Incidence and Mortality after Distal Radius Fractures in Adults Aged 50 Years and Older in Korea

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Received: 28 September 2015
Accepted: 23 December 2015

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Funding: This research was supported by a grant of the Korea Health Technology R&D Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Korea (grant number : HI13C1522).

The purpose of this study was to assess the incidence and mortality of distal radius fracture among patients 50 years of age and older with diagnosis code (ICD10; S52.5, S52.6) and treatment code using a nationwide claims database from 2008 to 2012. All patients were followed using patient identification code to identify deaths. Standardized mortality ratios (SMRs) of distal radius fracture were calculated based on age and gender-specific rates in the entire Korean population. The number of distal radius fractures increased by 54.2% over the 5-year study (48,145 in 2008 and 74,240 in 2012). The incidence of distal radius fracture increased from 367.4/100,000 in 2008 to 474.1/100,000 in 2012. The cumulative mortality rate over the first 12 months after distal radius fracture was decreased from 2.0% (968/48,145) in 2008 to 1.4% (1,045/74,240) in 2012. The mean year mortality over 5 years in men (2.6%, 1,279/50,128) over the first 12 months was 1.7-times higher than in women (1.5%, 3,952/257,045). The mean of SMR of distal radius fracture at 1 year post-fracture was 1.45 in men and 1.17 in women. This study using a nationwide database demonstrates that the distal radius fractures are increasing with a decreasing mortality in Korea.

Keywords: Distal Radius Fracture; Incidence; Mortality; Osteoporotic Fracture; Korea

INTRODUCTION

Osteoporosis and related fractures are important health problems in elderly patients. Osteoporotic fractures diminish the quality of life and are a major cause of hospitalization and medical expenses in elderly patients. The incidence, mortality and morbidity of hip and spine osteoporotic fractures have been reported (1-5).

Distal radius fractures occur in middle-aged women and men (6,7) and are a risk predictor of subsequent osteoporotic fractures (8). A better understanding of the incidence, mortality and excess mortality after distal radius fracture is needed for prevention of further osteoporotic fractures. Distal radius fractures are the second most common type of osteoporotic fracture including spine, humerus, and hip fractures. Yet, few epidemiologic studies of distal radius fractures have been published and involved western developed countries including Sweden, Norway and other European countries (6, 9,10). Only two Asian countries have reported on the incidence of distal radius fractures (7,11).

The purpose of this study was to determine the incidence, mortality and excessive mortality after distal radius fracture in Koreans among those 50 years of age and older using recent 5-year national claims data and to compare the findings with other studies.

MATERIALS AND METHODS

Korean National Health Insurance (KNHI) covers 100% of the population including 97% of health insurance and 3% of medical aid (2). All information about the volume and burden of disease can be obtained from this centralized database, with the exception of procedures that are not covered by insurance, such as cosmetic surgery or traffic accidents, which are covered by traffic insurance companies. All clinics and hospi-

tals submit claims data on inpatients and outpatients including data on diagnosis and medical costs.

KNHI data include information on date of discharge and discharge diagnoses (both principal diagnoses and additional diagnoses), assigned exclusively by the physician at discharge according to the International Classification of Diseases, 10th revision (ICD-10). The advantage of an osteoporotic fracture study using KNHI data is that the high-energy trauma that led to the fracture is spontaneously excluded because traffic accidents and industrial accidents are covered by different insurance systems. Complete paid claims data and eligibility files were merged to create a database consisting of data for all filled prescriptions, procedures, outpatient physician encounters and hospitalizations. All traceable personal identification number was transformed into an anonymous code.

Using KNHI data, we identified all claims records of outpatient visits or hospital admissions of patients among those 50 years of age and older between January 1, 2008 and December 31, 2012. One or more claims listing an International Classification of Disease, tenth revision diagnosis codes S52.5 (fracture of lower end of radius) and S52.6 (fracture of lower end of both ulna and radius) and treatment codes N0607 (open reduction of ulnar or radius), N0603 (open reduction of ulnar and radius), N0993 (closed pinning of ulnar or radius), N0994 (closed pinning of unlar and radius), N0983 (external fixation of forearm bone), N0643 (closed reduction of forearm bone), T6020 (long arm cast application), and T6030 (short arm cast application) were required for inclusion.

