CLINICAL ARTICLE

Current Incidence and Future Projection of Periprosthetic Fractures in South Korea: A Study Based on National Claim Database

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Abstract

Objective: To evaluate the current incidence and economic cost and to estimate the future burden of periprosthetic fracture (PF) after joint arthroplasties in South Korea.

Methods: This study was a retrospective registry-based study of patients who were diagnosed as periprosthetic fractures (PFs) in South Korea. Cases of PF from 2010 to 2017 in South Korea using Health Insurance and Review and Assessment (HIRA) database, which contains all medical claims for all South Korean patients, were identified. The operational definitions of PFs were identified from the Electronic Data Interchange (EDI) code of the Korean National Health Insurance Program (KHNIP). The annual incidence and medical costs during the period were calculated and the future increase of PF and its cost were projected through 2030 using generalized linear model with quasi-poisson link.

Results: During the 8-year period, 14,456 patients were treated due to PFs. The annual number of patients with PF remarkably increased from 1,322 in 2010 to 2,636 in 2017. The increment was prominent in age groups of 70–79 and ≧80. Total number of patients with PF were 9752 in women and 4704 in men during the study period. Mean personal costs were 1,155.4 USD in women and 1,185.5 USD in men. The total cost of PFs increased from 779,533 USD in 2010 to 3,888,402 USD in 2017. The personal cost of PFs also increased from 589.7 USD in 2010 to 1,475.1 USD in 2017. In 2017, the number of PF patients exponentially increased after 50 years of age especially in women. Estimated with our projection model, the number of PFs will increase by 2.5 times and the cost will increase by 10 times in the next 10 years.

Conclusion: The incidence and cost of PFs are rising and will represent a serious socioeconomic burden in South Korea.

Key words: Arthroplasty; Epidemiology; Incidence; Periprosthetic fractures; Republic of Korea

Introduction

Periprosthetic fractures (PFs) are fractures which occur around prosthesis after joint replacement arthroplasty. Along with the increase of life expectancy and the number of joint arthroplasties, the number of PFs is increasing worldwide[1]. Among patients undergoing hip arthroplasty, 0.8% to 2.4% will suffer a PF within 5 years after the procedure[2–6]. Periprosthetic fractures are associated with significant morbidity and mortality. These fractures frequently require surgical management and cause a serious financial burden[5,7–9]. Not only do these PFs

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normally require surgery, but the difficulty of the required surgeries is a challenge to orthopaedic surgeons[10]. Arthroplasty surgeons have made various efforts to prevent the PFs during the primary arthroplasty and evaluate the risks of PFs in the follow-up[11–13]. It has been suggested that age, gender, use of corticosteroids, poor bone quality, number of previous surgeries, stiff joints, neurological comorbidities, inflammatory arthropathy, and type of implants used in primary arthroplasties could increase the risk of PFs[2,4,6,14–17]. Prior to finding out the risk factors and figuring out whether it is controllable, the precise evaluation of incidence and burden of PFs is crucial.

The most common types of currently performed arthroplasty surgeries are total hip arthroplasty (THA) and total knee replacement (TKR). Therefore, PFs following these two types of total joint arthroplasties are most common among the PFs as well. Since most of these PFs after the arthroplasty in lower limbs would disable the capability to walk, they would cause higher morbidity and graver prognosis compared to PFs in upper limbs. Traditionally, the incidence of these two most common PFs are known as 1% after primary THA, 4% after revision THA, and 2% after TKA[4].

There have been several studies on the incidence, morbidity, mortality, and medical cost of PF from the USA, Scotland, and Scandinavian countries[5,6,18–20]. The trend of PF incidence was quite different among the studies. While some studies reported an increase of PF incidence, the incidence decreased in other studies. Thus, it is not clear whether the incidence of PF is increasing. To date, national burden of PF has not been reported from East Asia. Furthermore, to our knowledge, the future burden of PFs has not been studied despite the significant socioeconomic problem and severe morbidity.

Therefore, the purpose of this study was (i) to evaluate the current incidence and economic cost of PF and (ii) to estimate the future burden of PF in South Korea.

Methods

Data Sources

This study was a retrospective registry-based study of patients who were diagnosed as periprosthetic fractures in South Korea. Periprosthetic fractures were identified from the Electronic Data Interchange (EDI) code of the KNHIP, the principal codes of diagnoses and procedures in the HIRA database. From 2010 to 2017, all patients who had the code of PF (ICD-10 (M966)) as primary diagnosis were selected.

