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Outcomes of Femoral Neck Fracture Treated With Hip Arthroplasty in Solid Organ Transplant Patients

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ABSTRACT

Background: Solid organ transplant (SOT) patients have increased risk of complications, infection, and mortality after elective total hip arthroplasty (THA). The study aims to compare SOT recipients' clinical outcomes to a matched group of nontransplant patients after nonelective THA and hemiarthroplasty for acute femoral neck fracture (FNF).

Methods: A retrospective review identified 31 SOT patients undergoing hip arthroplasty (24 hemiarthroplasty and 7 THA) for FNF and were matched 1:1 to non-SOT patients based on age, sex, body mass index, surgical procedure, and year of surgery. Patient survivorship, perioperative outcomes, complications, and reoperations were compared. The mean follow-up was 3 years.

Results: The estimated survivorship free from mortality for SOT and non-SOT patients at 1- year was not different (77% and 84%, respectively, $P = .52$). The 90-day readmission rate was significantly higher with 8 (26%) in the SOT cohort and none in the non-SOT group ($P < .01$). Major medical complications occurred in 16% of SOT patients compared to 5% in controls ($P = .21$). Three (10%) reoperations/revisions were required for SOT patients and none in non-SOT group ($P = .24$).

Conclusion: SOT recipients undergoing nonelective hip arthroplasty for FNF demonstrated increased readmission rates compared to matched controls. For this rare clinical scenario, diligent perioperative care by surgeons and multidisciplinary transplant specialists is necessary to mitigate increased risk of SOT patients.

Introduction

For patients with end-stage disease of the kidney, liver, heart, lung, or pancreas, organ transplantation represents a life-saving treatment. The incidence of solid organ transplant (SOT) continues to increase with approximately 35,000 transplant surgeries performed in 2017 [1]. As defined by patient and graft survivorship, the success of SOT has also improved due to advances in donor allocation processes, surgical and medication techniques, and care continuity [2,3].

Although there have been increases in life expectancy, SOT patients are at a higher risk of bone loss and fracture complications, including an up to 5-time relative risk of hip fracture [4-9]. This risk is attributed to baseline bone disease from pre-existing organ failure, immunosuppressive medication (eg, high-dose corticosteroids), and fragility predisposing to falls [10-15]. Hip fractures and the corresponding surgical treatment are associated with high morbidity and mortality, and medically complicated SOT patients may incur additional risks [16-18].

Presently, little is known about SOT patient outcomes and survivorship after surgical treatment of hip fracture. Growing

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literature has demonstrated increased complications, infection, and mortality after total hip arthroplasty (THA) performed in SOT recipients [19-25]. However, the vast majority of surgical indications for THA in these studies are elective (degenerative joint disease or avascular necrosis), not urgent hip fracture surgery. This research aims to compare the perioperative outcomes, complications, and patient survivorship of SOT recipients undergoing THA and hemiarthroplasty (HA) for acute femoral neck fracture (FNF) to a matched cohort. We hypothesized SOT patients would demonstrate worse outcomes, more complications, and increased mortality compared to controls without a history of transplantation.

Material and methods

Institutional review board approval was obtained. A retrospective review of FNF treated with either hip HA or THA from 2012 to 2019 within a single health-care system was performed. Exclusion criteria included age $\leq$ 18 years, hip fractures treated without arthroplasty, and patients without a history of SOT before fracture. Thirty-one patients with SOT before FNF presentation were identified: 11 kidney, 8 liver, 5 kidney and liver, 3 kidney and pancreas, 1 heart, 1 heart and kidney, 1 lung, and 1 pancreas. These patients were then matched 1:1 to FNF patients without a history of SOT based on surgical procedure (HA or THA), age (±3 years), sex (exact), body mass index (BMI; ±5 kg/m^2), and year of surgery (±2 years).

After applying the match criteria, 31 SOT patients undergoing hip arthroplasty (24 HA and 7 THA) for FNF matched to 31 non-SOT patients undergoing the same procedure. The mean age at surgery was 69 years, 58% of patients were female, and the mean BMI was 24 kg/m^2 for both cohorts. The study cohorts were similar in baseline patient function and operative characteristics except for significantly higher ($P < .001$) Charlson Comorbidity Index in SOT recipients as compared in Table 1. The mean follow-up duration was 3 years (range, 0-8 years).

