Does Knowledge of Implant Cost Affect Fixation Method Choice in the Management of Stable Intertrochanteric Hip Fractures?

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Abstract

We conducted a study to determine if knowledge of implant cost affects fixation method choice in the management of stable intertrochanteric hip fractures. We retrospectively reviewed the cases of 119 patients treated with a sliding hip screw (SHS; Versafix), a short Gamma nail (SGN), or a long Gamma nail (LGN).

Of the 119 fractures, 71 were treated before implant costs were revealed, and 48 afterward. The 2 groups were similar in age, sex, fracture types, American Society of Anesthesiologists physical status classification, and preinjury ambulatory status. SHS was used in 38.0% of the before cases and 27.1% of the after cases, SGN in 29.6% of the before cases and 45.8% of the after cases, and LGN in 32.4% of the before cases and 27.1% of the after cases. Changes in implant use were not statistically significant. SHS was favored for 31-A1.1, 31-A1.2, and 31-A2.1 fractures in the before group but only for 31-A1.2 fractures in the after group. Gamma nails of both sizes were preferred in the after group for 31-A1.1, 31-A1.3, and 31-A2.1 fractures.

At our institution, surgeon knowledge of implant cost did not affect fixation method choice in the management of stable intertrochanteric hip fractures.

The continuing increase in the population of patients older than 65 years in the United States is well known. For orthopedic surgeons, this trend highlights the importance of effective geriatric fracture care, particularly hip fracture care. Hip fractures in the elderly are expected to increase 50% by 2025 and to number 500,000 by 2040.[1] The growing burden of hip fracture cases is accompanied by increasing costs of care. In 2012, 88% of the healthcare dollars spent on these patients were for direct fracture care, a significant increase from 60% in 2009.[2] Although fewer than 1 in 5 fractures in the elderly are hip fractures, these injuries account for 72% of the total cost of geriatric fracture care, more than the total cost of all other osteoporosis-related injuries combined.[1] Currently, the direct cost of hip fracture care ranges from $8358 to $32,195 and is expected, in total, to reach $25 billion by 2025.[2,3]

About 50% of geriatric hip fractures are extracapsular intertrochanteric or pertrochanteric.[4] Several studies have compared sliding hip screws (SHSs) with cephalomedullary nails (CMNs) in the effective management of stable intertrochanteric fractures.[5-11] Although these implants have shown an increased risk for peri-implant fracture and subsequent reoperation, markers such as mortality, medical complications, and restoration of prefracture function have

Take-Home Points

- The incidence of geriatric hip fractures is rising nationally.
- Costs associated with hip fracture care have risen significantly.
- CMN and SHS are effective for stable, intertrochanteric hip fractures.
- Current trends show increased utilization of CMN compared to SHS for stable introchanteric hip fractures.
- Surgeon awareness of implant cost is a critical factor in delivering cost-effective, evidence-based surgical care.

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Table 1. **Comparison of Patient Traits and Injury Types Between Before-Meeting Group and After-Meeting Group**

	Meeting Group		
Characteristic, n (%)	**Before (n = 71)**	**After (n = 48)**	***P***
Sex			
Male	15 (21.1%)	17 (35.4%)	
Female	56 (78.9%)	31 (64.6%)	.066
Age, y			
Mean	84.80	85.19	.808
<60	0 (0%)	1 (2.1%)	
60-69	3 (4.2%)	2 (4.2%)	
70-79	12 (16.9%)	5 (10.4%)	
80-89	35 (49.3%)	23 (47.9%)	
≥90	21 (29.6%)	17 (35.4%)	
Side			.083
Right	31 (43.7%)	26 (54.2%)	
Left	40 (56.3%)	22 (45.8%)	
Fracture type			
31-A1.1	16 (22.5%)	10 (20.8%)	.999
31-A1.2	18 (25.4%)	12 (25.0%)	.999
31-A1.3	12 (16.9%)	7 (14.6%)	.803
31-A2.1	25 (35.2%)	19 (39.6%)	.700

all been equivocal relative to SHSs.[12] Ultimately, one implant cannot be definitively recommended over the other for management of stable intertrochanteric hip fractures.[13,14] Nevertheless, the current trend increasingly favors CMNs over SHSs.[4,15] Most orthopedic surgeons are unaware of or underestimate the cost difference between these implants—a fact even more pronounced for newer implants.[4,16] Considering the ever growing cost burden of hip fractures in the United States, orthopedists must consider not only the efficacy of care but the cost of delivery.

