Distal Radial Fracture Treatment: What You Get May Depend on Your Age and Address

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Background: Distal radial fractures are common and confer a considerable financial burden on the health-care system; however, controversy surrounds the optimal treatment of these injuries. This study was performed to determine (1) the rate of distal radial fractures in the U.S. Medicare population stratified by hospital referral region and (2) whether the type of fracture treatment is affected by patient age, race, sex, comorbidity, or hospital referral region.

Methods: A 20% sample of Medicare Part-B claims from the years 1998 through 2004 was analyzed. Procedural codes for nonoperative treatment, percutaneous fixation, and open reduction and internal fixation of distal radial fractures were identified. These codes were then used to determine the overall rate of distal radial fracture. The rates of distal radial fracture were then evaluated according to hospital referral region and patient age, sex, comorbidity, and race. The types of treatment were determined and were also analyzed on the basis of hospital referral region and patient age, sex, comorbidity, and race. Regression analysis was performed with use of the above variables.

Results: We identified 107,190 patients. The rate of distal radial fracture was 125 per 10,000 Medicare beneficiaries. The rate of the fracture in white individuals (136 per 10,000) was more than twice that in non-white individuals (fifty-nine per 10,000), and the rate in women (189 per 10,000) was 4.8 times higher than that in men (thirty-nine per 10,000). The overall fracture rate varied widely across the United States, from forty-seven per 10,000 beneficiaries in New Orleans, Louisiana, to 220 per 10,000 in Spartanburg, South Carolina. Treatment rates were similar across race, with the rate of nonoperative treatment being 84% for white beneficiaries compared with 83% for non-white beneficiaries, the rate of percutaneous fixation being 11% for white beneficiaries compared with 10% for non-white beneficiaries, and the rate of open treatment being 6% for white beneficiaries compared with 7% for non-white beneficiaries. There was variation across the country, with the rate of nonoperative treatment ranging from 60% in San Luis Obispo, California, to 96% in Covington, Kentucky; the rate of percutaneous fixation ranging from 2% in Boulder, Colorado, to 39% in San Luis Obispo, California; and the rate of open treatment ranging from 0.4% in Wilkes-Barre, Pennsylvania, to 25% in Great Falls, Montana. While the rates of percutaneous fixation and nonoperative treatment remained relatively stable, the overall rate of operative fixation nearly doubled from 5% in 1998 to 8% in 2004.

Conclusions: There is wide variation in the rate of distal radial fractures across sex, age, race, and geographic region in the United States. There is also significant variation in the treatment of these fractures, driven mainly by age and region. Between 1998 and 2004, a strong trend toward more frequent operative fixation was apparent. While white individuals had more than twice as many fractures as did non-white individuals, there did not appear to be significant racial variation in the treatment of this injury.

Clinical Relevance: The national and local variations in distal radial fractures and the ensuing treatment are key features in developing evidence-based medicine for this ubiquitous injury.

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Distal radial fractures result in a considerable financial burden on the health-care system¹. Often occurring in the elderly, the fractures can be addressed with a number of operative and nonoperative treatments. Despite the ubiquity of these fractures, controversy surrounds the optimal treatment²⁻⁵.

There are three broad categories of treatment for distal radial fractures: closed treatment with a cast, percutaneous fixation with Kirschner wires and/or external fixation, and open reduction and internal fixation. While each has merits and disadvantages, there is no consensus regarding which is the best treatment option. A literature review by the Cochrane Collaboration revealed a lack of robust clinical evidence to support any one intervention over another⁶.

With a paucity of large randomized trials to delineate the optimum treatment and the indications for these treatment options, we hypothesized that treatment of distal radial fractures would vary across the country. Clear evidence of major racial and geographic differences in rates of elective orthopaedic surgery has surfaced, and we postulated that there may be similar discrepancies in the rates of fixation for distal radial fractures^{7,8}. This study was performed to better understand both the variation in the incidence of distal radial fractures and the variation in the methods of treatment of these fractures in elderly patients.

Materials and Methods

The incidence of distal radial fractures among U.S. Medicare beneficiaries was investigated with use of Medicare's National Claims History System for calendar years 1998 through 2004. The Current Procedural Terminology (CPT) codes for operative and nonoperative treatment of distal radial fractures were identified. These claims capture patients who were treated for a fracture as an outpatient or an inpatient. Because of the very large size of the database, we utilized a 20% random sample of Medicare Part-B beneficiaries, a method that has been used in previous studies^{9,10}. For each patient with a distal radial fracture, we identified demographic variables, ZIP (postal) code of residence, and comorbidity status as defined by the Charlson index¹¹.

