original article

Functional results and survivorship after medial unicompartmental knee arthroplasty: a single center experience from Saudi Arabia

Ammar Qutub,[a] Amjad Ghandurah,[a] Adel Alzahrani,[a] Ahmed Alghamdi,[b] Talal M. Bakhsh[a]

From the [a]Department of Surgery, King Abdulaziz University, Jeddah, Saudi Arabia; [b]Department of Orthopedic Surgery, East Jeddah General Hospital, Jeddah, Saudi Arabia

Correspondence: Dr. Ammar Qutub · Department of Surgery, King Abdulaziz University, PO Box 80200, Jeddah 21589, Saudi Arabia · afqutub@kau.edu.sa · ORCID: https://orcid.org/0000-0003-3134-5135

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BACKGROUND: Isolated involvement of the medial compartment of the knee in degenerative disease is encountered in about 25% of patients with gonarthrosis. We aim to show that in a well-selected group of such patients, medial unicompartmental knee arthroplasty (UKA) is a good option.

OBJECTIVES: Review the functional outcomes of patients undergoing UKA and determine the long-term survivorship of the implants and complications of the procedure.

DESIGN: Analytical retrospective chart review.

SETTING: Academic tertiary care medical center and tertiary care private hospital in the western region of Saudi Arabia.

PATIENTS AND METHODS: We selected patients who underwent medial UKAs by the same surgeon between December 1988 and December 2009. The life table approach and the Kaplan-Meier statistical method were used to estimate the survival rate (5–30 years) with revision as the endpoint. Functional outcome scores were determined according to the Knee Society Clinical Rating System.

MAIN OUTCOME MEASURES: Change in performance scores for pain, walking, and range of movement. Survivorship of the implants with removal of the implant as the endpoint; post-operative complications.

SAMPLE SIZE: 218 implants on 142 patients.

RESULTS: The survival rate for UKA was 94.7% at 10 years (95% CI 0.906-0.970), 80.9% at 20 years (95%CI 0.724-0.871), and at 30 years it was 77.8% (95%CI 0.669-0.855) of the total knee arthropathies. The average grand total functional score increased from 61 (maximum 200) at 0 months to above 150 at ≥6 months.

CONCLUSION: UKA is a good option for isolated medial compartment gonarthrosis with excellent functional outcome and good survivorship in selected patients.

LIMITATION: Single center experience, retrospective. We lost 6.0% of patients during follow-up.

CONFLICT OF INTEREST: None.

Isolated involvement of the medial compartment of the knee joint occurs in approximately 25% of patients with gonarthrosis.[1,2] This corresponds well with the fact that 26% of the knee arthroplasties performed at our institutions are medial unicompartmental knee arthroplasties. Isolated involvement of the lateral compartment of the knee joint occurs in 7-10% of cases of primary gonarthosis.[3] As we have rarely encountered such cases, this paper is limited to medial compartment disease.

Surgical treatment options for the medial unicompartmental degenerative disease include unicompartmental (or hemi-) arthroplasty (UKA), total knee arthroplasty (TKA), and high tibial osteotomy (HTO). Numerous reports have shown that in isolated degeneration of the medial compartment of the knee, UKA achieves functional results and survivorship that are comparable to results for total knee arthroplasty (TKA).[4-8] HTO also has comparable results with UKA in the younger patients.[9-11] For older patients UKA has the advantage of earlier weight-bearing mobilization.[11] An important advantage of medial UKA over TKA is the preservation of bone stock, making revision a rather straightforward procedure, using standard instrumentation and implants for TKA.[12,13]

In personal communication with many orthopedic surgeons in Saudi Arabia, we found that only a few colleagues perform medial UKA. Other colleagues refuse this procedure, claiming that all patients will eventually need conversion to TKA. In addition, we were not able to find any reports on survival after medial UKA in the Saudi population. In 2007, we reported on the functional results of medial UKA after 5-10 years of follow-up.[14] In this study, we report the long-term functional and survival results (5-30 years) of our patients after undergoing medial UKA for isolated medial compartment degenerative gonarthrosis. We hypothesize that medial UKA offers good long-term results (5-30 years) making it a good treatment option in suitable cases.