The Health Insurance and Review and Assessment (HIRA) database includes medical claims for all South Korean citizens. In South Korea, 97% of the population is legally obliged to enroll in the Korean National Health Insurance Program (KNHIP) and the remaining 3% are covered by a medical aid program. Thus, almost all information about claims of South Korean patients is available from the HIRA database, which has been used for nationwide epidemiological studies[21–23].

Current Burden of Periprosthetic Fractures

The annual number of patients with a diagnosis of PF was identified during a period from 2010 to 2017. The patients were divided into groups according to their age (subdivided into 10-year increments) and gender.

Total and personal costs for the treatment of PF were also evaluated during the study period.

Future Projection of Periprosthetic Fractures

The annual frequency and medical cost of PF was predicted through 2030.

In order to adjust the confounding effect of changing numbers of the general population in the future, the age and sex distributions of the entire South Korean population over the study period and the projections through 2030 were obtained from the web site KOSIS (http://www.kosis.kr), which is run by the Central Government Organization for Statistics[24].

Statistical Analysis

A quasi-poisson regression was used to predict the annual frequency and medical cost of PF through 2030[25]. The quasi-poisson regression model was given by the following formula.

$$\mathrm{Log}\left(E\left(y_m\right)\right) = \alpha + \beta year_m(df=7) + \gamma sex + \delta age(df=7) + offset(\log(population))$$

where m is the month of surgery; $E(y_m)$ is an expected count of annual surgery procedure; α is intercept; β,γ,δ are coefficients of variables. Census of Korea was set as an offset that adjusted the confounding effect from oscillating number of people in time-series data. All data and statistics were analyzed by using R software (version 3.5.3)[26].

Results

Current Burden of Periprosthetic Fractures

From 2010 to 2017, 14,456 PF patients were identified in South Korea (Table 1). The demographic characteristics of the PF patients are summarized in Table 2. The annual

TABLE 1 Number of patients who had periprosthetic fractures in South Korea from 2010 to 2017

Cost	2010	2011	2012	2013	2014	2015	2016	2017
Number of periprosthetic fractures	1,322	1,425	1,391	1,414	1,727	2,059	2,482	2,636
Total cost (USD)	779,533	992,309	1,218,582	1,435,815	2,133,629	2,765,132	3,630,445	3,888,402
Personal cost (USD)	589.7	696.4	876	1015.4	1235.5	1342.9	1462.7	1475.1

TABLE 2 Demographic characteristics of patients who had periprosthetic fractures in South Korea from 2010 to 2017

	Periprosthetic fractures	Total cost (USD)	Personal cost (USD)
Total	14,456	16,843,846	1165.2
Gender			
Female	9,752	11,267,075	1155.4
Male	4,704	5,576,772	1185.5
Age (years)			
10–19	87	74,012	850.7
20–29	152	129,301	850.7
30–39	220	176,673	803.1
40–49	384	428,843	1,116.8
50–59	1,130	833,660	737.8
60–69	2,934	2,762,124	941.4
70–79	5,994	6,701,578	1,118
≧80	3,555	5,737,656	1,614

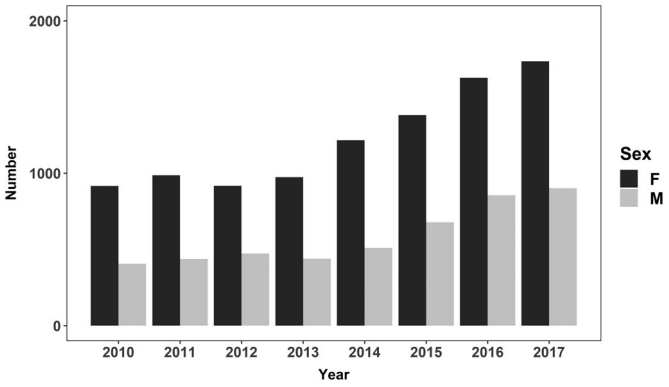

Fig. 1 Number of patients with periprosthetic fracture in South Korea from 2010 to 2017.

number of PF patients increased in both genders during the study period (Figure 1). Total cost and personal cost also increased during the study period (Figure 2A,B). The

