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Racial and Health Insurance Disparities of Inpatient Spine Augmentation for Osteoporotic Vertebral Fractures from 2005 to 2010

C.N. Gu, W. Brinjikji, A.M. El-Sayed, H. Cloft, J.S. McDonald, and D.F. Kallmes

ABSTRACT

BACKGROUND AND PURPOSE: Vertebroplasty and kyphoplasty are frequently utilized in the treatment of symptomatic vertebral body fractures. While prior studies have demonstrated disparities in the treatment of back pain and care for osteoporotic patients, disparities in spine augmentation have not been investigated. We investigated racial and health insurance status differences in the use of spine augmentation for the treatment of osteoporotic vertebral fractures in the United States.

MATERIALS AND METHODS: Using the Nationwide Inpatient Sample from 2005 to 2010, we selected all discharges with a primary diagnosis of vertebral fracture (International Classification of Diseases-9 code 733.13). Patients who received spine augmentation were identified by using International Classification of Diseases-9 procedure code 81.65 for vertebroplasty and 81.66 for kyphoplasty. Patients with a diagnosis of cancer were excluded. We compared usage rates of spine augmentation by race/ethnicity (white, black, Hispanic, and Asian/Pacific Islander) and insurance status (Medicare, Medicaid, self-pay, and private). Comparisons among groups were made by using χ^2 tests. A multivariate logistic regression analysis was fit to determine variables associated with spine augmentation use.

RESULTS: A total of 228,329 patients were included in this analysis, of whom 129,206 (56.6%) received spine augmentation. Among patients with spine augmentation, 97,022 (75%) received kyphoplasty and 32,184 (25%) received vertebroplasty; 57.5% (92,779/161,281) of white patients received spine augmentation compared with 38.7% (1405/3631) of black patients ($P < .001$). Hispanic patients had significantly lower spine augmentation rates compared with white patients (52.3%, 3777/7222, $P < .001$) as did Asian/Pacific Islander patients (53.1%, 1784/3361, $P < .001$). The spine augmentation usage rate was 57.2% (114,768/200,662) among patients with Medicare, significantly higher than that of those with Medicaid (43.9%, 1907/4341, $P < .001$) and those who self-pay (40.2%, 488/1214, $P < .001$).

CONCLUSIONS: Our findings demonstrate substantial racial and health insurance–based disparities in the inpatient use of spinal augmentation for the treatment of osteoporotic vertebral fracture.

ABBREVIATIONS: NIS = Nationwide Inpatient Sample; ICD = International Classification of Diseases

Vertebroplasty and kyphoplasty are frequently used in the treatment of symptomatic vertebral body fractures.¹ Prior studies have demonstrated that minority patients are significantly less likely to receive spine procedures such as cervical discectomy for the treatment of pain compared with whites.² The Nationwide Inpatient Sample (NIS) has been used in a number of prior studies to demonstrate racial and health insurance status disparities in access to treatment of a variety of diseases such as deep brain stimulation for Parkinson disease,³ revascularization for lower extremity ischemia,⁴ and surgical/endovascular treatment for intracranial an-

eurysms.⁵ The goal of this study was to investigate what, if any, racial or health insurance status disparities existed in the use of spine augmentation for the treatment of osteoporotic fractures in the United States by analyzing the NIS, a large public data base containing discharge information for nearly 8 million hospital stays per year.

MATERIALS AND METHODS

Patient Population

We purchased the NIS hospital discharge data base for 2005–2010 from the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality, Rockville, Maryland.⁶ The NIS is a hospital discharge data base representing 20% of all inpatient admissions to nonfederal hospitals in the United States. Inclusion criteria were the following: 1) adult patients who had a primary diagnosis of vertebral fracture (International Classification of Diseases [ICD]-9 diagnosis code 733.13), and 2) patients treated at centers that performed spine augmentation. Exclusion criteria were the following: 1)