Age standardized incidence rates of people in the corresponding age groups in a standard population were also determined.

Unique personal identifiers permitted the tracking of individuals for multiple visits or admissions. Where an individual had more than three outpatient visits or one admission for distal radius fracture, the patient was followed from the first event and recounted if a further event occurred 6 months or longer after the original visit or admission (2). We followed each patient by code to identify the death date.

Using the Poisson model, mortality at 1 year after distal radius fracture was compared to that of the general Korean population among those 50 years of age and older. The mortality of the general population was obtained from the web site of the Korean Statistical Information Service.

To determine the excess mortality associated with distal radius fracture, the standardized mortality ratio (SMR) was calculated as the observed mortality divided by the expected mortality for each age and gender group. All data of Korean men and women over 50-years-of-age was based on the web site of the Korean Statistical Information Service. SMR of greater than 1.0 indicated excess mortality associated with distal radius fracture. The 95% confidence intervals for the SMR of each group were calculated by the Poisson method. All database management and analysis were performed using SAS statistical package version 9.1.3 (SAS Institute, Cary, NC, USA).

Ethics statement

The study protocol was approved by the NHIS institutional review board (number: NHIS-2015-4-001). Informed consent was waived by the board.

RESULTS

The total number of distal radius fractures increased by 54.2% over the 5-year study (48,145 in 2008 and 74,240 in 2012), whereas the number of individuals among those 50 years of age and older in the general population increased by 19.5% (13,103,814 in 2008 and 15,657,674 in 2012) (Table 1). The annual incidence of distal radius fracture increased consistently. The incidence of distal radius fracture increased from 367.4/100,000 in 2008 to 474.1/100,000 in 2012. In terms of the gender-specific distribution of distal radius fracture from 2008 to 2012, the incidence of distal radius fracture was 134.8/100,000 for men and 566.1/100,000 for women in 2008, and 162.9/100,000 for men and 744.3/100,000 for women in 2012. During the 5-year period, the incidence of distal radius fractures increased by 20.8% in men and 31.5% in women.

The mean age-specific incidence by 5-year age groups increased in all age groups (Fig. 1). In terms of age-specific distribution of distal radius fracture from 2008 to 2012, the incidence of distal radius fractures steadily increased more in men and women in their 60s (Fig. 2).

Table 1. Incidence and mortality of distal radius fractures among patients 50 years and older from 2008 to 2012

Year	Number of distal radius fractures			Incidence of distal radius fractures (per 100,000)			Mortality following distal radius fracture at 12 months follow-up (%)		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
2008	48,145 (968)*	8,139 (234)	40,006 (734)	367.4	134.8	566.1	2.0	2.9	1.8
2009	49,367 (944)	8,392 (224)	40,975 (720)	360.2	132.6	555.6	1.9	2.7	1.8
2010	69,767 (1,204)	10,927 (293)	58,840 (911)	486.9	164.8	764.4	1.7	2.7	1.6
2011	65,654 (1,070)	10,815 (271)	54,839 (799)	437.7	155.4	682.0	1.6	2.5	1.5
2012	72,263 (978)	11,855 (257)	62,385 (788)	474.1	162.9	744.3	1.4	2.2	1.3
Total	307,173 (5,231)	50,128 (1,279)	257,045 (3,952)	427.9	150.8	666.6	1.7	2.6	1.5

