Total Joint Arthroplasty at a Tertiary Military Medical Center in Hawai‘i: Does Travel Distance Influence Short Term Complications?

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Abstract

As the health care delivery system in the United States changes, there has been an increase in the presence of specialized medical centers, translating into increased travel distance for patients. Tripler Army Medical Center in Honolulu, Hawai‘i serves a unique population of local patients and those traveling from neighboring Hawaiian Islands and from across the Pacific Basin and Asia. Previous studies have examined the role of distance traveled, but no study has looked at patients routinely flying in the immediate postoperative period. The purpose of this study is to investigate if increased travel distance is associated with a higher probability of complications after a total joint arthroplasty (TJA). A retrospective review of all patients receiving TJA at a single medical institution was performed. After meeting the inclusion criteria, 126 consecutive patients were reviewed for 30-day complications. Sixty-four patients were local (from O‘ahu, Hawai‘i), and 13 from neighboring Hawaiian Islands, while 49 were international. There were no significant differences in complications between the groups. Length of stay was not affected by distance. A significant risk factor for short-term complications was having a higher score based on the American Society of Anesthesiologists Physical Status Classification System (ASA), ASA 3 vs ASA 1&2 (14% vs 1%, P = *.015). There were no findings in our population to support inferior outcomes in patients traveling from the outer Pacific Basin during their initial postoperative course compared to the local population. No patient sustained a short-term complication after a patient returned to their island or country of origin. The results of this study will help to guide clinical decision making and effective resource management for patients seeking TJA traveling from a significant distance.*

Keywords

total hip and knee arthroplasty, joint replacement, postoperative orthopaedic complications, distance traveled

Abbreviations and Acronyms

ASA = American Society of Anesthesiologists Physical Status Classification System
BMI = body mass index
TJA = total joint arthroplasty
US = United States

Introduction

As the health care delivery system in the United States (US) changes, there has been increased specialization through “centers of excellence” within various regions of the US. This transition aligns with the shift in the health care model and payer system from volume to value. In recent years, payers, providers, and policymakers have placed increased emphasis on strategies to control costs and improve quality associated with elective surgical procedures such as total joint arthroplasty (TJA). As a result, more specialized surgical centers are developing throughout the US to minimize procedural expenses and in-patient length of stays through easier coordination of related health care providers. This finding has been the trend in the civilian health care market.[1] Consequently, increased pressures on the US government spending, illustrated through government shutdowns and cuts to the defense budget, has resulted in similar changes within the Military Health System, including 55 hospitals and more than 370 clinics across the nation and at US bases overseas.[2] These facilities are also now under the control of the Defense Health Agency. As a result, the Department of Defense has programmed a 25% reduction in workforce positions aligned to medical headquarters across the enterprise and a $202.5 million cut in health plan costs tied to that effort.[3] With these changes, the ability to improve quality of care while decreasing costs of standardized procedures are gaining more attention.

In recent years, the volume of patients undergoing TJA has increased due to an aging population, expansion of indications to include younger patients, and advances in technology, implant systems, and training. Therefore, this cost burden is expected to rise both in the civilian and military markets.[4] As more veterans and beneficiaries age, the percentage of the government health care budget required to address this need will only increase. Therefore, reducing costs and complications in TJA is at the forefront of cost reduction considerations.

Asian Americans and Pacific Islanders are one of the fastest-growing and most heterogeneous ethnic groups in the US currently accounting for 4% of the population but are expected to comprise 15.3% of the population by 2050.[5] Due to the geographic location of the Hawaiian island of O‘ahu, many of the same socioeconomic and access to care limitations are experienced by all patients regardless of their ethnicity.[6] It has also been reported that race, ethnicity, specifically Pacific Islanders, and geographic region are direct factors in disparities for utilization of TJA.[7-8] Furthermore, the socioeconomic disparities of the populations within the Pacific Basin have been associated with a higher rate of high-risk health behaviors, including smoking, alcohol abuse, obesity, and high-fat diet.[9] Several of these risky behaviors, particularly smoking, lack of diabetic control, and high body mass index (BMI), have been to be directly associated with rates of periprosthetic joint infections and overall complications in TJA.[10-12]

When looking at short-term outcomes, peri-prosthetic joint infection remains one of the most devastating complications in TJA. Not only does it lead to significant patient morbidity, but it can also create a cost burden to society by raising costs for primary TJA. [13-14] Total payments for a 30-day TJA episode in the US range from a mean of $25,568 for primary TJAs in patients with no comorbidities or complications to a mean of $50,648 for revision TJAs in patients with major comorbidities or complications.[14] Hence, reducing a single potential complication or identifying potential risk factors for complications can be a significant source of cost savings.

