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Original Research

First Reported Series of Outpatient Total Knee Arthroplasty in the Middle East

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ABSTRACT

Background: Outpatient total knee arthroplasty (TKA) is becoming more commonplace in the United States. Alternatively, the current practice in the Middle East involves an inpatient stay of 7-10 days in the hospital after TKA. This study reports the early results of the first reported series of outpatient TKA performed on patients in the Middle East and compares the clinical and functional outcomes with those of patients who underwent inpatient TKA.

Methods: Eighty-eight patients underwent TKA (inpatient: 44 and outpatient: 44) using the modified intervastus approach in 2 hospitals in the Middle East from 2017 to 2019. Clinical and functional outcomes were assessed by recording the Knee Injury and Osteoarthritis Outcome Score, visual analog scale (VAS) for pain, and knee range of motion (ROM) preoperatively, on the day of surgery, and postoperatively at 2 weeks, 6 weeks, 3 months, and 6 months.

Results: Two patients undergoing outpatient TKA had complications: one patient suffered a periprosthetic fracture on postoperative day 10 after a fall, and the other patient had drainage on postoperative day 5. No complications occurred in the inpatient TKA cohort. There were no significant differences observed in the VAS scores or knee ROM numbers recorded for inpatient and outpatient TKA groups at any of the follow-up periods. Overall, the Knee Injury and Osteoarthritis Outcome Score, VAS, and ROM significantly improved 6 months after surgery compared with preoperative values for both inpatient and outpatient TKA groups.

Conclusions: Outpatient TKA was safely implemented when compared with inpatient TKA, with satisfactory results. A total of 2 complications were seen in this study, which we believe are unrelated to the patient's discharge status. The concept of outpatient TKA using the modified intervastus approach was very well accepted by the patients in this study and can potentially be applied safely elsewhere in the region.

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Introduction

More than 600,000 total knee arthroplasty (TKA) procedures are performed in the United States annually [1]. Primary TKA procedures have traditionally relegated patients to a 3- to 5-day hospital stay. Hospital length of stay after TKA has been gradually declining over the past decade, and this can be attributed to modern anesthetic techniques, multimodal analgesia (with less emphasis on narcotic utilization), and early postoperative mobilization [2-5]. The clinical and functional outcomes after TKA have also improved secondary to enhanced instrument and implant designs, development of postoperative pathways, and better preoperative optimization protocols [2]. The recent Centers for Medicare and Medicaid Services removal of TKA from the inpatient-only procedure list reflects the overall advancement in the science and practice of knee arthroplasty [6].

Several approaches have been used to perform TKA procedures including the medial parapatellar, subvastus, and midvastus techniques. The modified intervastus (MIV) approach and its application

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in TKA has been previously described [7,8]. The advantages of this approach include its extensile nature, preservation of both the extensor mechanism and the vastus medialis, and a return to active knee extension that may occur more rapidly than is traditionally observed [7,8].

TKA is performed commonly as an outpatient (same-day discharge) or short-stay procedure requiring less than a 72-hour hospital stay in the United States. Current practice in the Middle East is an inpatient hospital stay of 7-10 days after a TKA procedure. Two-week hospitalizations after a TKA are not that uncommon. Recently, we introduced outpatient TKA with an MIV approach to the Middle East region. This article reports the early results of this first reported series of outpatient TKA performed on patients in the Middle East and compares the clinical and functional outcomes with those of patients who underwent inpatient TKA during the same time. We hypothesized that outpatient joint replacement surgery would be very well accepted and successfully performed with minimal complications. We also hypothesized that outpatient TKA would provide clinical and functional outcomes that are similar to those seen for inpatient TKA when compared using specific outcome measures. Specific outcome measures used in this study include independent ambulation, the Knee Injury and Osteoarthritis Outcome Score (KOOS), the visual analog scale (VAS) for pain, and the knee range of motion (ROM).