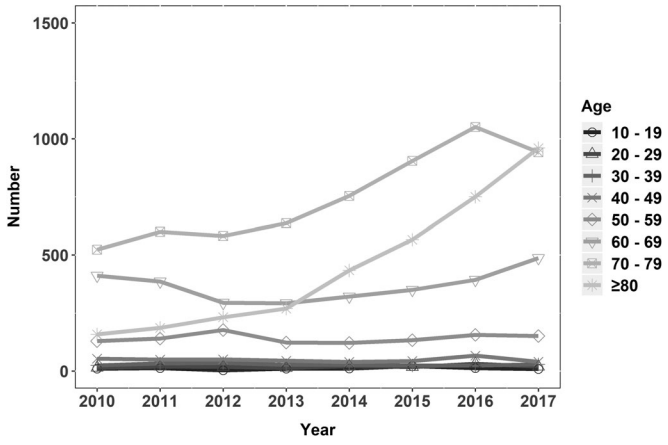

Fig. 3 Number of patients with periprosthetic fractures stratified by age group from 2010 to 2017.

increment was prominent in age groups of 70–79 and ≧80 (Figure 3). In 2017, the number of PF patients exponentially increased after 50 years, especially in women (Figure 4).

Future Projection of Periprosthetic Fractures

The projection model predicted that the number PF patients will increase by 2.5 times (Fig. 5), and total cost for PF will increase by 10 times in the next 10 years (Fig 6).

Discussion

Burden of Periprosthetic Fractures

The number of patients with PF has increased from 1,322 in 2010 to 2,636 in 2017 in South Korea and is projected to increase through 2030 by 2.5 times in this study.

Overall cost for PF treatment has increased from 779,533 to 3.888.402 USD and is predicted to increase by 10 times during next 10 years.

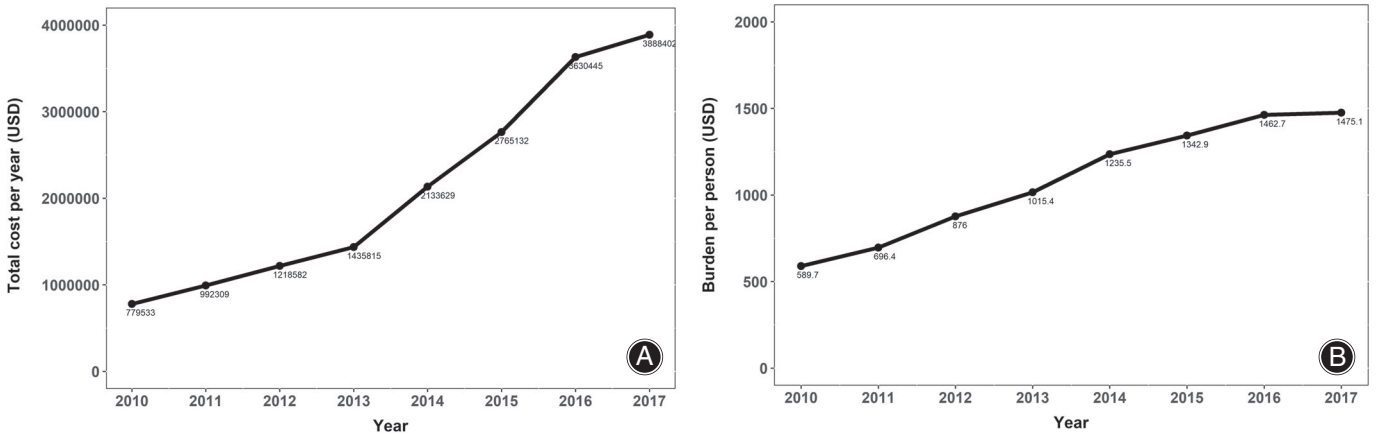

Fig. 2 (A) Total cost of treatment for periprosthetic fracture in South Korea from 2010 to 2017. (B) Personal cost of treatment for periprosthetic fracture in South Korea from 2010 to 2017.

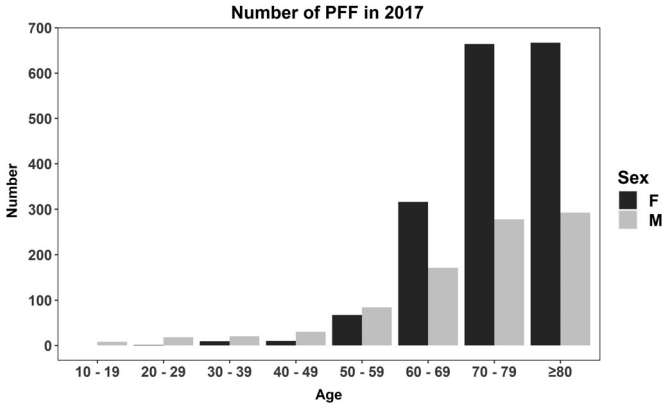

Fig. 4 Number of patients who had periprosthetic fracture in each age group in 2017.