PATIENTS AND METHODS

After obtaining approval from the ethics committee, we reviewed the records of all patients who underwent medial UKA at King Abdulaziz University Hospital and Bakhsh Hospital Group in Jeddah, Saudi Arabia, before 1 January 2010 (to allow for a minimum of 10 years of follow up). One of these patients was excluded from the analysis because she suffered a fracture of the medial head of the tibia intraoperatively, which was not noticed until she started mobilization.

Inclusion criteria for medial UKA were that 1) patients have significant pain interfering with daily activities despite sufficient analgesia; 2) radiographs showed degenerative changes limited to the medial compartment; 3) collateral and cruciate ligaments were intact; and 4) varus deformity and/or flexion contracture did not exceed 15 degrees. In the process of preoperative counseling, we stressed the possibility of the need for conversion to TKA at a later stage, and all patients had to agree to this possibility. Also, patients gave consent to TKA in case we found degenerative changes in the lateral compartment intraoperatively. We did not perform medial UKA on patients with inflammatory arthritis. The analysis was based on operations performed on patients between 19 December 1988 and 31 December 2009. The senior surgeon performed all operations.

Preoperative preparation

Patients were admitted the day before surgery, and demographics (age, gender, weight, height) and comorbidities (diabetes mellitus, essential hypertension, ischemic heart disease, hyperlipidaemia, and hypothyroidism) were recorded. On admission, patients received unfractionated or low molecular weight heparin for venous thromboembolism prophylaxis. Prophylactic antibiotics were given within 60 minutes before the start of surgery. According to the recommendation of the anesthetist and the preference of the patient, surgery was performed under general, epidural, or spinal anesthesia.

Operative procedures

A tourniquet was used routinely before a medial parapatellar incision and subvastus arthrotomy to expose the joint. After ensuring that the lateral compartment and anterior cruciate ligament were intact, we performed the hemiarthroplasty using the cemented ENDO sled prosthesis with a metal-backed tibial plateau (Link GmbH, Hamburg, Germany). The technical steps were done according to the manufacturer's recommendations. An x-ray was taken immediately postoperatively. Flexion exercises were started the next day and, if patients were comfortable, they started weight-bearing mobilization. When patients could mobilize on their own and achieve satisfactory pain control with oral analgesics, they were discharged, usually after 4-6 days.

Follow-up

We scheduled follow-up visits in the outpatient clinic every 3 months in the first year, then every 6 months in the second year and yearly thereafter, or whenever a patient needed consultation for any reason. At each visit, the patient was interviewed and examined clinically. Findings were documented, and performance

scores were registered according to the Knee Society Clinical Rating System.[15] Radiological examination was not routinely requested in the first 5 years. Then, we did radiological studies every 5 years to evaluate for lucencies around the implants or whenever a new complaint was present.

Statistical analysis

Statistical analysis was performed with Stata software version 16.0 (Stata Corp, College Station, TX, USA). The frequency and column percentages were determined for the different comorbidities. Fisher's exact test was used to compare the proportions of different comorbidities in males and females. The alpha was set at 0.05; all tests were 2-tailed. In all survival analyses, the endpoint for survival was defined as revision for any reason. We plotted the overall survival time distribution and its 95% confidence interval using the Kaplan Meier survival curve. We compared the survival distribution in male and female groups using the log-rank test. The univariate Cox regression model was used to determine factors associated with failure. An unadjusted hazard ratio (HR) and 95% confidence interval (95%CI) were calculated. The explanatory variables were age, gender (male/female), and body mass index. The multivariate Cox regression model was used to determine factors associated with failure and obtain the relative contribution of each predictor variable while controlling for the influence of other variables. An adjusted HR, 95% confidence interval (95%CI), and *P* value for all independent variables were calculated. The explanatory variables were age, gender (male/female), and body mass index. Finally, we assessed the proportional hazards assumption using the Schoenfeld residuals.