Material and methods

Patients and surgical procedures

A total of 192 patients with primary osteoarthritis of the knee underwent TKA using the MIV approach performed by 1 experienced orthopaedic surgeon between 2017 and 2019. The details of the MIV surgical approach to the knee have been previously described [7,8]. Eighty-eight of the 192 patients had similar preoperative medical status, body mass index (BMI), overall comorbidities, and American Society of Anesthesiologists score. Forty-four patients (age: 65.23 ± 8.28 years, BMI: 30.84 ± 7.81 kg/m^2) of these 88 patients underwent outpatient TKA, whereas the remaining cohort of 44 patients (age: 71.11 ± 8.24 years, BMI: 31.15 ± 7.75 kg/m^2) to which they were later compared had TKA performed as an inpatient (Table 1). Patients were selected for outpatient joint replacement surgery based on the following criteria—the overall medical condition, American Society of Anesthesiologists score < 3, controlled diabetes mellitus with hemoglobin A1c < 7.5, hemoglobin >12, and nonopioid dependence—and must be considered motivated with good home support after surgery. A multidisciplinary approach was followed as the anesthesia and internal medicine teams were consulted before surgery to assure compliance with the outpatient protocols. The TKAs were performed in 2 hospitals (Adam Vital Hospital in Dubai, United Arab Emirates, and Specialized Medical Center Hospital in Riyadh, Saudi Arabia). The study was approved by the institutional review board at each location.

Table 1
Patient demographics for inpatient and outpatient TKA groups.

Demographics	Inpatient	Outpatient	*P* value
Total no. of patients	44	44	
Gender			
Male	22	26	
Female	22	18	
Age (years)			
Mean ± standard deviation	71.11 ± 8.24	65.23 ± 8.28	**.001**
Range	52-89	52-86	
BMI (kg/m^2)			
Mean ± standard deviation	31.15 ± 7.75	30.84 ± 7.81	.884
Range	17-45	20-45	

The *P* values which have a significant effect are shown in bold type.

All patients received spinal anesthesia and were given an intraoperative periarticular pain block consisting of a mixture of ropivacaine, ketorolac, epinephrine, and clonidine. Patients also received 1 g of tranexamic acid at incision and closure with insertion of a hemovac drain that was removed on postoperative day 1 or 2, depending on the amount of drainage. The arthroplasty procedures were performed using the measured resection technique, and the implant used for all patients was the Persona Posterior Stabilized (Zimmer Biomet, Warsaw, IN) cemented knee system. Patella resurfacing was performed in the majority of cases at the surgeon's discretion after evaluating the degree of arthritis of the patellofemoral joint. Tracking of the patella was checked intraoperatively using the 'no-touch' technique [9,10], and the need for a lateral release was noted. All patients received a multimodal analgesic regimen preoperatively and postoperatively consisting of acetaminophen, oral opioids, anti-inflammatory pain medications, and gabapentinoids. None of the patients required the administration of intravenous narcotics for pain control. Intravenous antibiotics were continued for 24 hours postoperatively. Low-dose aspirin was used for thromboembolism prophylaxis for 28 days postoperatively [11,12]. Patients were mobilized on the day of surgery and were encouraged to bear full weight on both legs under the supervision of an experienced physical therapist. Static and dynamic quadriceps exercises were started on the same day of surgery along with active knee ROM exercises.

Clinical and functional outcome assessment

The patients undergoing inpatient TKA were admitted to the hospital after their surgery. Patients were then discharged after meeting all the criteria for discharge from the hospital, which include stable medical condition, ability to mobilize independently with or without ambulatory-assisted devices for at least 200 feet, pain controlled on oral analgesics, and available home support. The hospital length of stay for all inpatients was recorded. In contrast, all patients who underwent outpatient TKA were discharged from hospital on the same calendar day of surgery, and any reported complications and readmissions were documented at the latest follow-up. Patients who underwent inpatient and outpatient TKAs met the same discharge criteria before discharge. On discharge, all patients received daily home health nursing visits for 72 hours along with daily physical therapy visits for 12 days. Between postoperative days 5 and 7, patients in both groups had a scheduled follow-up visit with the internal medicine and orthopaedics service.

Clinical and functional outcomes were assessed by recording the KOOS, VAS for pain, the length of time required to ambulate independently (without assistance), and knee ROM. The KOOS was recorded preoperatively and postoperatively at 2 weeks, 6 weeks, 3 months, and 6 months. VAS for pain, knee ROM, and ambulation methods (independent, cane, walker) were recorded on the day of surgery and postoperatively at 2 weeks, 6 weeks, 3 months, and 6 months.

