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Research Article

Stable intertrochanteric hip fracture fixation: Device choice does not impact cost of care

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Introduction

There are over 300,000 hip fractures in the U.S. annually. Hip fractures create a substantial health and economic burden, with one-year mortality after a hip fracture approaching 30% and hip fractures creating healthcare costs of over $12 billion annually. Stable intertrochanteric hip fractures can be treated with either an extramedullary implant (sliding hip screw, SHS) or an intramedullary nail (IMN), which has a higher hardware cost. This study compared the cost of care between patients treated with IMN versus SHS after stable intertrochanteric hip fracture.

Methods

This was a retrospective cohort study of patients over age 55 with stable intertrochanteric hip fractures at a Level 1 trauma center over a 4-year period. We collected demographic information, fixation method, outcomes measures, and cost data. Statistical analysis compared patient characteristics, costs, and outcomes between SHS and IMN patients.

Results

83 patients were included, of whom 57 received an SHS and 26 received an IMN. There were no differences in age, gender, BMI, and ASA score between patients who received SHS vs. IMN (p>0.05 for all). There were no significant differences in mortality or

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readmission rates. SHS and IMN patients had no significant differences in length of stay (8.3 +/- 5.2 vs 8.0 +/- 3.5 days, p=0.76), direct costs ($22,324 +/- $10,603 vs $19,881 +/- $5,894, p=0.18), or health system profit (-$1,313 +/- $8,559 vs -$4,373 +/- $8,394, p=0.13).

Discussion

We compared the cost of care between patients treated with IMN versus SHS after stable intertrochanteric hip fracture. The use of IMN for the treatment of stable intertrochanteric hip fractures is controversial due to the significant cost of the implant. We found no differences in length of stay or care costs between patients treated with IMN versus SHS. Differences in implant cost were insignificant compared to the total cost of care.

INTRODUCTION

Hip fractures in the elderly are common and costly. In 2005, approximately 296,000 Americans suffered a hip fracture, and this number is expected to increase to 450,000 by 2025 (Bohl et al. 2014a). Worldwide, the incidence of hip fractures is expected to reach over 6 million per year by 2050 (Cooper, Campion, and Melton 1992). Despite constituting only 14% of osteoporosis-related fractures, hip fractures accounted for nearly 75% of the economic burden of these fractures, costing an estimated $12 billion per year in 2005 which is projected to increase to $18 billion by 2025 (Bohl et al. 2014a). Hip fractures are associated with significant morbidity and mortality, with one-year mortality approaching 30% in some studies (Wolinsky, Fitzgerald, and Stump 1997; Panula et al. 2011; Okike, Chan, and Paxton 2017). Among patients who survive, only about half return to their pre-injury level of function, and 10-20% are forced to move to long-term care facilities following their injuries (Dyer et al. 2016).

Approximately half of hip fractures occur in the intertrochanteric region and can be stable or unstable. Stable fractures include those that extend from the greater trochanter inferomedially toward the lesser trochanter with an intact posteromedial cortex and lateral wall and without subtrochanteric extension (OTA/AO 31A1.1- 31A1.3) (Swart et al. 2014). Unstable intertrochanteric fractures include those with posteromedial cortex comminution, lateral wall breach, reverse obliquity, or subtrochanteric extension (Knobe et al. 2013). Implant selection in stable hip fractures is controversial. Currently, stable intertrochanteric hip fractures can be successfully treated with either an extramedullary implant (sliding hip screw, SHS) or an intramedullary implant (intramedullary nail, IMN). The SHS was historically the treatment of choice, but in recent decades IMNs have gained in popularity and are now the more common implant used for intertrochanteric hip fractures (Niu et al. 2015). However, IMNs are more expensive than SHSs, and multiple prospective trials and retrospective reviews have failed to show significantly different outcomes between the two fixation techniques (Barton et al. 2010; Bohl et al. 2014b; Kaplan et al. 2008; Parker 2017; Parker and Cawley 2017; Saudan et al. 2002; Utrilla et al. 2005; Matre et al. 2013). This had led some authors to support the use of the SHS due to its lower hardware cost (Barton et al. 2010; Saudan et al. 2002). However, Bohl et al. (2014b) found that length of stay was shorter with IMN versus SHS, raising the possibility that total costs might be similar or even lower with IMN. A cost-effectiveness analysis found that SHS appears to be more cost effective for stable intertrochanteric fractures while IMN is more cost effective for unstable injuries, but this analysis assumed very similar failure rates for each device, a topic on which the literature is currently inconclusive (Swart et al. 2014).