RESULTS

Between 19 December 1988 and 31 December 2009, 218 operations were performed on 142 patients, including 26 males (16.8%) and 116 females (83.2%). The mean age was 61.0 (8.3) years. The mean body mass index was 31.3 (5.2). Common comorbidities included diabetes and hypertension (**Table 1**). Of the 142 patients, 25 had equal pain in both knees and requested simultaneous or successive replacement on both sides during the same admission. Intraoperatively, four of these patients had degenerative changes in the lateral compartment in one knee and underwent TKA on that knee. Only one knee was symptomatic in 46 patients, and they had unilateral medial UKA. The remaining patients had their knees replaced during different admissions; 24 of 71 (33.8%) had a TKA on the second knee.

Survival and functional outcome

The overall survival for UKA is shown in **Figure 1**. At 10 years, the survival rate was 94.7%; at 20 years, it was 80.9%; and at 30 years, it was 77.8% of the TKAs. A UKA survival analysis is shown in **Table 2**. The log-rank test for equality of survivor functions showed no difference in survival between males and females (log-rank chi-square=0.36, *P*=.549). Twenty-eight (12.8%) implants failed and were revised (**Table 3**). Progression of disease in the lateral compartment occurred in 16 of the 28 cases, while another 6 cases were revised due to polyethylene wear (**Table 4**). Aseptic loosening oc-

Table 1. Comparing different comorbidities between males and females who underwent medial unicompartmental knee arthroplasty.

Comorbidity	Males (N=41)	Females (N=177)	*P*	Total (N=218)
Diabetes mellitus	18 (43.9)	78 (44.1)	.563	96 (44.0)
Hypertension	17 (41.5)	82 (46.3)	.350	99 (45.4)
Hypothyroidism	0 (0.0)	27 (15.3)	.003	27 (12.4)
Dyslipidemia	5 (12.2)	34 (19.2)	.369	39 (17.9)

Data are number (%).

Table 2. Life-table survival analysis for patients who underwent medial unicompartmental knee arthroplasty.

Length of follow up (mo)	Number at the start	Failure	Deaths	Lost to follow up	Survival rate	Standard error	95% CI
Up to 5	218	4	6	4	0.981	0.009	0.951 - 0.993
> 5 to 10	204	7	8	4	0.947	0.016	0.906 - 0.970
> 10 to 15	185	12	19	4	0.865	0.027	0.803 - 0.909
> 15 to 20	82	4	9	0	0.809	0.037	0.724 - 0.870
> 20 to 25	37	1	12	1	0.778	0.047	0.668 - 0.854
> 25 to 30	13	0	1	0	0.778	0.047	0.668 - 0.854
> 30 to 35	1	0	0	0	0.778	0.047	0.668 - 0.854

curred in one case, and one case was revised because of ligament instability. Two cases were revised because of unexplained pain, and two knees were revised outside for unknown causes. Statistical analysis showed no difference in the failures in regard to gender, body mass index, age, or comorbidities (**Table 5**). Finally, the Schoenfeld test showed no departure from the proportional hazards assumption for the global test (χ^2=0.24, *P*=.971). **Table 6** summarizes changes in the functional scores for pain, range of movement, and walking distance. These scores are presented graphically in **Figure 2**. After 5, 10, and 15 years the walking scores reached an average of 38.45, 36.7, 35.9 out of 50 successively.

