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Retrospective Cohort Study

Two surgical pathways for isolated hip fractures: A comparative study

Admission Pathways for Hip Fracture Surgery

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Abstract

BACKGROUND

Hip fractures (HF) are common among the aging population and surgery within 48 h is recommended. Patients can be hospitalized for surgery through different pathways: trauma or medicine admitting services.

AIM

To compare management and outcomes among patients admitted through trauma pathway (TP) *vs* medical pathway (MP).

METHODS

This Institutional Review Board approved retrospective study included 2094 patients with proximal femur fractures (AO/Orthopedic Trauma Association Type 31) who underwent surgery at a level 1 trauma center between 2016-2021. There were 69 patients admitted through the TP and 2025 admitted through the MP. To ensure comparability between groups, 66 of 2025 MP patients were propensity matched to 66 TP patients by: age, gender, HF type, HF surgery, and American Society of Anesthesiology (ASA) score. The statistical analyses included multivariable analysis, group characteristics and bivariate correlation comparisons with the χ^2 test and t-test.

RESULTS

After propensity matching, the mean age in both groups was 75 years old, 62% of both groups were females, the main HF type was intertrochanteric (TP 52% *vs* MP 62%), open reduction internal fixation was the most common surgery (TP 68% *vs* MP 71%) and mean ASA score was 2.8 for TP and 2.7 for MP. The majority of patients in TP and MP (71% *vs* 74%) were geriatric (≥ 65 years old). Falls were the main mechanism of injury in both groups (77% *vs* 97%, $P = 0.001$). There were no significant differences in pre-surgery anticoagulation use (49% *vs* 41%), admission day of the week or insurance status. The incidence of comorbidities was equal (94% for both) with cardiac

comorbidities being dominant in both groups (71% *vs* 73%). The number of pre-operative consultations was similar for TP and MP, with the most common consultation being cardiology in both (44% and 36%). Hip fracture displacement occurred more among TP patients (76% *vs* 39%, P = 0.000). Time to surgery was not statistically different (23 h in both), but length of surgery was significantly longer for TP (59 *vs* 41 minutes, P = 0.000). Intensive care unit and hospital length of stay were not statistically different (5 *vs* 8 days and 6 days for both). There were no statistical differences in discharge disposition and mortality (3% *vs* 0%).

CONCLUSION

There were no differences in outcomes of surgeries between admission through trauma *vs* medicine pathways. The focus should be on the patient's health condition and on prompt surgical intervention.

Key Words: Isolated hip fractures; Admitting service; Trauma center; Time to surgery; American Society of Anesthesiologists score; Preoperative consultations

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Core Tip: We evaluated 2094 hip fracture patients admitted for surgery to a level 1 trauma center over a five year period. Patients were stratified based on the admitting service: trauma *vs* medical pathway. After a propensity score matching comparison of 66 patients in each group it was revealed that there was no difference in outcomes. Predictors of a prolonged hospital length of stay were increased ASA score and delayed time to surgery. Predictors of mortality were increased ASA score and increased age. The health condition of the patient and not the admitting service is the defining factor for management and outcomes.

INTRODUCTION

As life expectancy rises around the world, along with the number of elderly individuals, the incidence of hip fractures (HF) is estimated to reach 6.3 million in 2050 [1]. Each year in the United States alone over 300000 people aged 65 and older are hospitalized for HF [2-4].

Patients can be hospitalized for operative fixation of HF through different pathways: trauma, orthopedic or medicine admitting services [5-8]. In the studies comparing surgical *vs* nonsurgical pathways it has been reported that the admitting service can affect the management patterns and outcomes of patients with HF [5,6,9].

For example, in one study by Greenberg *et al*, the authors determined that patients with HF admitted to the medicine service had longer hospital stays than patients admitted to the orthopedic service, even after controlling for demographics and preoperative comorbidities [5]. A 2018 study by Lott *et al*, also concluded that patients with HF admitted to the medicine service had longer lengths of stay (LOS) and more complications compared to patients admitted to the trauma/orthopedic service [6]. In contradiction to these conclusions, other studies determined that there were no differences in complication rates or lengths of stay between the admitting services [8, 10].

The impact of preoperative pathways on the outcomes was previously addressed in diverse cohorts of patients, which differed in inclusion/exclusion criteria such as age, hospital settings, mechanism of injury, preoperative medication or surgical management [7,8,10-12]. The rationale for our study was the existing controversy over which hospital service is best suited for the optimal admission process for patients with HF and associated with the best outcomes.

