ORIGINAL ARTICLE

Risk of Revision and Adverse Outcomes Following Partial Knee Replacement and High Tibial Osteotomy for Unicompartmental Knee Osteoarthritis: A Nationwide Cohort Study

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Abstract

Purpose To investigate comparative study for potential associations of adverse outcomes as well as survival rates after high tibial osteotomy (HTO) and unicompartmental knee arthroplasty (UKA).

Methods We reviewed the Korean National Health Insurance claims database from January 1, 2007 to May 31, 2019. A total of 90,705 patients aged 30–90 years who were newly treated for HTO or UKA were identified considering their eligibility. We performed four rounds of propensity score matching to reduce imbalance of baseline characteristics, especially disparities among different age groups. Multivariable logistic regression models were used to compare the risk of revision and various unwanted medical problems between HTO and UKA treatment groups after propensity score matching.

Results 23,563 matched patients were assigned to each group on the basis of propensity score. HTO showed higher risk of revision than UKA at 5 years, 10 years and the whole observed period (hazard ratio: 1.21, 95% CI 1.10–1.34). Deep vein thromboembolism (0.27, 0.21–0.35), and surgical site infection (0.37, 0.30–0.44) were less likely for HTOs than UKAs. Postoperative admission to intensive care unit was significantly lower with HTO (odds ratio: 0.40, 0.29–0.54) while rehospitalization within 30 days (1.27, 1.16–1.38) and 90 days (1.24, 1.18–1.30) were higher than UKA.

Conclusion When choosing the surgical method for unicompartmental knee OA, not only the survival rate, but also the risk of other adverse outcomes should be considered. In particular, attention should be paid to the risk of developing deep vein thromboembolism and surgical site infection.

Keywords Knee arthroplasty · High tibial osteotomy · Survival rate · Comorbidity · Unicompartment

Introduction

Osteoarthritis (OA) of the knee joint, a global health problem regardless of race, region, or gender, is one of the major diseases that degrade quality of life [1]. The spectrum of treatment ranges from conservative to surgical treatments [2]. It is reported that about half of the OA cases of the knee joint predominantly occur in the medial compartment, relatively preserving the lateral compartment and patellofemoral joint [3–5]. Although total knee arthroplasty (TKA) is widely recognized as the ultimate and a popular treatment for symptomatic late-stage OA, it is not preferred as a primary surgical method for OA limited to the medial compartment [6]. Instead of TKA, high tibial osteotomy (HTO) and unicompartmental knee arthroplasty (UKA) are being implemented and considered as well-documented, representational treatments for medial knee OA [7–9]. However, in the orthopedic field, the appropriate choice of UKA or HTO for performing a surgical treatment in patients who failed conservative treatment is a debatable issue even after decades of research [10–12]. The number of UKAs and HTOs performed continues to increase, and the range of surgical indication is expanding with the improvement of surgical methods and advances in implant design [13–17]. Various factors on the patient's side affect the selection of the two surgical methods, and the operator's training background and personal experience are also deeply involved.

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Moreover, both UKA and HTO provide effective and reliable results [18]. Thus, the surgical indications for both procedures have expanded, sharing a large proportion of the patient selection criteria [19]. Numerous studies have been carried out to compare the advantages and clinical results between these surgical methods, but it has not been proven that one is superior to the other [20]. However, there only small-randomized, limited reviews of literature, short-term retrospective, and individual cohort studies comparing the two surgeries exist. This study aimed to: (1) evaluate trends in utilization and revision rates of the two surgical methods and (2) analyze perioperative complications considering age-stratified subgroup characteristics.

Materials and Methods

Data Sources

We carried out a nationwide cohort study using the National Health Insurance Service (NHIS) that covers the entire Korean population. South Korea has one of the largest NHIS systems in the world, which is mandated by law and covers up to 99% of the South Korean population [21, 22]. The Korean NHIS collects database records, diagnoses, and related procedures based on the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) codes and Electronic Data Interchange codes. The NHIS database of South Korea provides data on individual identification codes, and the data linked to each code provides information on the patient age, gender, diagnosis, hospitalization records, surgical records, medication prescriptions, and local information of the hospital. Data from 1 January 2008 to 31 May 2019 were collected. Details of patients diagnosed with knee joint OA and undergoing surgical treatment for it were collected. All patient identification codes were encrypted and anonymized to ensure confidentiality in our study.