All FNF patients were acutely diagnosed in the emergency department, indicated for surgery, and subsequently admitted to the hospital. Upon admission, each patient underwent optimization and risk stratification by the general internal medicine service, with specialty consults obtained as necessary. Although various antirejection medication are various and dependent upon each individual transplant, all SOT patients were continued on the baseline immunosuppressive medication regimen consisting of at least one antirejection medication and oral steroid commonly. The decision and timing to proceed with surgery was made between the orthopedic surgeon and the medical service(s). All surgeons were board-certified and high-volume total joint specialists. The type of surgical treatment (HA vs THA), approach, and technique (cemented vs uncemented) were made based on the discretion of the operative surgeon. Postoperatively, standard hip fracture protocols were instituted, including early and frequent mobilization with physical/occupational therapy on postoperative day one, mechanical and pharmaceutical venous thromboembolism (VTE) prophylaxis, and discharge planning with a multidisciplinary care team of nursing, case management, and family. Outpatient postoperative clinical follow-up was scheduled in the orthopedic clinic at routine intervals acutely and annually thereafter.

Clinical outcome data were obtained through a detailed electronic medical chart review. Specifically, patient preoperative demographics (including SOT history, baseline ambulatory status, BMI, American Society of Anesthesiologists classification score, Charlson Comorbidity Index, time from diagnosis to surgery, surgical details [type of surgery, approach, technique, duration], acute perioperative outcomes such as hospital length of stay [LOS], discharge disposition, major medical complications [stroke, myocardial infarction, acute renal failure, gastrointestinal bleed, or VTE], 90-day readmissions), reoperations, return to ambulation, and patient mortality were reviewed.

Statistical analysis

Study demographics and outcomes were described as counts, percentages, means, or medians. Categorical and continuous variables were assessed by Pearson chi-square and Kruskal-Wallis tests, respectively. For categorical variables with frequencies of five or fewer, Fisher's exact test was used. Kaplan-Meier survivorship curves were used to demonstrate patient survivorship for both the SOT and matched cohort. Cox regression models were used to

Table 1
A comparison of baseline and operative characteristics between femoral neck fracture patients treated by hip HA or THA with and without solid organ transplant.

Characteristics	Solid organ transplant patients	Matched (nontransplant) patients	*P* value
Number	31 (7 THA, 24 HA)	31 (7 THA, 24 HA)	1.00
Age (mean, range)	69.5 (44-84) years	69.3 (45-83) years	.91
Sex	18 (58%) female	18 (58%) female	1.00
	13 (42%) male	13 (42%) male	
BMI (mean, range)	24.4 (17-31) kg/m2	23.9 (16-30) kg/m2	.34
ASA Score (mean, range)	3 (2-4)	3 (2-4)	1.00
Charlson Comorbidity Index (mean, range)	6.3 (1-14)	3.1 (0-10)	**<.001**
Time to surgery			.29
<24 h	5 (16%)	9 (29%)	
24-48 h	20 (65%)	14 (45%)	
>48 h	6 (19%)	8 (26%)	
Ambulatory status[a]			.64
Community	26 (84%)	24 (77%)	
Household	5 (16%)	5 (16%)	
Nonambulator	0 (0%)	2 (7%)	
Approach			.84
Direct anterior	1 (3%)	2 (6%)	
Anterolateral	21 (68%)	19 (61%)	
Posterior	9 (29%)	10 (32%)	
Femoral stem type			.99
Cemented	21 (68%)	21 (68%)	
Uncemented	10 (32%)	10 (32%)	

ASA, American Society of Anesthesiologists. Bold indicates Charlson Comorbidity Index was signifinantly different between SOT and matched patients.
[a] Baseline/preoperative ambulatory status; all THA were community ambulators without an assistive device.

Table 2
Mortality, complications, and reoperations after hip arthroplasty for femoral neck fracture in solid organ transplant and nontransplant patients.

Complication type	Solid organ transplant patients	Matched (nontransplant) patients	*P* value
Overall mortality[a]	16 (52%)	12 (39%)	.31
30 d	1 (3%)	1 (3%)	1.00
90 d	4 (13%)	2 (6%)	.67
1 y	7 (23%)	5 (16%)	.75
Major medical complications	5 (16%)[b]	2 (6%)[c]	.21
90-d Readmission	8 (26%)	0 (0%)	.01
Any reoperation or revision	3 (10%)	0 (0%)	.24
Other surgical complications	2 (6%)	0 (0%)	.49

[a] Mortality at final follow-up.
[b] SOT patient complications: 1 stroke, 1 myocardial infarction (MI), 2 pulmonary emboli.
[c] Nontransplant patient complications: 1 stroke, 1 MI.

identify survival at 90 days and 1 year. Hazard ratios and 95% confidence intervals (CIs) are reported. All statistical analyses were conducted using STATA 16MP (StataCorp. 2019. Stata Statistical Software: Release 16.; College Station, TX, StataCorp LLC.), and significance was set at 0.05.