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patients with a diagnosis of cancer (ICD-9, 1400-1991, 2000-2089), and 2) patients treated at centers not performing spine augmentation procedures. Patients with vertebroplasty were identified by using the ICD-9 procedure code 81.65, and patients with kyphoplasty were identified by using the ICD-9 procedure code 81.66. Hospitals performing spine augmentation were identified by cross-matching ICD-9 procedure codes with hospital identifier codes. If a hospital performed ≥ 1 spine augmentation procedure in a given year, patients discharged from that hospital were included in this analysis. In addition to race and insurance, other demographic variables collected included age, Charlson Comorbidity Index (which predicts the 10-year mortality for patients with a variety of comorbid conditions),⁷ sex, and the presence of the following comorbidities: congestive heart failure, coronary artery disease, hypertension, hyperlipidemia, osteoporosis, diabetes mellitus, obesity, and smoking.

Usage

The usage rate of spine augmentation (combined vertebroplasty and kyphoplasty) was compared across racial/ethnic groups and insurance status. Racial/ethnic groups specified in our analysis included the following categories: white, black, Hispanic, and Asian/Pacific Islander. Patient insurance status groups specified in our analysis included Medicare, private insurance, Medicaid, and self-pay. Two sets of subgroup analyses were performed. First, we compared the ratio of kyphoplasty and vertebroplasty by racial/ethnic categories and by insurance category among patients receiving spine augmentation. Patients who did not receive spine augmentation were excluded from this analysis. Second, we compared spine augmentation usage rates by race/ethnicity among patients whose primary payer was Medicare. The analysis was performed because Medicare was the primary payer for most patients.

Statistical Analysis

First, χ^2 testing was used to study the usage rates of spine augmentation, vertebroplasty, and kyphoplasty. The white race was specified as the reference for analyses concerned with racial differences; Medicare was specified as the reference for analyses concerned with differences by insurance status. Odds ratios are presented with their corresponding 95% confidence intervals. Discharge weights were applied throughout our analyses. *P* values $< .05$ were considered statistically significant.

Second, a multivariable logistic regression model of spine augmentation use was fit by insurance status, race, age, Charlson Comorbidity Index, and sex to assess mutually adjusted disparities in spine augmentation rates. A second multivariate logic regression model comparing the odds of kyphoplasty use versus vertebroplasty among patients receiving spine augmentation was fit by insurance status, race, age, Charlson Comorbidity Index, and sex. This analysis was performed to assess mutually adjusted disparities in kyphoplasty usage rates compared with vertebroplasty. All statistical analyses were performed by using SAS-based JMP 9.0 software (www.jmp.com).

RESULTS

Spine Augmentation Use and Demographics

Between 2005 and 2010, a total of 228,329 patients were identified who were hospitalized with a primary diagnosis of vertebral frac-

ture. Of these patients, 56.6% (129,206/228,329) underwent any form of spine augmentation. Among patients with spine augmentation, 97,022 (75%) received kyphoplasty and 32,184 patients (25%) received vertebroplasty. Overall, 79.4% of patients were women (181,372/228,329), 91.9% (161,281/175,495) were white, and 88.8% (200,662/225,962) had Medicare. The mean age of the overall patient population was 78.9 years. The mean age among patients with spine augmentation was slightly younger (78.6 years) than the mean age of patients without spine augmentation (79.3 years). Patients with spine augmentation had lower mean Charlson Comorbidity scores than those without spine augmentation (0.8 ± 2.2 versus 0.9 ± 2.4 , $P < .001$). Patients with spine augmentation had significantly lower rates of congestive heart failure (11.9% versus 16.1%, $P < .001$) and significantly higher rates of osteoporosis (71.5% versus 63.1%, $P < .001$). Demographic and comorbidity characteristics of the patients in this study are summarized in Table 1.

Overall Spine Augmentation Use

The spine augmentation usage rate was 57.5% (92,779/161,281) for white patients, significantly higher than that of black patients (38.7%, 1405/3631, $P < .001$), Hispanic patients (52.3%, 3777/7222, $P < .001$), and Asian/Pacific Islander patients (53.1%, 1784/3361, $P < .001$). The spine augmentation usage rate for patients with Medicare was 57.2% (114,768/200,662), significantly higher than that among patients with private insurance (54.2%, 10,766/19,745, $P < .001$), those with Medicaid (43.9%, 1907/4341, $P < .001$), and those who self-pay (40.2%, 488/1214, $P < .001$). These data are summarized in Table 2.

