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Bone Health Evaluations and Secondary Fragility Fractures in Hip Fracture Patients

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Purpose: This study sought to examine the utilization of bone health evaluations in geriatric hip fracture patients and identify risk factors for the development of future fragility fractures.

Materials and Methods: A consecutive series of patients ≥55 years who underwent surgical management of a hip fracture between September 2015 and July 2019 were identified. Chart review was performed to evaluate post-injury follow-up, performance of a bone health evaluation, and use of osteoporosis-related diagnostic and pharmacologic treatment.

Results: A total of 832 patients were included. The mean age of the patients was 81.2±9.9 years. Approximately 21% of patients underwent a comprehensive bone health evaluation. Of this cohort, 64.7% were started on pharmacologic therapy, and 73 patients underwent bone mineral density testing. Following discharge from the hospital, 70.3% of the patients followed-up on an outpatient basis with 95.7% seeing orthopedic surgery for post-fracture care. Overall, 102 patients (12.3%) sustained additional fragility fractures within two years, and 31 of these patients (3.7%) sustained a second hip fracture. There was no difference in the rate of second hip fractures or other additional fragility fractures based on the use of osteoporosis medications.

Conclusion: Management of osteoporosis in geriatric hip fracture patients could be improved. Outpatient follow-up post-hip fracture is almost 70%, yet a minority of patients were started on osteoporosis medications and many sustained additional fragility fractures. The findings of this study indicate that orthopedic surgeons have an opportunity to lead the charge in treatment of osteoporosis in the post-fracture setting.

Keywords: Femur, Hip fracture, Fragility fracture, Osteoporosis, Bone health

INTRODUCTION

Osteoporosis can lead to progressive loss of bone mineral density (BMD) with resultant bone fragility and increased fracture risk[1,2]. Proximal femur fractures account for the majority of osteoporotic-related fractures and are associated with functional decline, decreased quality of life and potential mortality[3,4]. Among the Medicare population, the risk of sustaining a subsequent fracture increases significantly after an initial fragility fracture[5-8]. In an effort to minimize morbidity and prevent secondary injuries, there has been renewed focus on bone health optimization.

Optimizing bone health involves assessment of bone quality, identification and correction of metabolic deficits, and initiation of bone-fortifying therapies when indicated, such as calcium, vitamin D, antiresorptive drugs and/or anabolic medications[2,8-11]. Notably, however, a minority of patients with hip fractures receive pharmacologic treatment[12,13]. Similarly, few patients

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undergo BMD testing following osteoporotic fractures[14]. The American Orthopaedic Association's (AOA) "Own the Bone" (OTB) program attempted to address these discrepancies. OTB, a national, multidisciplinary initiative, was developed to improve bone health using 10 prevention measures in the post-fracture setting[10,14-17]. As of January 2020, OTB has been implemented in more than 275 institutions in the United States, which has led to improvements in BMD testing and medication prescribing rates[16,18,19].

Despite the success of OTB and other secondary prevention programs, there are still care gaps in the management of osteoporosis. Barriers to care include patient-, provider- and/or systems-based factors[10,14,17,18,20]. From a patient perspective, elderly patients may express concerns regarding polypharmacy, cost of treatment, and the side effects of medication[20]. Medication non-compliance may also be attributed to poor healthcare literacy. Potential provider-specific factors include confusion regarding treatment guidelines, poor knowledge base, and an assumption that another provider will manage treatment. Management of osteoporosis can involve multiple medical subspecialties, including orthopedics, primary care, rheumatology, endocrinology, and obstetrics/gynecology, which may contribute to a lack of ownership of patients[10,17,18,20]. Other systems-based factors include lack of time to fully address secondary prevention, need for prolonged follow-up, and concerns regarding appropriate compensation[10,17,18,20].

The purpose of this study was to examine bone health optimization among a cohort of geriatric patients with hip fractures who were treated within one hospital system and followed for a period of two years. We attempted to determine the impact of bone health on fracture prevention in the short-term period following a hip fracture and to identify potential areas for improvement.