When assessing the risk of complication, one of the newest variables in the discussion has been travel distance.[1,16] The impact of travel distance on orthopedic surgery outcomes is a growing area in need of investigation, as very few studies have examined the effect of distance traveled on patient outcomes. Previous studies in general surgery demonstrated an increased risk for complication with increased travel distance.[17] Conversely, a recent study in bariatric surgery showed no increased risk for distance traveled.[18] Despite multiple studies demonstrating improved outcomes in high volume TJA centers, only 1 has evaluated the effect of distance traveled within a high volume center.[1] Moreover, air travel is associated with an increased risk of venous thromboembolism in orthopedic surgery.[19] This is the first study to look at distance traveled in the Pacific and have comparison groups composed entirely of patients who underwent air travel within 30 days of surgery.

Taken together, few centers in civilian or military medicine provide total joint arthroplasties to the underserved patients from outlying Pacific Islands or international patients from an expansive referral network. The purpose of this study is to compare the short-term complications associated with TJA for patients from the island of O‘ahu versus neighboring Hawaiian Islands and patients referred from the outlying Pacific Basin and Asia.

Methods

Following institutional review board approval, the electronic medical records were reviewed for all patients receiving TJA at Tripler Army Medical Center in Honolulu, Hawai‘i from 2015 to 2017. One hundred and fifty sequential patients from a single surgeon were selected based on Current Procedure Terminology (CPT) codes for joint arthroplasty or rreplacement. Of these, 126 patients met the inclusion criteria, which was total joint arthroplasty, either hip or knee and completed the same preoperative evaluation instituted in 2015. Revisions were not excluded in this study to improve the generalizability of the results, and 13 revisions were included. Preoperative evaluation included medical clearance within 30 days of surgery by a primary care physician, dental clearance within 90 days, methicillin-resistant staphylococcus aureus screening, and basic laboratory evaluation with complete blood count, basic metabolic panel, hemoglobin A1c, nutritional status and immediate preoperative evaluation by an anesthesiologist. The American Society of Anesthesiologists Physical Status Classification System (ASA) is used to categorize risk for clinical decision making based on a patient’s health and medical co-morbidities. ASA 1 is a patient with no medical comorbidities and not a smoker. ASA 2 has mild systemic disease, current smoker, or well-controlled medical problems, such as hypertension or diabetes. ASA 3 is a patient with 1 or more severe systemic diseases, such as poorly controlled diabetes, hypertension, chronic obstructive pulmonary disease, or morbid obesity. ASA 4 is a patient with severe systemic disease that is a constant threat to life. ASA 5 is a moribund patient who is not expected to survive without the operation, and ASA 6 is a patient who has been declared brain-dead whose organs are being removed for donor purposes. For this analysis, we included age, gender, place of residence, preoperative laboratory results and nutrition status, ASA classification, length of hospital stay, disposition at time of discharge, and last date of follow-up either at the treating hospital or a Veteran’s Administration clinic. Patient ethnicity was not reliably available and was not included in this analysis.

Details of the in-patient admission and follow up care were retrospectively reviewed by 2 resident physicians and 1 fellowship trained total joints orthopedic surgeon. For the sake of this review, we defined the following events as complications: unplanned return to the operating room or unplanned transfer to a higher level of care, acute myocardial infarction, acute stroke, deep venous thrombosis, venous thromboembolism, postoperative neurologic deficit, wound complications, periprosthetic joint infection, and death. Travel distance was calculated based on home of record in the medical chart at the time of admission. Distance was then classified into 3 categories based on the patient‘s residence: (1) within the hospital’s island of O‘ahu, (2) outside of O‘ahu but part of the neighboring Hawaiian Island chain, and (3) international, which included Japan, Korea, Saipan, Thailand, Guam, Marshall Islands, and American Samoa. For context, O‘ahu is 30 by 44 miles in size. Travel from a neighboring island typically involves a flight to Honolulu ranging from 108 miles east from Lihue on the island of Kaua‘i to 210 miles west from Hilo on the Big Island. International locations range from 2117 miles to the Marshall Islands as the closest island chain in our referral network and 4170 miles to Korea, the farthest referral location.