Data Collection

We extracted data of patients who underwent UKA or HTO for treatment of knee OA between 1 January 2008 and 31 May 2019, using the diagnostic code for knee OA (M17) and procedure codes for UKA (N2712, N2717) or HTO (N0304). Patients under 30 or over 90 years of age at the time of surgery were excluded. To identify cases that were newly diagnosed and eliminate the influence of previous procedures, a 1-year washout period without documented knee OA and its surgical treatment was established. We compared UKA and HTO by analysing the conversion to primary TKA, unwanted medical adverse outcomes, and various perioperative complications. To balance the baseline characteristics

of the two groups and minimise the effect of potential confounders, we performed propensity score matching (PSM). The baseline characteristics were extracted based on the age, sex, type of insurance, type of hospital, the region of residence, and underlying diseases. The type of hospital was classified as teaching, general, independent, and private. The region of residence was classified based on the population as a city with a population of 10 million or more, 1 million or more, and city with a population of less than 1 million. The presence of underlying diseases was confirmed based on the ICD-10 diagnostic codes, with at least two claims within a year from the date of surgery. The Charlson Comorbidity Index (CCI) score was calculated from the ICD-10 codes by methods described in previous literature. We identified the difference in the baseline characteristics between the two groups and corrected it with PSM (Table 1).

Statistical Analysis

We calculated the person-years for each group of patients from the date of the primary surgery to the events of subsequent revision and perioperative complications. To estimate the difference in the survival rate between UKA and HTO, after PSM, we analysed a stratified log-rank and Kaplan–Meier curves with the consideration of potential confounders. Also, conditional logistic and stratified Cox regression analyses were conducted to calculate the perioperative complication rates. The adjusted hazard ratio (HR) and 95% confidence interval (CI) were calculated using a multivariable Cox proportional-hazard regression model adjusted for potential confounders. PSM was utilized to mitigate the imbalance of baseline characteristics between the two groups [23]. Propensity scores for being in the UKA group were estimated using a multiple logistic regression model that included baseline characteristics such as age, sex, CCI, comorbidities, type of insurance, region of residence, and type of hospital. After calculating the propensity scores, patients were matched using the nearest neighborhood (greedy matching) algorithm within a caliper width of 0.1 in propensity scores and with a ratio of 1:1. The balance of covariates between the groups was evaluated with a standardized mean difference (SMD). A SMD less than 0.1 was considered as a negligible difference between the groups.

Subgroup Analysis

Subgroup analyses, according to age (30–49 years, 50–69 years, 70 years and over) were performed; these variables are known to be associated with the indication for both the surgical methods. Outcome measures were analysed in the same context as the entire study population. As the number patients in each surgery group differed, we performed PSM at a different ratio. The applied ratios for

Table 1 Patient baseline characteristics before and after propensity score matching

