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Incidence and Mortality Following Hip Fracture in Korea

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This study was supported by the Korean Health Insurance Review and Assessment Service (HIRA) and conducted using data from the Korean National Health Insurance Claims Database.

The authors evaluated the incidence of hip fracture and subsequent mortality in Korea using nationwide data obtained from the Health Insurance Review and Assessment Service. This study was performed on patient population, aged 50-yr or older who underwent surgical procedures because of hip fracture (ICD10; S720, S721). All patients were followed using patient identification code to identify deaths. Crude hip fracture rates increased from 191.9/100,000 in 2005 to 207.0/100,000 in 2008 in women and from 94.8/100,000 in 2005 to 97.8/100,000 in 2008, in men respectively. Crude mortality within 12 months after hip fracture showed a similar trend (18.8% in 2005 and 17.8% in 2007). The mean of standardized mortality ratio of hip fracture was 6.1 at 3 months, 3.5 at 1 yr, and 2.3 at 2 yr post-fracture. The increasing incidence and the high mortality after hip fracture are likely to become serious public health problems and a public health program should begin to prevent hip fractures in Korea.

Key Words: Hip Fractures; Incidence; Mortality; Korea

INTRODUCTION

Of all fracture types in the elderly resulting from osteoporosis, hip fracture is the most serious, and has high associated levels of morbidity and mortality. In many countries, populations are aging and many studies have reported significant increases in the incidence of hip fracture with age (1, 2). It has been estimated that in 2050, approximately 50% of all hip fractures in the world will occur in Asia (2, 3), and thus, it is expected that hip fractures are likely to present a serious socioeconomic problem in developing Asian countries (2, 4, 5). Recently, population-based epidemiologic studies on hip fracture in Asia have reported relatively high incidences of hip fracture, and confirmed that the number of hip fractures is likely to increase markedly in the near future (4-6).

In contrast with studies on the incidence of hip fracture, morbidity and mortality studies related to hip fracture in Asia are rare, and the studies have been performed with limited sample size (7-9). Even though many epidemiologic studies related to mortality and morbidity following hip fracture have been published in the western countries (10), these studies cannot be used for reference purposes due to geographical variations (11, 12).

In this study, we evaluated nationwide data regarding incidence and mortality after hip fracture in Korea by using administrative claims database of the Health Insurance Review and Assessment Service (HIRA), which comprises of fully adjudicated medical and pharmacy claims for 50 million beneficiaries in Korea. Every clinic, hospital and pharmacy in Korea is obliged to submit patient data regarding healthcare services and medical costs to the HIRA for reimbursement. The purpose of this study is to assess incidences of hip fracture, patterns of mortality following hip fracture in the entire population, and to document excess mortality due to hip fracture in people over 50 yr of age in Korea.

MATERIALS AND METHODS

Characteristics of HIRA database systems

The Korean National Health Insurance Program covers 100% of the population (97% have health insurance and 3% are covered by medical aid). Thus, all information about the volume and burden of a disease can be obtained from a centralized database, with the exception of procedures not covered by insurance, such as cosmetic surgery and services for traffic accident injuries which are covered by traffic insurance companies. The HIRA in Korea, which was founded in July 2000, covers all contacts (for in- and out-patients) with health care institutes (hospitals, clinics, pharmacies, public health center, and maternity nursing care insti-

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tutes), and it has completely computerized incoming and archived data as of 2005.

This database contains information on date of discharge, discharge diagnoses (both principal diagnoses and additional diagnoses), assigned exclusively by a physician at discharge according to the International Classification of Diseases, 10th revision (ICD-10). The advantage offered by the HIRA database to studies on osteoporotic fractures is that high-energy traumas due to traffic or industrial accidents are not included. In the present study, we merged paid claims data and eligibility files to create a database consisting of data for all filled prescriptions, procedures, outpatient physician encounters, hospitalizations, and death date. All traceable personal identification numbers were transformed into anonymous codes. This cohort study was performed on the Korean population, which constituted approximately 13 million individuals who were 50 yr of age or older in 2008.