Patient satisfaction survey

Patients received a patient satisfaction survey measuring overall patient satisfaction, pain relief, percentage of improvement compared with their preoperative status, and whether they would have their surgery performed again for the same problem. Twenty of the patients who underwent outpatient TKA and 20 of the patients who underwent inpatient TKA were randomly selected to complete this survey.

Table 2
Methods of ambulation (independent, cane, and walker) at the day of surgery and postoperative at 2 weeks, 6 weeks, 3 months, and 6 months for both inpatient and outpatient TKA groups.

Ambulation	Category	Inpatient			Outpatient			*P* value
		Independent	Cane	Walker	Independent	Cane	Walker	
Day of surgery		10%	15%	75%	50%	32%	18%	**<.001**
Postoperative	2 weeks	15%	50%	35%	66%	25%	9%	**<.001**
	6 weeks	65%	15%	20%	80%	18%	2%	**.04**
	3 months	75%	20%	5%	98%	0%	2%	**.007**
	6 months	80%	20%	0%	98%	0%	2%	**.008**

The values are expressed as a percentage of total patients. *P* values indicate the significance level between inpatient and outpatient TKA groups at different times. The *P* values which have a significant effect are shown in bold type.

Statistical analysis

An independent *t*-test was performed to compare the KOOS, VAS, and ROM between the inpatient and outpatient groups preoperatively, on the day of surgery and during the postoperative follow-up periods. The one-way analysis of variance with a post hoc Tukey test was conducted to assess the statistical significance of the VAS and ROM results seen within each of the 2 study groups of patients on the day of surgery and during the postoperative follow-up periods (2 weeks, 6 weeks, 3 months, and 6 months). For the KOOS, preoperative values were compared with values for each of the follow-up periods by using the one-way analysis of variance with a post hoc Tukey test. The chi-squared test was used to assess and compare the assistive ambulatory device use results seen in the inpatient and outpatient study groups. All statistics were performed using SPSS software (version 26, IBM, Armonk, NY). Significance was set at $P < .05$.

Results

Complications

All patients were able to fully straight leg raise and demonstrate functional knee ROM on the day of surgery. The patella tracked centrally in all patients, and none required a lateral retinaculum release. All 44 patients who underwent outpatient TKA were released from the hospital on the day of surgery after meeting discharge criteria. The average length of stay in the hospital for inpatient TKA was 2.02 ± 1.55 days.

Two patients in the outpatient TKA study group experienced complications. One patient suffered a periprosthetic fracture on postoperative day 10 after a fall and was treated with a distal femur replacement procedure. The other patient had drainage on postoperative day 5 and was treated with subcutaneous wound irrigation and capsule repair. The intraoperative cultures were negative. Both patients had a full recovery and experienced an excellent functional outcome. No complications were observed in the inpatient TKA study group. None of the other patients in this study were readmitted or required an emergency department (ED) visit.

Walking ability

All patients were able to walk on the day of surgery either independently or using a cane or walker. Ten percent of the patients of the inpatient TKA study group walked independently on the day of surgery, and this increased to 15% by the end of the second postoperative week (Table 2). Within 6 weeks, 65% of the inpatient TKA group walked independently and 80% of the inpatient group was independent within 6 months of surgery. The remaining 20% of patients used a cane for mobilization. In contrast, 50% of the patients of the outpatient TKA study group were able to walk independently on the day of surgery. This number increased to 66% at the end of the second postoperative week. At 6-month follow-up, 98% of the patients of the outpatient TKA group were able to walk independently and only 2% required the occasional use of a walker. This represents a significant difference compared with the inpatient TKA group ($P < .05$, Table 2). Therefore, the ability to ambulate independently was significantly higher in the outpatient TKA group for all postoperative follow-up periods ($p's < 0.05$, Table 2).