We conducted a retrospective, single-center study of patients with stable intertrochanteric femur fractures examining the cost of care and implant selection. Our hypothesis was that the total cost of care would be higher for patients treated with IMN than those treated with SHS.

METHODS

PATIENT POPULATION

IRB approval was obtained for this retrospective study. All patients ages 55 years and older with hip fractures treated between 2010 and 2013 at a single center were identified using ICD-9 codes 820.0, 820.2, 820.8, and 733.14. ICD-9 codes were used to identify patients as the supporting institution's hip fracture database was organized as such. This initial query yielded 1539 hip fracture patients. Patients were then screened by the investigators and those with polytrauma, hip fracture in the 1-year period prior to the incident hip fracture, pathologic fracture, or nonoperative management were excluded. X-rays were reviewed by senior residents to classify fractures according to location, and patients with stable intertrochanteric hip fractures were included. Stable intertrochanteric hip fractures treated with SHS or IMN were included and fractures treated with devices other than SHS or IMN were excluded. Device choice was at the discretion of the senior surgeon. Patients with unstable fracture patterns (reverse oblique fracture, subtrochanteric extension, lateral wall breach, or posteromedial comminution) were excluded (AO/OTA 31A2 and 31A3). Utilizing the above inclusion and exclusion criteria yielded a total of 83 patients for the study.

DATA COLLECTION AND STATISTICAL ANALYSIS

Chart review was used for data abstraction. Demographic information such as patient age, sex, body mass index (BMI), and American Society for Anesthesiologists (ASA) score were collected. Medical and operative records were reviewed and estimated blood loss, procedure time, implant

Table 1. Cost definitions

	Definition
Direct Cost	All hospital costs directly associated with patient care, including but not limited to room costs, nursing care, implant cost, OR costs, etc.
Indirect Cost	Hospital costs attributed to patient but not directly related to patient care including hospital administration, information technology costs, hospital utilities, etc.
Total Cost	Sum of direct and indirect costs.
Profit	Calculated by subtracting both direct and indirect costs attributed to the patient from DRG-linked reimbursement for the patient

Table 2. Patient demographics

	SHS (n=57)	IMN (n=26)	P-value
Age	78.9 +/- 11.7	80.8 +/- 12.4	0.52
Sex (% Female)	59.7% Female	69.2% Female	0.40
Body Mass Index	23.6 +/- 4.9	22.8 +/- 5.3	0.54
ASA Score	3.0 +/- 0.6	2.9 +/- 0.6	0.55

Data are presented as mean +/- standard deviation

type, and anesthesia type were recorded. All charts were examined for readmission within 30 days and mortality within 90 days of surgery as well as length of stay. Discharge location (home vs. healthcare facility vs. deceased) was recorded for each patient. Data on hospital costs were collected, including direct costs, indirect costs, total costs, and profit (Table 1). Hospital cost data was obtained from the Strategic Decision Support Services Group within the health system. Descriptive and comparative statistics were performed. Students' T-test was used to compare groups for all continuous variables and Chi-Square test was used to compare categorical variables. Multiple regression was used to evaluate the effects of multiple independent variables on total costs. Statistical analysis was performed using JMP Pro statistical software (SAS Institute, Cary, NC).

RESULTS

Eighty-three patients with stable intertrochanteric hip fractures were included in this analysis. Fifty-seven patients (69%) underwent SHS placement, while 26 (31%) were treated with an IMN. Of the 26 patients treated with IMN, 10 were long IMNs and 16 were short IMNs. The average age at the time of admission was 79.5 +/- 11.9. Fifty-two patients (63%) were female, the average BMI was 23.4 +/- 5.0, and the average ASA score was 2.9 +/- 0.6. There were no significant differences between the IMN and SHS groups in regard to age, sex, BMI, or ASA score (Table 2). There were no differences in the proportion of patients who went to the OR within 48 hours of admission; 73.2% of SHS patients and 69.2% of IMN patients underwent fixation within 48 hours (p=0.71).

Length of stay averaged 8.1 +/- 4.7 days across all patients. The median length of stay was 6 days and 75% of patients were discharged within 9 days of admission. The longest length of stay was 28 days. An average of 1.4 +/- 1.0 consulting services were used for each patient. Nineteen percent of patients were discharged to home while 80% went to other healthcare facilities and one patient died. Nineteen percent of patients were readmitted within 30 days of discharge and 9% died within 90 days of discharge. Patients received an average of 1.2 +/- 1.5 units of red blood cells (RBCs). SHS patients received fewer units of RBCs, on average, than IMN patients (0.9 +/- 1.4 vs 1.9 +/- 1.5 units, p=0.02). There were no significant differences between SHS and IMN patients in length of stay, number of consults, discharge location, readmission rate, or mortality rate (Table 3).