Definition and validation of hip fracture

We identified all claims records for outpatient visits or hospital admissions for patients aged 50 yr or older treated between January 1st 2005 and December 31st 2008 and assigned a fracture diagnosis code according to the International Classification of Diseases (ICD)-10 of S72.0-fracture of the neck of the femur, or S72.1-trochanteric fracture, and who underwent related operations (open reduction of a fracture, closed pinning, closed intramedullary nailing, total hip arthroplasty, or hemiarthroplasty). The diagnosis code used for hip fracture was selected based on the findings of previous epidemiologic studies (4, 9, 12, 13) and was confirmed by orthopedic surgeons. All patient records were examined to identify individuals admitted to hospital for a hip fracture within the study period. If an individual was admitted more than once within 6 months for a hip fracture, this was considered as one event. But if a subsequent hospitalization occurred 6 months or more after the original admission it was considered as a second event. Therefore, the operational definition of hip fracture in this study was considered as one hip fracture to concur with adequate ICD code (S72.0 or S72.1), appropriate management procedure, and appropriate time intervals (minimum six months interval). We validated the algorithm which is used to identify hip fractures based on administrative claims data against the Jeju island hip fracture cohort enrollment between 2005 and 2007 (14). A comparison of administrative claims data of Jeju island at the same period with 449 patients aged between 50 and 100 yr in the Jeju cohort, revealed a sensitivity of 93.1% and a positive predicted value of 77.4%.

Analysis of hip fracture incidence

Incidence rates of hip fracture according to age and gender were calculated using the annual number of hip fractures divided by the mid-year population estimates. We used resident population data released annually by the Korea National Statistical Office to calculate mid-year populations, which is defined as the mean of populations in two consecutive years measured on January 1st. Annual change or increasing trend in level of age has been tested using Poisson regression model after controlling for covariates. Age-standardized incidence rates are weighted averages of the age-specific incidence rates of people in the corresponding age groups in a standard population, which was estimated for the Caucasian population in the United States on July 1st 1990 (15).

Analysis of mortality after hip fracture

Following the hospitalization for hip fracture, we followed each patient by code to identify death date using the Korean National Health Insurance Program. Mortality following hip fracture was compared to that of the general Korean population aged from 50 to 100 yr. Significance and 95% confidence interval were calculated assuming a Poisson distribution. In order to find excess mortality associated with hip fracture, standardized mortality ratios (SMR), defined as the ratio of observed mortality to expected mortality matched for age and gender group, were calculated. Expected numbers of death were calculated using age and gender-specific mortality rates for the general population (standard population). The age and gender distributions and mortality data of the entire Korean population in 2005 and 2007 were used as a standard, and were obtained from census data and life table obtained from the Korea National Statistical Office (16). To calculate the number of expected deaths, numbers of patients in each age-gender group were multiplied by their standard mortality rates. Expected numbers of deaths were then compared with the actual mortality numbers of the respective study of age-gender groups. SMRs were calculated for each group as ratios of observed over expected mortalities. Thus, SMRs of greater than one indicated excess mortality.

Ethics statement

This study was reviewed and approved by the institutional review board of the Health Insurance Review and Assessment Service. The board waived informed consent from involved subjects.