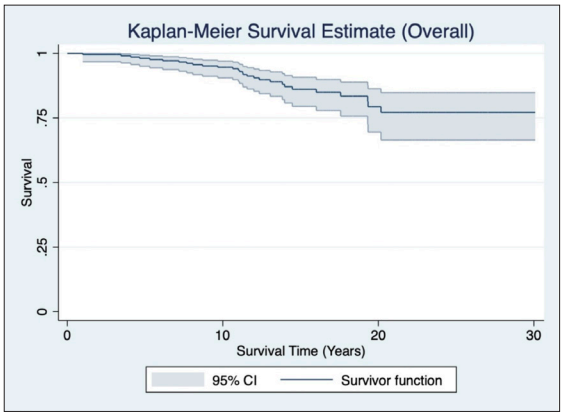

Figure 1. The survival rate for unicompartmental knee arthoplasties.

Table 3. Status of implants as of time of report.

Status	Frequency (%)	Cumulative percentage
Failed	28 (12.8)	12.8
Surviving	122 (56.0)	68.8
Deceased	55 (25.2)	94.1
Lost to follow up	13 (6.0)	100.0
Total	218 (100.0)	

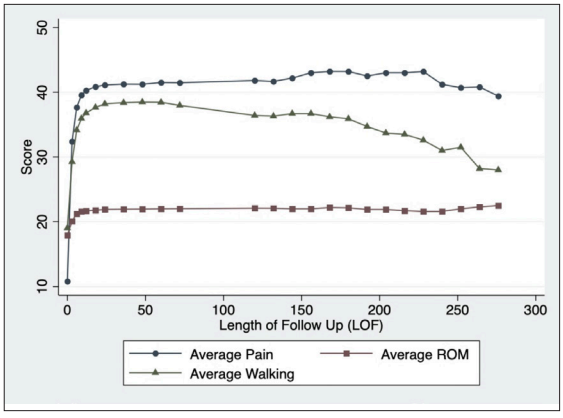

Figure 2. Clinical performance curve for unicompartmental knee arthoplasties (months).

Complications

Apart from the case excluded from the study who sustained a fracture of the medial tibial plateau, we observed only one morbidity, which was a symptomatic DVT in the second operated leg, two weeks after discharge from the hospital. This was a female patient, 72 years of age without comorbidities, who underwent staged bilateral medial UKA with an interval of 15 months between the two operations. She was treated conservatively and was well until she died of gynecological cancer 10.5 years later. No deaths were encountered in this series.

DISCUSSION

Many recent reports on medial UKA show results comparable to the established TKA. Advocates of medial UKA stress the advantages of medial UKA over TKA, including quicker recovery, shorter hospital stay, fewer morbidities and mortalities, preservation of bone stock, an easier revision to TKA, and lower costs.[4,13,16-19] Patil et al[20] examined knee kinematics on cadaveric knees and concluded that tricompartmental knee replacement significantly changed knee kinematics while medial UKA preserved knee kinematics, which might benefit the patient's rehabilitation and implant survival and wear. In a clinical context, research has shown that the gait pattern of patients undergoing UKA is closer to the physiological pattern.[21] Also, the knee extensor power compares well with normative data 5 years after UKA.[22]

Although we have no quantitative data in our series showing quicker recovery, we can confirm the impression that most patients do have a quicker recovery after medial UKA compared to TKA patients. Regarding morbidities, as stated in the results, we observed only one case of DVT. No deaths occurred. Although we have not published our own data on mortality after TKA other reports confirm our observation of the safety of UKA compared to TKA.[23]

Decreased blood loss is another advantage of medial UKA.[24,25] In our series, no patient required blood transfusion. Some authors state that medial UKA is suitable for older patients with limited physical activity,[26] while others could not find a negative correlation between the age of the patient and failure of the implants.[27-29] Others only advise caution when using medial UKA for patients younger than 60 years of age.[30,31] We could not find any statistical correlation between

the age of the patients and the failure of the prosthesis. Therefore, we do not list young age as a contraindication, but we stress to younger patients who otherwise meet the selection criteria that there is a higher revision rate. The benefits of medial UKA are explained and weighed against the possible need for revision.