To date, several studies from western countries reported the trends related to the frequency and hospital charges of PF, especially after hip arthroplasty. However, the results were different among the studies (Table 3).

An epidemiologic study using US Nationwide Inpatient Sample (NIS) analyzed the trend of PF frequency and showed that number of admissions due to PF after THA remained stationary from 2006 to 2010[18].

Another study based on Scottish national registry data investigated the incidence of PF after THA and TKR over a 10-year period from 1997 to 2008. In that study, the number of revision surgeries due to PF remained relatively stable during the study period[6].

However, a study from the Finnish Arthroplasty Register reported a decrease of PF incidence. The authors calculated separately the PF incidence for the years 1990–1994 and 1995–1999. The incidence in the second period (15.43 [*CI* = 9.14–26.05] per 100,000 person years) was lower than in the first (20.45 [*CI* = 13.93–30.04] per 100,000 person years)[19].

On the contrary, several studies have recently reported an increase in the incidence of PF.

Pivec *et al.* estimated the incidence of PF following THA based on 12 national joint registries data and created a projection model to predict the future PF burden. In the United States, the mean incidence of postoperative PFs requiring revision was 0.8%. They expected the number of PFs would rise steadily by mean 4.6% every decade over the next 30 years[8].

Thien *et al.* evaluated the incidence of PF after THA using the Nordic Arthroplasty Register Association database. The risk for revision due to early PF increased during the 2003 to 2009 period compared with the 1995 to 2002 period (relative risk, 1.44 [95% *CI*, 1.18 to 1.69]; $P < 0.0005$). The incidence of revision due to PF within postoperative 2 years was 0.47% for cementless stems and 0.07% for cemented stems[27].

Cause of the Increase in the Burden of Periprosthetic Fractures

Reportedly, there is a regional difference in the PF incidence. The difference might be related to the type of prostheses, fixation method (cemented *vs* cementless) and demographic characteristics in each country.

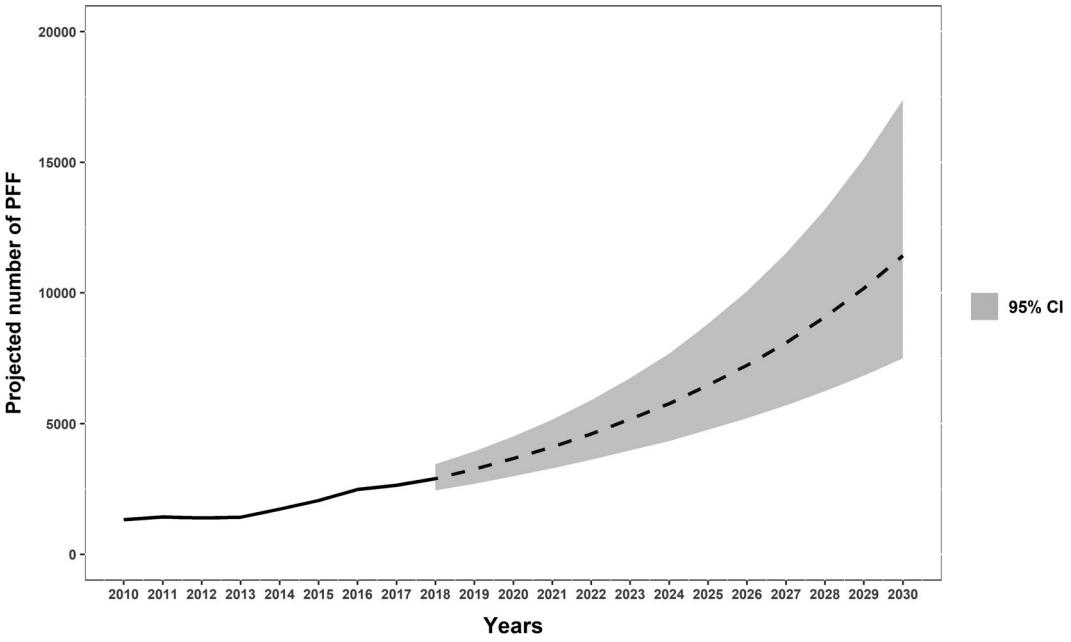

Fig. 5 Projected number of patients who have periprosthetic fracture.