	All patient				Matched patient		
	UKA ($N=29,560$)	HTO ($N=61,145$)	p value	SMD	UKA ($N=23,563$)	HTO ($N=23,563$)	SMD
Age (mean (sd))	63.81 (8.39)	56.53 (7.60)	<0.001	0.909	61.24 (7.06)	61.20 (6.93)	0.006
Sex (%)			<0.001	0.178			0.023
Female	24,184 (81.8)	45,536 (74.5)			18,785 (79.7)	19,003 (80.6)	
Male	5376 (18.2)	15,609 (25.5)			4778 (20.3)	4560 (19.4)	
Hypertension (%)	18,073 (61.1)	27,304 (44.7)	<0.001	0.335	13,054 (55.4)	13,293 (56.4)	0.02
Hyperlipidemia (%)	17,082 (57.8)	31,128 (50.9)	<0.001	0.138	13,054 (55.4)	13,349 (56.7)	0.025
Peripheral vascular disease (%)	9147 (30.9)	13,823 (22.6)	<0.001	0.189	6615 (28.1)	6545 (27.8)	0.007
Diabetes_with out complication (%)	9768 (33.0)	14,446 (23.6)	<0.001	0.21	7003 (29.7)	6816 (28.9)	0.017
Diabetes_with complication (%)	4066 (13.8)	5407 (8.8)	<0.001	0.156	2833 (11.4)	2680 (11.4)	0.02
Osteoporosis (%)	12,812 (43.3)	15,987 (26.1)	<0.001	0.367	4314 (18.3)	4279 (18.2)	0.004
Depression (%)	5694 (19.3)	9971 (16.3)	<0.001	0.077	8790 (37.3)	8864 (37.6)	0.006
Dementia (%)	1116 (3.8)	873 (1.4)	<0.001	0.148	548 (2.3)	574 (2.4)	0.007
Type of insurance (%)			0.206	0.009			0.017
Health insurance	28,442 (96.2)	58,937 (96.4)			22,645 (96.1)	22,721 (96.4)	
Medical benefits	1118 (3.8)	2208 (3.6)			918 (3.9)	842 (3.6)	
City of residence (%)			<0.001	0.170			0.017
Over 10milion	10,452 (35.4)	17,025 (27.8)			7726 (32.8)	7579 (32.2)	
Over 1milion	6733 (22.8)	16,889 (27.6)			5617 (23.8)	5574 (23.7)	
Others	12,375 (41.9)	27,231 (44.5)			10,220 (43.4)	10,410 (44.2)	
Type of hospital (%)			<0.001	0.105			0.025
Teaching hospital	2757 (9.3)	6656 (10.9)			2307 (9.8)	2222 (9.4)	
General hospital	6427 (21.7)	10,934 (17.9)			5005 (21.2)	4826 (20.5)	
Independent hospital	19,225 (65.0)	40,912 (66.9)			15,278 (64.8)	15,541 (66.0)	
Private clinic	1151 (3.9)	2643 (4.3)			973 (4.1)	974 (4.1)	
CCI (%)			<0.001	0.246			0.036
0	1636 (5.5)	5621 (9.2)			1500 (6.4)	1439 (6.1)	
1	3935 (13.3)	10,953 (17.9)			3586 (15.2)	3383 (14.4)	
2	5538 (18.7)	13,369 (21.9)			4794 (20.3)	4649 (19.7)	
≥ 3	18,451 (62.4)	31,202 (51.0)			13,683 (58.1)	14,092 (59.8)	

UKA unicompartmental knee arthroplasty, *HTO* high tibial osteotomy, *SMD* standardised mean difference, *CCI* Charlson comorbidity index

PSM were 1:5, 1:1, and 2:1 (for the age groups 30–49 years, 50–69 years, and 70–90 years, respectively) for UKA and HTO (Table 2). All statistical analyses were performed using the R software (version 3.4.1; R Foundation for Statistical Computing) and SAS Enterprise software (version 6.1; SAS Institute Inc.).