At our institution patients with HF can be admitted through the Emergency Department (ED) or through the Trauma Department depending on how they are transported to the hospital by the first responders. If the patient is admitted through the ED, the hospitalist or internal medicine physician will admit the patient to the Medical Service. If the patient is admitted through the Trauma Department, the trauma surgeon will admit the patient to the Trauma Service. After a radiographic confirmation of a HF,

a consultation of the orthopedic surgeon is requested by the admitting service. After admission to either service, the internal medicine physician or the trauma surgeon may request additional consultations, if necessary for preoperative clearance.

We set out to analyze clinical characteristics and outcomes of patients admitted for HF surgery through trauma services and to compare them to those admitted through medical services.

MATERIALS AND METHODS

This Institutional Review Board approved retrospective cohort study was granted a waiver of informed consent and included 2094 adult patients (≥ 18 years old) with HF who underwent operative fixation at an urban level 1 trauma center between January 1st 2016 and May 31st 2021. All patients presented AO/ Orthopedic Trauma Association fracture Type 31A-C [13]. Patients with other traumatic, non-orthopedic injuries requiring surgical intervention, including head, thoracic or abdominal injuries were excluded. Additional exclusion criteria were: in-hospital HF, patients with pathologic fractures, periprosthetic fractures, open fractures, previous fracture or surgery at the current fracture site.

Patients were stratified in two groups based on the admitting service: those who were admitted through the trauma pathway (TP) of the Level 1 trauma center (n = 69) and those who were admitted through the medical pathway (MP) (n = 2025).

To ensure comparability between groups, propensity matching by: age, gender, type of HF, type of HF surgery, and American Society of Anesthesiology (ASA) score was done, which resulted in 66 patients in each group for comparison (Figure 1). In the propensity matching process there were three TP patients who did not get a match, and therefore were excluded from the comparison.

Analyzed variables included: age, gender, body mass index, mechanism of injury, Glasgow Coma Score (GCS), comorbidities, pre-injury anticoagulation use, ASA score, insurance status, admission day of the week, number of preoperative consultations, type of HF, presence of fracture displacement, time to surgery, time of surgery, type of

HF surgery, intensive care unit and hospital lengths of stay (ICULOS, HLOS), discharge disposition, and mortality. We also analyzed the weekend effect of admissions in the propensity matched groups.

Variables were identified *via* the International Classification of Diseases 9th and 10th edition and extracted from patient's electronic medical records.

Geriatric age was defined as 65 or older [14].

Weekend effect was defined as any of the following due to admission from Friday to Sunday: a longer time to surgery, longer HLOS or higher mortality [12,15-17].

Extended HLOS was defined as more than six days. This number was based on our data and the commonly reported hospital length of stay for patients with HF [3,18-20].

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics software version 23.0 (IBM, Armonk, New York). Propensity score matching was done without replacement, with a 0.2 caliper and with a randomized order of patients while drawing matches, which resulted in a one-to-one paired selection. The analyses included group characteristics and bivariate correlation comparisons. Categorical variables were analyzed with the χ^2 test. Variable means were analyzed using independent samples t-test and Mann Whitney-U test. Multivariable analysis for the predictors of extended length of stay and mortality was done in the total population. Receiver operator characteristics area under the curve analysis (ROC AUC) was used to determine threshold values for extended length of stay and mortality prediction variables. One way analysis of variance (ANOVA) was used for the analysis of age and HLOS by ASA score. Statistical significance was assumed when the calculated *p* value was below 0.050.

RESULTS

Over the duration of 65 mo, 2094 patients with HF were admitted for surgical repair: 69 (3.3%) patients through TP and 2025 (96.7%) through MP.

General Comparison

General comparison between all TP and MP patients is presented in Table 1. MP patients were older and included more geriatric patients; however, geriatric patients comprised more than two thirds of each group. Falls were the prevailing mechanism of injury in both groups, comprising at least 74% in each group. The analyzed cohorts had slightly different types of HF. There were no differences in gender, admission day, ASA score distribution, time to surgery, type of HF surgery, HLOS, discharge disposition, and mortality.

Multivariable analysis and ROC analysis showed that increased ASA score and extended time from admission to surgery were two statistically significant predictors for the extended HLOS. The significant predictors for mortality were age > 83 (P = 0.000, odds ratio: 6.0) and ASA score ≥ 4 (P = 0.000, odds ratio: 5.1). The threshold values were based on the ROC curve with AUC or concordance index of 0.697 (CI: 0.640 – 0.755) and 0.698 (CI: 0.630 – 0.765).