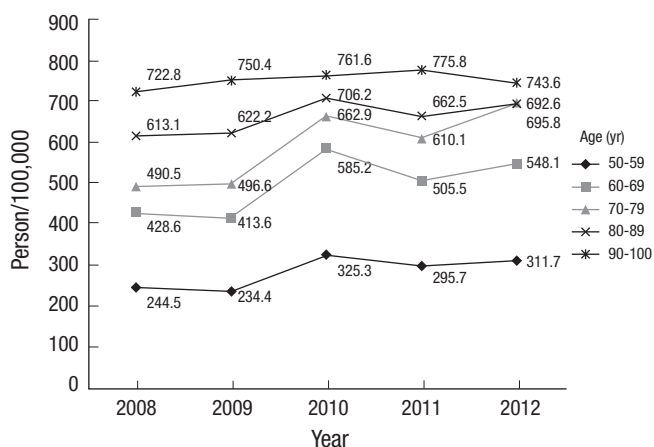*Numbers in parenthesis are patients who passed away at 12 months follow-up.

Fig. 1. Age-specific incidence of distal radius fractures in patients aged 50 years and older.
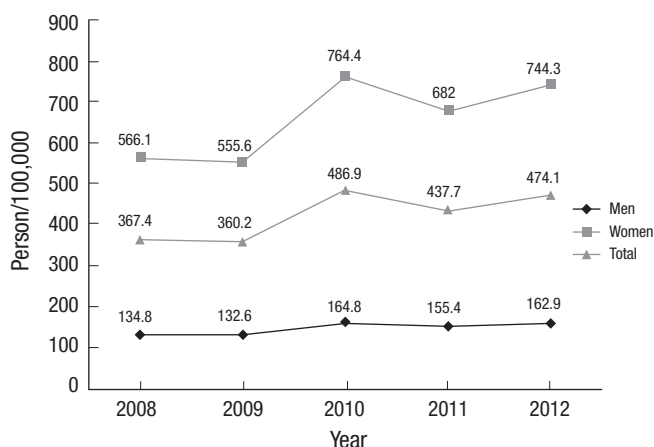

Fig. 2. Gender-specific incidence of distal radius fractures in patients aged 50 years and older.

The cumulative mortality rate over the first 12 months after distal radius fracture was decreased from 2.0% (968/48,145) in 2008 to 1.4% (1,045/74,240) in 2012. Mortality rates over the first 12 months were 2.9% (234/8,139) for men and 1.8% (734/40,006) for women in 2008, and 2.0% (257/11,855) for men and 1.3% (788/62,385) for women in 2012. During the 5-year study periods, the mean year mortality over 5 years in men (2.6%, 1,279/50,128) over the first 12 months was 1.7-times higher in men than in women (1.5%, 3,952/257,045) (Table 1).

Age- and gender-adjusted standardized mortality ratios for different study periods are shown in Table 2. The mean of SMR of distal radius fracture at 1 year post-fracture was 1.45 in men and 1.17 in women. Total SMR of distal radius fracture at the 1-year follow-up was slightly higher than the general population (Table 2). In men, higher SMR was observed for subjects aged 50-89 years, with no difference of SMR of 90-100 age group at 1 year post-fracture. In women, the higher SMR was only observed for subjects 80-89-years-of-age, with no difference of SMR other age groups at 1 year post-fracture (Table 2).

Table 2. Mortality and average standard mortality ratios adjusted for gender and age at 1-year follow-up

	Age (yr)	Mortality (%)	95% CI	SMR	95% CI
Men	50-59	0.93	0.01-0.01	1.57	1.37-1.82
	60-69	1.56	0.01-0.02	1.20	1.06-1.36
	70-79	4.17	0.04-0.05	1.14	1.04-1.25
	80-89	11.15	0.10-0.12	1.19	1.07-1.33
	90-100	20.64	0.16-0.26	0.89	0.70-1.12
	≥ 50	2.55	0.02-0.03	1.45	1.38-1.54
Women	50-59	0.20	0.00-0.00	1.00	0.85-1.20
	60-69	0.46	0.00-0.01	0.96	0.88-1.06
	70-79	1.64	0.02-0.02	0.92	0.86-0.97
	80-89	6.61	0.06-0.07	1.03	0.98-1.08
	90-100	17.43	0.16-0.19	0.90	0.83-0.98
	≥ 50	1.54	0.01-0.02	1.17	1.13-1.20
Total	50-59	0.36	0.00-0.00	0.91	0.83-1.01
	60-69	0.63	0.01-0.01	0.72	0.67-0.78
	70-79	1.99	0.02-0.02	0.77	0.73-0.81
	80-89	7.07	0.07-0.07	0.96	0.92-1.01
	90-100	17.73	0.16-0.19	0.88	0.82-0.95
	≥ 50	1.70	0.02-0.02	1.12	1.08-1.15