All patients with complete Medicare data who had sustained a distal radial fracture between 1998 and 2004 were included. As this provided a very large number of patients, hospital referral regions were used to better organize the data. Developed by the *Dartmouth Atlas of Musculoskeletal Health Care*⁹, hospital referral regions quantify, directly on the basis of Medicare beneficiary data, the migration patterns of hospital use among the elderly population in the United States. First, hospital service areas were formed by assigning ZIP code regions to local hospitals on the basis of where the plurality of residents were hospitalized. These areas were further aggregated into hospital referral regions on the basis of where most of the residents received major cardiovascular and neurosurgical procedures. The specifics of how the hospital referral regions were defined have been well detailed in the literature^{9,10}. While hospital referral regions are based on tertiary care cen-

TABLE I Demographic Overview (N = 107,190 Patients)

Parameter	Rate per 10,000 Medicare Beneficiaries
Overall	125
White	136
Non-white	59
Women	189
White	206
Non-white	87
Men	39
White	42
Non-white	19
Age	
65-69 yr	79
70-74 yr	140
75-79 yr	172
80-84 yr	191
≥85 yr	158

ters, our cohort included patients who were treated for a distal radial fracture in primary care offices and community hospitals, as well as in major referral centers.

The distal radial fracture rate was calculated by dividing procedure rates from Part-B claims in each of the 306 hospital referral regions by the appropriate denominator population for that geographic area. Denominator data for Medicare beneficiaries were obtained from the Medicare denominator file. The denominator file contains one record for each Medicare beneficiary, which includes demographic variables, ZIP code of residence, program eligibility, and mortality data. The relevant Medicare beneficiary population included individuals who were alive and at least sixty-five years of age on June 30 of each year.

The following categories were analyzed for each patient with a distal radial fracture: hospital referral region, patient age (in groups of five years for ages sixty-five years and older), sex, comorbidities, and race (white and non-white, with non-white including all race/ethnic groups other than non-Hispanic white).

Linear regression was used to calculate risk factors and associations with distal radial fractures, with use of the rate per 10,000 beneficiaries as the dependent variable and use of age, race, Charlson comorbidity index, hospital membership in the Council of Teaching Hospitals and Health Systems, and rate of orthopaedists per 100,000 beneficiaries as predictor variables. The density of orthopaedic surgeons within each hospital referral region was determined by self-designation of orthopaedic surgeons in the 1996/1997 American Medical Association and American Orthopaedic Association Masterfiles and the Medicare Unique Physician Identification Number (UPIN) file. A value of $p < 0.05$ was considered significant in the linear regression analysis. Because individuals treated with a procedure in a geographic area with a very low procedure rate potentially would be identifiable, we attempted to maintain confidentiality,

Fig. 1

Incidence of distal radial fractures across the U.S. The number of hospital referral regions per quintile is given in parentheses.

and to avoid sampling errors, by restricting our report of specific rates to hospital referral regions with at least twenty-five patients; this method has been used in prior studies¹⁰.

Source of Funding

This study received external funding from the National Institute on Aging, Small Bone Innovations, Smith and Nephew, Wright Medical Technology, Tornier, and Acumed.

Results

We identified 107,190 Medicare patients who had sustained a distal radial fracture between 1998 and 2004 (Table I). The overall rate of distal radial fractures was 125 per 10,000 Medicare beneficiaries. The rate was 136 per 10,000 white Medicare beneficiaries and fifty-nine per 10,000 non-white Medicare beneficiaries ($p < 0.01$), and the rate was 189 per 10,000 women and thirty-nine per 10,000 men ($p < 0.01$). Overall, white women

had the highest rate of fracture (206 per 10,000) and non-white men had the lowest rate (nineteen per 10,000) ($p < 0.01$).

The age group that had the highest fracture rate was the eighty to eighty-four-year-old group (191 per 10,000), whereas beneficiaries who were sixty-five to sixty-nine years old had a much lower rate of fracture (seventy-nine per 10,000) ($p < 0.01$). After adjustment for patient age, sex, and race, the hospital referral region with the highest rate was Spartanburg, South Carolina (220 per 10,000), whereas the lowest rate was in New Orleans, Louisiana (forty-seven per 10,000) ($p < 0.01$) (Fig. 1).

Eighty-three percent of the patients had nonoperative treatment, 11% underwent percutaneous fixation (and/or external fixation), and 6% underwent open reduction and internal fixation (Table II). These proportions were not significantly affected by sex or racial differences. The oldest age group (eighty-five years old or more) had the highest proportion of patients with nonoperative treatment (91%), whereas the

TABLE II Rates of Three Types of Treatment for Distal Radial Fracture

Parameter	Nonoperative (%)	Percutaneous Fixation (%)	Open Reduction and Internal Fixation (%)
Overall	83	11	6
Female	83	11	6
Male	84	10	6
Non-white	83	10	7
White	84	11	6
Age			
65-69 yr	78	13	9
70-74 yr	82	12	6
75-79 yr	85	11	5
80-84 yr	87	9	4
≥85 yr	91	7	2

youngest group (sixty-five to sixty-nine years old) had the highest proportion of patients treated with open reduction and internal fixation (9%) and percutaneous fixation (13%). Importantly, there was a significant increase in the rate of open reduction and internal fixation from 1998 to 2004, with it nearly doubling from 5% to 8% ($p < 0.05$) (Table III).