Across all patients, the average total cost was $29,999 +/- $13,985. Direct cost contributed the majority of the costs to each case, accounting for 72% of total costs. Neither SHS nor IMN were profitable for the hospital, and the average health system loss from patients with stable intertrochanteric hip fractures was $2,272 +/- $8,576. There were no statistically significant differences between IMN patients and SHS patients with regard to costs or health system profit (Table 4). A multiple regression was performed to evaluate the impact of implant type, age, sex, BMI, ASA score, and length of stay on total costs. Each additional year of age at admission was associated with a $206 +/- $96 decrease in total costs (mean +/- SEM, p=0.035) and each additional day in the hospital was associated with a $2,768 +/- $262 increase in total costs (mean +/- SEM, p<0.0001). There was no significant association between implant type, sex, BMI, or ASA score and total costs.

DISCUSSION

We hypothesized that treatment of intertrochanteric femur fractures with an IMN would result in higher direct costs

Table 3. Care and outcomes measures

	SHS (n=57)	IMN (n=26)	P-value
Time from admission to operating room (% <48 hours)	73.2%	69.2%	0.71
Blood transfusion (units)	0.9 +/- 1.4	1.9 +/- 1.5	**0.020**
Length of stay (days)	8.1 +/- 5.2	8.0 +/- 3.5	0.93
Consults (number of services consulted)	1.3 +/- 0.9	1.5 +/- 1.1	0.62
Discharge to home	18.5%	20.0%	0.33
30D readmission (%)	17.3%	22.7%	0.59
90D mortality (%)	6.3%	14.3%	0.28
Operating room time (minutes)	92.0 +/- 49.1	94.0 +/- 46.7	0.87
Estimated blood loss (mL)	155.4 +/- 92.4	153.1 +/- 133.2	0.94

Data are presented as mean +/- standard deviation

Table 4. Cost comparison

	SHS (n=57)	IMN (n=26)	P-value
Direct cost	$22,324 +/- $10,603	$19,881 +/- $5,894	0.18
Indirect cost	$8,443 +/- $6,297	$8,433 +/- $3,195	0.99
Total cost	$30,767 +/- $16,054	$28,314 +/- $7,739	0.64
Profit	-$1,313 +/- $8,559	-$4,373 +/- $8,394	0.13

Data are presented as mean +/- standard deviation

than treatment with a SHS. This analysis did not confirm our hypothesis. Overall, we found no significant difference in total costs between patients treated with SHS and IMN. The cost of each hospitalization was substantial, with an average total cost of nearly $30,000. According to Bohl et al. (2014b) the list price of an IMN was $2,793 while a SHS cost $1,298 in 2014 (with the caveat that the actual price paid for an implant is significantly lower than the list price and varies by institution). Thus, the hardware component made up <10% of overall costs in each case. Of note, our institution sustained a net negative income, on average, for all patients with intertrochanteric femur fractures, regardless of fixation method. The total direct cost of hospitalization was highly variable, but the only factors associated with higher costs were longer length of stay and younger patient age.

Our hypothesis centered on the assumption that the lower cost of the implant in the SHS group would lead to lower overall costs. However, Bohl et al. (2014b) and a meta-analysis of 909 patients in six RCTs have found a shorter average length of stay in patients who receive IMNs (Zhu et al. 2017). We did not find a difference in length of stay in our study population. This result is consistent with a 2010 Cochrane review (Parker and Handoll 2010) which found no difference in length of stay between IMN and SHS in a review of 43 studies. A randomized trial of 1,000 patients also found no difference in length of stay between the two treatments (Parker 2017).

Similar to past studies, after confirming that the baseline demographics of each group were not significantly different, we compared complications rates, readmissions rates, and 90-day mortality following surgery between the two groups. We found no significant differences in any of these metrics. Furthermore, there were no significant differences in operative time or estimated blood loss. Finally, after controlling for other factors including length of stay, implant type was not associated with any cost difference in this study. Length of stay was by far the strongest driver of costs, with each additional day in the hospital adding $2,768 in total costs.

