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# Nested Case Control Study on the Risk of Suicide Death in Elderly Patients with Pelvic Fractures Using a Nationwide Cohort

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**Background:** The aim of this study was to investigate the incidence rate of suicide deaths in elderly patients with pelvic fractures using a nationwide database and to analyze change in the risk of suicide death overtime after pelvic fractures compared to controls.

**Methods:** We used the National Health Insurance Service-Senior cohort (NHIS-Senior) of South Korea. Cases and controls were matched for sex, age, history of hospital admission within 1 year, and presence of depression on the date of suicide death. Controls were collected by random selection at a 1 : 5 ratio from patients at risk of becoming cases when suicide cases were collected. Incident pelvic fractures were identified from the NHIS-Senior as follows: first admission during the observational period (2002–2015) to an acute care hospital with a diagnostic code of International Statistical Classification of Diseases and Related Health Problems, 10th revision S321, S322, S323, S324, S325, or S328 and age 65–99 years. Conditional logistic regression analysis was performed to evaluate the association between pelvic fractures and the risk of suicide death.

**Results:** A total of 2,863 suicide cases and 14,315 controls were identified. Suicide case patients had been more frequently exposed to steroids (odds ratio [OR], 1.32; 95% confidence interval [CI], 1.21–1.45), benzodiazepines (OR, 1.76; 95% CI, 1.61–1.93), and non-steroidal anti-inflammatory drugs (OR, 1.18; 95% CI, 1.07–1.29). Pelvic fractures within 1 year from the date of suicide death were statistically significantly associated with increased risk of suicide (adjusted OR [AOR], 2.65; 95% CI, 1.29–5.45; $p$ = 0.008) compared to controls. The risk of suicide death declined as the incidence date of pelvic fracture was more remote from the date of suicide death: AORs of 2.59 (95% CI, 1.33–5.04; $p$ = 0.005) within 2 years and 2.13 (95% CI, 1.15–3.95; $p$ = 0.017) within 3 years. However, there was no statistical significance in the increased risk of suicide death for pelvic fractures that had occurred ≥ 4 years ago ($p > 0.05$).

**Conclusions:** Pelvic fractures in the elderly population increased the risk of suicide death within 3 years, suggesting the need for psychiatric support among elderly patients with pelvic fractures.

**Keywords:** *Pelvic fracture, Elderly, Suicide death*

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Suicide is one of the most important heath issues in the elderly population.[1] Several reports showed that suicide rates of elderly population in many countries were higher than those of young population.[2,3] Elderly patients tend to be reticent about expressing their emotional stress, depression, or suicidal thoughts.[4] Thus, suicide in elderly patients is easy to be ignored.[2] There are various factors that

increase suicide, and physical diseases that cause chronic pain, disability and dependency, and high costs for treatment are also one of the major factors.[5]

As the elderly population increases, the socioeconomic burden for osteoporotic fractures is a challenging issue in developed countries.[6,7] Although fragility pelvic fractures are not considered as a major osteoporotic fracture, it is reported that the incidence of elderly pelvic fractures is increasing.[6] Articles on clinical outcomes after treatment of pelvic fractures have reported that pelvic fractures are associated with considerable morbidity, high mortality rates, and significant costs.[8,9] In addition, even after fracture recovery, it is reported that patients suffer from chronic pain, limited mobility, and sexual dysfunction, and the quality of life is reduced.[10,11] Therefore, it seems natural for these patients to develop psychosocial problems. McMinn et al.[11] reported there was a high risk of mental disorders such as depression, alcohol use, and posttraumatic stress syndrome in patients with pelvic fractures.

We hypothesized that this painful situation could increase the risk of suicide death in elderly patients. Most reports on suicide-related pelvic fractures were focused on the type of pelvic fractures or clinical outcome after treatment.[12,13] Although Chang et al.[14] reported that the risk of suicide was twice as high after pelvic fractures, this study was conducted in patients over 40 years of age and included very high traumatic injuries, which are different from elderly pelvic fractures. Also, they did not suggest the incidence rate of suicide death in elderly patients with pelvic fractures.

The purpose of this study was to investigate the incidence rate of suicide in elderly patients with pelvic fractures in a nationwide cohort and to analyze the change in the risk of suicide over time after pelvic fractures in comparison with controls.

## METHODS

The protocol and design of our study were approved by the Institutional Review Board of Daejeon Eulji Medical Center (IRB No. 2020-07-035). Written informed consent was waived for all patients involved in this study.