Results

A total of 99,362 patients who underwent UKA or HTO during the 11.5-year period from 2008 to 2019 were identified, and regarding the eligibility, cases below the age of 30 or older than 90 years ($n=673$), prior history of knee arthroplasties or osteotomies around the knee joint ($n=7897$), and with inappropriate data ($n=87$) were excluded. In the final target cohort of 90,705 patients, 29,560 patients were treated with UKA and 61,145 patients underwent HTO in the same period. HTO was implemented about twice as many times as UKA (Fig. 1). The rates of UKA and HTO in 2018 compared to 2008 increased by 5.14 times and 6.54 times, respectively, showing a significant increase in both the surgeries in Korea. The average age for UKA was 63.8 years and for HTO was 56.5 years, while the proportion of women in both groups accounted for 81.8% and 74.5%, respectively. In both groups, more than 95% of the patients were covered by medical insurance, and each identified difference in the residential areas, the size of hospitals that conducted the surgery, CCIs, and preoperative underlying diseases are listed in Tables 1 and 2. After PSM, 23,563 patients were assigned to each group, and various indicators were compared after surgery using matched patients.
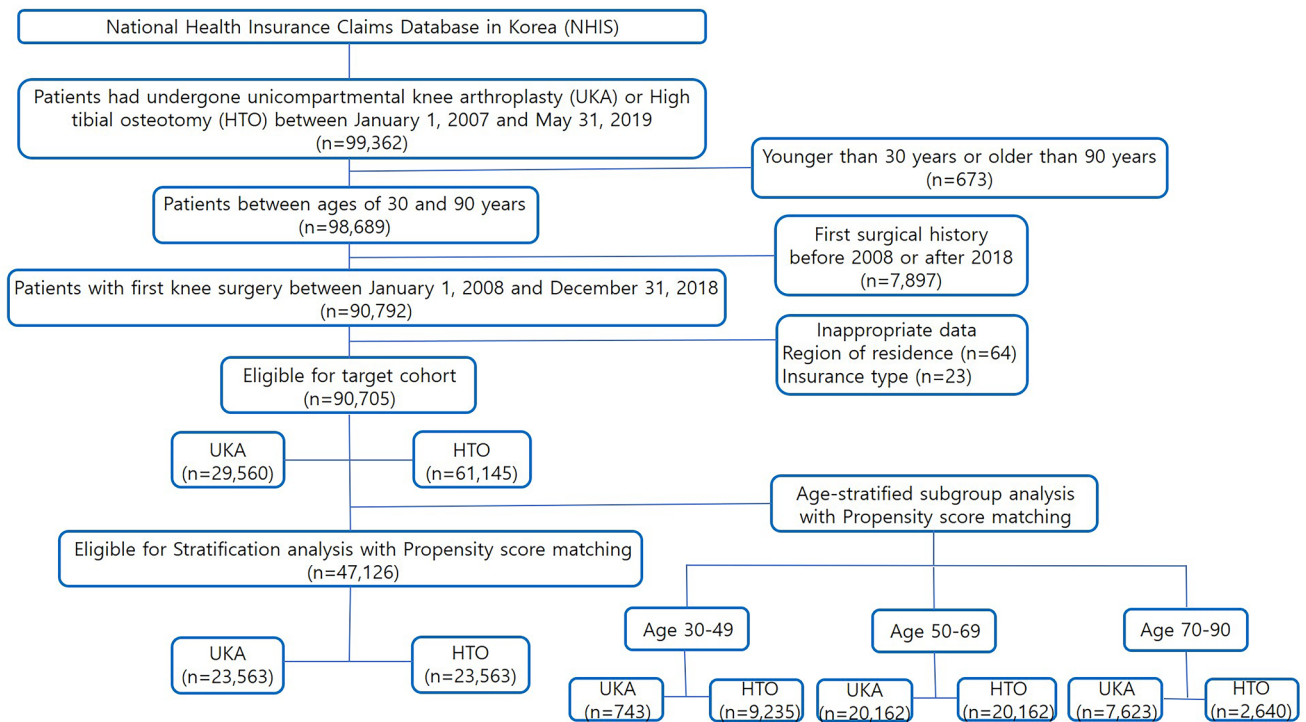
There was a significant difference in the survival rate between the two groups, with a more substantial increase

Table 2 Age stratified distribution of covariance after propensity score (PS) matching