Decreasing length of stay could be an effective approach to lowering total costs of care in these patients. A 2016 retrospective review of over 600 hip fracture patients compared length of stay for patients admitted to medicine versus orthopaedics (Greenberg et al. 2016). This study showed a significantly shorter length of stay for patients admitted to the orthopaedics service compared to patients admitted to the medicine service, averaging 4.5 days and 7 days, respectively. At our institution, orthopaedics is the default admitting service for all hip fracture patients with the geriatric service co-managing patients' medical comorbidities. Additionally, these patients are enrolled in the "hip fracture pathway" upon diagnosis of their hip fracture. The hip fracture pathway includes early mobilization with physical and occupational therapy daily, multi-disciplinary discharge planning beginning at time of admission, and multimodal analgesia including limited narcotics and the use of spinal anesthesia or fascia iliaca block. Our institution saw significant decreases in time to OR, length of stay, 30-day readmission rates, and in-hospital mortality after implementation of this pathway (Donegan et al. 2021). As such, the authors advocate for the orthopaedic service to admit hip fracture patients with geriatric co-management and implement an institution-specific hip fracture pathway.

Resident involvement in the treatment of intertrochanteric hip fractures has been shown to impact length of stay. A retrospective review of National Surgical Quality Improvement Program (NSQIP) database from 2010 to 2013 by Neuwirth et al. showed resident participation in surgical treatment of intertrochanteric hip fractures was associated with increased length of stay, operating room time, and time to discharge when a surgical case surpassed the 90th percentile for time parameters (Neuwirth et al. 2018). There was no difference in 30-day mortality or significant morbidity. Our institution involves residents in all hip fracture surgeries and this may have increased the overall length of stay; however, this does not skew the results of our study as residents participated in every surgery and the effect of resident participation impacted every case in the study group.

Younger patient age was associated with increased total costs. This may seem counterintuitive given that older patients are typically more medically complex and thus may require a longer length of stay. However, the authors argue that the overall health of the 60-year-old hip fracture patient is significantly different than the 90-year-old hip fracture patient. A patient who is frail enough to suffer a hip fracture at 60-years-old is likely much more medically complex than the 90-year-old patient who is essentially "appropriately frail." Given this, the 60-year-old hip fracture patient would likely require more care post-operatively. Additionally, the authors hypothesize that these patients are more likely to spend extra days in the hospital trying to clear physical therapy to discharge to home as opposed to a skilled nursing facility like their 90-year-old counterpart. Both of these factors lead to an increased length of stay and therefore, overall increased costs.

Despite having nearly identical EBL during surgery, patients undergoing IMN required more blood transfusions, on average, than patients undergoing SHS in our cohort. The literature on this topic is mixed. A review of 43 studies (Yu et al. 2015) found that, among 19 studies that reported data on blood loss, patients undergoing SHS had more blood loss than those undergoing IMN, and a meta-analysis of six randomized trials totaling 909 patients found the same result (Zhu et al. 2017). However, a recent randomized trial of 1,000 patients found no difference in blood loss or transfusion requirements between the two groups (Parker 2017). Meanwhile, a database study of 34,759 intertrochanteric femur fractures found that patients undergoing IMN were more likely to receive a transfusion than those undergoing SHS (Werner et al. 2015).

In recent years, IMN has become the predominant method for fixation of stable intertrochanteric femur fractures despite a lack of compelling evidence for the superiority of one method over the other. In 2005, less than half of intertrochanteric fractures were treated with IMN, but by 2011, nearly 80% received IMN (Werner et al. 2015). Meanwhile, the debate about which method is superior continues in the literature. A database study of patients in the US showed that SHS is associated with higher 1- and 2-year mortality than IMN (Werner et al. 2015), while a study of a UK database revealed higher 30-day mortality with IMN as compared to SHS (Whitehouse et al. 2019).

This study has limitations. As a retrospective cohort study, this study faces the limitations inherent to such a study, including the possibility of confounding by unmeasured variables. Another limitation in this study is the sample size. Despite including data from all patients treated over several years at a high-volume Level 1 trauma center, only 83 patients met inclusion criteria for this analysis. As such, this study was likely underpowered to detect the effects of a difference in device costs as they represent only a small proportion of the total cost of a hospitalization.

CONCLUSION

Our study found no significant difference in cost or length of stay between patients treated with IMN and SHS for stable intertrochanteric hip fractures, but we found a higher transfusion requirement among IMN patients. The literature on IMN versus SHS for intertrochanteric femur fractures is mixed, but this study suggests that differences in implant costs are relatively insignificant when evaluating total cost of care. Orthopaedic surgeons should choose the implant with which they are most comfortable to allow for stable fixation with immediate weightbearing. Given our data, cost containment measures should focus primarily on standardized care pathways for the management of geriatric hip fractures to decrease length of stay over dictating implant choice in the setting of stable intertrochanteric hip fracture.

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DECLARATIONS OF COMPETING INTERESTS

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