle of 6° of valgus and there was no evidence of any change in this alignment over

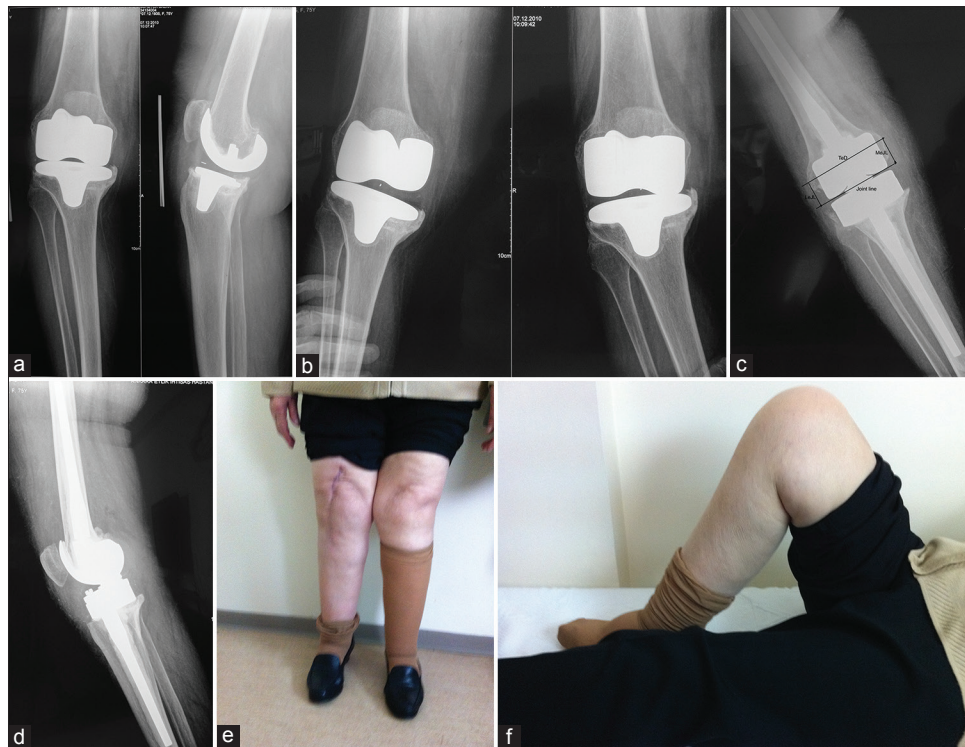


Figure 1: (a and b) Preoperative radiograph of the patient of the collapsed medial tibial plateau with varus deformation. Stress radiographies demonstrated ligamentous instability. (c and d) Postoperative radiograph of the patient with hinged knee prosthesis after 2.5 years. Block augment was applied on the tibial component. Joint line measurements are illustrated on the antero posterior radiograph. Although this patient had restored joint line (MeJL: 0.31 and LeJL: 0.27), the present joint line with the intended joint line (red line) were illustrated in this radiography (Me: Medial epicondyle, Le: Lateral epicondyle, TeD: Transepicondylar distance, MeJL: Medial epicondyle-joint line distance, LeJL: Lateral epicondyle-joint line distance, IJL: Intended joint line). (e and f) Clinical photograph of the patient showing range of motion

Table 2: The evaluation of outcomes according to age, BMI and gender

Demographic properties	KSS knee				KSS function				Patellar score	
	Preoperative	P	Followup	P	Preoperative	P	Followup	P	Followup	P
Age										
≤65 years (n=13)	23.61±9.78	0.085	76.15±13.69	0.200	15.77±16.81	0.313	71.92±11.09	0.413	16.15±4.39	0.536
Over 65 years (n=15)	15.93±12.48		69.27±13.94		9.67±14.57		69±7.37		17.4±5.88	
BMI										
≤30 (n=10)	22.4±12.5	0.341	80.4±9.75	0.022	18.5±19.87	0.133	75±6.67	0.045	18.2±6.07	0.303
Over 30 (n=18)	17.89±11.33		68.06±14.28		9.17±12.16		67.78±9.58		16.06±4.63	
Gender										
Male (n=7)	26.71±11.15	0.060	82±7.87	0.003	22.14±22.7	0.058	75±8.16	0.126	19±5.75	0.205
Female (n=21)	17.09±11.19		69.29±14.28		9.29±11.54		68.81±9.21		16.09±4.92	

BMI=Body mass index, KSS=Knee Society Score

time. No migration or progressive loosening was evident on the final radiographs. Nonprogressive radiolucent lines were seen in 3 cases and these were <2 mm in thickness. Joint line position was restored in 20 patients (71.4%) according to the epicondylar ratio method. The patient’s KSSs and patellar scores were also evaluated according to joint line restoration [Table 3].