### Data Source

We conducted a retrospective, nested case-control study that can eliminate immortal time bias and various confounding factors from the analysis of the antecedents of disease (case, suicide death) in the National Health Insurance Service-Senior cohort (NHIS-Senior) of Korea. The NHIS established claims databases that store all medical records of long-term care and healthcare services.[15,16] The NHIS-Senior consists of 558,147 people selected by 10% simple random sampling method from 5.5 million subjects aged 60 years and over in 2002.[16] Due to the compulsory medical insurance program of South Korea, all subjects could be followed up until 2015, except for instances of death or emigration.[16,17] The variables in the NHIS-Senior include all outpatient and inpatient medical claims data such as codes for diagnoses, prescriptions, and treatment procedures.[17,18]

### Case and Control Selection

Because South Korean law requires death certificates to be reported to Korea Statistics, information on death (cause and date) was collected from the agency and connected using individual identification numbers.[16,17] Suicide death (case) was identified as a set of deaths categorized under "X60 to X84" (Intentional Self-Harm, International Statistical Classification of Diseases and Related Health Problems, 10th revision [ICD-10] codes). The time of suicide was defined as the date of death by suicide (index date).

Case patients and control patients were matched based on age, sex, past history of hospital admission within 1 year and presence of depression, all of which are factors closely related to suicide risk. Then, controls were randomly selected at a 1 : 5 ratio from the set of individuals who were at risk of becoming cases at the time point when suicide cases were selected. Patients excluded during case selection were excluded from the risk set.

### Incident Pelvic Fractures

According to the methods of previous studies, incident pelvic fractures were identified from the NHIS-Senior as follows:[19] (1) first admission during the observational period (2002 to 2015) to an acute care hospital, and (2) pelvic fractures according to the ICD-10 codes (S321, fracture of sacrum; S322, fracture of coccyx; S323, fracture of ilium; S324, fracture of acetabulum; S325, fracture of pubis; and S328, fracture of other and unspecified parts of lumbar spine and pelvis). To eliminate the possibility of incomplete information, patients in the Medical Aid program were excluded. Also, patients under the age of 65 years or over the age of 99 years were excluded. The incidence date of pelvic fracture was defined as the date of admission to an acute care hospital that fulfilled the inclusion criteria.

### Statistical Analyses

The incidence rate of suicide (per 100,000 person-years) and 95% confidence interval (CI) among patients with

pelvic fractures were estimated by a generalized linear model (with Poisson distribution). Association between pelvic fractures and the risk of suicide death was evaluated by conditional logistic regression analysis. The adjusted odds ratios (AORs) and 95% CIs were calculated. Besides the matching variables in the nested case-control study design, confounders that we adjusted for were medication history (antidiabetic agents, anti-hypertensive agents, benzodiazepines, opioids, lipid-lowering agents, steroids, anti-rheumatic agents, and non-steroidal anti-inflammatory agents [NSAIDs], Cox-2 inhibitors, anti-platelet agents, anti-Parkinson medication, anti-Alzheimer medication, aspirin, anti-epileptic drugs, warfarin, and anti-psychotic drugs), past medical history (ischemic heart disease, neoplasm, stroke, depression, and chronic kidney disease), Charlson comorbidity index (CCI), number of outpatient visits, and socioeconomic variables (household income level, residential area, and registered disability), and the calendar year of suicide. Each subject's number of comorbidities was assessed by diagnostic codes using an ICD-10 coding algorithm of the CCI score suggested by Quan.[20] History of depression was defined as any prescription of antidepressants or presence of diagnostic code for depression within 1 year. History of opioid medication was classified by prescription days. Prescription of over 28 days for other medications was considered for the patients who had taken corresponding medications. Statistical significance was considered as a $p$-value < 0.05. SAS version 7.1 (SAS Institute, Cary, NC, USA) was used for all statistical analyses.

## RESULTS

We identified a total of 5,198 patients with pelvic fractures from 2002 to 2015 (Table 1). The incidence rate of suicide deaths in elderly pelvic fracture patients during the whole observational period was 128.1 per 100,000 person-years (95% CI, 87.2–188.3). Especially, the incidence rate of suicide deaths was the highest at 285.3 per 100,000 person-years within 1 year after pelvic fractures.