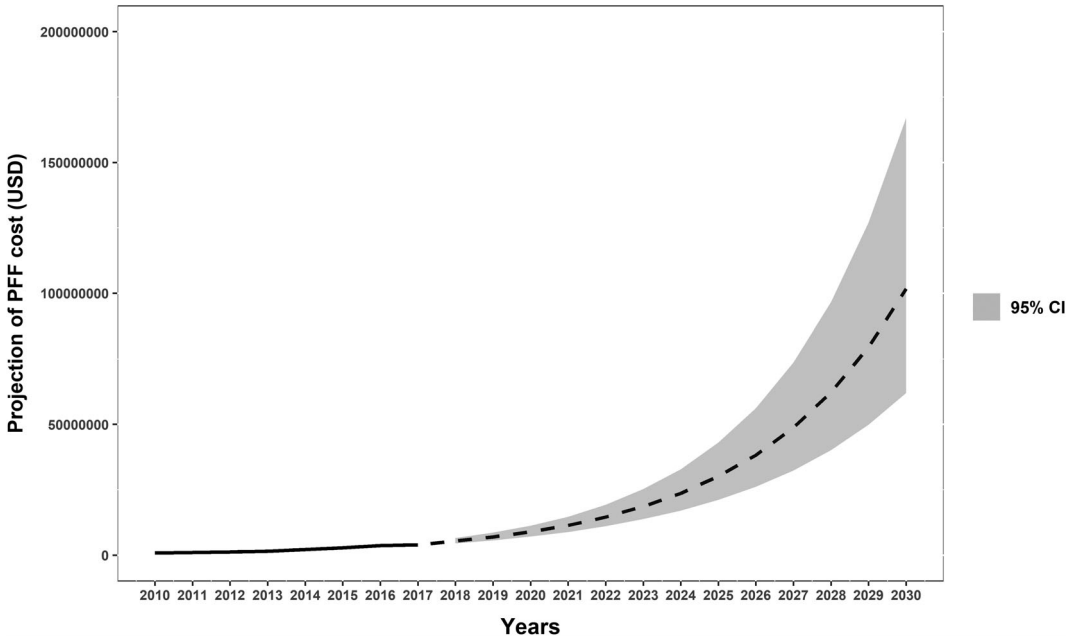

Fig. 6 Projected total cost of treatment for periprosthetic fracture.

TABLE 3 Periprosthetic fractures in previous studies

Authors	Country	Study period	Number of PF	Economic cost
Cox *et al.*[18]	USA	2006–2010	Stationary	Increased
Meek *et al.*[6]	Scotland	1997–2008	Stable	NA
Sarvilinna *et al.*[19]	Finland	1990–1999	Decreased	NA
Thien *et al.*[27]	Norway	1995–2009	Increased	NA
Lindahl *et al.*[20]	Sweden	1979–2000	Increased	NA

Abbreviations: NA, not applicable; PF, periprosthetic fracture.

Cementless hip fixation is associated with higher rate of PF compared to cemented fixation. However, on-table and very early postoperative death, so called bone cement implantation syndrome (BCIS), is implicated with cemented fixation[28,29].

During the past decade, cementless fixation has been increasingly used in hip arthroplasty due to BCIS risk of cemented stems[17]. This indicated an increase in utilization of cementless femoral fixation for THA and hemiarthroplasty despite the association between cementless fixation and risk of PF.

In the current study, the number and economic burden of PFs increased during the last 8 years. This increase seems to be related to aging of our population, increase in the number of joint arthroplasties, and popular use of cementless stems in South Korea.

The features of PFs closely resemble those of osteoporotic fractures, especially in higher occurrence and morbidity in the elderly population[30]. In our study, 86% of periprosthetic fracture patients from 2010 to 2017 were older than 60 years of age. Many anti-osteoporosis medications have been reported to be clinically effective in preserving periprosthetic bone mineral density, and thus effective in preventing PFs[31–34]. This suggests that patient education including fall prevention as well as anti-osteoporotic medication could be an option for prevention of PFs, particularly in the elderly patients.

Limitations

A de-identified database was used in this study. Thus, we could not identify the type of arthroplasty (THA, TKA, or arthroplasty of other joints) and the associated risk factors for PF.

In spite of these limitations, this is the first nationwide study on the future projection as well as the current trends of PF in East Asia.

Conclusion

The number of PFs and cost for treatment have risen and will be steadily rising, and PF will lead to a serious burden on the healthcare system. Further consideration to prevent PF after arthroplasty is urgently warranted.

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