RESULTS

Incidences of hip fracture

Hip fractures increased by 21% over the 4 yr of study (16,866 in 2005 and 20,432 in 2008); the increase in the number of individuals older than 50 yr in general population was 14.1% (11,430,579 in 2005 and 13,047,524 in 2008). Although the annual incidence of hip fracture was fluctuated, incidence of hip fractures showed increasing tendency. The incidence of hip fractures increased from 191.9/100,000 in 2005 to 207.0/100,000 in 2008 in women and from 94.8/100,000 in 2005 to 97.8/100,000 in 2008 in men,

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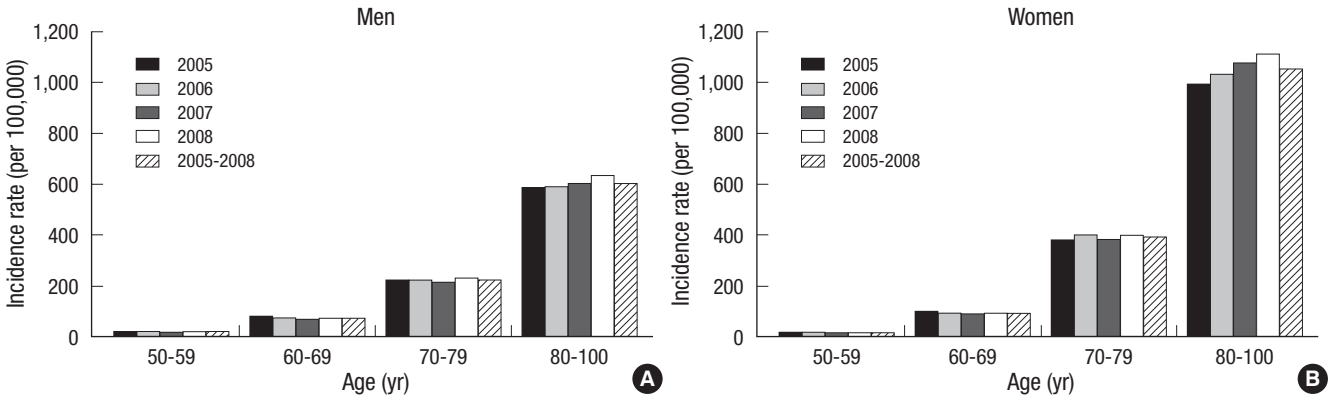

Fig. 1. Hip fracture rates (per 100,000) by age and gender in 2005-2008.

Table 1. Crude incidence (per 100,000) of hip fractures among persons > 50 yr of age in Korea from 2005 to 2008

Year	Population		Fracture		Rate	
	Men	Women	Men	Women	Men	Women
2005	5,217,928	6,212,651	4,945	11,921	94.8	191.9
2006	5,473,663	6,469,549	5,134	12,843	93.8	198.5
2007	5,741,961	6,737,733	5,243	13,367	91.3	198.4
2008	6,025,375	7,022,149	5,894	14,538	97.8	207.0

Table 2. Geographical variation of hip fracture incidence (per 100,000)

Geographic location	Years of study	Women	Men	Women/ Men
Beijing, RP China (18)	1990-1992	87	96	0.91
Shenyang, PR China (19)	1994	92	104	0.88
Tottori prefecture, Japan (5)	1998-2001	342	110	3.11
Hong Kong (4)	1997-1998	482	189	2.56
Singapore (4)	1997-1998	444	164	2.71
Thailand (4)	1997-1998	273	112	2.43
Malaysia (4)	1997-1998	219	88	2.49
Current study	2005	269	135	1.99
Current study	2008	286	139	2.06
The United States (22)	1989	553	193	2.87
Oslo, Norway (21)	1996-1997	922	341	2.7
Mexico City (20)	2000	260	115	2.26

Incidence figures are age adjusted to the 1990 U.S. Caucasian civilians ≥ 50 yr of age. PR, People's Republic. ( ), reference number.

respectively. In terms of the gender-specific distribution of hip fractures from 2005 to 2008, the incidence of hip fracture in women (7.8%) was more increased than that in men (3.2%) (Table 1).