The rates of all three treatment modalities varied considerably according to geographic location. The rate of nonoperative treatment ranged from 60% in San Luis Obispo, California, to 96% in Covington, Kentucky. The rate of percutaneous fixation was lowest in Boulder, Colorado (2%), and highest in San Luis Obispo, California (39%) (Fig. 2). The rate of open reduction and internal fixation was lowest in Wilkes-Barre, Pennsylvania (0.4%), and highest in Great Falls, Montana (25%) (Fig. 3).

Regression analysis showed patient age, sex, race, and comorbidities as well as the density of orthopaedists and the teaching status of the treating hospital to each have an independent effect with regard to predicting treatment. Importantly, however, many of these effects were either not significant or only mild. For nonoperative treatment, the odds ratio was 0.86 (95% confidence interval, 0.82 to 0.91) for female sex, 1.24 (95% confidence interval, 1.11 to 1.37) for non-white race, 1.21 (95% confidence interval, 1.17 to 1.26) for the presence of a teaching hospital in the region, and 1.07 (95% confidence interval, 1.05 to 1.08) for the density of orthopaedists in the region. For percutaneous fixation, the odds ratio was 1.2 (95% confidence interval, 1.2 to 1.3) for female sex, 0.70 (95% confidence interval, 0.62 to 0.80) for non-white race, 0.77 (95% confidence interval, 0.74 to 0.80) for the presence of a teaching hospital in the region, and 0.91 (95% confidence interval, 0.90 to 0.93) for the density of orthopaedists in the region. For open reduction, the odds ratio was 1.01 (95% confidence interval, 0.94 to 1.09) for female sex, 1.05 (95% confidence interval, 0.90 to 1.21) for non-white race, 0.98 (95% confidence interval, 0.93

to 1.04) for the presence of a teaching hospital in the region, and 1.00 (95% confidence interval, 0.98 to 1.02) for the density of orthopaedists in the region. The variables with the largest effect are shown in Table IV. Age had a major association with nonoperative treatment (odds ratio, 2.9). Older age decreased the likelihood of both open reduction and internal fixation and percutaneous fixation, although the effect on the likelihood of open reduction and internal fixation was somewhat greater (odds ratio, 0.22). Women were slightly more likely to be treated with percutaneous fixation (odds ratio, 1.2), but the patient's sex had no effect on the likelihood of open reduction and internal fixation being performed. The variable that had the strongest effect on the decision to proceed with open reduction and internal fixation was the presence of comorbidities (odds ratio, 1.9). An increasing number of comorbidities decreased the likelihood of percutaneous fixation (odds ratio, 0.19).

Discussion

In this study, significant variation in both the rate of distal radial fracture in elderly patients as well as in the type of treatment of these fractures was found across the United States. Sex and race had a major influence on the incidence of distal radial fracture. Age and regional location had the greatest influence on treatment, independent of sex, race, the teaching status of the hospital, and the density of orthopaedists in the region.

Not surprisingly, we found the rate of distal radial fractures to be higher in women than in men. This finding is likely attributable to the higher rates of osteoporosis in women¹². There was also a significant racial discrepancy in the incidence of distal radial fractures, with the incidence in white individuals being more than twice that in non-white individuals. This observation is consistent with the findings of Baron et al., who reported that the relative rate of distal forearm fractures in black women, as compared with that in white women, was 0.30 and the relative rate in black men, as compared with that in white men, was 0.45¹³. These results are probably also related to the fact that white individuals have higher rates of both osteoporosis and falling as compared with black individuals¹⁴⁻¹⁶.

TABLE III Yearly Rates of Treatment of Distal Radial Fracture

Year	Nonoperative (%)	Percutaneous Fixation (%)	Open Reduction and Internal Fixation (%)
1998	84	11	5
1999	85	11	4
2000	84	12	5
2001	83	12	5
2002	83	11	6
2003	82	12	7
2004	83	9	8

Fig. 2

Incidence of percutaneous fixation across the U.S. The number of hospital referral regions per quintile is given in parentheses.