We conducted a study to determine the effect that surgeon knowledge of implant cost had on rates of use of SHSs and CMNs in the management of stable intertrochanteric hip fractures.

Patients and Methods

On May 1, 2012, all 9 attending orthopedic surgeons in a private practice group serving a suburban level II trauma center met to discuss implant prices and implant-related costs for the $850 Versafix SHS, the $1950 short Gamma3 nail (SGN), and the $2900 long Gamma3 nail (LGN), all manufactured by Stryker. All surgeons denied previous knowledge of the costs of these implants. During the discussion, no particular implant was recommended for management of any specific type of fracture. Surgeons were not directly instructed to consider implant cost in subsequent hip fracture surgeries and were not informed of our upcoming study of implant utilization.

After obtaining Institutional Review Board approval, we performed a retrospective chart and radiologic review of all hip fractures (*Current Procedural Terminology* [*CPT*] code 27244 or 27245) managed with fixation at our institution between May 1, 2011 and April 30, 2013. Two hundred six patients were identified (**Figure 1**). Patients with complicated fractures, defined as ipsilateral femoral head, femoral neck, subtrochanteric, femoral shaft, or distal femur fractures, were excluded. In addition, patients who underwent ipsilateral stemmed total knee arthroplasty were excluded to prevent discrimination against LGN use. All 185 uncomplicated fractures were classified using available radiographs and computed tomography scans and the Orthopaedic Trauma Association (OTA) nomenclature for intertrochanteric hip fractures (**Figure 2**).[17] Patients with unstable fracture patterns, defined as region 31 type A2.2, type A2.3, and all A3 types,[14] were excluded. One hundred fifty-five patients with uncomplicated stable intertrochanteric hip fractures remained. After review of admission, physical therapy, and anesthesia records, patients who were nonambulators before surgery and patients with an American Society of Anesthesiologists (ASA) score of ≥4 were excluded. These exclusion criteria were used to eliminate cases in which the operative surgeon may have changed implant use secondary to lack of baseline ambulation or medical comorbidities. The eligible patient set was divided into 2 groups: patients treated before the educational meeting and after the educational meeting.

One year later, surgeons were again shown their respective hip fracture radiographs, with patient identifying data removed. They were asked to reclassify their respective cases using the OTA system and then indicate the implant they would use for operative fixation in each of their cases.

Patient age, sex, injury side, fracture types, and utilization rates of the SHS, SGN, and LGN implants were compared between the groups. For each eligible patient, implant cost and other financial data were obtained from the hospital's finance department. Statistical analyses were performed with SPSS (Statistical Package for the Social Sciences) Version 20 for Macintosh. Inde-

pendent 2-sample *t* test was used for parametric comparisons, and Fisher exact test was used for nonparametric comparisons.

Results

One hundred nineteen patients met the inclusion criteria: preoperative ambulation, uncomplicated stable intertrochanteric hip fracture managed with SHS or CMN fixation between May 1, 2011 and April 30, 2013, and ASA score of ≤3. **Table 1** summarizes the population data of our study sample. Percentage of female patients was higher ($P = .066$) in the before-discussion group (78.9%) than in the after-discussion group (64.6%). Mean patient age was slightly higher ($P = .808$) in the after group (85.19 years) than in the before group (84.80 years). A majority (56.3%) of injuries were on the left side in the before group—a notable difference ($P = .083$) compared with the after group (45.8%). None of these differences was statistically significant.

The injuries most commonly treated in the before (35.2%) and after (39.6%) groups were 31-A2.1 fractures ($P = .700$), and the injuries least commonly treated in the before (16.9%) and after (14.6%) groups were 31-A1.3 fractures ($P = .803$). **Table 2** summarizes the overall cohort's implant use rates. Although percentage of use was fairly similar for SGN (36.1%), SHS (33.6%), and LGN (30.3%), these relationships changed in the before–after comparisons. Whereas 38.0% of uncomplicated stable intertrochanteric hip fractures were managed with SHS fixation during the calendar year before the meeting, only 27.1% of similar injuries were managed with the same fixation during the year after the meeting ($P = .240$). SGN was the implant least commonly used (29.6%) in the before group; by contrast, SGN use was 45.8% ($P = .082$) in the after group.