Statistical Analysis

Associations between the odds of having a complication and travel distance and patient characteristics (age, gender, BMI, ASA score) were first examined in univariate analyses. Subsequently, multivariable analyses were performed to determine the effect of travel distance on the odds of having a complication while controlling for patient characteristics. The multivariable logistic regression model included all patient characteristics listed above, as well as significant 2-way interactions. The

multivariable analysis was also performed with distance represented as a categorical variable as defined above. Independent and dependent paired t-tests were used to examine significant difference between groups and difference within pre- and postoperative data. Nonparametric testing (Mann-Whitney and Wilcoxon signed-rank tests) were used to verify the significance of each variable because of small sample sizes. The *P* value for statistical significance was set at .05.

Results

After meeting the inclusion criteria, 126 consecutive patients were reviewed for 30-day complications. Patients had a mean age of 63.1 years ± 10.1 years. The majority of our patients were male (n = 93; 74%). In total, 49 patients were international, 64 were local from O'ahu, Hawai'i, and 13 from neighboring Hawaiian Islands (Table 1). There were no significant differences in complications between the groups (Table 2). Length of stay was not significantly different between the groups ($P > .0776$).

There were 6 patients with complications among the 126 patients, representing an overall 5% who experienced a complication (Figure 1). The most frequent complication was an unplanned transfer to a higher level of care (n = 4; 67%). The only significant risk factor for short-term complications was having a higher ASA score (ASA 3 vs ASA 1 & 2 [14% vs 1%, $P = .0151$]).

The 30-day outcomes in each group showed 2 significant surgical complications in our international patients (2 of 49, 4%), with 1 patient requiring return to the operating room on postoperative day 19 for an acute postoperative infection and underwent an irrigation and debridement with polyethylene exchange. The other patient had a pulmonary exacerbation due to chronic obstructive pulmonary disease that required escalation of care and during the same hospital admission went on to develop a wound dehiscence requiring a gastrocnemius flap approximately 5 weeks from his index surgery.

Among the 64 local patients, 3 (5%) had complications. One patient had a mechanical fall at home, sustaining a peri-prosthetic hip fracture on postoperative day 6, and 2 patients had medical complications during their initial admission that required escalation of care.

Among the 13 patients from neighboring islands, 1 (7%) patient sustained a minor embolic stroke on postoperative day 2 with no residual sensory or motor defects at the time of hospital discharge. There were no findings within our measured outcomes to support inferior results in those who have immediate access to care compared to patients traveling from the Pacific Basin. No patient sustained a short-term complication after a patient returned to his or her island or country of origin.

Table 1. Patient Demographics

	International	O'ahu, Hawai'i	Neighboring Hawaiian Islands
Age, y	60 ± 11.3	64 ± 9.2	68 ± 4.9
Sex	37 males [M], 12 females [F]	43M, 21F	13M
TKA	28	44	10
THA	21	19	3
Revision Joint Arthroplasty	5	5	2
BMI, kg/m^2	32.7	31.1	29.8
ASA 1 or 2	66%	66%	73%
ASA 3	34%	34%	27%
Complications	2 (4%)	3 (5%)	1 (8%)
Length of Stay, days	5.2 ±7.7	5 ±4.1	7.1 ±3.1

Abbreviations: TKA, total knee arthroplasty; THA, total hip arthroplasty; BMI, body mass index; ASA, American Society of Anesthesiologist Physical Status Scale

Table 2. Postoperative Complications among Total Joint Arthoplasty Patients by Study Characteristics				
	Complication Associations			
	N[a]	**N[b]**	**%**	***P* value[c]**
Patient Groups	**126**	**6**	**5**	
Age, y				
39-59	43	1	2	.66
≥60	83	5	6	
Sex				
Female	33	0	0	.34
Male	93	6		
BMI, kg/m^2				
<25	15	0	0	.08
25-<30	32	4	13	
30-<35	32	0	0	
35-<40	13	0	0	
≥40	14	2	12	
Veteran's Administration				
Yes	68	4	6	.69
No	58	2	3	
Origin				
O'ahu	64	3	5	.86
International	49	2	4	
Outer Island	13	1	8	
Procedure				
THA	39	1	3	.48
TKA	74	4	5	
THA revision	5	1	20	
TKA revision	8	0	0	
ASA				
1	5	0	0	.06
2	65	1	2	
3	34	5	15	
3E	1	0	0	
ASA				
1/2	70	1	1	**.02**
3/3E	33	5	14	
Laterality				
Left	69	5	7	.22
Right	57	1	2	
Albumin				
<3.5	2	0	0	.72
3.5-3.99	10	0	0	
≥4	114	6	5	
Hematocrit				
20-34.9	16	1	6	.97
35-38.79	23	1	4	
38.8-50	78	4	5	