	Age 30–49			Age 50–69			Age 70–90		
	UKA (N=743)	HTO (N=3715)	SMD	UKA (N=20,162)	HTO (N=20,162)	SMD	UKA (N=5280)	HTO (N=2640)	SMD
Age (mean (sd))	46.78 (2.93)	46.74 (2.87)	0.016	60.05 (4.94)	60.02 (4.86)	0.006	74.00 (3.46)	73.98 (3.78)	0.007
Sex (%)			0.004			0.005			0.044
Female	569 (76.6)	2838 (76.4)		16,365 (81.2)	16,403 (81.4)		4240 (80.3)	2073 (78.5)	
Male	174 (23.4)	877 (23.6)		3797 (18.8)	3759 (18.6)		1040 (19.7)	567 (21.5)	
Hypertension (%)	249 (33.5)	1184 (31.9)	0.035	11,164 (55.4)	11,262 (55.9)	0.01	3804 (72.0)	1816 (68.8)	0.071
Hyperlipidemia (%)	265 (35.7)	1263 (34.0)	0.035	11,516 (57.1)	11,496 (57.0)	0.002	3079 (58.3)	1475 (55.9)	0.049
Peripheral vascular disease (%)	120 (16.2)	541 (14.6)	0.044	5618 (27.9)	5260 (26.1)	0.04	1984 (37.6)	950 (36.0)	0.033
Diabetes without complication (%)	139 (18.7)	593 (16.0)	0.073	5927 (29.4)	5643 (28.0)	0.031	2169 (41.1)	1017 (38.5)	0.052
Diabetes with complication (%)	52 (7.0)	201 (5.4)	0.066	2402 (11.9)	2194 (10.9)	0.032	956 (18.1)	431 (16.3)	0.047
Osteoporosis (%)	62 (8.3)	287 (7.7)	0.023	7890 (37.2)	7713 (36.4)	0.017	3225 (61.1)	1562 (59.2)	0.039
Depression (%)	118 (15.9)	556 (15.0)	0.025	3635 (18.0)	3564 (17.7)	0.009	1123 (21.3)	560 (21.2)	0.001
Dementia (%)	3 (0.4)	12 (0.3)	0.013	340 (1.7)	345 (1.7)	0.002	453 (8.6)	241 (9.1)	0.019
Type of insurance (%)			0.029			0.005			0.044
Health insurance	689 (92.7)	3472 (93.5)		19,507 (96.8)	19,524 (96.8)		4964 (94.0)	2453 (92.9)	
Medical benefits	54 (7.3)	243 (6.5)		655 (3.2)	638 (3.2)		316 (6.0)	187 (7.1)	
City of residence (%)			0.068			0.014			0.033
Over 10milion	202 (27.2)	921 (24.8)		6812 (33.8)	6848 (34.0)		1266 (24.0)	615 (23.3)	
Over 1milion	160 (21.5)	767 (20.6)		4702 (23.3)	4586 (22.7)		1354 (25.6)	652 (24.7)	
Others	381 (51.3)	2027 (54.6)		8648 (42.9)	8728 (43.3)		2660 (50.4)	1373 (52.0)	
Type of hospital (%)			0.068			0.013			0.078
Teaching hospital	88 (11.8)	417 (11.2)		1917 (9.5)	1919 (9.5)		551 (10.4)	339 (12.8)	
General hospital	173 (23.3)	882 (23.7)		4189 (20.8)	4135 (20.5)		1201 (22.7)	597 (22.6)	
Independent hospital	463 (62.3)	2355 (63.4)		13,319 (66.1)	13,324 (66.1)		3248 (61.5)	1578 (59.8)	
Private clinic	19 (2.6)	61 (1.6)		737 (3.7)	784 (3.9)		280 (5.3)	126 (4.8)	
CCI (%)			0.045			0.012			0.067
0	105 (14.1)	538 (14.5)		1278 (6.3)	1277 (6.3)		184 (3.5)	116 (4.4)	
1	188 (25.3)	952 (25.6)		2999 (14.9)	2912 (14.4)		525 (9.9)	277 (10.5)	
2	172 (23.1)	792 (21.3)		4118 (20.4)	4129 (20.5)		782 (14.8)	425 (16.1)	
≥3	278 (37.4)	1433 (38.6)		11,767 (58.4)	11,844 (58.7)		3789 (71.8)	1822 (69.0)	

in the revision rate in HTO than in UKA ($p < 0.001$) (Fig. 2). The adjusted analysis considering base properties after PSM showed a significantly higher revision rate in HTO (HR: 1.21, 95% CI 1.10–1.34, $p = 0.0002$). At different time points, HRs were 1.19 (1.07–1.33) at 5 years and 1.21 (1.10–1.34) at 10 years (Table 3). After matching

Fig. 1 Flowsheet for eligibility

for different age groups, the revision rate was significantly higher for HTO in the age group of 50–69 years, (HR: 1.20, 1.12–1.28, $p < 0.0001$) and 70–90 years (HR: 1.62, 1.14–2.31, $p = 0.007$). On the other hand, there was no significant difference in the revision rate in the 30–49 years age group ($p = 0.46$).

Deep vein thromboembolism (DVT) was significantly less likely for HTO than UKA (HR: 0.27, 95% CI 0.21–0.35, $p < 0.0001$). Surgical site infection was also significantly lower in HTO than in UKA (HR: 0.37, 95% CI 0.30–0.44, $p < 0.0001$) in the total target population. Other adverse outcomes, including pulmonary thromboembolism, cerebrovascular disease, myocardial infarction, acute renal failure, and postoperative delirium, showed insignificant differences (Table 4). Postoperative admission to the ICU was significantly lower with HTO (OR: 0.40, 95% CI 0.29–0.54, $p < 0.0001$), while rehospitalization within 30 days (OR: 1.27, 1.16–1.38, $p < 0.001$) and 90 days (OR: 1.24, 1.18–1.30, $p < 0.001$) were significantly increased compared to that with UKA. However, blood transfusion during or after surgery did not differ significantly between the two methods (eTable 10 in the supplementary appendix). When stratified analysis by age was conducted for survival rates and postoperative adverse outcomes, results of the group aged 50–69 years were broadly similar to those of all the patients (eTable 4, eTable 5 in the supplementary appendix). Specifically, DVT and surgical site infection occurred