Analysis of our data showed no correlation between the failure of the implants and the body mass index of the patients. Some researchers list morbid obesity as a relative contraindication to medial UKA, while others found no correlation between body mass index and failure of the medial UKA.[32-36] Although in our series, we have a few patients with a body mass index of around 40 kg/m^2, we are cautious regarding high body mass index, especially if patients are not motivated to lose weight after being able to mobilize better without pain.

The most common reason for revision to TKA was the progression of disease in the lateral compartment

Table 4. Details of cases that underwent revision to total knee arthroplasty (n=28).

	Gender	Date of operation	Date of conversion	Reason for conversion	Time to failure (mo)
1	F	16/05/2009	15/05/2010	Unexplained pain	1
2	F	08/07/2003	01/05/2017	Lateral OA	13.9
3	F	15/08/1992	15/08/2008	Polyethylene wear	16
4	M	23/10/1989	15/11/1997	Lateral OA	8.1
5	M	28/12/1992	15/02/1999	Lateral OA	7
6	F	29/10/1994	15/04/2009	Lateral OA	14.6
7	F	19/06/1995	10/10/2019	Lateral OA	24.4
8	F	28/06/1995	10/10/2019	Lateral OA	24.4
9	F	14/12/1993	15/02/2001	Lateral OA	8
10	M	19/03/1994	15/04/1998	Lateral OA	4.1
11	F	18/07/1994	15/07/2005	Polyethylene wear	11
12	F	15/04/1995	15/08/2007	Polyethylene wear	12.4
13	F	11/03/1995	15/06/2006	Lateral OA	11.3
14	F	27/11/1995	15/07/2006	Lateral OA	10.8
15	F	08/01/1996	15/09/2004	Lateral OA	8.8
16	M	23/03/1996	15/04/2007	Failing ligaments	11.1
17	M	19/05/1997	15/07/2017	Lateral OA	20.2
18	F	03/03/1997	15/08/2000	Polyethylene wear	3.5
19	F	01/07/1998	15/07/2011	Loose tibial implant	13
20	F	30/10/1999	15/10/2013	Lateral OA	4
21	F	15/04/2000	15/12/2009	Unexplained pain	9.8
22	F	29/09/2001	15/01/2007	Lateral OA	5.4
23	F	25/05/2002	15/01/2007	Lateral OA	4.8
24	F	31/08/2002	15/12/2013	Lateral OA	11.4
25	M	25/02/2007	15/09/2018	Lateral OA	11.7
26	F	14/06/1997	10/02/2005	Polyethylene wear	22.4
27	F	23/05/1992	15/12/2009	Polyethylene wear	26.5
28	F	21/07/2005	Jul 2017	Lateral OA	14.3

OA: Osteoarthritis; F: Female; M: Male

Table 5. Unadjusted and adjusted hazards ratio for potential predictors of failure of medial unicompartmental knee arthroplasty (n=28).

Predictors	Univariate cox proportional hazard model	Multivariate cox proportional hazard model[a]	
	Unadjusted HR (95% CI)	*P* value	Adjusted HR (95% CI)	*P* value
Age	0.98 (0.93 to 1.04)	.550	0.97 (0.92 to 1.03)	.316
Gender (Males)	0.59 (0.23 to 1.50)	.271	0.46 (0.17 to 1.25)	.129
Body mass index	1.00 (0.92 to 1.08)	.978	1.00 (0.92 to 1.08)	.986
Diabetes mellitus (Yes)	1.29 (0.57 to 2.93)	.539	1.12 (0.47 to 2.67)	.792
Hypertension (Yes)	1.34 (0.59 to 3.04)	.485	1.38 (0.56 to 3.40)	.481
Dyslipidemia (Yes)	1.42 (0.56 to 3.62)	.457	1.39 (0.49- 3.94)	.539

[a]Long rank chi square $\chi^2 = 3.39$, P=.759.

Table 6. Development of performance scores over time in patients who underwent medial unicompartmental knee arthroplasty (n=218).