MATERIALS AND METHODS

The study was approved by the Institutional Review Board (IRB) of NYU Langone Health (No. S23-01521) and Jamaica Hospital Medical Center (No. 1700018-1). Written consent was waived by the IRB due to the study's retrospective design. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

A consecutive series of patients aged 55 years or older who underwent surgery for treatment of a hip fracture (femoral neck, intertrochanteric, subtrochanteric) between September 2015 and July 2019 at our hospital were retrospectively identified from an IRB-approved prospective hip fracture registry. All patients underwent treatment within a large, urban, academic medical center, which was enrolled in OTB. Patients with pathologic fractures or those who died during admission or were discharged to hospice were excluded. Information on patient demographics, medical comorbidities, and functional status was collected. Analysis of comorbidities was performed using the Charlson comorbidity index (CCI) and the American Society of Anesthesiologists (ASA) Physical Status Classification System. Characteristics of injury, including hip fracture subtype were recorded.

A bone health evaluation was defined as either an inpatient consult or an outpatient visit focused on bone health. During each admission and subsequent outpatient follow-up, it was determined whether or not the patient had undergone a bone health evaluation on either an inpatient or outpatient basis, if BMD testing was performed, and if any osteoporosis medications were prescribed. Assessment of vitamin D and calcium levels was performed routinely during the index admission as part of the standard postoperative fragility fracture order set. Additional laboratory testing was performed if recommended by consulting services on either an inpatient or outpatient basis. At our institution, bone health for inpatients is typically overseen by the Department of Rheumatology; however, these services are provided by a number of other providers in an outpatient setting, including primary care, orthopedics, endocrinology, and obstetrics/gynecology. The number of outpatient visits to these departments, as well as the number of additional emergency room to inpatient admissions for the two-year period were calculated. Data on the number of additional fragility fractures sustained was also collected. Calculation of the rates of subsequent contralateral hip fractures and secondary fragility fractures was performed using standard *t*-test analyses for comparison between patients who did and did not receive osteoporosis medications. In addition, differences between those patients with postoperative follow-up and those without follow-

up were calculated with respect to demographics, clinical health status, and whether or not they were prescribed pharmacologic therapy postoperatively using both *t*-test and chi-square analyses. A *P*-value of <0.05 was used in performance of statistical analyses. All analyses were performed using IBM SPSS Statistics software (ver. 23; IBM Corp.).

RESULTS

A total of 854 consecutive patients with hip fracture were identified during the study period. Eighteen patients who either died as an inpatient or were discharged to hospice were excluded. Four additional patients were excluded for pathologic fractures, thus, 832 patients were analyzed. The mean age of patients in the entire cohort was 81.3±9.9 years, and the majority of patients were female (71.3%). The majority of patients had an ASA score of 3, and the mean CCI for the entire cohort was 1.4±1.7. Details regarding additional patient demographics are shown in Table 1.

Approximately 20.9% of patients (n=174) underwent a postoperative evaluation of bone health, defined as either an inpatient rheumatology consult, or as an outpatient visit focusing on optimization of bone health. Most of these evaluations were performed on an inpatient basis (116/174). Evaluation of 32 patients was conducted in the outpatient setting, and 26 patients underwent both inpatient and outpatient evaluations. Of the 174 patients who underwent an evaluation of bone health, 63.2% (n=110) were started on pharmacologic therapy including vitamin D (n=94), calcium (n=26), anti-resorptive drugs (n=21), or anabolic medications (n=23). BMD testing was performed for 73 patients. Forty-four patients had undergone previous treatment for osteoporosis prior to their initial hip fracture.