SMR, standardized mortality ratio; CI, confidence interval.

DISCUSSION

Of osteoporotic fractures including spine, hip, humerus, and distal radius fractures, in terms of morbidity and mortality, distal radius fractures tend to be less important than hip and spine fractures. However, distal radius fractures in elderly patients can be a significant risk predictor of subsequent osteoporotic fractures (8). The present nationwide, claims database based, observational study of distal radius fracture in Korea determined incidence, mortality, and excess mortality. Distal radius fractures in subjects among those 50 years of age and older increased in incidence during the study period, with mortality was decreasing.

Distal radius fractures represent the second most common type of osteoporotic fracture in Korea (12). The total number of distal radius fracture increased by 50.1%, from 48,145 in 2008 to 74,240 in 2012, and the annual incidence of distal radius fracture increased by 21.3%, from 367.4/100,000 in 2008 to 474.1/100,000 in 2012. The incidence of distal radius fracture in this study is one of the highest among data of reported countries (Table 3). In this study, the total incidence of distal radius fractures in 2012 was 474.1/100,000. This finding is slightly lower than Norway (525.7/100,000) (6) and Finland (494.4/100,000) (10). However, lower incidence has been reported in the same region including Taiwan (144.9/100,000 in 2007) (7) and Japan (111.1/100,000 in 2006) (11).

The trend of incidence of distal radius fracture increased from 2008 to 2012. This finding is similar to a population-based study using claims data that investigated the trend in incidence of distal radial fractures in Taiwan from 2000 to 2007 (7). The authors reported that the incidence of distal radius fracture increased annually. However, studies in the developed industrialized coun-

Table 3. Reported incidence and mortality after distal radius fracture

Author	Region	Year	Incidence (/100,000)	1-yr mortality	5-yr mortality	Study design
Øyen (17)	Southern Norway 2004-2005 ≥ 50 yr	2014	T: 525.7 M: 190 F: 750	T: 3.4% M: 5.4% W: 2.9%	T: 4.6% M: 4.0% F: 4.8%	Population-based
Koski (18)	Finland 2005-2006 ≥ 50 yr	2014	M: 168 F: 658	NR	NR	Population-based
Putter (9)	The Netherland 1999-2009 ≥ 50 yr	2013	M: 100.4 F: 457.8	NR	NR	Population-based (decreasing trend of DRF)
Flinkkila (10)	Finland (Oulu) 2008 ≥ 50 yr	2011	T: 494.4 M: 223.2 F: 710.2	NR	NR	Population-based
Tsai (7)	Taiwan 2000-2007 ≥ 50 yr	2011	T: 144.9 M: 100.2 F: 189.4 In 2007	NR	NR	Claims data-based (increasing trend of DRF)
Oinuma (11)	Japan (Sado island) 2004-2006 ≥ 60 yr	2010	T: 111.1 In 2006			Population-based (steady trend of DRF)
O'Neill (19)	United Kingdom 1997-1998 ≥ 35 yr	2001	M: 90 F: 368	NR	NR	Population-based
Johnell (14)	Sweden (Malmo) 1994 ≥ 60 yr	2004	NR	T: 6%	T: 26%	Population-based
Current study	Korea 2008-2012 ≥ 50 yr		T: 474.1 M: 162.9 F: 744.3 In 2012	T: 1.4% M: 2.2% W: 1.3% In 2012	NR	Claims database