Examination of implant use per fracture classification revealed an interesting change. In the before group, SHS was the implant most commonly used for 31-A1.1 fractures (7/16, 43.8%), 31-A1.2 fractures (8/18, 44.4%), and 31-A2.1 fractures (10/25, 40.0%), and LGN was used in 66.7% (8/12) of 31-A1.3 fractures. By contrast, in the after group, SHS was most commonly used only for 31-A1.2 fractures (7/12, 58.3%), SGN was used in 90% (9/10) of 31-A1.1 fractures, and LGN was used in 42.1% (8/19) of 31-A2.1 fractures. In addition, 85.7% (6/7) of 31-A1.3 fractures were managed with a version of the Gamma nail.

Reclassification resulted in more A2.1 fractures (42.0% vs 37.0%) and fewer A1.3 fractures (10.1% vs 16.0%). About the same numbers of fractures were classified A1.1 (21.0% vs 21.8%) and A1.2 (26.9% vs 25.2%). SHS was favored for A1.1 fractures (92.0%) and A1.2 fractures (65.6%). SGN was favored for A1.3 fractures (75.0%). Gamma nails of both sizes were favored for A2.1 fractures (88.0%).

Table 2. **Comparison of Implant Use Between Patients in Before-Meeting Group and Patients in After-Meeting Group**

	Meeting Group		
Implant Type, n (%)	**Before**	**After**	***P***
Overall	N = 71	N = 48	
SHS	27 (38.0%)	13 (27.1%)	.240
SGN	21 (29.6%)	22 (45.8%)	.082
LGN	23 (32.4%)	13 (27.1%)	.684
31-A1.1	N = 16	N = 10	
SHS	7 (43.8%)	1 (10.0%)	
SGN	5 (31.3%)	9 (90.0%)	
LGN	4 (25.0%)	0 (0%)	
31-A1.2	N = 18	N = 12	
SHS	8 (44.4%)	7 (58.3%)	
SGN	5 (27.8%)	3 (25.0%)	
LGN	5 (27.8%)	2 (16.7%)	
31-A1.3	N = 12	N = 7	
SHS	2 (16.7%)	1 (14.3%)	
SGN	2 (16.7%)	3 (42.9%)	
LGN	8 (66.7%)	3 (42.9%)	
31-A2.1	N = 25	N = 19	
SHS	10 (40.0%)	4 (21.1%)	
SGN	9 (36.0%)	7 (36.8%)	
LGN	6 (24.0%)	8 (42.1%)	

Abbreviations: LGN, long Gamma3 nail (cephalomedullary; Stryker); SGN, short Gamma3 nail (cephalomedullary; Stryker); SHS, sliding hip screw (Versafix; Stryker).

Discussion

Comparisons of SHS/plate and CMN constructs in the management of stable intertrochanteric hip fractures have long been discussed in the orthopedic literature. The major concern with CMNs (vs SHSs) is a statistically significantly higher rate of revision surgery, most often for peri-implant fracture. Rates of previous revision surgery for peri-implant fracture have ranged from 2.4% to 6% for CMNs and from 0.6% to 4% for SHSs.[5-7,9] In a *Cochrane* review of 22 studies (3749 patients), Parker and Handoll[12] compared CMN and SHS outcomes in 23 categories and found a statistically signifi-

Before Meeting		After Meeting
7	Subtrochanteric involvement	8
3	Stemmed total knee arthroplasty	2
1	Ipsilateral femur fracture	0
5	A2.2	0
3	A2.3	4
3	A3.1	1
4	A3.2	4
2	A3.3	4
18	ASA ≥4	8
3	Preoperative nonambulatory	7

Figure 1. Flowchart of patient selection process using exclusion criteria.
Abbreviation: ASA, American Society of Anesthesiologists.