We found a 4.7-fold difference in the incidence of distal radial fractures across the country, with a rate of 220 per 10,000 in Spartanburg, South Carolina, compared with forty-seven per 10,000 in New Orleans, Louisiana. To our knowledge, no other studies of distal radial fractures have focused on geographic differences. However, such regional variation has been seen in studies of other types of fractures. For example, in a Medicare population similar to the one in the present study, we found an eightfold difference in the incidence of ankle fractures between San Francisco, California, and Hickory, North Carolina¹⁰. As seen in Figure 1 in the current paper, there is a

concentration of distal radial fractures in the eastern United States. A similar “fracture belt” was observed by Hinton et al.¹⁷ and by Karagas et al.¹⁸ in their studies of hip fractures. There are many possible explanations for this regional concentration of fractures, including differences in weather conditions (e.g., frequency of icy and snowy conditions); in osteoporosis levels (e.g., due to limited exposure to sunlight and varying consumption of fluorinated water); and in participation in athletic activity, which may affect the rate of falls.

We investigated the rates of three different methods of treatment for distal radial fractures: nonoperative, percutane-

TABLE IV Most Influential Variables in the Regression Analyses

Treatment	Positive Effect	Odds Ratio (95% Confidence Interval)	Negative Effect	Odds Ratio (95% Confidence Interval)
Nonoperative	Age >85 yr	2.9 (2.7-3.1)	Female sex	0.86 (0.82-0.91)
Percutaneous fixation	Female sex	1.2 (1.2-1.3)	Comorbidity	0.19 (0.15-0.26)
Open reduction and internal fixation	Comorbidity	1.9 (1.7-2.0)	Age >85	0.22 (0.20-0.25)

Fig. 3

Incidence of open reduction and internal fixation (ORIF) across the U.S. The number of hospital referral regions per quintile is given in parentheses.

ous fixation, and open reduction and internal fixation. The rates of these different methods varied considerably across the United States, ranging from predominantly nonoperative treatment (a 96% rate in Covington, Kentucky) to pockets of percutaneous fixation (a 39% rate in San Luis Obispo, California). Regression analysis did not show these differences to be driven by race. In fact, there was no single major variable that was highly associated with any of the treatments for distal radial fracture. The regression models suggested that many different factors influenced the choice of treatment. Age was the most influential variable determining whether a patient would receive nonoperative care, and being female increased the likelihood of undergoing percutaneous fixation. Interestingly, the presence of comorbidities had opposing effects on the likelihood of surgical intervention, as it increased the chance of having open reduction and internal fixation but decreased the likelihood of having percutaneous fixation. The reasons behind these findings are difficult to identify. The effect of comorbidities

on the choice of treatment may be explained by surgeons' desire to minimize immobilization time for medically ill patients by using internal fixation and their hesitancy to have exposed hardware (an external fixator) in these ill patients. Given that age had a positive effect on the likelihood of nonoperative treatment, it is likely that, in this Medicare cohort, those who underwent open reduction and internal fixation were younger and had comorbidities. The patient's sex may influence the use of percutaneous fixation, as women may be less willing to accept the appearance of a dorsally angulated malunion or they may be more likely to have a highly comminuted fracture that is not amenable to nonoperative treatment or open reduction and internal fixation. Importantly, neither race nor sex significantly influenced the likelihood of any of the treatment options.

These major differences in treatment rates are not surprising given the large variability in fracture patterns and treatment options and the lack of consensus in the literature regarding the best way to treat these injuries²⁻⁵. It is likely that

differences in local surgeon preference coupled with local cultural biases explain these major differences.

Limitations of this study include the standard limitations of any database study. There is no way to determine the accuracy of the data. We used Medicare billing codes, which, by nature of the current climate in which audits are feared, are likely to be accurate. The coding for operative treatment is probably particularly accurate given its direct correlation with higher reimbursement. Furthermore, the Medicare database is limited by the depth of the data. It does not indicate the mechanism of injury, the fracture pattern, the functional status of the patient, or the functional outcomes. Without this information, we cannot comment on the appropriateness of the different interventions.

This large national database provided a comprehensive overview of the incidence of distal radial fractures among Medicare beneficiaries and the way they were treated in the United States. With such a broad spectrum of treatment rates, it is clear that there is not a standardized method of addressing these injuries. The geographic variation in management strategies reflects a combination of inadequate evidence and, to a lesser extent, inadequate attention to the available evidence. Nonscientific influences (physician training, local culture, and regional and personal preferences) often prevail and, at least in part, can drive therapeutic decisions. No one knows the appropriate rate of operative treatment of distal radial fractures,

but the wide variation found in this study supports the notion that better evidence-based treatment guidelines are needed. With more data on outcomes, including patient satisfaction, functional results, and complications, we might be able to identify the “right rate.” This study has revealed significant variation in a very common decision process that orthopaedists face daily. ■

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