Among the whole subjects of the NHIS-Senior, 2,863 suicide cases and 14,315 control patients were identified (Table 2). The two groups had similar distributions regarding the matching variables, including sex, age, past history of hospital admissions, and depression at the index date. The suicide cases had more neoplasm (odds ratio [OR], 1.44; 95% CI, 1.24–1.69) and stroke (OR, 1.18; 95% CI, 1.02–1.37). The suicide case patients had been more frequently exposed to steroids (OR, 1.32; 95% CI, 1.21–1.45), benzodiazepines (OR, 1.76; 95% CI, 1.61–1.93), and NSAIDs (OR, 1.18; 95% CI, 1.07–1.29).

Pelvic fractures within 1 year from the index date was statistically significantly associated with the increased risk of suicide (AOR, 2.65; 95% CI, 1.29–5.45; $p = 0.008$), compared to controls (Table 3). The risk of suicide death declined as the incidence date of pelvic fractures from the index date was more remote: AORs of 2.59 (95% CI, 1.33–5.04; $p = 0.005$) for pelvic fractures within 2 years and 2.13 (95% CI, 1.15–3.95; $p = 0.017$) for pelvic fractures within 3 years. However, there was no statistical significance in the increased risk of suicide death for pelvic fractures that had occurred within 4 years or earlier ($p > 0.05$).

## DISCUSSION

The main findings of our study are as follows: First, the incidence rate of suicide death in elderly patients with pelvic fractures was 128.1 per 100,000 person-years during the whole observational period. Second, the incidence rate of suicide death was the highest within 1 year after fracture (285.3 per 100,000 person-years). The risk of suicide death after pelvic fractures increased up to 3 years after fracture,

**Table 1.** Incidence Rates of Suicide Death in Elderly Patients with Pelvic Fractures

| Exposure | No. of patients | No. of suicide deaths | Person-years | Incidence rate (95% CI) per 100,000 person-years |
|---|---|---|---|---|
| 0–1 yr | 5,198 | 13 | 4,543.0 | 285.3 (165.6–491.4) |
| 1–2 yr | 4,053 | 4 | 3,658.2 | 109.0 (40.9–290.4) |
| 0–2 yr | 5,198 | 17 | 8,201.2 | 206.9 (128.6–333.0) |
| 2–3 yr | 3,296 | 1 | 2,934.7 | 34.0 (4.8–241.2) |
| 0–3 yr | 5,198 | 18 | 11,135.9 | 161.43 (101.7–256.3) |
| Whole period | 5,198 | 26 | 20,279.8 | 128.1 (87.2–188.3) |

CI: confidence interval.

**Table 2.** Baseline Characteristics of the Sample

| Characteristic | Suicide case (n = 2,863) | Control (n = 14,315) | Crude OR (95% CI) |
|---|---|---|---|
| Age (yr) | 76.75 ± 6.89 | 76.75 ± 6.89 | Matched |
| 65–69 | 453 (15.82) | 2,265 (15.82) | |
| 70–74 | 759 (26.51) | 3,795 (26.51) | |
| 75–79 | 710 (24.80) | 3,550 (24.80) | |
| 80–84 | 524 (18.30) | 2,620 (18.30) | |
| ≥ 85 | 417 (14.57) | 2,085 (14.57) | |
| Sex | | | Matched |
| Male | 986 (34.44) | 4,930 (34.44) | |
| Female | 1,877 (65.56) | 9,385 (65.56) | |
| Household income level | | | 0.92 (0.90–0.95) |
| Low | 523 (18.27) | 2,317 (16.19) | |
| Mid–low | 372 (12.99) | 1,646 (11.50) | |
| Middle | 428 (14.95) | 1,869 (13.06) | |
| Mid–high | 581 (20.29) | 2,696 (18.83) | |
| High | 959 (33.50) | 5,787 (40.43) | |
| Residential area | | | 1.22 (1.12–1.32) |
| Metropolitan | 991 (34.61) | 5,596 (39.09) | |
| Non-metropolitan | 1,872 (65.39) | 8,719 (60.91) | |
| Registered disability | 47 (1.64) | 249 (1.74) | 0.94 (0.69–0.30) |
| Calendar year | | | Matched |
| 2002–2005 | 609 (21.27) | 3,045 (21.27) | |
| 2006–2009 | 667 (23.30) | 3,335 (23.30) | |
| 2010–2012 | 798 (27.87) | 3,990 (27.87) | |
| 2013–2015 | 789 (27.56) | 3,945 (27.56) | |
| Charlson comorbidity index score | | | 1.11 (1.08–1.15) |
| 0 | 1,200 (41.91) | 6,734 (47.04) | |
| 1 | 784 (27.38) | 3,838 (26.81) | |
| 2 | 430 (15.02) | 1,909 (13.34) | |
| 3 | 225 (7.86) | 989 (6.91) | |
| 4 | 95 (3.32) | 401 (2.80) | |
| ≥ 5 | 129 (4.51) | 444 (3.10) | |
| Past history of hospital admissions | 1,307 (45.65) | 6,535 (45.65) | Matched |