cant difference only in postoperative fracture rate. However, in a meta-analysis of studies conducted between 2000 and 2005, Bhandari and colleagues[8] found no statistically significant difference in risk of femoral shaft fracture between CMNs (0.6%) and SHSs (0.1%). In addition, Utrilla and colleagues[10] reported no postoperative fractures with use of Gamma3 CMNs. These recent studies may indicate that newer CMN designs can reduce the incidence of postoperative peri-implant fracture.[8,10] Other outcome measures, such as 1-year mortality, functional outcome, and medical complication rate, have shown no statistically significant differences between the 2 implants.[10-12] Ultimately, the current recommendation for fixation of stable intertrochanteric hip fractures is either SHS or CMN.[13,14]

Of our study patients, 78.9% (before group) and 64.6% (after group) were female, and 49.3% (before group) and 47.9% (after group) were between 80 and 89 years of age. Similarly, a review of hip fracture Medicare claims made between 1999 and 2002 revealed that >75% of the patients were females and 48% to 49% were octogenarians.[4,18] However, our rates of different fracture types differed from those of Adams and colleagues.[5] In a 1-year single-institution study, they found that, for both CMNs and SHSs, the most common stable intertrochanteric fractures were 31-A1.1 fractures; in our study's before and after groups, more than one-third of injuries were 31-A2.1 fractures. Least common were 31-A1.3 fractures, both in the study by Adams and colleagues[5] and in our before (16.9%) and after (14.6%) groups. Although our fracture rates differ from those of previous studies, all 4 classification categories fall under the umbrella of stable intertrochanteric hip fracture, which is the sole focus of this study.[14]

We hypothesized that cost would be a significant driver of implant choice in the management of these injuries. Given that SHS costs $1186.91 less than SGN and $1625.88 less than LGN at our institution, we expected that the before-discussion group's overall SHS use rate of 38.0% would increase after discussion. Instead, SGN became the favored implant, with use in almost half of all fractures in the after group. Although the change in overall implant use rate was notable, these findings were not statistically significant. Examination of individual fracture patterns revealed 2 areas of interest. First, SHS was assumed to be the implant of choice in the management of the relatively simple 31-A1.1 fractures. Although this assumption was verified in the before group (SHS use in 43.8% of fractures), SGN was used in almost every case (90%) in the after group. However, when surgeons were asked 1 year later to recommend an implant for A1.1 fractures, 92% suggested SHS. The more cost-effective SHS construct may be the most amenable for use in these injury types given all intertrochanteric hip fracture patterns, though this has not been studied.

On the other hand, for 31-A2.1 fractures, perhaps the most complicated of the stable patterns, LGN became the implant of choice (42.1%). Despite surgeons' awareness of the cost differences, management of these fractures shifted in the after group to the most expensive implant, indicative of surgeon concern about eventual loss of reduction with SHS and surgeon comfort with a particular procedure. This trend held when surgeons were asked to reclassify fractures 1 year later, as CMNs were recommended for 88% of 31-A2.1 fractures. Although both SHS and CMN were acceptable in 97% of the fractures included in this study, SGNs or LGNs were preferred for almost every fracture pattern involving the lesser trochanter. All 9 attending surgeons described involvement of the lesser trochanter as an indicator of posteromedial calcar injury. Surgeons became particularly concerned when this fracture pattern occurred in patients with significant osteopenia; SHS fixation, in their opinion, would be poor in the setting of a combination of greater posteromedial instability and poor bone quality. In a level I prospective, randomized

trial, Barton and colleagues[7] found no difference in outcomes between LGN and SHS fixation for 31-A2 proximal femur fractures and recommended SHS implants for the cost savings. In the clinical experience of this group, however, A1.3 and A2.1 fractures were at especially high risk for failure with SHS use, which necessitated greater implant stability through CMN fixation. On the other hand, for simpler fracture patterns, most surgeons suggested SHS implants. In their opinion, SGN and LGN implants offered no additional benefit of stability without evidence of posteromedial injury, even in the setting of osteopenia. For A1.2 fractures, posteromedial involvement was judged on the basis of size of the inferomedial spike or the extent of the inferomedial fracture line. Two surgeons preferred CMN for simple fractures, one because of the increased comfort with the implants and the other because of the minimally invasive surgical technique. Overall, our results indicate that knowledge of implant cost is not a strong enough factor to change surgeon behavior in selecting fixation for uncomplicated stable intertrochanteric hip fractures in previously ambulatory elderly patients.