Thirty-one patients (3.7%) sustained a contralateral hip fracture within two years, which occurred at a mean 294.1±197.7 days after the initial hip fracture. Sixteen of these patients sustained a femoral neck fracture, and 15 patients sustained an intertrochanteric hip fracture. Twenty-five patients (80.6%) with a second hip fracture sustained the same type of hip fracture as that of their initial injury. Of the 113 patients who were started on pharmacotherapy after undergoing index surgery, three patients sustained a second hip fracture within two years. Details regarding the rate of secondary fragility fractures and utilization of pharmacologic treatment are shown in Table 2. No difference in the rate of second hip fractures based on the use of osteoporosis medications was observed (2.6% among patients treated for osteoporosis vs. 3.9% among patients who did not receive treatment, *P*=0.788). In-

Table 1. Patient Demographics (n=832)

Demographic	Value
Age (yr)	81.3±9.9
No. of female patients	593 (71.3)
CCI	1.4±1.7
ASA class	
1	17 (2.0)
2	235 (28.2)
3	440 (52.9)
4	140 (16.8)
Ambulation status	
Community ambulator	617 (74.2)
Household ambulator	183 (22.0)
Non-ambulatory	32 (3.8)
Use of assistive device preoperatively	449 (54.0)
Race	
White	686 (82.5)
African American	22 (2.6)
Asian	63 (7.6)
Hispanic	10 (1.2)
Other	38 (4.6)
Unknown	13 (1.6)
BMI (kg/m^2)	24.2±4.8
Length of stay (day)	6.4±3.8

Values are presented as mean±standard deviation or number (%).
CCI: Charlson comorbidity index, ASA: American Society of Anesthesiologists, BMI: body mass index.

Table 2. Pharmacologic Treatment and Subsequent Fragility Fractures

	Total cohort (n=832)	No additional fragility fractures within two years (n=729)	Additional fragility fractures within two years (n=103)	*P*-value
Patients who received pharmacologic treatment	113 (13.6)	96 (13.2)	17 (16.5)	0.352
Patients who did not receive pharmacologic treatment	719 (86.4)	633 (86.8)	86 (83.5)	0.352

Values are presented as number (%).

cidences of secondary fragility fractures following the index hip fracture are listed in Table 3. No difference was observed in the rate of additional fragility fractures based on the use of osteoporosis medications (15% among patients treated for osteoporosis vs. 12% among patients who did not receive treatment, P=0.352). Postoperatively, three patients with intertrochanteric hip fractures experienced hardware failure requiring conversion total hip arthroplasty. Three patients who had undergone hemiarthroplasty had periprosthetic fractures that required reoperation. One patient experienced a prosthetic hip joint dislocation. One patient experienced implant loosening that required revision to total hip arthroplasty.

The majority of patients interacted with the healthcare system during the two-year period following their index hip fracture. After discharge from the hospital, 585 patients (70.3%) followed up on an outpatient basis within our healthcare system. Most of these patients (n=556) received outpatient orthopedic care; however, patients were also seen by medicine (n=114), rheumatology (n=43), endocrinology (n=31), and/or obstetrics and gynecology (n=5) (Table 4). As expected, patients who sustained additional fractures (both hip and all fragility fractures) were more likely to experience additional inpatient and outpatient encounters (Table 4). More than 200 patients (n=229; 27.5%) had additional emergency room visits that resulted in an inpatient admission. On mean, patients who had additional inpatient admissions during the follow-up period were older (83.3±8.8 years vs. 80.2±10.3 years, P<0.001), had higher ASA scores (3.2±0.6 vs. 2.7±0.7, P<0.001), and were less likely to have undergone a bone health evaluation. No difference in age, sex, body mass index (BMI), or race was observed among patients who underwent a bone health evaluation and those who did not receive an evaluation. Similarly, no demographic differences were observed among patients treated for osteoporosis compared to those who were not treated. On mean, patients who followed-up with orthopedics as an outpatient were younger (80.2±10.1 years vs. 82.9±9.6 years, P<0.001), with lower ASA scores (2.8±0.7 vs. 3.0±0.7, P<0.001), higher BMI (24.6±4.9 kg/m^2 vs. 23.5±4.5 kg/m^2, P=0.004), female (73.7% vs. 66.2%, P=0.024), and more likely to have undergone an evaluation of bone health (24.0% vs. 13.7%, P=0.001). In addition, patients who followed-up with primary care were more likely to have undergone an evaluation of bone health (28.4% vs. 19.1%, P=0.023).