Two patients had arthroscopic release to improve ROM postoperatively. One of these patients had 40° and the other patient had 30° ROM for knee flexion and needed arthroscopic release 2 months after the operation.

We released the adhesions of the quadriceps tendon arthroscopically in these patients and gained 110° knee flexion intraoperatively. There was no evidence of postoperative tibiofemoral instability in any of the patients. Five patients had a superficial infection that responded to local care. One patient had deep infection and was treated with two stage exchange arthroplasty. This patient had wound dehiscence after the previous operation and the wound was closed with a skin flap. This patient had the worst functional outcome (KSS knee and functional scores were 42 and 45 respectively, ROM was 70°).

DISCUSSION

Although the older generation of hinge knee prosthesis had early failures,^{17,18} the newer designs of this prosthesis provides stability and functional improvement.^{4,5,12,19} It can be a salvage procedure when there is huge bone loss or global instability and provides great convenience to the surgeon.^{4,5,12,19,20} Hinged knee prosthesis was determined to provide improvement in the outcomes of the patients in the current study as a salvage procedure. Although the joint line alteration did not affect the KSSs, patellar scores were affected.

This study demonstrated that RHKA is a good solution in cases of large bone defects or marked ligamentous insufficiency. All the patients improved clinically. No loosening was detected at the final followup. Although the functional demand was low, especially in revision cases and where there were difficulties due to large bone defects, RHKA offers the surgeon the advantage of easy application despite the distorted anatomy [Figure 2].^{4,5,12,19,21}

Different results have been reported with the hinged knee prosthesis in the literature [Table 4]²²⁻²⁹ and the overall results were low for fixed hinged knee prosthesis.³⁰ Although

Table 3: Patient's outcomes according to joint line restoration

Outcome assessment	Joint line restored	Joint line altered	P
Knee Society knee score	63.38±16.13	74.25±15.9	0.138
Knee Society functional score	70±9.26	65±9.26	0.227
Patellar score	17.63±4.1	12.25±1.83	0.009



Figure 2: (a) Preoperative radiograph of the knee joint showing the detachment of the medial tibial component associated with infection. (b and c) After two stage exchange arthroplasty, the patient was treated with hinged knee prosthesis. Due to the medial bone loss, metal augment was applied to the medial tibial component. (d and e) Clinical photograph of the patient after 3 years showing range of motion

the results of rotating type hinge knee prosthesis were better, the followup periods were short and the design of the prosthesis was different.^{4,5,12,19-21} Böhm and Holly evaluated 422 knees of 330 patients who had primary RHKA surgery at a mean of 6 years.³¹ The survival rates varied from 86.8% to 96.0% depending on the end points at 20 years. Although the results were encouraging, the functional state was not reported, and success was reported as revision surgery as an end point. Barrack reported satisfactory clinical results in 23 knees of 22 patients comparable to revision knee arthroplasty with hinged TKAs evaluated at 2–9 year followup.³² Joshi and Navarro-Quilis reviewed the results of 78 revision TKAs using a rotating hinge device in patients requiring revision arthroplasty due to aseptic loosening.³³ Excellent results were determined in 57 patients with ROM of 104° in flexion and complete extension. However, Pour *et al.* reported that RHKA should be reserved primarily for sedentary and elderly patients.³⁴ The rate of prosthetic survival was 79.6% at 1 year and 68.2% at 5 years with revision or reoperation as the end point of 44 patients in their study. In the current study, the average ROM of the knee ($92.14 \pm 13.47^\circ$) was slightly low compared with the literature ($93.6\text{--}104^\circ$). The most important determinant of postoperative ROM was the preoperative ROM of the patient, thus the patients in our study had multiple operations formerly and the soft tissue of the knee of these patients were deteriorated and this leads to lower ROM values in our study population. However, the outcome in our series was comparable with the literature so that the relatively lower ROM did not affect the functional state. Additionally, if the patient who had the worst result in our study was excluded, the average ROM in our series was improved to $94.52 \pm 11.82^\circ$ that comparable with the literature.