Propensity Matched Comparison

The comparison of propensity matched patients, 66 TP and 66 MP, is presented in Table 2. Propensity matched TP patients had statistically higher motor vehicle collision as a mechanism of injury (falls were still the prevailing mechanism of injury in more than three quarters of patients in both groups), more presence of HF displacement, more requests for neurological consultation and longer duration of surgery.

There were no differences between the groups in the body mass index, comorbidities, anticoagulation use, admission day, number of consultations before surgery, insurance status and mean time from admission to HF surgery. An additional analysis of the time from admission to surgery through TP and MP divided in 12-hour increments is presented in Figure 2. At any 12 h interval, the number of patients in the TP and MP groups was similar, with two thirds (63.6% in TP and 66.7% in MP) having surgery within 24 h and over 90% (95.5% in TP and 93.9% in MP) having surgery within 48 h of admission.

The two groups had comparable ICULOS and HLOS. The similar distribution of HLOS in propensity matched TP and MP is shown in Figure 3. The discharge disposition and

mortality were also comparable. The two expired patients in the TP group were 87 and 96 years old, one patient had renal failure and was discharged to hospice and another one had a cardiac arrest during surgery.

Within the propensity matched TP there were 41 patients admitted on a weekday and 25 admitted on a weekend. The two sub-groups had comparable time to surgery (22.8 *vs* 22.5 h, $P = 0.926$), HLOS (5.6 *vs* 7.6 days, $P = 0.130$), and mortality (2.4% *vs* 4.0%, $P = 0.720$). Within the propensity matched MP there were 37 patients admitted on a weekday and 29 admitted on a weekend. The two sub-groups had comparable time to surgery (21.7 *vs* 24.7 h, $P = 0.490$) and HLOS (5.3 *vs* 6.9 days, $P = 0.239$). There was no mortality in MP sub-groups.

Mean age and HLOS stratified by ASA score in the different patient groups is presented in Table 3. By the ANOVA analysis we found that in the total population, age and HLOS both increased significantly (both $P = 0.000$) as ASA increased. In the propensity matched TP population, age increased significantly ($P = 0.001$) as ASA increased from 2 to 4. Higher ASA was associated with older age and longer HLOS.

DISCUSSION

In studies that relate to different admission pathways and how the admission pathway affects the outcomes in patients with HF, there is a noticeable difference in the age of included patients, ranging from 50 to 75 years old [7,9-11]. Other inclusion/exclusion criteria also differ significantly, as some HF studies exclude patients undergoing total hip replacement, patients who expired before hospital discharge, patients who were not admitted to a surgical ICU, or include only patients with mechanism of injury as fall or only patients with pre-surgical transthoracic echocardiography [7,12,17,19,21]. There is also a broad array of different settings ranging from Level 1 trauma centers to safety-net and tertiary hospitals [8,19,22,23].

In our study, we utilized propensity score matching to address the imbalance in the characteristics of TP and MP patients, as was recommended by Chuang *et al* in their comparison of medicine *vs* orthopedic service for management of HF [10]. There are only

two published studies on patients with HF that utilized the propensity score matching methodology, however, they were done to evaluate the impact of preoperative echocardiography [24,25].

Our results indicate that ASA score as a measure of patient's condition is a predictor of a longer HLOS and mortality. Our findings support the conclusions reported by Garcia *et al* that an increase in ASA score has a strong association with an increased length of stay in elderly patients with HF [26]. Our observations are also in compliance with reports that ASA score is associated with mortality, length of stay and time to surgery [17,27,28]. Mok *et al* correspondingly recommended that ASA score be added as a criterion for allocation of high-risk patients with HF and for indicating the appropriate admitting service [28].

In our study, the average number of consultations per patient was similar in all groups. Cardiology was the most common consultation in TP and MP cohorts. While cardiac comorbidities were registered in approximately 70% of patients, cardiology consultations were implemented in only around 40% of patients. Our data are remarkably similar to that recently reported by Hoehmann *et al*, with a 44.4% rate of cardiology consultations in patients with HF in a geriatric population of 65 and older [19]. Neurology was the second most common consultation in TP, while pulmonology was the second most common in MP patients. Having a similar GCS in both groups and having excluded traumatic brain injury patients, the higher rate of neurological consultations in TP patients may be a result of precaution, attributed to the higher number of motor vehicle collisions as mechanism of injury.