The proportion of hip fracture incidence in the age-specific incidence for 10-yr age groups showed a similar pattern during the 4 yr study period. The mean age-specific incidence by 10-yr age groups increased from 18.1/100,000 for those aged 50-59 to 1,052.5/100,000 for those aged 80-100 in women and 23.8/100,000 to 605.8/100,000 in men (Fig. 1). The incidence of hip fracture with increasing age increased steeply. In terms of gender differences, although the hip fracture rates of both genders increased substantially for those older than 70 yr, the incidence of hip fracture in women increased more rapidly (Fig. 1). The fracture incidence in the population aged from 50 to 100 yr, which is age adjusted to the United States' Caucasian population in 1990, increased from 135/100,000 for men and 269/100,000 for women in 2005 to 139 for men and 286/100,000 for women in 2008 (Table 2).

Mortality following hip fracture

The cumulative mortality rate over the first 12 months post-fracture was 18.8% (3,166/16,866) in 2005 and 17.8% (3,307/18,610) in 2007 (Table 3). Using data from the year 2007, the mortality rates over the first 12 months were 21.8% (1,141/5,243) for men and 16.2% (2,166/13,367) for women, and 31% for men and 24.1% for women over the first 24 months. Thus, the mortality rate was 1.3 times higher for men than for women over 24 months of follow-up.

Age and gender adjusted SMRs for different study periods are shown in Table 4. SMRs of hip fracture was the highest during the first 3 months after the fracture, and it gradually declined, but SMR was almost twice at the 2 yr follow-up. All age groups showed the same pattern: that is, a peak at 3 months followed by a gradual decline. The highest SMRs was observed for men aged 50-59 yr and both men and women over-80 yr of age had elevated SMR at 2 yr post-fracture (Table 4).

DISCUSSION

The present study is the first nationwide, database-based, observational study of hip fracture conducted in Korea in terms of its incidence, mortality, and excess mortality. After the complete

Table 3. Cumulative mortality rate (%) for hip fractures among persons ≥ 50 yr of age in Korea for the period 2005-2007

Year	6 months			12 months			24 months		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
2005	2,204 (13.1)	730 (14.8)	1,474 (12.4)	3,166 (18.8)	1,049 (21.2)	2,117 (17.8)	4,647 (27.6)	1,559 (31.5)	3,088 (25.9)
2006	2,443 (13.6)	788 (15.3)	1,655 (12.9)	3,413 (19.0)	1,121 (21.8)	2,292 (17.8)	4,882 (27.2)	1,573 (30.6)	3,309 (25.8)
2007	2,266 (12.2)	792 (15.1)	1,474 (11.0)	3,307 (17.8)	1,141 (21.8)	2,166 (16.2)	4,851 (26.1)	1,626 (31)	3,225 (24.1)

Table 4. Average SMR adjusted by gender and age group during study periods (2005-2007)

Gender	Age (yr)	3 months		6 months		12 months		24 months	
		SMR	95% CI	SMR	95% CI	SMR	95% CI	SMR	95% CI
Men	50-59	14.21	10.55-18.73	11.94	9.53-14.79	10.97	9.31-12.85	8.69	7.65-9.83
	60-69	10.46	9.02-12.07	9.13	8.17-10.17	7.08	6.48-7.73	5.27	4.91-5.65
	70-79	7.99	7.32-8.70	6.54	6.10-6.99	4.88	4.62-5.16	3.49	3.33-3.65
	80-89	5.68	5.27-6.11	4.22	3.97-4.48	2.94	2.79-3.10	2.05	1.96-2.15
	90-100	6.93	6.58-7.30	5.49	5.27-5.72	4.05	3.92-4.19	2.93	2.85-3.02
	50-100	7.15	6.80-7.52	5.53	5.30-5.75	3.95	3.82-4.08	2.72	2.64-2.80
Women	50-59	39.38	28.01-53.84	33.83	26.22-42.97	23.27	18.76-28.54	16.51	13.85-19.53
	60-69	17.54	15.10-20.27	15.03	13.42-16.79	11.79	10.77-12.88	8.16	7.58-8.78
	70-79	7.97	7.41-8.55	6.65	6.29-7.03	5.17	4.94-5.40	3.76	3.62-3.89
	80-89	4.86	4.65-5.08	3.77	3.63-3.91	2.69	2.60-2.77	1.93	1.88-1.98
	90-100	5.78	5.57-5.99	4.62	4.49-4.76	3.42	3.34-3.50	2.49	2.44-2.54
	50-100	5.99	5.78-6.21	4.64	4.51-4.78	3.30	3.22-3.38	2.27	2.23-2.32
Total	50-59	19.74	15.85-24.29	16.75	14.19-19.65	13.67	12.02-15.49	10.42	9.4-11.50
	60-69	13.06	11.77-14.46	11.30	10.44-12.21	8.82	8.28-9.38	6.35	6.03-6.68
	70-79	7.98	7.55-8.42	6.61	6.33-6.89	5.05	4.88-5.23	3.65	3.55-3.75
	80-89	5.06	4.87-5.25	3.88	3.76-4.00	2.75	2.68-2.82	1.96	1.92-2.01
	90-100	6.12	5.94-6.30	4.88	4.77-5.00	3.61	3.54-3.68	2.62	2.58-2.66
	50-100	6.07	5.89-6.25	4.69	4.58-4.80	3.34	3.28-3.41	2.31	2.27-2.35