Medicare Subgroup Analysis

In our subgroup analysis considering only patients whose primary payer was Medicare, we found that black patients with Medicare had a spine augmentation usage rate of 40.7% (1083/2660), significantly lower than that among white patients (57.9%, 83,477/144,263, $P < .001$). Hispanic patients also had significantly lower rates of spine augmentation use compared with white patients (53.0%, 2870/5326, $P < .001$) as did Asian/Pacific Islander patients (54.9%, 1484/2703, $P < .001$). These data are summarized in Table 3.

Comparative Use of Kyphoplasty and Vertebroplasty among Patients with Spine Augmentation

Among white patients receiving spine augmentation procedures, 78.8% (73,059/92,779) underwent kyphoplasty and 21.3% (19,720/92,779) underwent vertebroplasty. Among black patients receiving spine augmentation procedures, 78.0% (1096/1405) underwent kyphoplasty and 22.0% (309/1405) underwent vertebroplasty ($P = .52$ compared with white patients). Hispanic patients with spine augmentation were less likely to receive kyphoplasty compared with white patients as 74.0% (2795/3777) of Hispanic patients received kyphoplasty and 26.0% (982/3777) received vertebroplasty ($P < .001$). Asian/Pacific Islander patients were also significantly less likely to receive kyphoplasty as 76.4% (1362/1784) received kyphoplasty and 23.6% (422/1784) received vertebroplasty ($P = .02$).

Among patients with Medicare, 76.8% (88,187/114,768) re-

Table 1: Summary of patient demographics for inpatients with vertebral spinal fractures from 2005 to 2010

Variable	All Patients	Patients without Spine Augmentation	Patients with Spine Augmentation	P
Mean age (SD) (yr)	78.9 (24.0)	78.6 (21.7)	79.3 (26.6)	<.001
Female (No.) (%)	18,137 (79.5)	79,467 (80.2)	10,1905 (78.9)	<.001
Mean (SD) (CCI) comorbidities	0.8 (2.3)	0.9 (2.4)	0.8 (2.2)	<.001
Congestive heart failure	31,377 (13.7)	15,953 (16.1)	15,424 (11.9)	<.001
Coronary artery disease	53,902 (23.6)	23,347 (23.6)	30,555 (23.7)	.60
Diabetes mellitus	41,551 (18.2)	18,065 (18.2)	23,487 (18.2)	.77
Hypertension	14,0843 (61.7)	61,020 (61.6)	79,824 (61.8)	.28
Hyperlipidemia	52,651 (23.1)	22,126 (22.3)	30,525 (23.6)	<.001
Smoking	14,656 (6.4)	5804 (5.9)	8853 (6.9)	<.001
Obesity	7968 (3.5)	3589 (3.6)	4380 (3.4)	.003
Osteoporosis	15,4941 (67.9)	62,528 (63.1)	92,313 (71.5)	<.001
Race (No.) (%)				
White	16,1281 (91.9)	68,502 (90.4)	92,779 (93.0)	<.001
Black	3631 (2.7)	2226 (2.9)	1405 (1.4)	
Hispanic	7222 (4.1)	3445 (4.5)	3777 (3.8)	
Asian/Pacific Islander	3361 (1.9)	1577 (2.1)	1784 (1.8)	
Insurance status (No.) (%)				
Medicare	20,0662 (88.8)	85,893 (87.6)	11,4768 (89.7)	<.001
Private	19,745 (8.7)	8979 (9.2)	10,766 (8.4)	
Medicaid	4341 (1.9)	2434 (2.5)	1907 (1.5)	
Self-Pay	1214 (0.5)	725 (0.7)	488 (0.4)	

Note:—CCI indicates Charlson Comorbidity Index.