Knee Injury and Osteoarthritis Outcome Score

The 2-week postoperative KOOS for patients who underwent inpatient TKA was 51.14 ± 9.85, which is nearly a twofold and statistically significant improvement from the preoperative KOOS (25.74 ± 5.64), (98.68%, $P < .001$) (Table 3). The improvement trend continued to the end of the 6-month follow-up period at which a net improvement of 225% over the preoperative value was seen ($P < .001$). We observed similar improvement in the patients of the outpatient TKA study group. The preoperative KOOS in this group was 30.23 ± 10.56 and was noted to increase to 60.33 ± 11.84 after 2 weeks of surgery (99.57%, $P < .001$) (Table 3). At 6-week follow-up, the KOOS climbed to 85.75 ± 10.30 with a significant net improvement of 183.66% over the preoperative value ($P < .001$).

Patients who underwent outpatient TKA had a better KOOS preoperatively (inpatient: 25.74 ± 5.64 and outpatient: 30.23 ± 10.56, $P = .031$) (Table 3). The patients undergoing outpatient TKA tended to be healthier and more motivated than inpatients, and that could explain why they had a better KOOS preoperatively. Patients who underwent outpatient TKA had a higher KOOS postoperatively at 2 weeks ($P = .004$); however, there was no significant difference between patients who underwent inpatient and outpatient TKAs for the rest of the follow-up periods.

Table 3
Knee Injury and Osteoarthritis Outcomes Score for joint replacement preoperatively and postoperatively at 2 weeks, 6 weeks, 3 months, and 6 months for both inpatient and outpatient TKA groups.

KOOS	Category	Inpatient	Outpatient	*P* value
Preoperative		25.74 ± 5.64	30.23 ± 10.56	**.031**
Postoperative	2 weeks	51.14 ± 9.85[a]	60.33 ± 11.84[b]	**.004**
	6 weeks	65.85 ± 7.81[a]	70.21 ± 10.54[b]	.103
	3 months	73.51 ± 10.96[a]	78.34 ± 12.08[b]	.132
	6 months	83.67 ± 9.33[a]	85.75 ± 10.30[b]	.443

The KOOS is expressed for the interval score (0 to 100 scale). *P* values indicate the significance level between inpatient and outpatient TKA groups at different times. The *P* values which have a significant effect are shown in bold type.

[a] Indicates a significant change at postoperative times from preoperative for inpatient TKA ($P < .05$).

[b] Indicates a significant change at postoperative times from preoperative for outpatient TKA ($P < .05$).

VAS for pain

There was no statistically significant difference between the inpatient TKA group and outpatient TKA group in terms of the VAS on the day of surgery or at any other follow-up time (Table 4). Inpatient and outpatient TKA groups showed similar improvement for the pain score. For both groups, the VAS initially at 2 weeks did not change from the day of surgery (Table 4). The VAS started to decrease 6 weeks after surgery, and this trend continued until 6 months of follow-up for both inpatient and outpatient TKA study groups. The VAS score decreased 69.88% in the inpatient TKA group 6 months after surgery (the day of surgery: 4.15 ± 1.18 and 6th month postoperative: 1.25 ± 0.85, $P < .001$), whereas patients who underwent outpatient TKA showed a 76.90% decrease in their VAS score over the same time period (the day of surgery: 3.55 ± 1.92 and 6th month postoperative: 0.82 ± 0.95, $P < .001$).

Range of motion

No statistically significant difference in the knee ROM values were observed at any time when the patients in the inpatient TKA study group were compared with the patients in the outpatient TKA study group (Table 5). However, the knee ROM significantly improved after surgery in both groups. All patients who underwent inpatient and outpatient TKAs had significantly increased knee ROM values 2 weeks after surgery (inpatient: 7.82% and outpatient: 9.92%, P's $< .001$) (Table 5). The knee ROM values observed at 6 weeks, 3 months, and 6 months were also significantly improved from the day of surgery in both inpatient and outpatient groups (P's $< .001$). The net improvement in the knee ROM 6 months after surgery was 25.97% for the inpatient TKA group and 31.98% for the outpatient TKA group (P's $< .001$). Overall, there was a significant, comparable improvement in the knee ROM observed in the inpatient and outpatient TKA groups.

Patient satisfaction survey

Ninety-eight percent of outpatients and 93% of inpatients reported very high satisfaction with their TKA (Table 6). Similarly, 98% of patients who underwent outpatient TKA reported improved condition compared with the preoperative status while 95% of patients who underwent inpatient TKA reported an improvement. Ninety-nine percent of patients in the outpatient TKA group and 97% of patients in the inpatient TKA group reported pain relief after recovering from the surgery (Table 6). All patients from both groups would do the surgery again for the same problem. Specifically, patients from the outpatient TKA group would prefer the same-day surgery discharge again.