T, total; M, male; F, female; NR, not reported; DRF, distal radius fracture.

tries of Japan and the Netherlands reported steady or decreasing trend of distal radius fracture (9,11). The reasons for the differences from this study might be related to the proportion of the elderly population, the health care system, and preventive programs of osteoporotic fractures. Of these, the proportion of elderly population is an important factor for the increasing rate of distal radius fracture. In Korea, the proportion of the elderly is the highest increasing rate in the world. Korea became an aging society (elderly population ≥ 7% of the total population) in 2000. In 2018, Korea will become an aged society (defined as an elderly population ≥ 14% of the total population), and by 2026 will be a super-aged society (elderly population ≥ 20% of the total population).

Total annual mortality rates in this study decreased from 2.0% in 2008 to 1.4% in 2012. Although the incidence of distal radius fracture in men was lower than in women, the mortality rate in men was 1.7-times higher than in women. However, the mortality rate of distal radius fracture was lower than in other studies (13,14). Endres et al. (13) observed that 3% of the distal radius fracture patients from Germany died during a 1.5-year follow-up period. Johnell et al. (14) reported a 1- and 5-year mortality rate of 6% and 26%, respectively, in a Swedish study. The reasons for these differences may involve cohort characteristics, geographic difference, and the proportion of older patients (Table 3).

The mortality risk after distal radius fracture was similar to that of general populations (14-16). However, SMRs of both gender in this study were slightly higher than the general population until 1 year after distal radius fractures. Therefore, distal radius fractures might reflect frailty and poorer comorbidity, resulting in high mortality in these groups.

This study has some limitations. First, the incidences based on medical claim database might be underestimated. For example, distal radius fractures may not be diagnosed or treated by health care institutions not necessary to require hospitalization. Second, reliance on ICD-10 diagnostic codes to identify incident fractures may have caused incident distal radius fracture to be misclassified. To minimize this problem, we analyzed ICD-10 diagnostic codes with treatment codes such as operation and cast or splint application codes. Third, there was not considered medical comorbidity to analysis of mortality, which influence mortality in older patients. Thus, the confounding effect on results imposed by medical comorbidity is inevitable in this study. Fourth, patients with multiple traumas such as hip fracture with other sites of fracture could not be detected. Such patients are more susceptible to mortality and poor morbidity. Finally, whereas incidence of distal radius fracture in this study increased, mortality rate after distal radius fracture decreased. The possible reason of decreasing mortality after distal radius fracture could be evaluated through further study such as co-

hort based study.

In conclusion, this study using a nationwide database demonstrates that the distal radius fractures are increasing with a decreasing mortality in Korea. Considering the increasing incidence rate of distal radius fractures, we can expect an increased risk of associated osteoporotic fractures. Therefore, a public health strategy to prevent distal radius fractures is prudent to minimize secondary osteoporotic fractures, economic burden, and improve public health.

ACKNOWLEDGMENT

DISCLOSURE

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

AUTHOR CONTRIBUTION

Study design: Kwon GD, Jang S, Lee YK, Ha YC. Data acquisition: Park EJ, Lee A. Data analysis: Kim HY, Jang S, Park C, Park EJ, Kim TY. Writing manuscript: Kwon GD, Ha YC, Park C. Approval of final manuscript and ensuring research integrity: all authors.