Table 2: Use of spine augmentation among 228,329 patients presenting with a primary diagnosis of vertebral fracture

	No. (%) Not Receiving Spine Augmentation	No. (%) Receiving Spine Augmentation	P
Race			
White	68,502 (42.5)	92,779 (57.5)	Ref
Black	2226 (61.3)	1405 (38.7)	<.001
Hispanic	3445 (47.7)	3777 (52.3)	<.001
Asian/Pacific Islander	1577 (46.9)	1784 (53.1)	<.001
Insurance			
Medicare	85,893 (42.8)	11,4768 (57.2)	Ref
Private	8979 (45.5)	10,766 (54.2)	<.001
Medicaid	2434 (56.1)	1907 (43.9)	<.001
Self-Pay	725 (59.8)	488 (40.2)	<.001

Note:—Ref indicates reference.

Table 3: Comparative usage rate of spine augmentation among patients on Medicare

	No. (%) Receiving Spine Augmentation	P Value
Race		
White	83,477 (57.9)	Ref
Black	1083 (40.7)	<.001
Hispanic	2870 (53.0)	<.001
Asian/Pacific Islander	1484 (54.9)	<.001

Note:—Ref indicates reference.

ceived kyphoplasty and 23.2% (26,582/114,768) received vertebroplasty. Among patients with private insurance, 77.6% (8352/10,766) received kyphoplasty and 22.4% (2414/10,766) received vertebroplasty ($P = .08$ compared with Medicare). Patients with Medicaid had significantly lower relative use of kyphoplasty compared with those with Medicare as 71.3% (1360/1907) received kyphoplasty and 28.7% (547/1360) received vertebroplasty ($P < .001$). The same was true for self-pay patients as 60.2% (294/488) received kyphoplasty and 39.8% (195/488) received vertebroplasty ($P < .001$). These data are summarized in Table 4.

Table 4: Comparative usage rate of kyphoplasty versus vertebroplasty among patients with spine augmentation

	No. (%) Receiving Kyphoplasty	No. (%) Receiving Vertebroplasty	P Value
Race			
White	73,059 (78.8)	19,720 (21.3)	Ref
Black	1096 (78.0)	309 (22.0)	.52
Hispanic	2795 (74.0)	982 (26.0)	<.001
Asian/Pacific Islander	1362 (76.4)	422 (23.6)	.02
Insurance			
Medicare	88,187 (76.8)	26,582 (23.2)	Ref
Private	8352 (77.6)	2414 (22.4)	.08
Medicaid	1360 (71.3)	547 (28.7)	<.001
Self-Pay	294 (60.2)	195 (39.8)	<.001

Note:—Ref indicates reference.

Multivariable Analysis

After we performed multivariable analysis, black patients had lower odds of receiving any spine augmentation compared with whites (OR = 0.46; 95% CI, 0.43–0.49; $P < .001$). The same was true for Hispanic patients (OR = 0.83; 95% CI, 0.79–0.99; $P < .001$). Patients with private insurance had significantly lower odds of spine augmentation compared with those with Medicare (OR = 0.77; 95% CI, 0.75–0.80; $P < .001$) and Medicaid (OR = 0.50; 95% CI, 0.47–0.53; $P < .001$) and those who self-pay (OR = 0.41; 95% CI, 0.37–0.56; $P < .001$).

Among patients receiving spine augmentation, comparative use of kyphoplasty was similar between black and white patients (OR = 0.90; 95% CI, 0.79–1.02; $P = .11$), though Hispanic patients had significantly lower use of kyphoplasty compared with white patients (OR = 0.76; 95% CI, 0.70–0.82; $P < .001$). Patients with private insurance (OR = 0.85; 95% CI, 0.80–0.89; $P < .001$), those with Medicaid (OR = 0.53; 95% CI, 0.48–0.59; $P < .001$), and those who self-paid (OR = 0.35; 95% CI, 0.29–0.42; $P < .001$) had significantly lower odds of kyphoplasty use compared with those with Medicare. These data are summarized in Table 5.