Table 3. Number of Patients with Subsequent Fractures within Two Years (n=103)

Fracture	Value
Hip	31 (30.1)
Other lower extremity	20 (19.4)
Pelvic	4 (3.9)
Rib	8 (7.8)
Upper extremity	21 (20.4)
Vertebral	17 (16.5)
Multiple	2 (1.9)

Values are presented as number (%).

DISCUSSION

In this study, the follow-up rate within the hospital system was approximately 70% following a geriatric hip fracture with the majority of these patients estab-

Table 4. Post-hip Fracture Outpatient Follow-up

Follow-up location	All patients (n=832)	Patients with additional fractures within two years (n=103)	Patients with additional hip fracture within two years (n=31)	P-value*	P-value†
Inpatient admission	229 (27.5)	51 (49.5)	14 (45.2)	<0.001	0.025
Outpatient medicine	114 (13.7)	21 (20.4)	5 (16.1)	0.035	0.689
Outpatient OB/GYN	5 (0.6)	0 (0)	0 (0)	>0.999	>0.999
Outpatient rheumatology	43 (5.2)	15 (14.6)	2 (6.5)	<0.001	0.742
Outpatient orthopedics	556 (66.8)	81 (78.6)	23 (74.2)	0.007	0.375
Outpatient endocrine	31 (3.7)	4 (3.9)	1 (3.2)	0.582	>0.999

Values are presented as number (%).
OB/GYN: obstetrics/gynecology.
*Difference between patients who did and did not sustain additional fractures within two years.
†Difference between patients who did and did not sustain additional hip fracture within two years.

lishing care with orthopedic surgery. Despite this relatively high follow-up rate, only a minority of patients underwent a formal bone health evaluation and even fewer actually received treatment.

The undertreatment of osteoporosis in patients with fragility fractures has been documented in previously published studies[12-14,16,21]. A retrospective cohort study conducted by Balasubramanian et al.[12] reported initiation of osteoporosis medications in 10%-19% of patients and diagnostic testing rates of 15%-30%. We observed similar results with approximately 20% of patients undergoing a bone health evaluation, and approximately 9% undergoing BMD testing postoperatively. The majority of patients who underwent a bone health evaluation were started on medications; however, only a small number of these patients were started on antiresorptive and anabolic medications. At our institution, a bone health consult and laboratory testing are initiated automatically as part of the postoperative order set for patients with fragility fractures; however, patients are often discharged from the hospital prior to full evaluation. While some patients are seen on an outpatient basis, the majority do not undergo a complete assessment of bone health, and even fewer have multiple visits focusing on bone health.

The results of our study showed a relatively high rate of follow-up among geriatric patients with hip fractures, with almost 70% seen on an outpatient basis postoperatively. In this cohort, approxiamtely 95% of patients were seen by orthopedic surgery for standard post-fracture care. Separate evaluation of bone health is routinely performed by only one of the orthopedic traumatologists within our hospital system; the remainder of bone health consults were conducted by rheumatology or endocrinology. Orthopedic surgeons have rarely provided comprehensive care for osteoporosis, but intervention in the fracture-clinic setting has been proposed to improve the management of osteoporosis[12,16,22]. In our study, we found that patients who followed up with orthopedics postoperatively were more likely to have received a bone health evaluation. Hawker et al.[22] suggested that surgeons provide a standardized letter to patients' primary care physicians to encourage management of bone health by these providers. However, we argue that orthopedic surgeons should take on a more active role in the treatment of this metabolic bone disease in the post-fracture setting and consider overseeing the management of testing, pharmacotherapy, and the long-term follow-up required for these patients with consultation and co-management with other subspecialties as necessary. Considering the existing high rate of outpatient visits with orthopedic surgery postoperatively, this could improve the identification and treatment of osteoporosis. While surgeons may express concern regarding the perceived time commitment, preventing fragility fractures can lead to decreased utilization of healthcare and overall cost as well as improved patient outcomes[16]. In addition, a visit dedicated to optimization of bone health can be billed outside of the standard bundled payment for hip fractures, which may provide further incentive for orthopedic surgeons to take ownership of these patients[23]. Our institution utilizes a geriatric fragility fracture liaison service formed by our orthopedic traumatologists, nurse practitioners, and a licensed clinical social worker in an attempt to ensure that patients receive appropriate follow-up for their osteoporosis and started on treatment when indicated. Similar fracture liaison services have been previously described[24]. While these service have improved fracture care, our findings demonstrate that many patients still do not undergo complete evaluations or receive adequate treatment.