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REFERENCES

1. Kim SR, Ha YC, Kim JR, Kim R, Kim SY, Koo KH. Incidence of hip fractures in Jeju Island, South Korea: a prospective study (2002-2006). *Clin Orthop Surg* 2010; 2: 64-8.
2. Yoon HK, Park C, Jang S, Jang S, Lee YK, Ha YC. Incidence and mortality following hip fracture in Korea. *J Korean Med Sci* 2011; 26: 1087-92.
3. Chau PH, Wong M, Lee A, Ling M, Woo J. Trends in hip fracture incidence and mortality in Chinese population from Hong Kong 2001-09. *Age Ageing* 2013; 42: 229-33.
4. Lee YK, Jang S, Jang S, Lee HJ, Park C, Ha YC, Kim DY. Mortality after vertebral fracture in Korea: analysis of the National Claim Registry. *Osteoporos Int* 2012; 23: 1859-65.
5. Kang BJ, Lee YK, Lee KW, Won SH, Ha YC, Koo KH. Mortality after hip fractures in nonagenarians. *J Bone Metab* 2012; 19: 83-6.
6. Diamantopoulos AP, Rohde G, Johnsrud I, Skoie IM, Hochberg M, Haugeberg G. The epidemiology of low- and high-energy distal radius fracture in middle-aged and elderly men and women in Southern Norway. *PLoS One* 2012; 7: e43367.
7. Tsai CH, Muo CH, Fong YC, Lo WY, Chen YJ, Hsu HC, Sung FC. A population-based study on trend in incidence of distal radial fractures in adults in Taiwan in 2000-2007. *Osteoporos Int* 2011; 22: 2809-15.
8. Chen CW, Huang TL, Su LT, Kuo YC, Wu SC, Li CY, Chen KB, Sung FC. Incidence of subsequent hip fractures is significantly increased within the first month after distal radius fracture in patients older than 60 years. *J Trauma Acute Care Surg* 2013; 74: 317-21.
9. de Putter CE, Selles RW, Polinder S, Hartholt KA, Looman CW, Panneman MJ, Verhaar JA, Hovius SE, van Beeck EF. Epidemiology and health-care utilisation of wrist fractures in older adults in The Netherlands, 1997-2009. *Injury* 2013; 44: 421-6.
10. Flinkkilä T, Sirniö K, Hippi M, Hartonen S, Ruuhela R, Ohtonen P, Hyvönen P, Leppilahti J. Epidemiology and seasonal variation of distal radius fractures in Oulu, Finland. *Osteoporos Int* 2011; 22: 2307-12.
11. Oinuma T, Sakuma M, Endo N. Secular change of the incidence of four fracture types associated with senile osteoporosis in Sado, Japan: the results of a 3-year survey. *J Bone Miner Metab* 2010; 28: 55-9.
12. Park C, Ha YC, Jang S, Jang S, Yoon HK, Lee YK. The incidence and residual lifetime risk of osteoporosis-related fractures in Korea. *J Bone Miner Metab* 2011; 29: 744-51.
13. Endres HG, Dasch B, Lungenhausen M, Maier C, Smektala R, Trampisch HJ, Pientka L. Patients with femoral or distal forearm fracture in Germany: a prospective observational study on health care situation and outcome. *BMC Public Health* 2006; 6: 87.
14. Johnell O, Kanis JA, Odén A, Sernbo I, Redlund-Johnell I, Petterson C, De Laet C, Jönsson B. Mortality after osteoporotic fractures. *Osteoporos Int* 2004; 15: 38-42.
15. Cooper C, Atkinson EJ, Jacobsen SJ, O'Fallon WM, Melton LJ 3rd. Population-based study of survival after osteoporotic fractures. *Am J Epidemiol* 1993; 137: 1001-5.
16. Center JR, Nguyen TV, Schneider D, Sambrook PN, Eisman JA. Mortality after all major types of osteoporotic fracture in men and women: an observational study. *Lancet* 1999; 353: 878-82.
17. Øyen J, Diamantopoulos AP, Haugeberg G. Mortality after distal radius fracture in men and women aged 50 years and older in southern Norway. *PLoS One* 2014; 9: e112098.
18. Koski AM, Patala A, Patala E, Sund R. Incidence of osteoporotic fractures in elderly women and men in Finland during 2005-2006: a population-based study. *Scand J Surg* 2014; 103: 215-21.
19. O'Neill TW, Cooper C, Finn JD, Lunt M, Purdie D, Reid DM, Rowe R, Woolf AD, Wallace WA; UK Colles' Fracture Study Group. Incidence of distal forearm fracture in British men and women. *Osteoporos Int* 2001; 12: 555-8.