Results

Patient survivorship

At 90-day, 1-year, and final follow-up, the mortality rate of SOT patients was 13%, 23%, and 52%, and that of nontransplant patients was 6%, 16%, and 39% ($P = .31$), respectively (Table 2). Four acute deaths (<90 days) were present in the SOT cohort, with 3 patients dying from acute decompensation of chronic disease (1 from transplanted kidney failure; 2 from a nontransplanted heart failure) after fracture treatment. Similarly, two of three deaths in the matched cohort were attributed to the similar etiology of an acute decompensation chronic organ failure. SOT patients' estimated survivorship at 90 days and 1 year after hip arthroplasty for FNF was 87% (95% CI = 69%-95%) and 77% (95% CI = 58%-88%) compared to the nontransplant cohort of 93% (95% CI = 77%-98%) and 84% (95% CI = 65%-93%; hazard ratio = 1.5, 95% CI = 0.5-4.6; $P = .52$) (Fig. 1).

Perioperative outcomes

For SOT patients, the median hospital LOS was significantly longer than nontransplant patients (6 vs 4 days, $P = .02$); however, discharge disposition to skilled-nursing facilities was not different (77% vs 71%, $P = .56$). The 90-day readmission rate was also significantly higher, with 8 (26%) readmissions in the SOT cohort vs none in the non-SOT group ($P < .01$). Excluding death as a complication, SOT patients demonstrated a nonsignificant trend toward more major medical complications (16% vs 5%, $P = .21$) (Table 2). In addition, 4 SOT patients were readmitted more than once for a variety of etiologies, including pain/weakness (1), electrolyte imbalance (2), and gastrointestinal bleed (1).

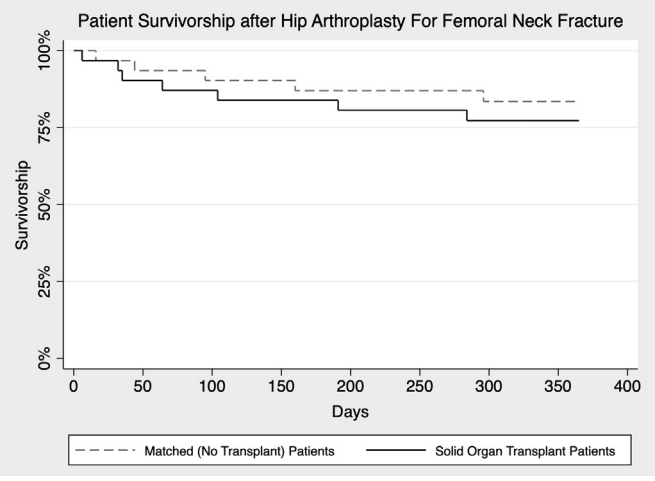

Figure 1. One-year Kaplan-Meier survivorship representing solid organ transplant vs nontransplant patient survivorship free from death after hip arthroplasty for femoral neck fracture.

Reoperations, revisions, complications

There were 3 (10%) reoperations or revisions after hip arthroplasty for the SOT patients and none in the matched cohort ($P = .24$) (Table 2). One HA patient underwent reoperation for debridement of superficial infection, whereas two patients underwent component revision—1 THA for periprosthetic fracture and 1 HA converted to THA for aseptic femoral component loosening, both used a modular tapered fluted femoral stem for the femoral revision. In addition, 2 (6%) surgical complications were present only in the SOT group, including 1 HA dislocation treated with closed reduction and 1 sciatic nerve palsy requiring ankle-foot orthosis use. Both groups ultimately had a similar, high rate of return to community ambulatory status (87% for SOT, 83% for nontransplant, $P = .32$).

Discussion

Displaced FNF are routinely treated with hip HA or THA; however, perioperative complications, limited return to baseline function, and mortality remain high [26-28]. Although patient demographics, medical comorbidities, and surgical variables undoubtedly affect outcomes, research has yet to exclusively evaluate SOT populations and their outcomes after undergoing hip arthroplasty for FNF. With the sample size available for this rare clinical scenario, the SOT patients demonstrated significantly higher 90-day hospital readmissions but no significant difference in complications and reoperations compared to a matched cohort.