Table 4
Visual analog scale pain for joint replacement on the day of surgery and postoperatively at 2 weeks, 6 weeks, 3 months, and 6 months for both inpatient and outpatient TKA groups.

VAS	Category	Inpatient	Outpatient	*P* value
Day of surgery		4.15 ± 1.18	3.55 ± 1.92	.129
Postoperative	2 weeks	4.15 ± 0.99	3.73 ± 1.95	.254
	6 weeks	3.30 ± 1.34[a]	2.80 ± 1.52[b]	.207
	3 months	2.40 ± 1.19[a]	1.73 ± 1.28[b]	.051
	6 months	1.25 ± 0.85[a]	0.82 ± 0.95[b]	.086

P values indicate the significance level between inpatient and outpatient TKA group scores at different times.
[a] Indicates a significant change at postoperative times from the day of surgery for inpatient TKA ($P < .05$).
[b] Indicates a significant change at postoperative times from the day of surgery for outpatient TKA ($P < .05$).

Table 5
Knee range of motion in degrees on the day of surgery and postoperatively at 2 weeks, 6 weeks, 3 months, and 6 months for both inpatient and outpatient TKA groups.

Knee ROM	Category	Inpatient	Outpatient	*P* value
Day of surgery		101.65 ± 12.80	101.48 ± 14.67	.964
Postoperative	2 weeks	109.60 ± 12.76[a]	111.55 ± 14.04[b]	.599
	6 weeks	118.10 ± 11.65[a]	120.32 ± 14.31[b]	.546
	3 months	127.55 ± 13.18[a]	129.84 ± 17.42[b]	.603
	6 months	128.05 ± 14.35[a]	133.93 ± 18.86[b]	.220

P values indicate the significance level between inpatient and outpatient TKA groups at different times.
[a] Indicates a significant change at postoperative times from the day of surgery for inpatient TKA ($P < .05$).
[b] Indicates a significant change at postoperative times from the day of surgery for outpatient TKA ($P < .05$).

Discussion

In this study, we have compared the clinical and functional results of TKA performed using the MIV approach on patients who were hospitalized as inpatients with the results of patients who had the same TKA performed as an outpatient TKA. Our first hypothesis was that outpatient joint replacement surgery would be very well accepted and successfully performed with minimal complications. This hypothesis was supported as the concept of outpatient TKA was very well accepted by the patients in this study, which is the first of its kind reported in the Middle East. As seen with the results of the patient satisfaction survey, the outpatient TKA group rated their experience and overall satisfaction as excellent. Similarly, the inpatient TKA group also showed a very high overall satisfaction. The patients who underwent outpatient TKA in this study were noted to have very good clinical and functional outcomes with minimal complications. All of the patients were enrolled in the rapid recovery program, and this program involves preoperative patient education, spinal anesthetic, active preoperative pain management, same-day mobilization, immediate and frequent supervision by a well-trained therapy team, and significant patient access to providers for any problems that present the patient obstacles to rapid recovery. These program factors are important for the success of an outpatient TKA procedure [2]. A strong social support system is extremely beneficial for early postoperative recovery [2,13-15]. The Middle Eastern culture is the one rich with strong and close family relationships and support systems. Strong and widely available family support systems for postoperative patient support are thus the norm in the Middle East, and this makes outpatient knee arthroplasty an excellent and attractive option where it is applicable. This first reported series of outpatient total knee replacement on patients in the Middle East documents a positive reception to the concept by patients and families and also shows the ability to have excellent clinical and functional outcomes using the MIV approach to the knee for knee arthroplasty.

Our results show significant improvement in clinical and functional outcomes after both inpatient and outpatient TKA surgeries. Independent ambulation on the day of surgery and at 6-month follow-up was more prevalent in the outpatient group than in the inpatient group. The selection criteria for outpatient TKA likely and

Table 6
Results from patient satisfaction survey for both inpatient and outpatient TKA groups.