significantly lesser with HTO than with UKA throughout all the age groups (eTable 2, eTable 5, eTable 8 in the supplementary appendix). In the 30–49 years age group, there was significantly lesser difference in survivorship (eTable 1 in the supplementary appendix) and in the risk of adverse outcomes following the two procedures, except for occurrence of DVT (HR: 0.27, 0.09–0.82, $p = 0.02$) (eTable 2 in the supplementary appendix). The risk of rehospitalization within 30 days (OR: 1.28, 1.01–1.61, $p = 0.04$) and 90 days (OR: 1.25, 1.09–1.43, $p = 0.001$) was higher with HTO than with UKA (eTable 9 in the supplementary appendix).

Discussion

Primary surgical treatments considered for knee OA limited to the unicompartment can be broadly divided into UKA and HTO [24]. According to previous studies, up to 47% of the patients suitable for knee replacements only have medial compartment OA [3–5]. Therefore, instead of TKA, it is necessary to choose the appropriate primary surgical method for treating medial knee OA. In the present study, during the 11.5-year follow-up period, the survival rate of UKA was significantly higher than that of HTO. Additionally, we found that the incidence of adverse outcomes after each treatment was different. Interestingly, the incidence of postoperative DVT and surgical site infection were higher
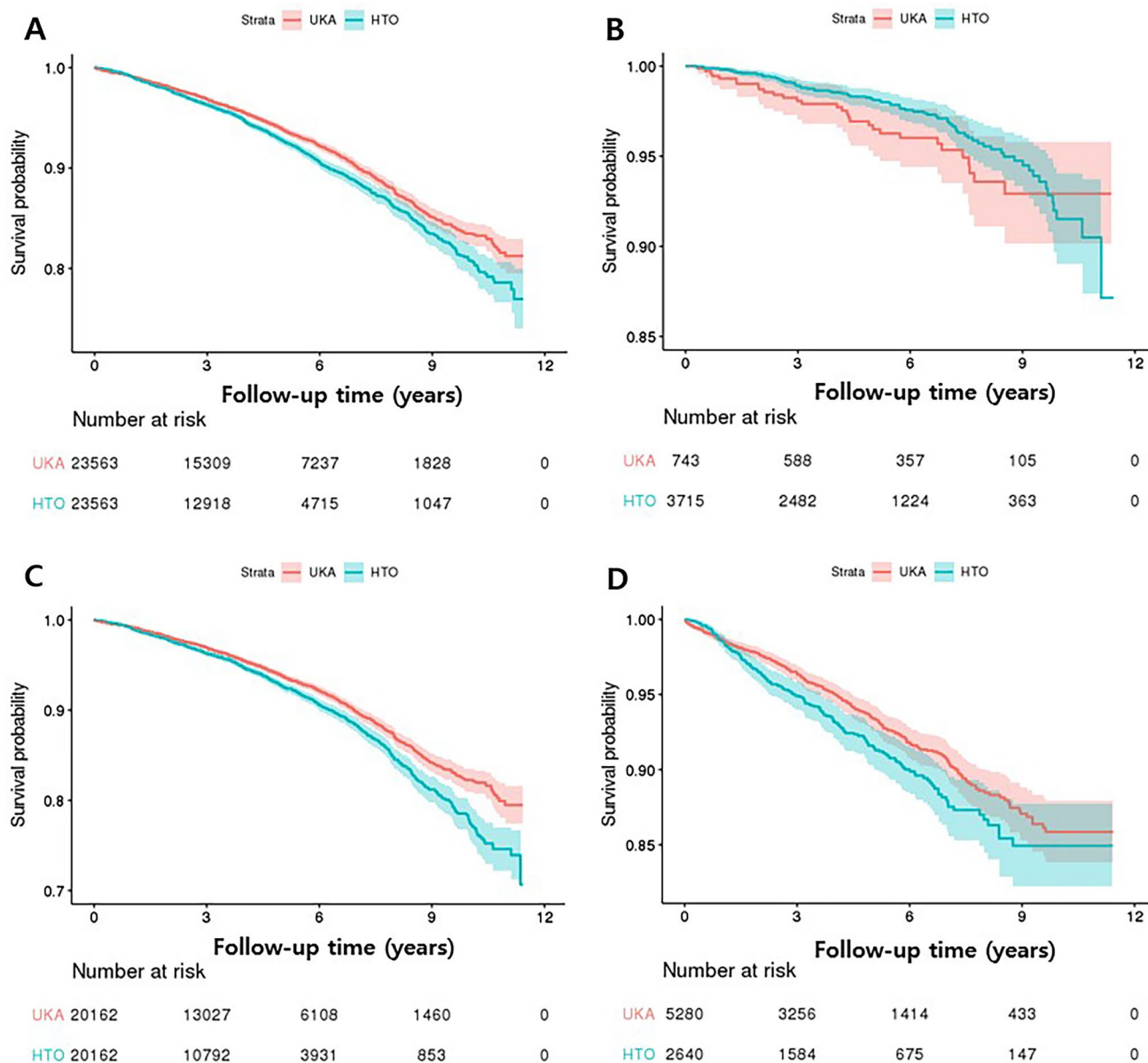
Fig. 2 Kaplan–Meier survivorship curve: 11.5-year survivorship in matched patients. **A** Total patients, **B** age 30–49, **C** age 50–69 and **D** age 70–90