Table 5: Multivariate analysis

	Odds of Spine Augmentation		Odds of Kyphoplasty ^a	
	OR (95% CI)	P	OR (95% CI)	P
Race				
White	Ref	Ref	Ref	Ref
Black	0.46 (0.43–0.49)	<.001	0.90 (0.79–1.02)	.11
Hispanic	0.83 (0.79–0.99)	<.001	0.76 (0.70–0.82)	<.001
Asian/Pacific Islander	0.89 (0.84–0.96)	.002	0.93 (0.84–1.04)	.23
Insurance status				
Medicare	Ref	Ref	Ref	Ref
Private	0.77 (0.75–0.80)	<.001	0.85 (0.80–0.89)	<.001
Medicaid	0.50 (0.47–0.53)	<.001	0.53 (0.48–0.59)	<.001
Self-Pay	0.41 (0.37–0.56)	<.001	0.35 (0.29–0.42)	<.001

Note.—Ref indicates reference.

^a Only patients receiving spine augmentation were included in this analysis.

DISCUSSION

Our study demonstrated significant racial and health insurance-based disparities in the use of spinal augmentation for the treatment of osteoporotic vertebral fracture. Compared with white patients, all racial and ethnic minority groups had significantly lower rates of inpatient spine augmentation. Indeed, less than one-half of black patients admitted with a primary diagnosis of vertebral fracture were treated with spine augmentation, while nearly two-thirds of white patients underwent spine augmentation. Differences in spine augmentation use among Hispanic and Asian/Pacific Islander patients compared with white patients were also statistically significant, but the degree of difference was much less marked than that seen in black-versus-white patients. Conversely, when implemented, the type of augmentation used, either kypho- or vertebroplasty, was quite similar among racial groups. Despite the large sample size in our study, there is significant under-representation of patients who were not white as black patients composed only 2.7%, Hispanic patients composed 4.1%, and Asian/Pacific Islander patients composed 1.9% of the sample size. The reason for this difference is unclear and may be multifactorial, including lower fracture rates for black, Hispanic, and Asian women compared with white women⁸ and disparities in osteoporosis treatment in these minority groups.⁹

Similar to race, the insurance provider also had a profound impact on the use of spine augmentation, with patients with Medicare and private insurance having augmentation at markedly higher rates than either patients with Medicaid or those who self-paid. In our multivariate analysis, the differences noted above were as great or greater than those in the univariate analyses. Overall, these findings suggest that significant health insurance status disparities exist in the use of spine augmentation procedures, findings consistent with the already reported disparities in access to health care by minorities and the uninsured.^{5,10–15}

These current findings are potentially clinically relevant because prior studies have shown that patients receiving spine augmentation procedures demonstrate improved survival and quality of life compared with patients receiving nonoperative treatment.^{16,17} In a study of the 2006 Medicare Provider Analysis and Review File data base, Chen et al¹⁶ demonstrated that patients who underwent vertebroplasty and kyphoplasty had significantly higher 3-year survival rates compared with patients receiving

nonoperative management. The Fracture Reduction Evaluation study, which randomized patients into balloon kyphoplasty and nonsurgical management, demonstrated that kyphoplasty was associated with improved quality of life.¹⁷

While this study was not designed to determine the specific causes behind racial and insurance-based disparities, we believe that the causes of such disparities are multiple, including but not limited to physician bias, access to care, patient preferences, and communication barriers.^{18–23} While high costs of spine augmentation procedures could contribute

to the lower rates of spine augmentation in some groups, our subgroup analysis of patients with Medicare demonstrated that racial minorities still had lower rates of spine augmentation despite having the same type of insurance as their white counterparts. Racial disparities in the care of patients with osteoporosis have been previously identified. In a study of patients with Medicare and osteoporotic fractures, Liu et al²⁴ demonstrated that black patients were significantly less likely to receive both prefracture and postfracture care compared with white patients. Yoo et al²⁵ demonstrated significant racial disparities in osteoporosis drug maintenance therapy between black and white patients, especially among patients with Medicare, among whom supplementary health insurance was not affordable.