Surgical intervention for HF is recommended within 48 h [29-30]. Recent studies indicate that surgery within 24 h of admission is associated with shorter HLOS or mortality [31-33]. Delaveau *et al* also recommended "early" surgery within 24 h of admission in orthogeriatrics [11]. Two thirds of our patients underwent hip surgery within 24 h of admission and the majority were geriatric. In our study, less than 5% of patients had surgery later than the recommended 48 h benchmark, compared to 9.5% in the report from Level I and II trauma centers by deMeireles *et al*, and compared to 16.3% in the

review of the National Trauma Data Bank by Bhatti *et al* that included Level I-IV trauma centers and other hospitals [2,7]. Our findings support the notion that longer time to surgery is correlated with extended HLOS. The longer time of orthopedic surgery in our TP patients can be attributed to displaced HF occurring more often.

Elkbuli *et al* in his comparison done in a similar setting to ours found that patients with isolated HF admitted to a surgical service had shorter ICULOS and that mortality did not differ from the nonsurgical admission pathway, however nonsurgical admission patients were younger [9]. In our propensity matched comparison study, mortality was also not statistically different and ICULOS tended to be shorter in TP patients but the difference did not reach statistical significance, however, our patients were propensity matched by age.

Our data did not show the weekend effect reported by others, as there was no delay of surgery, longer HLOS or higher mortality [15,16,34,35]. Our observations are in line with reports by Nijland *et al* and Yeo *et al* who also did not find the weekend effect [12,22].

The distribution of insurance types between TP and MP patients did not show statistical significance, however, it seems that there was a trend towards less insured patients in TP. In the study by Bhatti *et al* there was no difference in repair times for patients with public insurance or no insurance when compared to patients with private insurance [2].

The main conclusion of our study is that the health condition of the patient and not the admitting service is the defining factor in the management and outcomes of patients with HF. Our conclusion is in compliance with a recent report by Bauman *et al* that the severity of illness impacts the outcomes more than the admitting service [8].

In an analysis of geriatric patients with isolated HF, as a result of a fall, surgically treated at 35 Level 1 or Level 2 trauma centers, deMeireles *et al* did not find an association between the admitting service and mortality or hospice discharge, however they found that it was the comorbidity burden that correlated with an increased risk of mortality [7].

Limitations.

This study has limitations that must be considered when interpreting the results. The retrospective nature of this study brings up deficiencies in prerecorded data and the assessments available for extraction and analysis. Although collection of data was done for a considerable amount of time, the records of only one hospital were analyzed.

CONCLUSION

There were no notable differences in the management and outcomes between patients who underwent HF surgery but were admitted through two different pathways: trauma *vs* medicine. Prolonged length of stay was associated with an increased ASA score and longer time to surgery, while mortality was associated with an increased ASA score and age. The admission pathway is not the defining factor in the management of patients with HF. The focus should be on the patient's health condition upon admission and a prompt surgical intervention.

ARTICLE HIGHLIGHTS

Research background

Isolated hip fractures (HF) are common, especially among the elderly population, and falls are the main mechanism of injury. Depending on the hospital settings and institutional policies, patients can be admitted for surgery through different pathways: medicine or trauma. There is scarcity of studies utilizing the propensity score matching methodology in the analysis of the data on this subject.

Research motivation

It has been reported that the admitting service may influence the outcomes of patients with HF. The motivation behind this study were the conflicting conclusions and ongoing debates over which admitting service is associated with better results. We believed it is necessary to contribute new data and a new outlook to help achieve improvements in the treatment of patients with HF.

Research objectives

To analyze the characteristics and compare the outcomes of similarly injured patients with HF admitted through trauma *vs* medicine service at an urban level 1 trauma center.

Research methods

This was a retrospective cohort study. Patients with HF were divided in two groups based on the admitting service: trauma *vs* medicine. Propensity score matching was utilized to ensure comparability between the groups. Patients were propensity matched by age, gender, HF type and surgery, and the American Society of Anesthesiology (ASA) score. The statistical analyses included group characteristics, bivariate correlation comparisons, multivariable analysis and one-way analysis of variance.

Research results

Time to surgery, time in the intensive care unit, hospital length of stay, discharge disposition and mortality were not statistically different between two groups. The average number of preoperative consultations was similar in both groups with cardiology consultation being the most common. Higher ASA score was associated with a longer hospital stay and mortality.

Research conclusions

The health condition of the patient, and not the admission pathway is the defining factor in the management and outcomes of patients with HF.

Research perspectives

Research should be conducted across multiple medical centers to include larger cohorts with more focus on predictors of adverse outcomes, as well as the potential cost differences between the admission pathways.

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