Survey questions	Inpatient	Outpatient
Overall patient satisfaction	93%	98%
The percentage of improvement compared with the preoperative status	95%	98%
Pain relief	97%	99%

reasonably explain the observed difference. Selected outpatients are motivated patients who preoperatively are believed likely to recover more rapidly. The satisfaction rates in both patient groups were very high and slightly higher in the outpatient group overall. This could be related to the selection bias for outpatients who tend to be healthier and more motivated patients who reach their end goals possibly quicker than the inpatients. The survey also shows that outpatient TKA was very well accepted with a high satisfaction rate in a medical culture biased toward inpatient TKA. Many studies have shown that a key to success of outpatient TKA is adopting a specialized pathway for outpatient total joint surgery with close surveillance [16,17]. Some of the essential elements involved in outpatient joint surgery are proper patient selection and preparation, intraoperative techniques using spinal anesthesia and adequate hemostasis achieved with a meticulous surgical technique, controlled hypotension, and perioperative use of tranexamic acid. Postoperatively, multimodal pain management and close surveillance with nurse navigators and home health were used to minimize potential complications [18]. Other than the 2 complications mentioned, none of the patients required an ED visit or a readmission. All patients had close postoperative follow-up with the internist by postoperative day 7 with 72 hours of daily home nursing. All patients postoperatively also had direct access to the surgeon and his assistants at all times so that problems or questions could immediately be addressed. We believe this close surveillance in the outpatient program implemented reduced potential complications, ED visits, readmissions, and improved overall patient satisfaction.

We also hypothesized that outpatient TKA would provide similar clinical and functional outcomes compared with inpatient TKA. When comparing between inpatient and outpatient TKA groups at all postoperative follow-up time intervals, no statistically significant difference was observed in VAS and knee ROM values. This supports our hypothesis that the clinical and functional outcomes observed in the 2 groups would be similar. With the prevalence of knee osteoarthritis in the younger population, the need for an increased knee ROM after TKA becomes more important so patients can return to work and function at their baseline. Several recent articles have also reported the excellent benefits of outpatient TKA compared with traditional inpatient surgery [2,19-23]. Studies have shown that there are no significant differences in patient-reported outcomes, satisfaction levels, or functional outcomes when comparing TKA done as an inpatient to TKA done as an outpatient [17,21]. A study of outpatient TKA with 2 years of minimum follow-up in 928 patients reported significant improvement in the ROM and outcomes scores with low revision rate [20]. Berger et al, reported on 111 outpatient TKAs and noted that 94% of patients were discharged on the day of surgery, and that only 3.6% were readmitted later with complications [24]. Courtney et al. also confirmed that TKA can be performed safely as an outpatient procedure in healthy Medicare patients with complication rates similar to those experienced by patients who underwent inpatient TKA [22]. In another study by Courtney et al. reports results of a querie of where the American College of Surgeons–National Surgical Quality Improvement Program between 2011 and 2014 for all patients undergoing a primary TKA or total hip arthroplasty. They found no differences in readmission rates between inpatient and outpatient arthroplasty surgeries with minimal complications [25]. It was also concluded that outpatient surgery itself did not lead to an increased risk of short-term complications when patients are carefully selected [25]. We implemented the MIV approach to the knee in all patients in this series. The MIV approach is a muscle- and tendon-sparing approach. This approach closes with restoration of the anatomy that results in a robust double-layered watertight seal closure of the proximal half of the arthrotomy, which enables or tolerates an aggressive postoperative patient behavior, knee ROM or function [7]. Although the advantages of a specific surgical approach in the knee arthroplasty have been a controversial topic, several studies have shown that with quadriceps-sparing approaches that patients may possibly have a quicker rehabilitation in the short term, which may therefore enhance outpatient knee arthroplasty [26,27].