Insurance-based disparities in spine augmentation use may, at least in part, be explained by costs. In general, Medicare provides higher reimbursement rates for all medical services compared with Medicaid. In 2013, the Medicaid-to-Medicare fee index was 0.66 across the entire United States.²⁶ The inability of patients who self-pay and those with Medicaid to pay for the costs associated with spine augmentation could contribute to their lower rate of spine augmentation use overall. Cost differences may also explain our finding that patients with Medicaid and those who self-pay had significantly lower usage rates of kyphoplasty compared with patients who were privately insured, because kyphoplasty has been reported to cost between 2 and 20 times more than vertebroplasty.^{27,28} It is unclear to us as to why patients who were privately insured used spine augmentation less than those with Medicare in our study; one theory may be that there are preauthorization barriers that discourage the use of spine augmentation in this population.

Several prior studies have demonstrated disparities in the surgical treatment of back pain. Carey et al demonstrated that hospitalization and surgery rates were significantly lower in black patients with chronic back pain.²⁹ In a study of the Nationwide Inpatient Sample, Alosch et al³⁰ found that racial minorities were significantly less likely to receive cervical spine surgery for the treatment of degenerative cervical spine disease. The Alosch et al study also demonstrated that patients with Medicaid were significantly less likely to receive surgery compared with those with private insurance.³⁰ In a study of Workers' Compensation claims in Missouri, Chibnall et al³¹ found that white patients were significantly more likely to receive a diagnosis of a herniated disk and

that among those with such a diagnosis, whites were significantly more likely to undergo surgery compared with black patients. These studies further support our findings that minorities and the underinsured are treated differently for spine disease.

There are several limitations to our study. Our use of broad racial designations (white, black, Hispanic, Asian/Pacific Islander) in an effort to maintain consistency within the NIS data base may have limited our sample population because some racial groups are heterogeneous. Despite our ability to demonstrate usage disparities, we did not analyze outcome data for these procedures and cannot comment on morbidity or postoperative functional status across groups. Our study only examined disparities among inpatients diagnosed with osteoporotic vertebral fractures. However, a prior study of Medicare enrollees found that only 40% of vertebroplasties between 2001 and 2005 were performed as inpatient procedures. In addition, while the NIS is a large inpatient data base, it does not include federally funded health care facilities. It is unclear to us as to why privately insured patients used spine augmentation less than Medicare patients in our study; one theory may be that there are preauthorization barriers that discourage the use of spine augmentation in this population. As with any analysis of a large data base, errors in coding are also a potential limitation,³² though error rates are likely similar between racial and insurance groups. Finally, given the very large size of the data base, numerous comparisons reach statistical significance yet have a very small, absolute difference; we have attempted throughout the article to highlight differences that may be clinically relevant.

CONCLUSIONS

Our study demonstrated significant racial and health insurance-based disparities in the use of spine augmentation for the treatment of osteoporotic vertebral fractures. Significantly more white patients received spine augmentation compared with black, Hispanic, and Asian/Pacific Islander patients and significantly more patients with Medicare received spine augmentation compared with those with Medicaid and those who self-pay. While our findings echo many of the already reported disparities in surgical care, further research is needed to explain the underlying cause.

Disclosures: Harry Cloft—UNRELATED: Grants/Grants Pending: Site Principal Investigator at the enrolling site for the Stenting and Angioplasty with Protection in Patients at High Risk for Endarterectomy registry sponsored by Cordis Endovascular.* Jennifer S. McDonald—UNRELATED: Grants/Grants Pending: GE Healthcare.* Comments: investigator-initiated research grant to study contrast-induced nephropathy. David F. Kallmes—UNRELATED: Consultancy: ev3/Covidien, Medtronic, Comments: planning and implementation of clinical trials. Grants/Grants Pending: MicroVention,* Benvenue Medical,* ev3/Covidien,* Codman,* Sequent Medical,* SurModics.* Comments: preclinical and clinical research. Royalties: University of Virginia Patent Foundation, Comments: spine fusion. *Money paid to the institution.

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