The lack of effect could be a consequence of surgeons' training and comfort with various implants, especially among younger attending surgeons. Most of the attendings in the practice are under age 50 years, which correlates with a preference for CMN fixation.[19] Case loads of >80 intertrochanteric hip fractures per calendar year, as in the after group, also correlates with more CMN use.[19] However, the before group had more intertrochanteric hip fractures, and yet SHS was the implant of choice. Resident physician experience and comfort with various implants may play a role too, as teaching hospitals with resident assistance also correlate with CMN use.[19] However, no major change in resident physician involvement was undertaken during this period. The institution studied is near a major metropolis in the Northeast, a region that has disfavored SHS in recent years.[18] The change from before to after fits an overall trend in changing implant use. Anglen and colleagues[15] found a significant decrease in SHS use, from 97% in 1999 to 33% in 2006, for intertrochanteric fracture fixation. Simultaneously, CMN use increased from 3% to 67%.

This study had several limitations. First, its overall sample size was small, and therefore any data fluctuations may be exaggerated. Furthermore, changes in utilization rates were compared over 2 years, which may not be long enough to show a changing trend in implant selection. Post hoc analysis of the sample size determined a power of 0.76 for an α of 0.05 and an effect size of 0.50. Second, radiologic classification was performed in a retrospective review, not officially by the operative surgeon. Fractures that we considered stable may have been considered unstable by the operative surgeon, influencing implant selection. Third, patients were selected from only one hospital, and orthopedic surgeons from other institutions may be more sensitive to cost considerations, changing implant selection more quickly. Fourth, initial selection of patients by *CPT* code might not have captured all those who satisfied the inclusion criteria. Fifth, only a single intervention was used, and follow-up meetings certainly could have increased the effectiveness of the intervention. Last, this and other retrospective studies are inherently weaker because of possible bias.

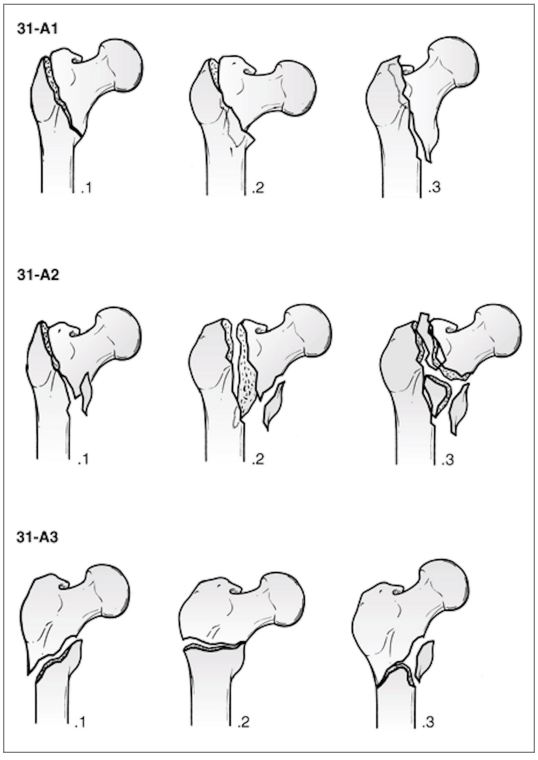

Figure 2. Orthopaedic Trauma Association classification of intertrochanteric hip fractures.

Conclusion

Our study results showed that implant cost is not a significant factor in implant selection for uncomplicated stable intertrochanteric hip fractures in previously ambulatory elderly patients. By itself, knowledge of implant cost may not be a strong enough force to change surgeon behavior or preference secondary to consequences of failure or comfort

with particular implants. In an economic climate in which healthcare is scrutinized for both its medical effectiveness and cost-effectiveness, further study of forces that could influence orthopedic surgeons to select a more cost-effective implant is warranted.