Although contradictory findings were reported in the literature, patients with BMI ≥ 40 , >80 years and female gender had more activity limitation after revision knee arthroplasty.^{35,36} Our study group in this study was small so that we grouped the patients into ≤ 65 years and over and found no significant difference between defined age groups. However, we found better KSS in patients with BMI ≤ 30 in this study. Although patellar scores were dependent with body weight, we did not find any significant difference according to BMI ($P = 0.303$). Additionally, women had worse KSS knee scores both preoperatively and postoperatively. The male gender patients with ≤ 65 years and BMI ≤ 30 had better outcome after RHKA in our study.

Joint line restoration of the knee in revision arthroplasty is difficult.^{7,8} Femoral and tibial defects lead to joint line elevation if the bone lost from the distal femur is not reconstructed and the defect is addressed by thickening the tibial insert. The restoration of the joint line has a positive

Table 4: Previous reports about rotating hinge knee arthroplasty in the literature

Study	Number of patients	Mean age (years)	Male/female ratio	Complications	Followup	Main findings
Hernández-Vaquero and Sandoval-García, 2010 ⁵	26	77	5/21	5 patients had medical complications 3 required revision 5 patients had patella and extensor mechanism complications	46 months (24-107 months)	KSS improved from 40 to 77 KSS functional score improved from 36 to 51 23 mobilized with 1 crutch, 3 with 2 crutches It is last resort in the presence of a ligamentous instability
Bistolfi <i>et al.</i> , 2012 ²²	29	72.8	5/24	3 patients had medical complications 7 failures (2 aseptic loosening, 2 septic loosening, 3 clinical failures)	60.3 months (32-100 months)	HSS knee score improved from 65.5 to 88.4 ROM improved from 90.9° to 124.4° RHKA still the implant of choice for revision knee surgery in ligamentous instability
Smith <i>et al.</i> , 2013 ²³	271	68.1	84/187	51 patients had complication in 111 patients that can be evaluated (29 medical complications, 22 mechanical complications)	6.9 years/ 4.1 years	Infection was the leading cause of failure and nonmechanical failures account for more than half of the failures
Fuchs <i>et al.</i> , 2004 ²⁴	26 (10 hinged knee arthroplasty)	68.5	Not given	Not given	20.4 months	HSS, KSS, VAS, Tegner activity score, patella score did not differ Patients with a hinged implant had significant better scores in the mental components of the SF36 quality-of-life assessment
Baker <i>et al.</i> , 2014 ²⁵	964	73	278/686	20 revision (8 infection, 4 periprosthetic fracture, 3 aseptic loosening)	Max 7 years	The 5-year survival rate was 96.8% Hinged knee replacement is a viable alternative in the primary setting and should be considered in complex cases in instability
Pradhan <i>et al.</i> , 2004 ²⁰	50 (51 knees)	70.25	21/29	7 patients requiring plastic surgery for soft tissue cover 7 patients requiring a tibial osteotomy for adequate exposure of the joint	4 (2-6) years	HSS improved from 35.9 to 72.1 44 (86%) patients were satisfied with the outcome of the revision surgery, 3 (6%) noncommittal and 4 (8%) disappointed
Deehan <i>et al.</i> , 2008 ⁴	64 (72 knees)	69	19/45	23 patients (10 persistent pain, 5 extensor dysfunction, 5 infection, 3 periprosthetic fracture, 2 skin problems, 1 aseptic loosening)	10 (3-18) years	10 patients died from unrelated causes The median (best case) survival for the whole group was 90% (95% CI: 86-94), and worse case was 58% (42-74) at 5 years
Barrack <i>et al.</i> , 2000 ²⁶	13 (14 knees)	69	8/6	1 intraoperative femoral fracture, 1 patellar subluxation, 1 axle of prosthesis back-up, 1 partial peroneal palsy and soft tissue defect	51 months (2-6 years)	KSS improved from 41 to 131 ROM improved from 78° to 93° Knee alignment 7° valgus

Contd...

Table 4: Contd...