Barriers to acceptance of outpatient TKA procedures could be the possibility of postoperative medical problems arising outside of the hospital setting that would be best treated in the inpatient setting and their related consequences or complications [20]. In our study, there were only 2 complications for outpatient TKA, and no complications were observed for inpatient TKA. When we reviewed those 2 patients who had complications in more detail, the one patient who had a fall on postoperative day 10 had several reports by the nursing homecare of being noncompliant with the use of her walker after discharge. This resulted in a mechanical fall that would have most likely occurred regardless of the patient's inpatient or outpatient status. The second patient who was admitted for postoperative wound drainage and required a washout was a heavy smoker. He was counseled on the postoperative surgical risks of smoking, and his surgery was delayed 12 months in an attempt to quit smoking. He was able to cut down, yet his arthritis became more debilitating and therefore was scheduled for surgery. Smoking is known to be a cause for infection and potential wound problems after TKA surgery [28]. None of the patients in the inpatient group were smokers. Thus, we believe the complications that have occurred in the TKA outpatient group are not directly related to their status of being an outpatient and could have occurred regardless of their discharge status. In future, we would consider smoking cessation is a prerequisite to outpatient TKA.

This study has several limitations. First, the study is retrospective and retains the potential bias associated with these types of clinical studies. In addition, the clinical and functional outcomes are reported only for first 6 postoperative months and longer term data will be necessary to validate this procedure. The selection criteria for the outpatient TKA group favor healthier and more motivated patients. The inpatient TKA group had an average hospital length of stay of 48 hours consistent with the average hospital length of stay in the United States and which is likely considerably less than the typical TKA hospital length of stay in the Middle East. We used the North American multidisciplinary approach to total joint arthroplasty during the study period and attribute the hospital length of stay in part to that approach that is widely used in the United States. This study suggests that when this approach is implemented and used in conjunction with firm pathways for patients undergoing total joint arthroplasty, excellent outcomes may be replicated with the observed length of stay, regardless of the region. Future studies should include the quantitative assessment of muscle forces by electromyography or using a dynamometer to understand the consequences of muscle function using the MIV approach, and outcomes should be reported with a lengthier follow-up period.

Conclusions

In summary, our study documents both safety and good clinical and functional outcomes using the MIV approach in outpatient TKA surgery for the first time in the Middle East region. As we hypothesized, the concept of outpatient TKA was very well accepted by the patients in this study and the outcomes were found to be comparable with inpatient TKA. We conclude that outpatient TKA can be safely implemented in the region with satisfactory outcomes.

Conflict of interests

B. Levine is a paid consultant for Exactech, Link, and Merete, receives research support from Zimmer Biomet–institutional, receives royalties, financial, or material support from Human Kinetics and

SLACK Inc, is a member of the editorial/governing board of the *JOA, AT*, and *Orthopedics* and an Associate CME Editor of the *JBJS*, and is a board member of the AAHKS patient education and research committees, MAOA education committee, and AAOS evaluation committee; all other authors declare no potential conflicts of interest. Dr. Levine is the Deputy Editor of *Arthroplasty Today* and was recused from the editorial process for this article, which underwent blinded peer review.

References

[1] Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am 2007;89(4):780.

[2] Edwards PK, Milles JL, Stambough JB, Barnes CL, Mears SC. Inpatient versus outpatient total knee arthroplasty. J Knee Surg 2019;32(08):730.

[3] Burn E, Edwards CJ, Murray DW, et al. Trends and determinants of length of stay and hospital reimbursement following knee and hip replacement: evidence. BMJ Open 2018;8(1):e019146.

[4] Kim S, Losina E, Solomon DH, Wright J, Katz JN. Effectiveness of clinical pathways for total knee and total hip arthroplasty: literature review. J Arthroplasty 2003;18(1):69.

[5] Stambough JB, Nunley RM, Curry MC, Steger-May K, Clohisy JC. Rapid recovery protocols for primary total hip arthroplasty can safely reduce length of stay without increasing readmissions. J Arthroplasty 2015;30(4):521.

[6] Federal Register/Vol. 82, No. 217/Monday, November 13 2017/Rules and Regulations. Medicare program: hospital outpatient prospective payment and ambulatory surgical center payment systems and quality reporting programs. https://www.govinfo.gov/content/pkg/FR-2017-11-13/pdf/2017-23932.pdf; 2017. [Accessed 20 August 2020].

[7] Sartawi M, Kohlman J, Della Valle C. Modified intervastus approach to the knee. J Knee Surg 2017;31(5):422.