**Table 2.** Continued

| Characteristic | Suicide case (n = 2,863) | Control (n = 14,315) | Crude OR (95% CI) |
|---|---|---|---|
| No. of outpatient visits | | | 1.15 (1.11–1.19) |
| 0 | 121 (4.23) | 729 (5.09) | |
| 1–9 | 562 (19.63) | 3,018 (21.08) | |
| 10–19 | 681 (23.79) | 3,865 (27.00) | |
| 20–29 | 473 (16.52) | 2,629 (18.37) | |
| ≥ 30 | 1,026 (35.84) | 4,074 (28.46) | |
| Past medication history | | | |
| Anti-hypertensive agent | 1,805 (63.05) | 8,792 (61.42) | 1.08 (0.99–1.18) |
| Anti-diabetic agent | 572 (19.98) | 2,774 (19.38) | 1.04 (0.94–1.15) |
| Lipid lowering agent | 677 (23.65) | 3,849 (26.89) | 0.82 (0.74–0.91) |
| Steroid | 1,170 (40.87) | 5,044 (35.24) | 1.32 (1.21–1.45) |
| Benzodiazepine | 1,833 (64.02) | 7,609 (53.15) | 1.76 (1.61–1.93) |
| Opioid (prescription day) | | | 1.10 (1.06–1.14) |
| 0 < day ≤ 14 | 602 (21.03) | 3,154 (22.03) | |
| 15 < day ≤ 30 | 347 (12.12) | 2,035 (14.22) | |
| 31 < day ≤ 60 | 371 (12.96) | 2,083 (14.55) | |
| > 61 day | 1,257 (43.91) | 5,491 (38.36) | |
| Anti-rheumatic agent | 36 (1.26) | 155 (1.08) | 1.17 (0.81–1.68) |
| Non-steroidal anti-inflammatory agent | 1,868 (65.25) | 8,924 (62.34) | 1.18 (1.07–1.29) |
| Cox-2 inhibitor | 249 (8.70) | 1252 (8.75) | 0.99 (0.86–1.15) |
| Anti-platelet | 1,253 (43.77) | 6,431 (44.92) | 0.95 (0.87–1.03) |
| Parkinson medication | 129 (4.51) | 516 (3.60) | 1.28 (1.04–1.57) |
| Alzheimer medication | 122 (4.26) | 896 (6.26) | 0.63 (0.52–0.78) |
| Aspirin | 1,121 (39.15) | 5,766 (40.28) | 0.95 (0.87–1.04) |
| Anti-epileptic drug | 273 (9.54) | 1,161 (8.11) | 1.21 (1.05–1.40) |
| Warfarin | 67 (2.34) | 369 (2.58) | 0.91 (0.70–1.18) |
| Anti-psychotic drug | 1,121 (39.15) | 5,766 (40.28) | 0.95 (0.87–1.04) |
| Past medical history | | | |
| Neoplasm | 238 (8.31) | 867 (6.06) | 1.44 (1.24–1.69) |
| Ischemic heart disease | 256 (8.94) | 1,374 (9.60) | 0.92 (0.80–1.06) |
| Stroke | 252 (8.80) | 1,088 (7.60) | 1.18 (1.02–1.37) |
| Chronic kidney disease | 43 (1.50) | 199 (1.39) | 1.08 (0.78–1.51) |
| Depression | | | Matched |
| Diagnosis and medication | 11 (0.38) | 55 (0.38) | |
| Medication only | 707 (24.69) | 3,535 (24.69) | |

Values are presented as mean ± standard deviation or number (%) unless otherwise indicated.
OR: odds ratio, CI: confidence interval.