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References

1. Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A. Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. *J Bone Miner Res.* 2007;22(3):465-475.
2. Kilgore ML, Curtis JR, Delzell E, et al. A close examination of healthcare expenditures related to fractures. *J Bone Miner Res.* 2013;28(4):816-820.
3. Budhia S, Mikyas Y, Tang M, Badamgarav E. Osteoporotic fractures: a systematic review of U.S. healthcare costs and resource utilization. *Pharmacoeconomics.* 2012;30(2):147-170.
4. Aros B, Tosteson AN, Gottlieb DJ, Koval KJ. Is a sliding hip screw or IM nail the preferred implant for intertrochanteric fracture fixation? *Clin Orthop Relat Res.* 2008;466(11):2827-2832.
5. Adams CI, Robinson CM, Court-Brown CM, McQueen MM. Prospective randomized controlled trial of an intramedullary nail versus dynamic screw and plate for intertrochanteric fractures of the femur. *J Orthop Trauma.* 2001;15(6):394-400.
6. Ahrengart L, Törnkvist H, Fornander P, et al. A randomized study of the compression hip screw and Gamma nail in 426 fractures. *Clin Orthop Relat Res.* 2002;(401):209-222.
7. Barton TM, Gleeson R, Topliss C, Greenwood R, Harries WJ, Chesser TJ. A comparison of the long Gamma nail with the sliding hip screw for the treatment of AO/OTA 31-A2 fractures of the proximal part of the femur: a prospective randomized trial. *J Bone Joint Surg Am.* 2010;92(4):792-798.
8. Bhandari M, Schemitsch E, Jönsson A, Zlowodzki M, Haidukewych GJ. Gamma nails revisited: Gamma nails versus compression hip screws in the management of intertrochanteric fractures of the hip: a meta-analysis. *J Orthop Trauma.* 2009;23(6):460-464.
9. Osnes EK, Lofthus CM, Falch JA, et al. More postoperative femoral fractures with the Gamma nail than the sliding screw plate in the treatment of trochanteric fractures. *Acta Orthop Scand.* 2001;72(3):252-256.
10. Utrilla AL, Reig JS, Muñoz FM, Tufanisco CB. Trochanteric Gamma nail and compression hip screw for trochanteric fractures. *J Orthop Trauma.* 2005;19(4):229-233.
11. Verettas DA, Ifantidis P, Chatzipapas CN, et al. Systematic effects of surgical treatment of hip fractures: gliding screw-plating vs intramedullary nailing. *Injury.* 2010;41(3):279-284.
12. Parker MJ, Handoll HH. Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults. *Cochrane Database Syst Rev.* 2010;(9):CD000093.
13. Kaplan K, Miyamoto R, Levine BR, Egol KA, Zuckerman JD. Surgical management of hip fractures: an evidence-based review of the literature. II: intertrochanteric fractures. *J Am Acad Orthop Surg.* 2008;16(11):665-673.
14. Lindskog DM, Baumgaertner MR. Unstable intertrochanteric hip fractures in the elderly. *J Am Acad Orthop Surg.* 2004;12(3):179-190.
15. Anglen JO, Weinstein JN; American Board of Orthopaedic Surgery Research Committee. Nail or plate fixation of intertrochanteric hip fractures: changing pattern of practice. A review of the American Board of Orthopaedic Surgery Database. *J Bone Joint Surg Am.* 2008;90(4):700-707.
16. Streit JJ, Youssef A, Coale RM, Carpenter JE, Marcus RE. Orthopaedic surgeons frequently underestimate the cost of orthopaedic implants. *Clin Orthop Relat Res.* 2013;471(6):1744-1749.
17. Marsh JL, Slongo TF, Agel J, et al. Fracture and dislocation classification compendium—2007: Orthopaedic Trauma Association classification, database and outcomes committee. *J Orthop Trauma.* 2007;21(10 suppl):S1-S133.
18. Forte ML, Virnig BA, Kane RL, et al. Geographic variation in device use for intertrochanteric hip fractures. *J Bone Joint Surg Am.* 2008;90(4):691-699.
19. Forte ML, Virnig BA, Eberly LE, et al. Provider factors associated with intramedullary nail use for intertrochanteric hip fractures. *J Bone Joint Surg Am.* 2010;92(5):1105-1114.