[8] Sartawi M, Rahman H, Kohlmann J, Leighton R, Kersh ME. A retrospective analysis of the modified intervastus approach. Am J Orthop (Belle Mead NJ) 2018;47(12). https://doi.org/10.12788/ajo.2018.0106.

[9] Cho WS, Woo JH, Park HY, Youm YS, Kim BK. Should the "no thumb technique" be the golden standard for evaluating patellar tracking in total knee arthroplasty? Knee 2011;18(3):177.

[10] Laskin RS. Lateral release rates after total knee arthroplasty. Clin Orthop Relat Res 2001:88.

[11] Faour M, Piuzzi NS, Brigati DP, et al. Low-dose aspirin is safe and effective for venous thromboembolism prophylaxis following total knee arthroplasty. J Arthroplasty 2018;33(7):S131.

[12] Azboy I, Groff H, Goswami K, Vahedian M, Parvizi J. Low-dose aspirin is adequate for venous thromboembolism prevention following total joint arthroplasty: a systematic review. J Arthroplasty 2020;35(3):886.

[13] Hanchate AD, Zhang Y, Felson DT, Ash AS. Exploring the determinants of racial and ethnic disparities in total knee arthroplasty: health insurance, income, and assets. Med Care 2008;46(5):481.

[14] Jha AK, Fisher ES, Li Z, Orav EJ, Epstein AM. Racial trends in the use of major procedures among the elderly. N Engl J Med 2005;353(7):683.

[15] Johnston M, Vogele C. Benefits of psychological preparation for surgery: a meta-analysis. Ann Behav Med 1993;15(4):245.

[16] Berend KR, Lombardi AV, Berend ME, Adams JB, Morris MJ. The outpatient total hip arthroplasty: a paradigm change. Bone Joint J 2018;100B(1):31.

[17] Kolisek FR, McGrath MS, Jessup NM, Monesmith EA, Mont MA. Comparison of outpatient versus inpatient total knee arthroplasty. Clin Orthop Relat Res 2009;467:1438.

[18] Li J, Rubin LE, Mariano ER. Essential elements of an outpatient total joint replacement programme. Curr Opin Anaesthesiol 2019;32(5):643.

[19] Moore MG, Brigati DP, Crijns TJ, Vetter TR, Schultz WR, Bozic KJ. Enhanced selection of candidates for same-day and outpatient total knee arthroplasty. J Arthroplasty 2020;35:628.

[20] Crawford DA, Adams JB, Berend KR, Lombardi AV. Low complication rates in outpatient total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2020;28:1458.

[21] Gauthier-Kwan OY, Dobransky JS, Dervin GF. Quality of recovery, post-discharge hospital utilization, and 2-year functional outcomes after an outpatient total knee arthroplasty program. J Arthroplasty 2018;33(7):2159.

[22] Courtney PM, Froimson MI, Meneghini RM, Lee GC, Della Valle CJ. Can total knee arthroplasty be performed safely as an outpatient in the Medicare population? J Arthroplasty 2018;33(7):S28.

[23] Cassard X, Garnault V, Corin B, Claverie D, Murgier J. Outpatient total knee arthroplasty: readmission and complication rates on day 30 in 61 patients. Orthop Traumatol Surg Res 2018;104(7):967.

[24] Berger RA, Kusuma SK, Sanders SA, Thill ES, Sporer SM. The feasibility and perioperative complications of outpatient knee arthroplasty. Clin Orthop Relat Res 2009;467:1443.

[25] Courtney PM, Boniello AJ, Berger RA. Complications following outpatient total joint arthroplasty: an analysis of a national database. J Arthroplasty 2017;32(5):1426.

[26] Tzatzairis T, Fiska A, Ververidis A, Tilkeridis K, Kazakos K, Drosos GI. Minimally invasive versus conventional approaches in total knee replacement/arthroplasty: a review of the literature. J Orthop 2018;15(2):459.

[27] Berstock JR, Murray JR, Whitehouse MR, Blom AW, Beswick AD. Medial subvastus versus the medial parapatellar approach for total knee replacement: a systematic review and meta-analysis of randomized controlled trials. EFORT Open Rev 2018;3(3):78.

[28] Singh JA. Smoking and outcomes after knee and hip arthroplasty: a systematic review. J Rheumatol 2011;38(9):1824.