Study	Number of patients	Mean age (years)	Male/female ratio	Complications	Followup	Main findings
Gehrke <i>et al.</i> , 2014 ²⁷	141 available of 238 patients	67	49/189	19 patients had revision (6 secondary patellofemoral arthritis, 5 deep infection, 3 failure of the implant) 9 patients had revision without component removal	13 years	The mean postoperative knee range of movement was 118° (95-130°) 54% excellent and 20% good results according to HSS 78% very good and 16% good results according to VAS The overall survival rate at 13 years followup with revision for any cause as an end point was 90%
Petrou <i>et al.</i> , 2004 ²⁸	80 (100 knees)	70	11/94	2 deep infection, 1 dislocation, 1 supracondylar periprosthetic fracture	11 years (7-15)	Good or excellent results were seen in 91% of knees Survival at 15 years was 96.1%
Guenoun <i>et al.</i> , 2009 ²⁹	85	72.4	24/61	Complications were observed in 24 patients (28.2%): 9 deep infections, 4 patellar complications, 3 cases of aseptic loosening	36 months (0-99)	No significant difference was found between the primary arthroplasties and the revisions regarding all complication types

KSS=Knee Society Score, OR=Odds ratio, ROM=Range of motion, CI=Confidence interval, HSS=Hospital for Special Surgery, VAS=Visual Analog Scale, RHKA=Rotating hinge knee arthroplasty

influence on the clinical results and long term survival rates.³⁷ Although there are no reports in literature about the impact of the joint line position on the success or long term survival in hinged knee arthroplasties, elevation of the joint line results in patella baja, thereby causing patellar impingement and anterior knee pain.^{6,7,37} It has been reported in literature that clinical results deteriorate with 5–8 mm joint line elevation.^{7,8,11} Contrary to expectations in the current study, it was found that the joint line alteration did not affect the outcomes in RHKA except in respect of patellar scores. The constrained system eliminates the need to provide ligamentous balance. The successful results after arthroplasty are associated with ligamentous balance and correlated with joint line restoration, but the outcomes after RHKA were not affected by the joint line regardless of ligamentous balance. However, the patellar score was affected by the joint line alteration because of the uncoupling of the patella and the constrained system [Figures 3 and 4].

Although there is no consensus on measurement methods of the joint line position in revision knee surgeries, large bone defects and previous surgeries make it complicated and challenging to define the joint line position.⁷⁻⁹ The femoral epicondyles, the adductor tubercle, the fibular head, the tibial tubercle, and the inferior patella pole have frequently been used for measurement.^{1,4,7,38,39} Soft tissue landmarks are inherently inaccurate as they are usually distorted from previous surgeries. Bony landmarks provide more reliable guides in revision surgeries, although the fibular head is not a reliable guide for the joint line in revision surgery because of wide variation independent of patient size.¹⁶ Although



Figure 3: (a) X-ray of knee joint anteroposterior and lateral views showing dislocation of total knee arthroplasty (b and c) X-ray of knee joint anteroposterior and lateral views showing hinged knee prosthesis *in situ* (a case of multidirectional instability) (d and e) Clinical photographs showing range of motion

the tibial tubercle also provides a reliable method, its use is limited due to the need for preimplant radiography or contralateral radiography of the knee to determine the native joint line. Furthermore, the standard value of the distance between the tibial tubercle to the joint line as



Figure 4: (a and b) X-rays knee joint anteroposterior and lateral views showing severe varus deformity associated with degenerative arthritis (c) The clinical photograph of the same patient showing the severe varus deformity (d and e) X-rays of knee joint anteroposterior and lateral views showing hinged knee arthroplasty as a primary surgery

described by Servien *et al.* has shown huge interindividual differences.¹⁵ In the current study, the epicondylar method was used to define the joint line because of reliability and easy applicability to defective bones.

An altered joint line after arthroplasty results in a change in the patellar contact area.⁶ Joint line elevation may result in patella baja with impingement of the patella on the tibial component during knee flexion and increased patellofemoral contact forces leading to anterior knee pain, increased component wear or extensor mechanism failure.^{6,7} Anterior knee pain and patellar scores for functions such as rising from a chair and stair climbing were lower in patients with an altered joint line after RHKA in the current study.

Some limitations were identified in this study. First, the relatively small patient population means that a general conclusion cannot be made. Furthermore, our study is a retrospective study and control group was not found. In addition, the followup period was not long enough to make a decision about the long term survival in RHKA. Although the joint line measurement was reliable, the native joint line cannot be determined unless the preimplant or contralateral

radiographs are available. Therefore, strict decisions cannot be made about the functional state according to joint line position.

CONCLUSION

Rotating hinge knee arthroplasty is an effective salvage procedure for serious instability and large bone defects. Restoration of the joint line improves the patellar score even though the clinical outcome was not affected.

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Conflicts of interest

There are no conflicts of interest.

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