SMR, standardized mortality ratio; CI, confidence interval.

computerization of the claims database in 2005, HIRA data now represent a secure source of data that can be easily studied. From 2005 to 2008, the number of hip fractures increased by 21% (from 16,866 in 2005 to 20,432 in 2008) and the annual hip fracture incidence increased by 2.3% (from 147.6/100,000 to 156.6/100,000). Our data show that the age-standardized annual incidence of hip fractures was 199.4/100,000 for women and 94.5/100,000 for men in 2008. In agreement with previous studies on the incidence of hip fracture in Korea, the incidence of hip fracture has increased. Kang et al. (9) performed a cohort study using HIRA data and reported age-standardized annual incidence rates for hip fractures: 146.38/100,000 for women and 61.72/100,000 for men in 2003. Recently, Kim et al. (14) performed a cohort study using hospital based record and radiographic data and analyzed hip fracture incidence in Jeju island over a five-year period (2002-2006). They reported that the crude incidence rate of hip fractures was 174.4/100,000 for women and 66.1/100,000 for men (14). However, a higher incidence of hip fracture using HIRA data has been reported by Lim et al. (13). They reported that the age-standardized annual incidence rates of hip fracture were 262.8/100,000 for women and 151.8/100,000 for men in 2003 (13). A comparison of the three findings indicates that results of Lim et al. (13) were somewhat overestimated. In our consideration, this discrepancy emerged due to the difference in operational definition of the hip fracture using HIRA data (9, 13, 14). Lim et al.'s study was not used in the operational definition of the hip fracture but they used only on ICD code (S72.0 and S72.1). We have confirmed that the incidence of hip fracture, using only ICD codes (S72.0 and S72.1) was four times higher than the incidence of hip fracture with using the operational definition.

Rates of hip fracture in Korea that can be found in the present study are slightly higher than the rates reported by population-based studies conducted in South East Asia (Thailand and Malaysia) (4), China (18, 19), and Mexico (20), but lower than the rates reported in other Asian countries such as Japan (5), Hong Kong (4), and Singapore (4), and those in Norway (21), and the United States (22). Recently, some studies report that incidence of hip fracture in some countries such as Japan, Austria, and France shows steady or decreasing trend (23-25). However, hip fractures in Korea are projected to increase dramatically because the rate of the increase of the elderly population in Korea is greater than that of anywhere else in the world.

In this study, the cumulative mortality rate after hip fracture continued to increase throughout the study period, and the crude mortality rate in patients over 50 yr of age at 1-yr post-injury was 17.8% (21.8% in men and 16.2% in women). Although the crude mortality rate in Korean population is similar to that reported by others (7, 8, 26, 27), the crude mortality at one-year post-fracture varies due to population heterogeneity with respect to age, pre-fracture health status, socio-economic status, and mental health.