Length of follow up (mo)	Average of performance of scores					
	Pain	Range of movement	Walking	Total positive score	Total negative score	Grand total score
0	10.80	17.91	19.02	88.42	15.77	61.78
3	32.39	20.09	29.26	136.72	2.14	137.3
6	37.66	21.22	34.15	151.3	1.59	151.64
9	39.56	21.6	35.93	157.1	1.37	154.33
12	40.26	21.68	36.79	159.47	1.28	156.83
18	40.84	21.78	37.65	161.71	1.21	157.49
24	41.11	21.91	38.21	163.14	1.2	158.28
36	41.25	21.94	38.39	163.19	1.22	158.74
48	41.23	21.96	38.48	163.24	1.165	158.74
60	41.49	22	38.45	163.4	1.04	158.3
72	41.46	22.02	37.96	162.02	1	162.02
120	41.8	22.1	36.41	159	1.38	153.11
132	41.66	22.09	36.3	158.4	1.56	155.22
144	42.18	22	36.7	159.7	1.9	158.9
156	43	22	36.7	160.6	1.68	164.1
168	43.21	22.2	36.19	159.4	1.9	166.4
180	43.2	22.15	35.9	158	2.17	168.7
192	42.5	21.9	34.7	154.9	2.4	164.5
204	43	21.9	33.7	153.1	2.8	165.25
216	43	21.7	33.5	152	2.6	160.4
228	43.2	21.6	32.6	150.5	3.5	162.6
240	41.2	21.6	31	144.6	4.7	162.6
252	40.7	22	31.5	187	0	187
264	40.8	22.3	28.2	187	0	187
276	39.4	22.5	28	172	0	169.5

(16 cases=57.1%). This occurred in two cases in less than 5 years, and it raises the suspicion that the intraoperative evaluation of the lateral compartment at the time of surgery was not accurate. This might even apply to another four cases revised after less than 10 years. Polyethylene wear was the reason for revision in six cases (21.4%). One patient was revised after only 3.5 years because of malpositioning of the tibial implant. One case was revised for ligament instability due to significant weight gain. Another case was revised for aseptic loosening of the tibial implant. Two patients had unexplained pain. After revision, they both continued to complain of pain despite good performance levels. One patient underwent a revision of both knees at another hospital, and we have no information on the reason for the revision.

As can be seen from the study of the details of failures, results can be improved with an accurate intraoperative evaluation of the joint and exact positioning of the implant. Determining whether minimally invasive and computer-guided techniques can improve survival will need further study. Significant improvement in the final outcome occurred within the first 6 months after surgery in our series. This improvement remained over the following years, except for the walking distance, which declined slightly due to aging and comorbidities.

In preoperative counseling, patients always ask about post-operative activity levels and especially regarding praying. We stress that all activities of daily living (walking, stairs climbing, kneeling, cross-leg sitting) are permissive. The only limitation is full weight-bearing squatting. Although patients may be able to do so, we advise them not to, as there are reports of the implant loosening due to full weight-bearing squatting.[37-39] These references refer to TKA. We are not aware of any research regarding UKA loosening. One could argue that knee kinematics are not altered in UKA due to the preservation of ligaments.[20] Therefore, implant loosening due to a full weight-bearing squat might not apply to UKA. Still, we do not want to take any risks of increased failures and continue to advise our patients to avoid full weight-bearing squatting. All patients were praying on a chair preoperatively, and therefore were happy with this restriction. We teach them after 2-3 months from surgery how to kneel down for "Sujood". Then, they can either sit on their buttocks with their legs aside ("Tawarruk") or sit cross-legged. Alternatively, they can go back on the chair for "Tashahud". Most patients are happy to perform their prayers in this way. Some patients, especially obese females, are unable to get up from the floor and continue praying on the chair. In conclusion, medial UKA offers a good functional outcome and has good long-term survival. We believe it should be offered to all patients meeting the criteria for selection.

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