Table 2. Postoperative Complications among Total Joint Arthoplasty Patients by Study Characteristics (Continued)				
Hemoglobin				
<12	20	2	10	.41
12-15.5	96	4	4	
>15.5	10	0	0	
Hemoglobin				
<12	20	2	10	.24
>12	106	4	4	
Protein				
5-7	41	1	2	.69
>7-7.5	49	3	6	
>7.5	36	2	6	
Hemoglobin A1c				
<5.7	42	1	2	.63
5.7-6.4	45	3	7	
>6.4	24	1	4	

[a] N=number of patients within specified group; [b] n=observed complication(s) within the specified group; [c] *P* values calculated using Chi-squared test or Fisher's exact test.
Abbreviations: BMI, body mass index; THA, total hip arthroplasty; TKA, total knee arthroplasty; ASA, American Society of Anesthesiologist Physical Status Scale

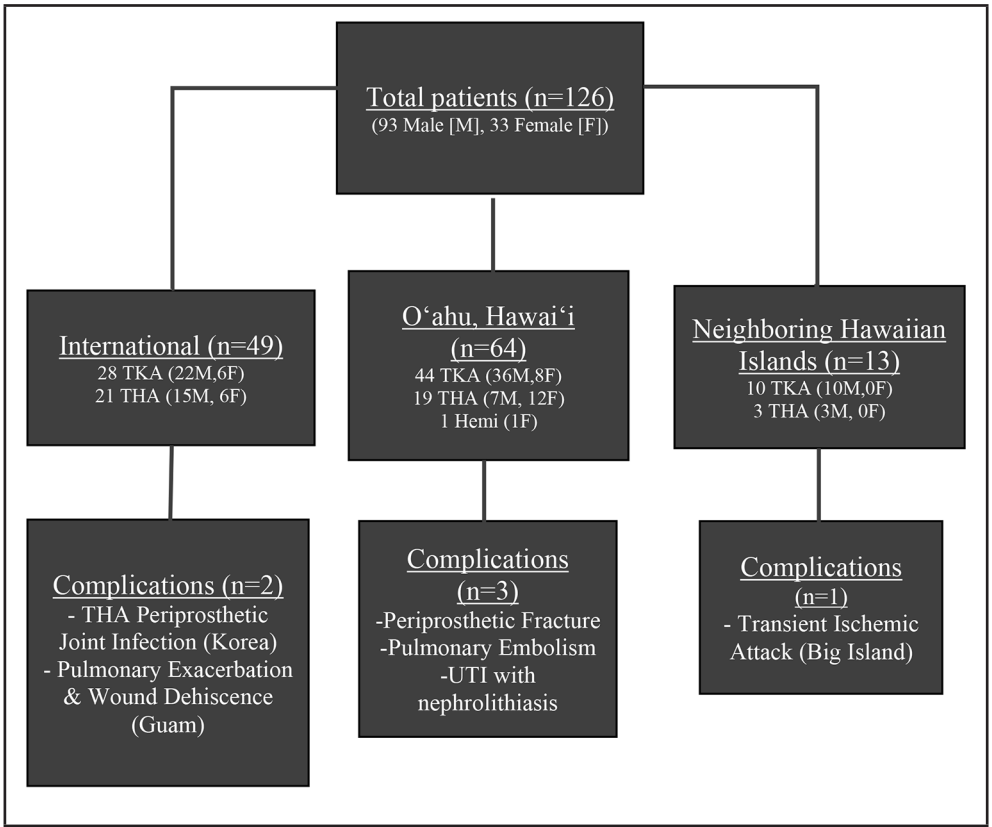

Figure 1. Postoperative Complications among Total Joint Arthoplasty Patients by Place of Residence

Abbreviations: THA, total hip arthroplasty; TKA, total knee arthroplasty; UTI, urinary tract infection