in UKA than in HTO in the total study population and all age subgroups. For surgical site infections, only deep infections were included and superficial infections were excluded through review of diagnostic codes and a series of medical records.

Surgical treatment of predominantly medial knee OA using UKA or HTO is increasing steadily. In previous literature that reported the utilization status of UKA, UKA accounted for only 5% of the total number of knee arthroplasties in England and Wales, and 8% in the United States and increased by 32.5% annually [16, 17]. In the case of HTO, the number of procedures increased substantially

during the last decade, comprising about 11% of TKA utilizations in South Korea [25]. Worldwide, the market for knee replacement surgery is nearing £5 billion annually [2] and the number of procedures for unicompartmental knee OA is also expected to increase [15, 24]. Despite numerous comparative investigations between these two reliable surgical methods, there still exists a lack of clarity regarding the longevity or durability and perioperative adverse outcomes [24, 26].

Long-term survival results, that is conversion to TKA following UKA and HTO varied in previous studies, some authors reported that UKA tends to need revision sooner

Table 3 COX proportional hazard survival analysis for risk of revision after PS matching for total patients

	HTO (n = 23,563)			UKA (n = 23,563)			After PSM (adjusted)		
	N	%	1000 PY	N	%	1000 PY	HR	95% CI	P value
Revision									
Event	1399	(5.94%)	15.57	1509	(6.40%)	14.10	1.21	(1.10,1.34)	0.0002
Days	1291.04	±887.14		1441.93	±929.29				
Revision (5 years)									
Event	1033	(4.38%)	13.70	1002	(4.25%)	11.90	1.19	(1.07,1.33)	0.0012
Days	858.88	±501.05		891.01	±525.75				
Revision (10 years)									
Event	1386	(5.88%)	15.49	1498	(6.36%)	14.07	1.21	(1.10,1.34)	0. 0002
Days	1267.42	±856.83		1424.23	±909.32				

UKA unicompartmental knee arthroplasty, *HTO* high tibial osteotomy, *HR* hazard ratio, *CI* confidence interval, *PY* person year, *reference* UKA, *PSM* propensity score matching

Adjusted variable: age, sex, co-mobidities, type of insurance, region of residence, type of hospital, CCI

CCI: myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease, peptic ulcer disease, mild liver disease, moderate or severe liver disease (3), diabetes without complications, diabetes with complications (2), paraplegia and hemiplegia (2), renal disease (2), cancer (2), metastatic carcinoma (6), AIDS/HIV (6)

Table 4 Adverse outcomes following unicompartmental knee arthroplasty and high tibial osteotomy (matched analysis)