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Recently, Abrahamsen et al. (10) performed a meta-analysis of mortality after hip fracture and reviewed 1,114 studies. They reported that the crude mortality rate at one-year post-fracture ranged from 50% to 5.9% (8, 27-29).

To compare mortality after hip fracture with that in other studies, we calculated SMRs. Although direct comparisons were difficult, it was possible to compare mortalities. In our study, the SMRs of patients who were older than 50 yr were averaged at 6.1 at 3 months, 3.5 at 1 yr, and 2.3 at 2 yr post-fracture. Tsuboi et al. (8) performed a 10-yr follow-up study on hip fracture mortality in 1,169 patients who were older than 50 yr. They reported that SMRs were 2.7 at 1 yr, 2.0 at 2 yr, 1.7 at 5 yr, and 1.94 at 10 yr. Richmond et al. (26) performed an observational study on 836 hip fracture patients older than 65 yr, and reported that SMR peaked at 2.8 at 3 months post-fracture. However, excess mortality was still observed at 2 yr post-fracture with an overall SMR of 1.3 (26). Although there was a difference between their report and ours due to the nature of the study population, the trends of the two studies are similar. The reason for the higher SMR observed in this study is related to patient age, which is inversely correlated with SMR. In addition, we found that SMR is inversely correlated with cumulative crude mortality rates and that it decreases over the course of follow-up. Therefore, the present study shows that excess risk of mortality is the greatest during the immediate post-fracture period.

In this study, male mortality after hip fracture was found to be 1.4 times higher than female mortality. Other studies have reported that male mortality is about twice as high as female mortality during the first year post-fracture (9, 30). Although reports tend to differ regarding male mortality rates, this finding is consistent with other studies. In these studies, it was demonstrated that the reasons for higher male mortality are: comorbidities, higher infection rates, poor osteoporosis management, and a higher risk of postoperative complications (9, 30).

This study has some limitations. First, incidences based on insurance claims records might be underestimated. For example, hip fractures may not be diagnosed or treated by health care institutions. However, due to the emergent character of hip fracture, it requires hospitalization, and thus we believe that the incidence of hip fractures determined using claims records represents reality. In addition, contralateral hip fracture which could occur within 6 months and nonoperatively treated hip fracture such as impacted femoral neck fractures were not included. This was the other factor of underestimation.

Second, the reliance on ICD-10 diagnostic codes to identify incident fractures may have caused incident hip fractures to be misclassified. In addition, high energy injury such as fall from a height and simple greater trochanteric fracture could be included. However, we confirmed the accuracy of the diagnostic algorithm. In this study, the sensitivity of the algorithm was found to be 93.1% using diagnosis codes from HIRA claims records with respect to direct hospital based record and radiographic data.

Third, the mortality rates of hip fracture were compared with the mortality rates of an age matched general population, which included some hip fracture patients and this potentially may have caused an underestimation of excess associated mortality.

In conclusion, we have shown that the incidence of hip fracture in women showed an increasing tendency from 2005 to 2008. Considering its increasing rate in the elderly population, hip fracture is likely to become a huge socioeconomic burden in Korea. Furthermore, hip fracture has a pronounced excess mortality rate. These findings should be used to alert the general population, health institutions, and health policy decision makers to take action on reducing the incidence of hip fracture and minimizing complications after hip fracture.

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AUTHOR SUMMARY

Incidence and Mortality Following Hip Fracture in Korea

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Hip fracture is the most serious complication of osteoporosis due to its high mortality and morbidity. This medical claim data-based retrospective study demonstrates that the incidence after hip fracture has rapidly increased in Korea and that the mortality is higher for men than for women. Initiation of public health program to prevent hip fractures is requested in Korea.

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