Mortality after hip fracture is well-documented with 1-year rates between 12% and 33% [16,26,28,29]. Although the wide range of mortality is related to heterogeneous populations, our study demonstrated a similar range for both the SOT and nontransplant cohorts who experienced mortality rates of 23% and 16% at 1 year, respectively. These rates are substantially more impressive than the 1.9% mortality rate at 1 year as reported by Chalmers et al. in SOT patients undergoing elective THA [21]. More recently, literature has begun to focus on associated increased 30-day mortality of THA performed specifically for the indication of FNF compared to osteoarthritis [30-32]. Patient age, sex, cardiopulmonary disease, and cemented implant type are known risk factors for higher mortality after FNF surgery [30]. Although a history of SOT

with ongoing immunosuppression could intuitively be implicated as additional mortality risk, no significant difference was seen compared to controls. Type II error may exist; thus, larger, more well-powered studies are required to better understand mortality risk in these patients. Nonetheless, decreased patient survivorship after hip arthroplasty for FNF is a well-known risk that should be discussed with the patient and caregivers before surgery in all patients.

Hip arthroplasty for FNF is associated with common and serious perioperative complications, even in previously healthy patients. Through the French National Discharge Database, Le Manach et al. compared patients undergoing hip fracture surgery to those undergoing elective THA through multivariate population matching and found higher rates of mortality, major postoperative complications, and longer LOS [33]. In another study, Kester et al. reported the indication of FNF to perform THA and HA as the strongest independent risk factor for 90-day readmission with nearly 3-fold risk compared to those performed for other diagnoses [34]. Not surprisingly, the transplant population's perioperative outcomes in this study were even less desirable than those in the matched FNF cohort: longer LOS, more medical complications, and significantly higher rate of readmission. Efficient preoperative hip fracture patient medical optimization remains a major consideration as reducing time to surgery is reported to decrease the risk for postoperative complications [35]. Risk assessment of cardiopulmonary status remains the priority before surgery, whereby routine optimization strategies for chronic medical conditions and VTE or delirium prophylaxis should extend throughout the postoperative period [36]. Despite the obvious medical complexity and optimization required for a transplant patient, the time to surgery remained similar between cohorts with no significant subgroup differences. This may be attributed to our tertiary referral center with the available medical transplant specialist able to provide efficient SOT patient perioperative care. Furthermore, there was no specific, avoidable recurrent etiology for readmission of SOT patients: All readmissions were medically related, with half of the readmission requiring subsequent readmission. The results suggest that ongoing multidisciplinary care must be continued throughout the perioperative period for the high-risk SOT cohort to decrease the greater risk for complication and readmission.

In addition to increased readmissions, more reoperations (10%) and surgical complications (16%) were found in the SOT undergoing hip arthroplasty for FNF, although they were not significantly different than the matched cohort with the numbers available. Numerous prior reports have demonstrated the increased risk of reoperations and complications after elective hip and knee arthroplasty in SOT patients [20-25]. Ledford et al. cited periprosthetic joint infection as the most common indication for revision in a series of revision THAs performed in SOT [22]. In contrast, a large database review by Labaran et al. unexpectedly showed mechanical loosening, not infections, to be the leading indication for renal transplant patients undergoing revision THA [37]. Each reoperation and complication in this SOT cohort was of separate, indistinguishable etiologies, including only one superficial infection successfully treated with debridement and no further sequelae. The variability of these results and limited sample size makes it difficult to conclude if true differences exist between those with and without history of transplant. Still, most patients return to community ambulation from both SOT (87%) and nontransplant (83%) groups after hip arthroplasty for FNF may be considered a good display of success.

The retrospective design, time variance of follow-up, and small population of patients available for review are major inherent limitations of this research—all of which can result in inadequate power for nonsignificant findings and limit the strength of conclusions. Case-control matching did not include underlying medical conditions, and, unsurprisingly, a significant difference existed in comorbidity indices between SOT and matched controls. Such difference introduces potential for a confounding error as it is unknown if differences between groups were due to SOT status or other nonmatched conditions. Surgical decision-making to perform HA or THA and technique (approach, implant type, fixation method) is variable; thus, surgical decision-making biases exist. Furthermore, both HA and THA results were analyzed together despite the potential for separate complication profiles. Matching was performed to include surgery type to mitigate potential differences attributed to each procedure; however, admittedly, the small cohort can only illustrate trends. The subjective nature of preoperative medical optimization and postoperative medical care (ie, decision for readmission) can also be widely variable based on clinician judgment. Finally, the SOT patient population is extremely heterogeneous (including the organ type, number of transplants, present function of the transplant, and immunosuppressive regimen), and the role of these factors on the results was not specifically evaluated.

Conclusions

Patients with a history of SOT present with unique medical complexity and surgical risk profile. In a matched case-control series, hip arthroplasty performed in SOT recipients with acute FNF resulted in significantly more hospital readmissions postoperatively. The study results highlight the importance of diligent, continuous perioperative care of SOT recipients by surgeons and multidisciplinary medical transplant teams, particularly to reduce subsequent readmissions.

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