	HTO (n = 23,563)			UKA (n = 23,563)			After PSM (adjusted)		
	N	%	1000 PY	N	%	1000 PY	HR	95% CI	p value
Deep vein thromboembolism									
Events	133	(0.56%)	1.48	445	(1.89%)	4.16	0.27	(0.21, 0.35)	<0.0001
Days	699.70	±860.22		297.80	±657.60				
Pulmonary thromboembolism									
Events	79	(0.34%)	0.88	113	(0.48%)	1.06	0.78	(0.59, 1.05)	0.0989
Days	617.77	±804.16		774.77	±959.45				
Cerebrovascular disease									
Events	3817	(16.20%)	42.49	4237	(17.98%)	39.59	1.03	(0.99, 1.08)	0.16
Days	732.23	±795.41		859.86	±862.53				
Myocardial infarction									
Events	247	(1.05%)	2.75	283	(1.20%)	2.64	1.01	(0.86, 1.21)	0.86
Days	820.80	±921.52		979.82	±977.86				
Acute renal failure									
Events	171	(0.73%)	1.90	207	(0.88%)	1.93	1.01	(0.82, 1.23)	0.96
Days	1081.58	±978.64		1203.01	±943.17				
Postoperative delirium									
Events	42	(0.18%)	0.47	38	(0.16%)	0.36	1.34	(0.86, 2.08)	0.20
Days	831.36	±843.03		1325.66	±1018.10				
Surgical site infection									
Events	210	(0.89%)	2.34	565	(2.40%)	5.28	0.37	(0.30, 0.44)	<0.0001
Days	553.37	±782.56		525.61	±763.79				

UKA unicompartmental knee arthroplasty, *HTO* high tibial osteotomy, *HR* hazard ratio, *CI* confidence interval, *PY* person year, *reference* UKA, *PSM* propensity score matching

[27], whereas another resulted in UKA showing better longevity than HTO [4, 12], the others revealed no significant differences in the survivorship [18, 24]. However, a majority of the previous comparative studies had different baseline characteristics. Few studies have performed appropriate survival analyses considering censoring and other confounding factors, which might lead to the known attrition bias. In our study, after PSM and regarding adjusted variables, UKA showed better survival rate than HTO at the 5-year, 10-year follow-up, and throughout the entire study period in

all the patients. After the stratified analysis by age, similar results were reported in the patients aged 50–69 years and 70–90 years (eTable 4 and eTable 7 in the supplementary appendix).

The results for postoperative complications varied among different studies in the literature. Some researchers reported that UKA leads to significantly better functional outcomes with lower postoperative complications than HTO [10, 18, 28], while others showed no significant differences [11, 20]. However, to the best of our knowledge, major medical adverse outcomes associated with the two surgical treatments have not been investigated. In particular, the incidence of DVT and surgical site infection was significantly low in the HTO group (Table 4).

The HTO group showed significantly low infection rate, which may be related to a relatively short operation time [29, 30], and showed low risk of DVT possibly due to routine usage of mechanical compression after surgery [31], and pharmacologic prophylaxis [32]. These possible attributing factors were not identified by the Korean NHIS data. The perioperative complications, including admission to the ICU and postoperative rehospitalization within 30 days and 90 days, showed a significant difference between UKA and HTO (eTable 10 in the supplementary appendix). In several studies, the cemented arthroplasty depicted as an independent predictor of a significantly increased likelihood of admission to the ICU after the operation [33, 34]. The strength of our study is the use of one of the largest NHIS systems worldwide. Using strict PSM, we reduced confounders with a well-designed statistical technique. Regarding the different surgical indications mentioned by previous publications, we performed additional three rounds of PSM for each stratified age group (30–49, 50–69, and 70–90), which probably minimised the sampling bias. Even excluding UKA under 50 years old and HTO over 70 years old, the results of age stratified subgroup analysis of between 50 and 70 years showed similar to those of total patients. However, this study has several limitations. First, claims-based studies have inherent problems, including inaccurate diagnostic codes. The diagnostic and procedure codes cannot reflect actual medical history. Second, The Korea National Health Insurance Corporation database does not provide detailed medical records of patients. Thus, the clinical scores and various outcome-associated factors such as body mass index, osteoarthritis stage and degree of leg deformity were not provided. Third, the maximum follow-up period of this study was 11.5 years which can be extended in future studies. Fourth, in the treatment of medial compartment knee OA, it should also be considered that selection bias may occur because each surgeon has different preferences for surgery. Finally, there are still many confounding factors after considerable adjusting of variables and appropriate matching. The severity of OA cannot be identified radiologically, and other confounders such as the type of implants used or different surgical techniques were not considered. Despite these limitations, to the best of our knowledge, the current study is the first large-scale, long-term cohort study with a well-designed validation to evaluate comparative effectiveness of UKA and HTO. Nevertheless, a randomized, level one study is required to compare these two well-documented surgical methods for unicompartmental knee OA.

Conclusions

When choosing the surgical method for unicompartmental knee OA, not only the survival rate, but also the risk of other adverse outcomes should be considered. Notably, patients considering UKA should pay attention to DVT and surgical site infection that may occur after surgery.

Declarations

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