Fragility fractures are predictive of a future fracture[5,6]. We found that 12.5% of patients sustained additional fragility fractures during the two-year period following their index hip fracture with almost 4% of patients sustaining a contralateral hip fracture. This finding is similar to those reported in previously published literature which estimate that the incidence of a second hip fracture is between 4%-10%[16,25]. Our findings indicate that the morphology of the second hip fracture is often the same as that of the initial injury. Of particular interest, we found no significant difference in the rate of second hip fracture among patients who received osteoporosis medications. In addition, no difference in the rate of other fragility fractures was observed among patients treated for osteoporosis. This finding differs from previous literature which demonstrates a higher incidence of additional fragility fractures in patients who received inadequate treatment for osteoporosis[5]. Despite this finding, we still believe that optimization of bone health is a key component of post-fracture care for geriatric hip fracture patients. While our study examined additional fracture risk after two years, it is unclear if fracture risk becomes significantly mitigated with longer follow-up.

This study has several limitations. It was conducted at a single, academic, urban medical center consisting of a level one trauma center, an orthopedic specialty hospital, and a tertiary care center. Our patient population may not reflect those of other institutions or geographic locations. In addition, our electronic medical record was not able to capture patients who later presented to outside institutions for management of osteoporosis, postoperative complications, or treatment of additional fragility fractures. Thus, it is possible that the rates of osteoporosis treatment, failure rates, and the incidence of additional fragility fractures were underestimated. Finally, the known inherent limits of a retrospective study can be applied to this study.

CONCLUSION

This study highlights the underutilization of bone health evaluations in patients with hip fractures. We did not observe a significant difference in subsequent fragility fractures between patients who underwent a bone health evaluation and/or were treated for osteoporosis and those who did not over the two-year post index fragility fracture period. Despite this finding, we believe in the importance of osteoporosis treatment as it is possible that fracture risk is lessened with longer follow-up. In addition, analysis of outpatient follow-up trends demonstrates that patients are seen by multiple providers postoperatively, and there are many opportunities for post-hip fracture intervention. Careful monitoring of patients with hip fractures should be performed to ensure that patients do not "fall through the cracks" even with participation in nationally recognized programs. Appropriate postoperative care following a hip fracture requires a team approach and should be integrated into care management algorithms established by treating institutions.

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Conflict of Interest

Sanjit R. Konda is a paid consultant for Stryker and serves on a committee for the Orthopaedic Trauma Association. Philipp Leucht is a paid consultant for Ankasa Regenerative Therapeutics and Stryker. He also serves in a leadership role for the Orthopaedic Trauma Association and the American Academy of Orthopaedic Surgeons. He is a member of the editorial or governing board of the Journal of Orthopaedic Research and receives support from Springer. Nirmal Tejwani is a paid consultant for DePuy Synthes, Acumed, and Stryker. He holds leadership positions in the American Academy of Orthopaedic Surgeons, American Orthopaedic Association, Orthopaedic Trauma Association, and the Foundation for Orthopaedic Trauma. Kenneth A. Egol is a paid consultant for Exactech. He receives research support from Acumed and Synthes. Kenneth A. Egol has served as a paid presenter for Smith & Nephew. He serves on a task force for the Orthopaedic Trauma Association and has reserved publishing royalties, financial or material support from SLACK Incorporated and Wolters Kluwer Health – Lippincott Williams & Wilkins. Emily M. Pflug and Ariana Lott declare that they have no conflict of interest.

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