**Table 3.** Increased Risk of Suicide in Elderly Patients after Pelvic Fractures

| Exposure | No. of pelvic fractures | | Crude OR (95% CI) | *p*-value | Adjusted OR (95% CI) | *p*-value |
|---|---|---|---|---|---|---|
| | Suicide case (n = 2,386) | Control (n = 14,315) | | | | |
| Within 1 yr | 12 (0.42) | 23 (0.16) | 2.65 (1.31–5.37) | 0.007 | 2.65 (1.29–5.45) | 0.008 |
| Within 2 yr | 14 (0.49) | 27 (0.19) | 2.63 (1.37–5.04) | 0.004 | 2.59 (1.33–5.04) | 0.005 |
| Within 3 yr | 15 (0.52) | 36 (0.25) | 2.10 (1.15–3.85) | 0.017 | 2.13 (1.15–3.95) | 0.017 |
| Within 4 yr | 16 (0.56) | 45 (0.31) | 1.79 (1.01–3.17) | 0.047 | 1.77 (0.99–3.18) | 0.055 |
| Within 5 yr | 16 (0.56) | 51 (0.36) | 1.58 (0.90–2.77) | 0.114 | 1.52 (0.86–2.70) | 0.151 |
| Whole period | 22 (0.77) | 68 (0.48) | 1.63 (1.01–2.65) | 0.048 | 1.55 (0.95–2.54) | 0.082 |

Values are presented as number (%) unless otherwise indicated.
OR: odds ratio, CI: confidence interval.

and the highest was 2.65 times within 1 year after fracture.

In one study surveying suicide of elderly patients with spinal fractures in a nationwide cohort, the incidence rate of suicide death was 116 per 100,000 person-years in the whole follow-up period and 156 per 100,000 person-years within 1 year after fracture.[21] Also, Jang et al.[22] reported that the incidence rate of suicide death in elderly patients with hip fractures was approximately 207 per 100,000 person-years within 1 year after fracture. In our study, incidence rates of suicide death in elderly patients with pelvic fractures were 128.1 per 100,000 person-years during the whole follow-up period and 285.3 per 100,000 person-years within 1 year. We noted that the suicide death rate of patients with pelvic fractures was not lower than that of patients with other fractures and diseases. In particular, the incidence rate of suicide death was the highest within 1 year after fracture in patients with pelvic fractures.

Changes in the risk of suicide death overtime seem to reflect the characteristics of each disease or injury. In cancer patients, the risk of suicide death increased within 1–3 years after diagnosis and then decreased.[23,24] However, when cancer recurs, the risk of suicide death has been reported to increase again. Elderly patients with hip fractures had a mortality rate of 20%–30% within 1 year, and since the surviving patients were healthy or in a well functional state, the risk of suicide death did not increase after 1 year.[22] Since spine fractures tend to recur in multiple spine bones, a previous report showed the risk of suicide death increased during the entire follow-up period.[21] In our study, the risk of suicide death after pelvic fractures increased up to 3 years after fracture, and the highest was 2.65 times within 1 year after fracture. A comparative study of pelvic fractures and femoral neck fractures in patients over 70 years of age by Reito et al.[25] showed that mortality and readmission rates of pelvic fracture patients were as high as those of patients with hip fractures. However, compared to hip fractures, pelvic fractures can be treated conservatively for nondisplaced fractures, so the percentage of patients undergoing surgery is low. Therefore, recovery of ambulation ability is very slow due to muscle weakness caused by bed rest after fracture and complications from fracture seem to chronically affect patients compared to hip fracture patients. Thus, it is thought that the suicide rate is higher for a longer period than that in hip fracture patients. Compared to spine fracture patients, pelvic fracture patients have higher mortality, so it is not considered that the increased risk of suicide death was maintained over a long period of time.

There are several limitations in this study. First, the treatment and diagnostic codes of the inclusion criteria could not represent the real status of a patient's disease or trauma and it is a fundamental limitation of insurance claims database. However, the incidence of elderly pelvic fractures could be ascertained because all hospitals followed the fee-for-service system and all treatment and operational procedures were claimed. Additionally, the NHIS-Senior has a large sample size with a very low follow-up loss rate over 13 years due to the nature of the national administration data and represents the total population over 60 years of age in South Korea. Thus, we believe that it represents all elderly pelvic fracture patients in South Korea. Second, we could not analyze the causative factors of suicide in the elderly with pelvic fractures. Third, we could not consider the severity of pelvic fractures or use of surgical treatment for pelvic fractures in our analysis. Further studies on these factors and effects of socioeconomic and political support on reducing suicide

rates are needed. In conclusion, we found that pelvic fractures in elderly patients increased the risk of suicide death within 3 years after fracture. This result implies the need for psychiatric support among elderly patients with pelvic fractures.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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