Discussion

As health care delivery continues to evolve, there will be a shift towards value and accountability on the operating surgeon or hospital to minimize complications and adverse outcomes. Specifically, previous studies have shown an association between surgical volume at both the surgeon- and hospital-levels with complication rates and readmission rates after primary TJA.[20] These studies suggest that efforts to regionalize joint replacement services or concentrate surgical procedures at higher-volume institutions may reduce early readmissions and postoperative complications after primary TJA.[21-22] This will inevitably lead to an increase in patient travel as regional centers displace smaller institutions. However, none of these studies included significant air travel in patients undergoing TJA at these centers, which is known to increase risk of venous thromboembolism. Although our overall complication rate was 5% in this population, when we only include complications that resulted in a return to the operating room, our complication rate was 2%. This rate is lower than the overall short-term complication rate of 3.9% reported by previous series of 15,383 joint arthroplasties.[23] This finding is in spite of the fact that we did not exclude revisions in our series, which are known to have a higher complication rate. This lower complication rate observed may be due to our specific preoperative evaluation required before TJA, which was is not universal in most large database studies or that our series was underpowered. We must also address that 2 of the 3 complications that required a return to the operating room were international. While this likely was not attributable to travel based on known complications secondary to travel demonstrated in other reports and more so due to the patients being ASA 2 and 3 with uncontrolled medical comorbidities, it is possible that with a larger sample size, we could identify new complications associated with travel.

As previously discussed, preoperative optimization of risk continues to be a major focus of research in preventing complications in TJA. Some of the most important risk factors for early complication are chronic disease states such as diabetes mellitus, obesity (BMI > 40 kg/m^2), inflammatory arthritis, preoperative anemia, congestive heart failure, and renal disease.[24-29] One specific outlier in our series is BMI. Several large database studies indicated BMI > 40 kg/m^2 is an increased risk of surgical site infection, and many centers have begun to refuse TJA in these patients until they achieve a lower BMI.[11] Our study's average BMI was 31.6 kg/m^2 with a standard deviation of 7.0; 11% of our patients with BMI > 40 kg/m^2. This larger percentage in our series is due to much of our patient population being flown to our center just before surgery with limited ability to refuse strictly due to BMI after otherwise obtaining medical clearance. Additionally, owing to our location, our series included a higher proportion of patients of Polynesian descent whose unique body composition has been shown to have a BMI value of up to 5 kg/m^2 higher than Europeans of equivalent levels of body fat.[30] This difference in body mass composition may explain why we could not identify BMI as a risk factor for complications despite our population, including patients with a higher BMI than normally assessed in TJA literature.

Second, unlike previous studies that were able to identify specific patient comorbidities that were independently associated with an increased risk of infection in the 90-day postoperative period, we did not find specific preoperative risk factors for complication including distance traveled.[21] Our study did, however, identify that ASA classification system was independently predictive of postoperative complications. To our knowledge, ASA class has not been demonstrated in TJA to be an independent risk factor, although it has been demonstrated as a risk factor in orthopedic trauma patients.[31] More recently, ASA class has been used in a novel risk calculator to predict readmission following TJA.[32] In our population, ASA 3 was the only variable significantly associated with complication risk. Even with the relatively low patient volume of our study group (126 patients), power analysis showed the minimum number needed to detect a difference between rates of 1% and 10% was 121 patients, and we found an increased risk in ASA 3 vs ASA 1 & 2 (14% vs 1%, $P = .0151$). This finding highlights the potential prognostic importance of the ASA class to identify patients at high risk of complications better.

We found no statistically significant difference in patients receiving TJA related to patient distance traveled and there was no significant difference in length of stay between the local population and those traveling internationally. Lastly, all patients were followed until a follow-up was completed in their country of origin, and no complications were observed after a patient returned to their country of origin.

This study is the first to look at distance traveled and its relation to short term perioperative outcomes of TJA in the military veteran and Pacific Basin population. As additional studies demonstrate reduced complications and hospital costs when TJA is performed at higher volume centers, travel distance of patients undergoing these procedures will likewise increase. This study demonstrated no increased risk for patients traveling from neighboring islands or the Pacific Basin. Inherently in the study design, we are limited by its retrospective nature. We are also limited by the small sample size of our series that is underpowered to identify significant differences in rare complications associated with TJA. Further research will aid in the optimization and clinical decision making for patients seeking TJA within large referral networks requiring air travel prior to surgery.

Conclusion

The results of this study may help to guide clinical decision making and effective resource management for patients seeking total joint arthroplasty at a tertiary medical center. We have not demonstrated an increased risk of complication regarding travel

distance, but we show complication risk significantly increases with ASA 3 patients, suggesting that further optimization of a patient's medical comorbidities may need to be fully addressed and corrected prior to travel. Regional "centers of excellence" appear to be a viable model in health care reorganization; however, continued attention should be paid to attenuating the individual patient risk factors, especially patient comorbidities prior to TJA, in efforts to minimize perioperative complications.

The views herein are the private views of the authors and do not reflect the official views of the Department of the Army or the Department of Defense.

Conflict of Interest

None of the authors identify a conflict of interest.

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